unavoidably through a natural gas pipeline.

4.3.2. System Analysis for the Palo Seco Power Plant in Toa Baja

The annual rental cost would be some $70 to $80 million dollars. The power plant does not have available space to locate the CNG receiving terminal. It is estimated that the time required to make the system operational, in compliance with all the applicable state and federal legislation, will be between 5 and 8 years. The permits process is complicated and costly. In the area of the Palo Seco Power Plant there are low-income communities near the project which could be affected, for which reason in an environmental justice analysis the project would probably not be favored. The Palo Seco Power Plant is in the vicinity of CAPECO where there was an explosion on October 23, 2009 that affected the nearby communities, a situation that is still very recent in their memories and could support the opposition's position, even if it is an allegation lacking in merit. Another aspect which must be taken in consideration during the analysis of this option is the fact that the energy of the Atlantic Ocean is significant, which possibly would require specialized construction techniques for the mono-buoy system in said area. The construction of this alternative would have an environmental impact on the Boca Vieja Bay. For all the reasons set forth above, the construction of the system for the Viejo Power Plant within the time frame required for the action under As a consequence, the supply of natural gas to dably through a natural gas pipeline.

4.3.3. [illegible] for the Cambalache Power Plant in Arecibo

The annual rental cost would be some $70 to $80 million dollars. The power plant does ace to locate the CNG receiving terminal. It is estimated that the the system operational, in compliance with all the applicable 5 to 8 years. The permits process is complicated and cost mmunities near the project that could be affected, for which re mental justice analysis the project would probably not be favored. Anothe at must be taken in consideration during the analysis of this option is the faci he energy of the Atlantic Ocean is significant, which would probably require spec zed construction techniques for the mono-buoy system in said area. As a point of reference, at present the delivery of fuel to the Cambalache facility owned by PREPA is affected by marine conditions an average of 3 to 4 months a year, this supports the facts and concerns previously expressed. For all the reasons set forth above, the construction of the system for the Cambalache Power Plant within the time frame required for the action under consideration was discarded. As a consequence, the supply of natural gas to this power plant will have to be inevitably through a natural gas pipeline.

Neither can the system interfere with international navigation and other reasonable uses of the high seas, as defined in treaties, agreements or in the customary international law. At the state level the authorization of the governor of the state adjacent to the project is required.

The public must be kept informed of the whole process by means of the Federal Register and through the publication of all the related documents in the Federal Docket Management System: www.regulations.gov. In addition, processes under NEPA, as well as the state processes, provide for holding public hearings through which citizen participation is assured, similar to the processes established by the Environmental Quality Board in the applicable regulations (which are designed as what is denominated as a "NEPA- like process").

The environmental impacts of this alternative are similar to those analyzed for the previous alternative. Despite not having to dredge to permit accommodating the great draft of the tankers, a submarine line would have to be built from the buoy to the CNG tank and that would have an impact on an ecologically sensitive area such as the San Juan Bay and its estuary, or in the north coast areas which are considered as critical habitat for five species of coral in danger of extinction, such as the acropora.

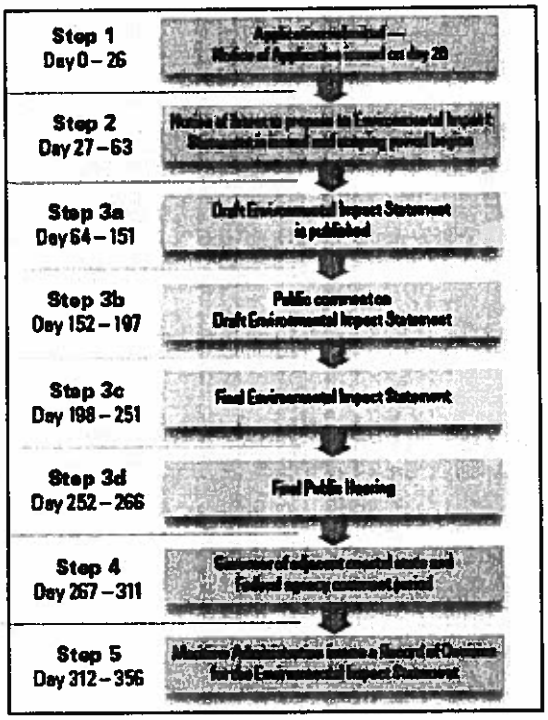
PREPA evaluated the viability of the construction of these systems in three areas: San Juan, Toa Baja and Arecibo. The criteria considered in said evaluation were environmental impact, costs, space, time to start operations, permits, security, environmental justice, and past experiences in Puerto Rico and in the United States.

4.3.1 System Analysis for the San Juan Power Plant

The annual rental cost would be some $70 to $80 million dollars. The power plant does not have available space to locate the CNG receiving terminal. It is estimated that the time required to make the system operational, in compliance with all the applicable state and federal legislation, will be between 5 and 8 years. The permit process is complicated and costly, which together with the area's physical limitations, limits keeping this alternative as a viable one to respond to the energy infrastructure crisis. The pipeline on the ocean floor to the area of the San Juan Power Plant would run through an area of intense maritime traffic, which would raise safety and Homeland Security issues, this being a national and international port. There are low-income communities near the project which could be affected, for which reason in an environmental justice analysis the project would probably not be favored. The San Juan Power Plant is in the vicinity of CAPECO where there was an explosion on October 23 of 2009 that affected the nearby communities, which is still very recent in their memories and could support the opposition's position, even if it is an allegation lacking in merit. The project would entail impacts on San Juan Bay and its estuary. For all the reasons set forth above, the construction of the system for the San Juan Power Plant within the time frame required for the action under consideration was discarded. As a consequence, the supply of natural gas to this power plant will have to be

Secretary of Transportation under the Deepwater Port Act, as amended, was delegated on this office in 2002. The temporary regulation 33 CFR, Parts 148, 149 and 150, which govern the license application process for the construction and operation of these systems, arises under this law.

The license application process starts with a pre-application phase during which the applicant discusses the project with the concerned agencies, both at the state and federal levels. Then the application is filed and a 356-day term is activated within which the MARAD has to issue a Record of Decision (ROD), in accordance with what is set forth in the diagram on the right, taken from MARAD's internet web page.[4]



After the publication of the ROD, the applicant must have its installation completely operational before the MARAD grants the license. This process usually takes from two to four years.

In parallel form to the process before the MARAD, the applicant must comply with the requirements of the National Environmental Policy Act (NEPA), which usually takes some 240 days from the moment in which the application notification is issued. During this 240-day period, other agencies intervene and the Environmental Impact Statement is produced. Also in parallel form the permits and endorsements from the state sphere are procured. The Environmental Impact Statement generated under the NEPA process, as well as the data and studies which supplement the same, can be used also to satisfy the requirements of the state's Environmental Public Policy Act.

Given that the ownership of the system will be in private hands, one of the most important aspects MARAD considers before issuing the required license is the applicant's financial capacity to construct and operate the tankers and buoys system under consideration. Moreover, the private applicant must have the financial capacity to post a bond sufficient to cover the expenses of the complete removal of the system, once the license expires or is revoked.

In addition, the private applicant must prove that the tankers and mono-buoy system is in the national interest and that it is consistent with the federal public policies on national security, energy independence and environmental quality, among others.

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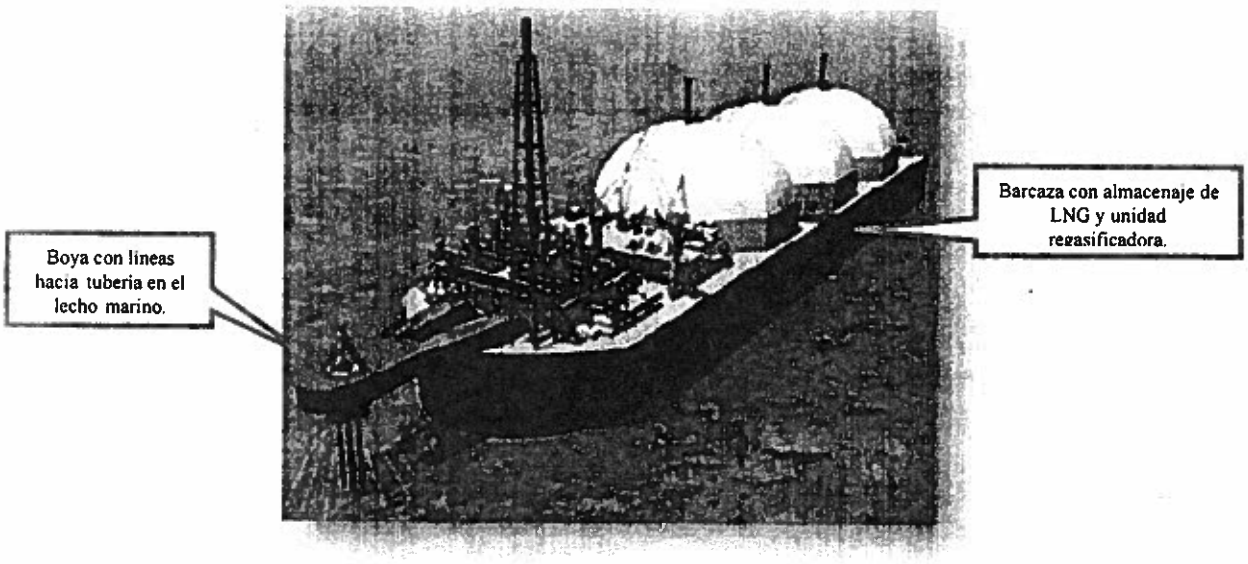
[4] http://www.marad.dot.gov/ (March, 2010)



The construction, installation and operation of these tankers and buoys systems are regulated by two leading agencies: the Maritime Administration (MARAD), ascribed to the Federal Department of Transportation, and the US Coast Guard, under their Deepwater Ports Standards division. Other federal agencies with jurisdiction over the construction, installation and operation of these systems are: Advisory Council on Historic Preservation (ACHP), Council on Environmental Quality (CEQ), Department of Energy (DOE), Department of State, Environmental Protection Agency (EPA), Federal Energy Regulatory Commission (FERC), Minerals Management Service (MMS), National Marine Fisheries Service (NMFS), Department of Commerce under its National Oceanographic and Atmospheric Administration (NOAA), Pipeline and Hazardous Material Safety Administration (PHMSA), US Army Corps of Engineers (USACE), US Fish and Wildlife Service (FWS), and the White House Energy Streamlining Task Force. At the state level the agencies with jurisdiction are: Office of the Governor, Department of Natural and Environmental Resources (DRNA), Puerto Rican Culture Institute (ICP), State Historic Preservation Office (SHPO), Ports Authority, Public Service Commission (CSP), Environmental Quality Board (JCA), Urban Planning Board (JPU) and the Electric Power Authority (AEE).

PREPA would request a private company experienced in the matter, to design, construct and operate the tankers and buoy system. This would have an approximate annual cost to PREPA of 70 to 80 million dollars, subject to signing a contract with said company for a term of not less than 20 years. At the end of the 20 years, the total cost would be some 1.6 billion dollars.

The process to obtain the permits for the construction and operation of these systems begins by filing an application with the MARAD. The authority to grant licenses for the construction and operation of the tanker systems which was conferred on the Federal

medium-term project, which would not satisfy our need for an immediate project to bring about the transition from petroleum to renewable sources of energy. The construction cost of the existing terminal was over $570 million in 1995 dollars. When we consider the cost of the present dollar and add the cost, as we indicated before, of the construction of a pipeline to transport natural gas which would connect the power plants of the north of the island, the project would be too onerous because it would surpass a billion dollars. Being a project of the Government of Puerto Rico, it would have to be financed through bond issues, which limits the savings in the electric energy bills.

The construction of an importation terminal inside or near the grounds of the SJSP as an alternative is not viable when the physical situation of the area is compared with the physical conditions required by this type of terminal. In addition, the environmental consequences in the area would be adverse and above all the time required to complete the approval of permits, as well as the construction time, would not permit a response to the energy infrastructure crisis in the least possible time. When the evaluation criteria were applied to this project, together with the previously described data, deficiencies were found that make it little or not viable at all. Although there is a maritime dock area, as opposed to the other power plants in the north area, it does not comply with the depth requirements or with the capacity for the anchorage of tanker ships of this kind. Were this alternative to materialize, there is no area for the disposal of dredged material and the dredging activity would be adverse to the area's benthic system and it would affect the water quality parameters the SJSP must comply with. Maritime traffic would be highly compromised because there is only one entrance channel to the San Juan Bay (Bay Channel) and the Anegado Channel is the only passageway to the tankers' discharge area. This would greatly affect the local economy, as well as the tourism industry.

4.3 Tankers and Buoys System

PREPA considered the installation and operation of a system of tankers and monobuoy for the receipt, storage, regasification and transport of natural gas to each one of the north area power plants as one of the alternatives to the project.

These systems of tankers and buoy, known as Deepwater Ports, suppose the construction of a receiving terminal for compressed natural gas (CNG) in the vicinity of each one of the power plants. This terminal would receive the gas from a station located some 5 km offshore, in which a tanker bringing the natural gas from its exportation point would anchor and couple. Said tanker would have a regasification unit that would couple to a buoy that holds and keeps afloat the connection lines from the tanker to the pipeline lying on the ocean floor and will transport the compressed gas to the receiving terminal near the power plant. The CNG receiving terminals require a minimum area of 2,500 m^2.

with regulations 49 CFR 193, 33 CFR 127 and NFPA 59A. Locating the different elements of the importation terminal in the areas around the SJSP, outside of it, would not comply with these standards, not only because of how distant they would be from each other, but also because there isn't enough free and available space in the surroundings. Also the exclusion zone required by regulations would be unavailable, because the SJSP is located in one of the most densely populated areas of Puerto Rico.

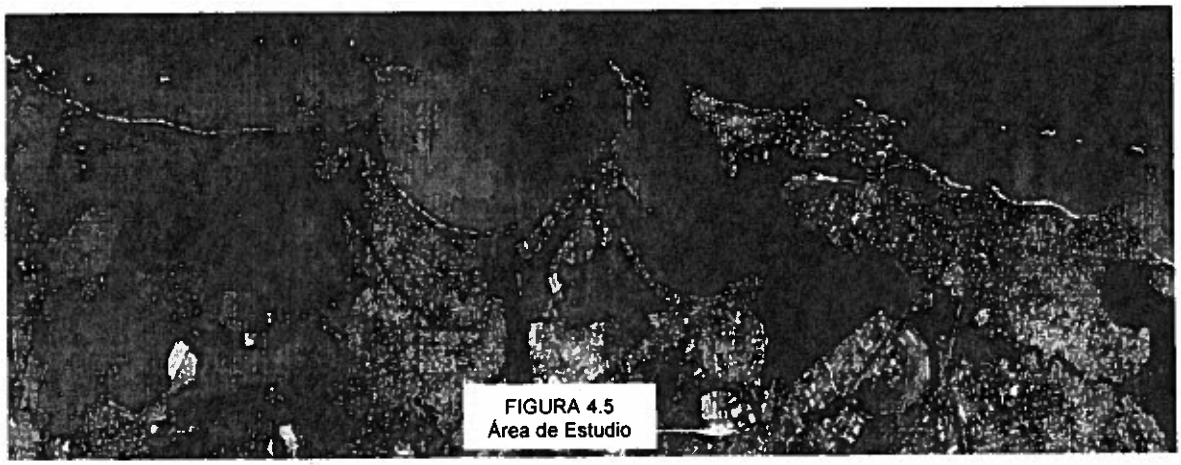
The alternative of constructing an importation terminal in or near the SJSP is not a viable one to comply with the purpose of eliminating the environmental impact associated with the construction of trenches for the natural gas pipeline. Even if the construction of the importation terminal were to materialize, it would be necessary to carry natural gas to the other power plants in the north area, Palo Seco and Cambalache. This would have to be by the construction and installation of a pipeline to transport natural gas. The construction, installation and operation of said terminal does not exclude the environmental impact the construction and installation of a pipeline to transport natural gas would bring.

In addition to the environmental factors, costs and space limitations for the construction of an importation terminal in or near the SJSP, we have to consider that the process of construction and operation of a natural gas importation terminal is complex. Obtaining the permits and endorsements for the same are regulated by the Federal Energy Regulatory Commission (FERC). Taking by comparison the importation terminal existing in Puerto Rico, EcoEléctrica, the process of studies and permits together with the construction and beginning of operations can take between 6 and 7 years. The previously featured data of the time to obtain the permits and the construction of these facilities are supported by information obtained from projects recently developed in the United States, which are described in the table illustrated below:

Evaluated Area	Information Collection Time	Permits Approval Time	Construction Time	Average Total Time
Gulf	1 year	1.5 years	3 years	5.5 years
East	1 year	2-3 years	3 years	6 to 7 years
West	1 year	2-3 years	3 years	6 to 7 years

Through this observation, PREPA doesn't pretend to circumvent the permit processes before the federal agencies. The purpose of evaluating the times it takes to establish this type of project is to identify an option that could respond to the energy infrastructure crisis in an opportune and diligent manner.

This reality would turn the alternative of constructing an importation terminal into a



It is anticipated that an importation terminal, in combination with the existing SJSP system, will cause an impact on the water temperature in the Puerto Nuevo Bay, the body receiving the cooling and discharge waters of the power plant. The temperature of the discharged waters of the importation terminal would exceed the water's ambient temperatures, especially during the winter and spring months. This would produce a warming of the waters adjacent to the discharge structure during these months.

In addition, the extraction of marine water for the importation terminal's cooling system, added to the present extraction of the SJSP, would have a cumulative effect on the benthic community of the Puerto Nuevo Bay and, in consequence, the San Juan Bay, especially on the community of microalgae. It is to be expected that a loss of these would have an impact on the local populations of invertebrates and fish, added to the impact that the already mentioned turbidity and sedimentation associated with dredging would have on these species. Also, the rise in the discharge temperature would affect water quality and, consequently, the water quality parameters required in the environmental permits which govern the SJSP, specifically temperature.

The installation of the components of an importation terminal in the SJSP area would occupy a surface area of 25 acres, approximately. The SJSP covers 32.85 acres and does not have any free space (see Figure 4.1). The space is totally occupied by its diverse systems, among which are included: generating units, service and fuel reserve tanks, plants to demineralize and treat water, water storage tanks, cooling towers, buildings for warehouses, offices and laboratories. An importation terminal must comply with the regulations that regulate, among other things, the spaces that must be kept between the different elements inside the terminal (such as the distance between the liquid natural gas storage tank and the vaporizers) and the space that must be kept between the terminal itself and populated areas (exclusion zone). This, in compliance

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1997.

(Trichechus manatus) and several species of marine turtles, among them the hawksbill turtle *(Eretmochelys imbricata)* and the leatherback turtle *(Dermochelys coriacea)*; 160 species of bird, such as the brown pelican *(Pelecanus occidentalis)* and the great egret *(Egretta alba egretta)*; 19 species of reptiles and amphibians, such as the coqui frog (*Eleutherodactylus coqui*) and the Puerto Rican boa *(Epicrates inornatus)*; 124 species of fish, such as the tarpon *(Megalops atlanticus)* and the snook *(Centropomus undecimalis)*; 300 species of wetland plants. The estuarine system sustains resident and migratory species and also external species that exit through one of the system's three outlets to the ocean.[2]

The body of water nearest to the SJSP is the Puerto Nuevo Bay, which is part of the San Juan Bay. An area of microalgae exists near the turning basin for vessels in the Army Terminal dock. The existence at that location of mats of *Gracilaria Sp.*, and, in lesser quantities, of *Enteromorpha sp.*, were reported. Associated with these microalgae, the presence of an abundant population of invertebrates was reported, among which are: tube worm *(Onuphia sp.)*, blue crab *(Callinectes sp.)* and some classes of bivalves (*Corbula contracta* and *Diplodonta semiaspera*). There is no evidence of coral reefs in the SJSP area.

The area of the Constitution Bridge and the entrance to the Martin Peña Canal, which are part of the EBSJ, were designated as costal Critical Wildlife Areas. The same are near the shores of the SJSP. However, there is no mangrove growth in the vicinity of the power plant.

Among the mega invertebrates are: *Callinectes sp.*, *Micropanope sp.*, and the pink shrimp (*Pemaeus duorarum*). Although no fish studies have been conducted in the vicinity of the SJSP, it is reasonable to expect that the same are those found in the San Juan Bay. Among the fish found in this bay are: tarpon (*Megalops atlantica*), guppy (*Lebistes reticulatus*), *Lepomis macrochirus*, *Elops saurus*, *Eleotris pisonis* and *Ictalurus punctatus*. No species of vertebrate wildlife, protected or endangered, are perceived near the SJSP.

However, in studies that cover the coastline from Punta Las Marías to Punta Boca Juana (the mouth of the La Plata River), which includes the San Juan Bay (see Figure 4.5), threatened and endangered species were seen, such as: green turtle *(Chelonia mydas)*, hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), West Indian Manatee *(Trichechus manatus)*, the brown pelican (Pelecanus occidentalis) -recently removed from the endangered species list- and an as yet unidentified school of dolphins. These turtles and manatees were not seen in the lagoons, canals or the bays that were in the study area or near the SJSP, although the brown pelican was seen near this power plant.[3]

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[2] http://www.estuario.org/

[3] Section 316(a) and (b), Demonstration, San Juan Power Plant; ENSR; July,

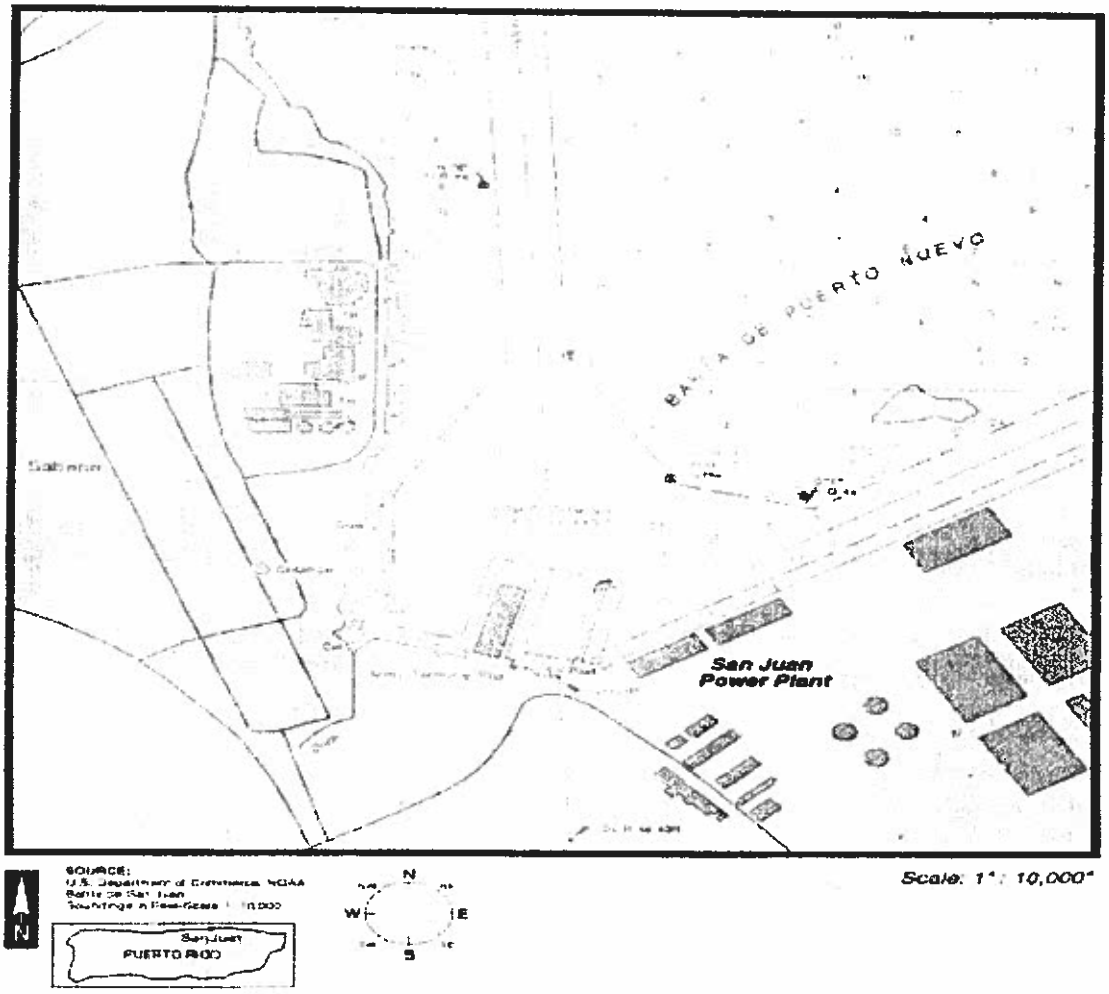
The disposal of the dredged material would have to be offshore, in an ocean disposal site. This presents several inconveniences. The area would have to be sufficiently large so the amount of material to be disposed of does not have an adverse impact on the area's benthic community or the impact is minimal. In addition, it should have the capacity to receive material from the routine maintenance dredging necessary to avoid interrupting the continuous flow of receipt of liquid natural gas. The initial effect of the disposal operations would be a high concentration of sediments near the surface (due to the suspended sediments). Carried by the ocean currents, this material would not necessarily reach the bottom of the ocean disposal site, for which reason the benthic area impacted would be larger than the estimated. It is underscored that the use of this disposal option is highly limited, because at present there isn't an approved ocean dumping area near the San Juan bay.

The dredging operations would produce a degradation of water quality due to the fine suspended sediments, since the dredging activities would take months. The turbidity plume would affect daily during working hours and up to two hours after the same, before the sedimentation of suspended material. This would affect the water quality and, consequently, the parameters of water quality required in the environmental permits which govern the SJSP, especially the turbidity, sedimentation and suspended solids.

The docks and ports of San Juan Bay receive annually 80% of the products imported into Puerto Rico and they play a crucial part in the export process of all kinds of products. The Port of San Juan Bay is number 17 by size in the world. Over 1.3 million tourists visit in cruise ships. It receives an average of 700 cruise ships annually. Over one thousand fishermen use the system every year, with an average catch of 350,000 pounds of fresh fish.[1] All the maritime traffic in the bay uses the Bay and Anegado common channels. In addition, the majority of the imported goods cargos that arrive in this bay, arrive at the Army Terminal dock, so they use the channel to reach that dock. It is estimated that a liquid natural gas importation terminal would increase maritime traffic in the San Juan Bay area at the rate of 25 to 60 crossings yearly, depending on the size of the liquid natural gas tankers used. The tankers would have to use these three channels until they reach the discharge point of the liquid natural gas in the dock of the Puerto Nuevo Channel. This represents an increase in maritime traffic that would affect our economy and tourism disproportionally, for diverse reasons. Among these reasons are: the high security restrictions on maritime traffic, which preclude other users from using the navigation channels or the dock simultaneously with the tanker ships.

The San Juan Bay Estuary (EBSJ) is composed of several bodies of water. Of these, one of the most important is the San Juan Bay. The EBSJ offers food and shelter to: 8 animal and 17 plant species in danger of extinction such as the West Indian Manatee

[1] http://www.estuario.org/



Bathymetry of Bahia de P[illegible] FIGURE 4.1 [illegible] San Juan Power Plant

To prepare the maritime area to receive tanker ships, the navigation channels and the existing turning basin would have to be dredged to reach a depth of 40 feet and for the navigation channels to reach a minimum width of 300 feet. The disposal of this dredged material would present the problem of finding an adequate site for its disposal in a way that would not represent a harmful impact on the environment. At present, Puerto Rico does not have land sites with the capacity to receive or process the amount of material that would be generated during dredging of such magnitude. Historically, it has been demonstrated that the majority of land sites for disposal of dredged material are not appropriate for industrial or commercial development, which would disable the area for future uses and development.

Nuevo navigation channel.

According to the bathymetric charts, the anchorage area for the tankers that serve PREPA has a depth of little more than 30 feet. The maximum depth of the Army Terminal turning basin is, in just one point, of 40 feet, fluctuating mostly between 35 and 37 feet. This basin connects with the Army Terminal channel which is the one that reaches the Anegado Channel. This last one joins the channel that serves as the entrance for every ocean-going vessel to the San Juan bay, the Bay Channel (see Figures 4.3 and 4.4).

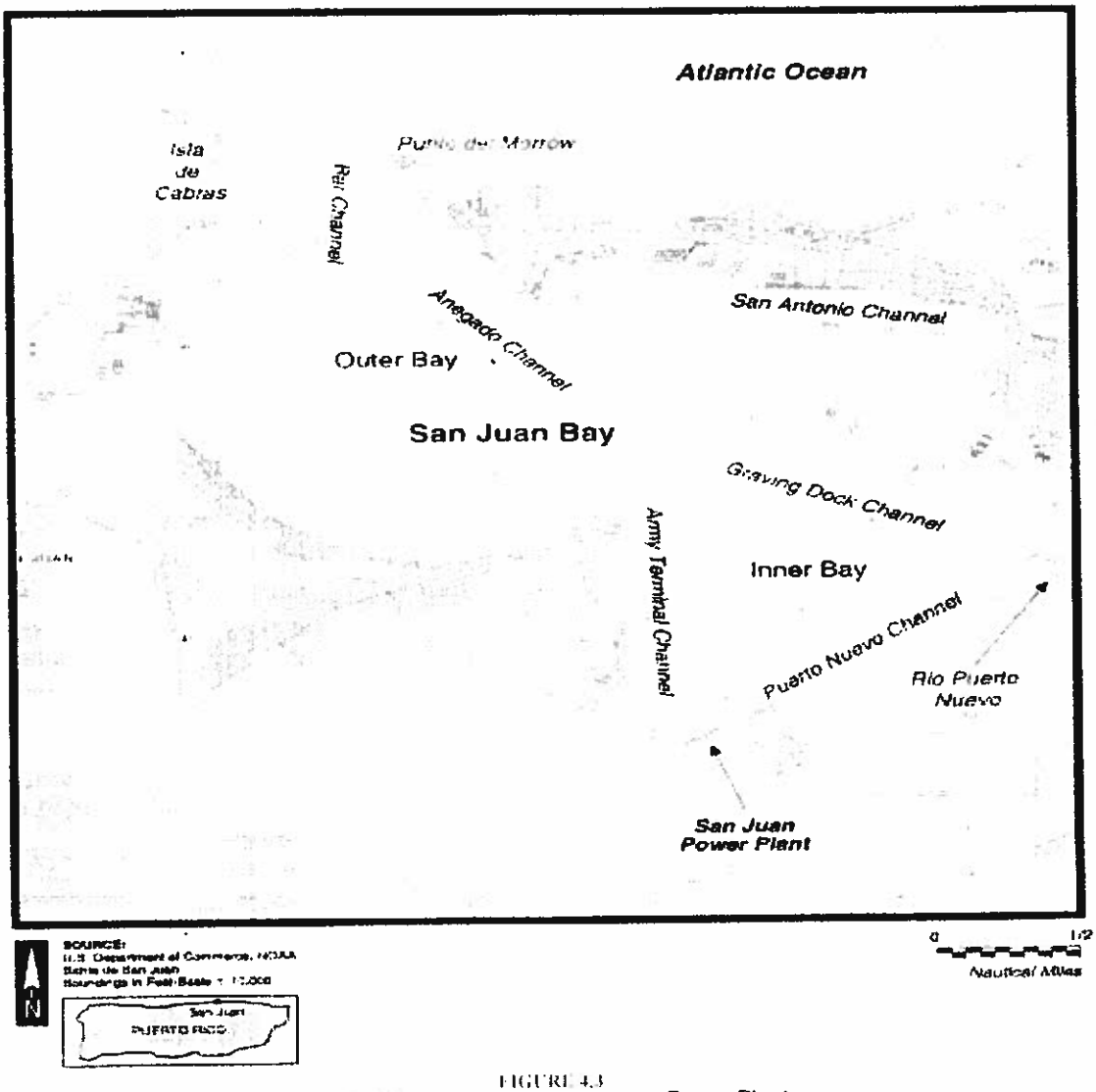


FIGURE 4.3
Approximate Location of San Juan Power Plant
and San Juan Bay Shipping Channels

clearance height for the operation of a typical tanker ship, which would be in the rank of 950 feet long by 150 feet wide and which would require a minimum depth of 40 feet in the navigation channel and an obstacle clearance height of 180 feet.

- Turning area (amplitude and proximity): a typical liquefied natural gas tanker ship would require a turning basin with a minimum diameter of 1,200 feet and a depth greater than 40 feet.

• Environmental issues

- Environmental consequences: minimize the environmental impact by using sites within a previously impacted area, including the site for the dock and areas zoned for that use.

- Compatibility with regional plans: the location must be compatible with the future development of the adjacent properties.

- Zoning and land use: one of the goals of the project is to avoid or minimize adverse impacts on the environment due to development. The site must be located within an area zoned for industrial development to help confine any environmental impact in previously industrialized areas.

- Distance to populated areas: the location would be catalogued depending on its distance from populated areas or residences. Avoiding populated areas will help towards ensuring compliance with the location criteria of the DOT (49 CFR 193.2055, 193.2057 and 193.2059), which regulates in regard to the establishment of an exclusion zone, or an area where a terminal cannot be constructed due to population density. Respect for the distance established in this exclusion zone minimizes the negative public perception of safety issues normally associated with liquid natural gas terminals.

The tanker ships commonly used to transport liquid natural gas have a capacity ranging from 125,000 m^3 to 140,000 m^3. The longer ships range from 950 to 1,000 feet in length, with a typical draft of 38 to 40 feet. To insure that liquid natural gas tanker ships don't run aground easily or frequently, an additional depth of 2 feet under keel clearance is required. This implies that tanker ships require a maritime access and a docking and turning basin area in bodies of water with depths of more than 40 feet.

The SJ consists of 32.85 acres (132,941 m^3). It receives fossil fuel from the dock located to the west of it, in the San Juan port zone. Said dock is located on the Puerto Nuevo navigation channel, east of the Army Terminal dock (see Figures 4.2 and 4.3). This maritime area was prepared for the navigation of fuel vessels, among others. Currently, the tankers that service PREPA unload the fuel at the dock on the Puerto

gasify the liquid natural gas so it can be transported to the turbines in the power plants. Other factors to consider associated with the location are the activities, external and adjacent to the terminal, and the distance or separation the terminal must observe to these areas of activity and to densely populated areas (49 CFR Parts 193.2055, 193.2057 and 193.2059).

- Availability of coastal area: the location must have available an area of maritime dock with anchoring facilities for tankers 950 feet long, 140,000 cubic meters capacity and minimum draft of 40 feet. The criteria used to evaluate whether a port or dock has the capacity for this type of project are the depth of the navigation channels (over 40 feet), the extension of the obstacle clearance height (greater than 180 feet) and its proximity to the liquid natural gas storage and gasification terminal. The dock must be approximately 30 feet wide by 1,700 feet long and possess, among others, equipment to secure the tanker to the dock, a two-level platform at the end, 40 feet wide by 100 feet long in the lower level and 20 feet wide by 76 feet long on the upper level, and a spill collection basin in case of emergencies.

- Dredged material disposal site: an area must be located for the disposal of the material to be dredged to create an appropriate navigational channel that will permit an increase in maritime traffic and the receipt of tankers with liquid natural gas and to dispose of the material generated by the routine maintenance dredging required for the appropriate flow of ships.

- Infrastructure: the importation terminal will require an adequate infrastructure that includes a reliable source of energy and appropriate highways or roads, especially for emergency response, as well as an access for tankers for the receipt of construction materials.

• Maritime operations

- Increase in the traffic of ships: the transit of tanker ships is subject to more restrictive federal regulations than general maritime traffic, which could influence the traffic of other ships and increase the risk of affecting other users of the navigation channel.

- Access to the navigation channel: the sooner a tanker can arrive at the terminal, unload, and return to sea, the better the economy of the area will be. In addition, a shorter channel would diminish the effect in traffic for other ships due to the maritime traffic restrictions on tanker ships. This is achieved with the availability of a navigation channel next to the storage and gasification terminal and with sufficient depth, width and obstacle

terminal to be constructed must possess the capacity to receive, unload and store an approximate maximum amount of 160,000 cubic meters of liquid natural gas imported over the high seas; in addition to installations to gasify and handle the same. The construction of such terminal would imply an environmental impact associated with the different stages of the construction and operation of the same, among which would be included:

- Constructing, repairing or expanding, as the case may be, a dock for the receipt of liquid natural gas.
- Increase in the traffic of ships, which has an impact on the ships that supply us with the products we import, as well as on the tourism cruisers that use San Juan Bay regularly.
- Construction of a storage tank for liquid natural gas and a gasification plant. This would occupy an area of approximately 25 acres, in addition to an exclusion zone in accordance with the regulations in effect.
- Conditioning the navigation channels to support the transit of tankers, which would imply dredging and disposing of the dredged material.

The selection of a place for the construction of a natural gas receiving and regasification terminal requires the existence of deep ports to minimize the environmental impact associated with the development and operation of such terminal and the existence of areas of low population density suitable for an industrial development.

Three criteria were used to determine whether constructing an importation terminal near our installation was a viable alternative: location-specific factors, maritime operations and environmental issues.

- Location-specific factors
  - Availability of the land area: the location must have sufficient space available to accommodate the proposed installation and all the safety components required by the regulations of the Federal Department of Transportation (49 CFR Part 193), the United States Coast Guard (33 CFR Part 127) and the National Fire Protection Association (NFPA, NFPA 59A); in addition it must comply with the regulatory distance between the gasification plant and the liquid natural gas storage tank. The land facilities would occupy an area of approximately 25 acres (101,173 m^3). They would include, among other components: a double containment tank 167 feet tall and 269 feet in diameter, with a storage capacity of 1,000,000 barrels (160,000 cubic meters) of liquid natural gas at a temperature of -260°F and pressure of 2.0 psig; vaporization or gasification systems to

4.2. Liquefied Natural Gas Receiving Terminal in the San Juan Power Station

There are millions of miles of pipelines to transport natural gas throughout the world and over 1,500,00 of these are in the United States. This Nation has eight liquefied natural gas receiving terminals servicing it. Puerto Rico has one of these importation terminals, the EcoEléctrica Co-generator in the Municipality of Peñuelas, which has the capacity to supply our needs. Even so, the alternative of constructing an importation terminal near one of our installations with the purpose of eliminating part of the environmental impact associated with the construction of trenches for the natural gas pipelines was considered. Among the three power plants in the North area where the use of natural gas to generate electricity is contemplated, the San Juan Steam Plant (SJSP) was selected because it is the only one next to an existing fossil fuel receiving dock (see: Figure 4.2, San Juan Thermoelectric Power Plant). The dock has the infrastructure to transport diesel and Bunker C to two power plants, San Juan and Palo Seco. The other power plants don't have appropriate infrastructure next to the power plant.

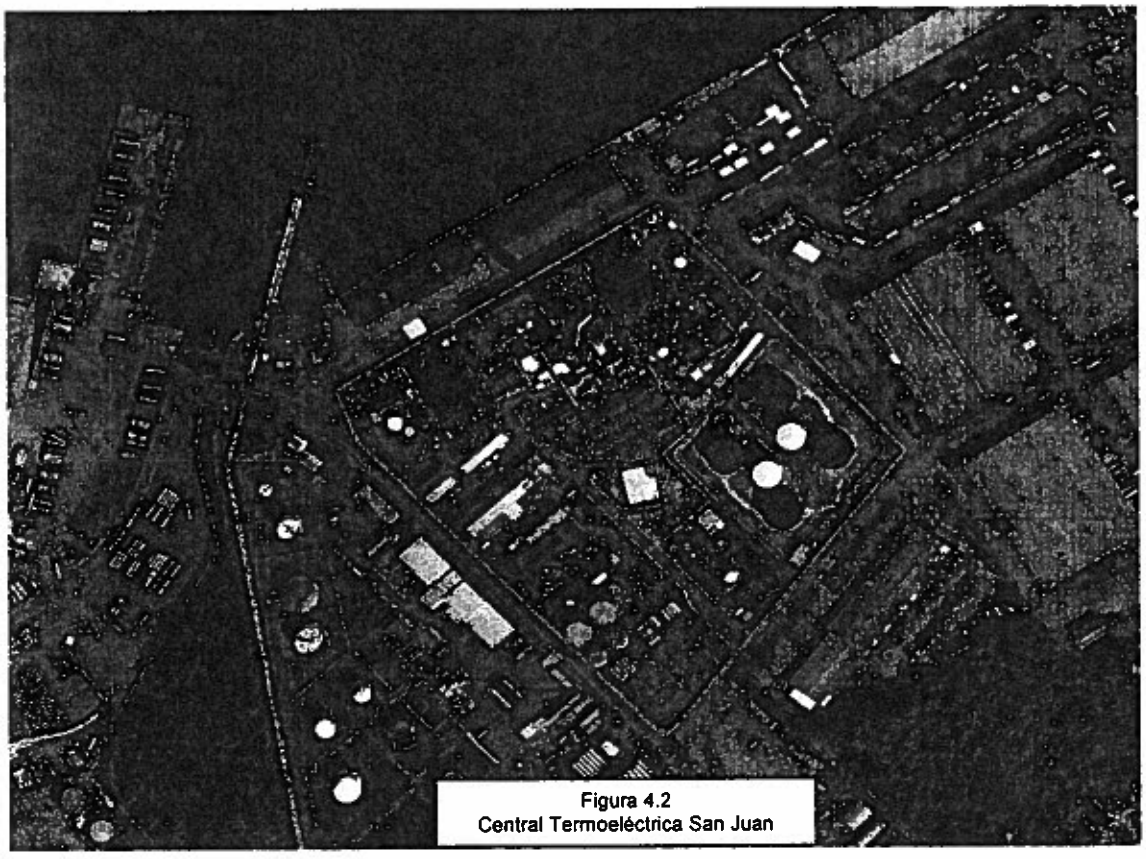
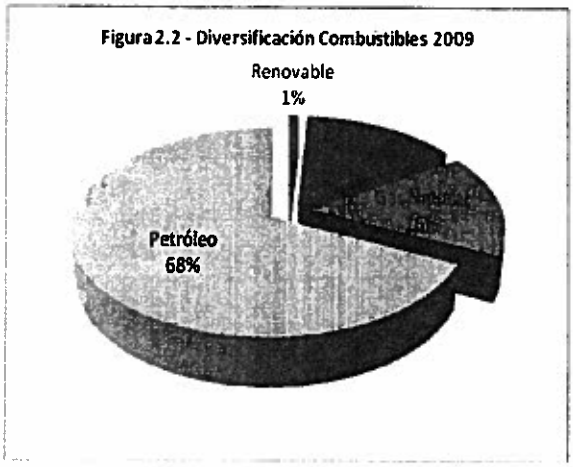


Figura 4.2
Central Termoeléctrica San Juan

When we use by way of example the importation terminal existing in Puerto Rico, the

The construction of Via Verde is the largest fuel diversification project PREPA will be able to make in these times. This diversification guides PREPA to establish the actions required to comply with the new federal environmental regulations in a structured manner. Together with the above, there are important environmental considerations that will help PREPA to manage its energy costs effectively.

As shown in Figure 4.1, Puerto Rico depends on petroleum in a significant percent. At this moment, PREPA uses only No. 2 fuel oil (light distillate) and No. 6 (Bunker C) in its generating units and, at the same time, purchases the electricity produced in the AES co-generator in the Municipality of Guayama (coal) and EcoEléctica in the Municipality of Peñuelas (natural gas). With the introduction of the co-generators, we began to purchase electricity generated without the use of petroleum, but internally, PREPA still depends exclusively on it.



PREPA's goal is to reduce its dependence on the use of petroleum, which at present is 68%, approximately, for which reason the plan is to reduce it to close to 12% by 2014. For this, PREPA has to take action and identify alternative fuels that can supply the capacity its clients demand. Lack of action would only worsen the dependence on petroleum, and in times of embargo or high world demand, our island would not have viable alternatives to generate electricity. In addition, the No Action alternative leaves a latent impression that PREPA is affected by sudden changes in the cost of petroleum, which diminishes the agency's economic capacity and, in consequence, Puerto Rico's economy.

It is important to underscore that PREPA is limited by federal and state permits on the type of fuel it can burn in its units. The greater limitation is in the percentage of sulfur the fuel contains. This fuel is more expensive than fuel with higher sulfur percentages. If there is a scarcity of this type of fuel or if it is not possible to enter into purchase contracts with the suppliers, PREPA has two options: to cease generating electricity, which is not viable, or burn a cheaper fuel with a higher sulfur percentage than that established in the environmental permits and be exposed to fines and sanctions from the regulatory agencies.

The use of natural gas significantly reduces the atmospheric emissions of pollutants to the environment. No Action means that PREPA will maintain an investment of capital to reduce its emissions from petroleum, and will provide maintenance to its units instead of using that capital to develop a more efficient system that uses a cleaner fuel.

will become effective in 2020, requires an additional and compulsory reduction in the quantity of emissions of certain air pollutants. To achieve said reduction, PREPA would be forced to install emission control equipment, such as Electrostatic Precipitators (ESP) or Multiple Bag Collectors (Baghouses for the removal of particulate matter), catalytic converters (for the removal of nitrogen oxide, NOx), and Scrubbers (for the removal of sulphur dioxide, SO_2). This kind of equipment is very costly, which would require a great capital investment, and would result in an increase in the cost of the kilowatt/hour. In addition, this kind of equipment requires a lot of space, which would represent a difficulty to PREPA, because some of our power plants do not have the space necessary for its installation. The conversion of our units to use natural gas will have the impact of reducing emissions to the levels required by this new regulation, without the need to install this equipment, which requires an estimated capital investment cost of $200 million dollars, and at the same time providing a more economical fuel for the generation of electricity.

In addition, it is emphasized that the maintenance related to units that burn petroleum derivatives must be made frequently and with higher costs to insure the optimal functioning of the same. Continuing to burn petroleum derivatives has other implications, such as a greater frequency of deliveries of said fuels in our ports, which increases the erosion of the seabed and the probability of spills. The continued use of petroleum-derived fuels increases the cost of the electric energy service, which in its stead impacts negatively the Puerto Rican economy and results in a lower quality of life for its citizens. Of no less importance is the fact that the use of these fuels exposes PREPA to market value fluctuations, which creates instability in energy production costs and in the electric bills. All of the above, together with the impact of the new federal environmental regulations projected for 2020, force PREPA to establish a definite strategy to avoid a dislocation of the electrical system as a result of the installation of additional control equipment required by the EPA.

Recognizing that the Puerto Rican economy is directly related to the stability of PREPA, it is important for the company to comply with its strategic development plans and maintain a fixed cost structure that avoids sudden peak variations in the cost of the fuel purchased. Complying with these plans attests PREPA's vision, stability and commitment to its clients. In addition, it demonstrates the company's ability to evaluate complex global situations and develop strategies to diminish their impact, which facilitates broadening the fuel use options in the future.

After evaluating the local and global dynamic, PREPA developed a Strategic Corporate Plan 2009-2012. This Plan includes the following parameters, among others:

- Adding alternative energy sources to reduce the cost of fuel
- Protecting the environment
- Collaborating with all efforts to improve the quality of life in the Puerto Rican society

Chapter 4. STUDY OF ALTERNATIVES AND SELECTION OF THE ALIGNMENT

The different alternatives evaluated for the execution of this project are discussed in this chapter. Among said alternatives the construction of a liquefied natural gas receiving terminal in the north of the island, the installation of tankers and buoys systems for the receipt, storage and regasification of liquefied natural gas and several terrestrial alignments for a natural gas pipeline were considered. Also analyzed were the alternative of using renewable energy sources technically available in the commercial sphere and the No Action alternative.

4.1 No Action

The No Action alternative, although considered, was found to be unfeasible due to the transcendence, importance and public well-being pursued by the project.

In Chapter 6, Impacts and Mitigation, of this Preliminary Environmental Impact Statement (DIA-P), the direct and indirect impacts associated to the construction of the natural gas pipeline are considered. If the project is not constructed, the following impacts are averted:

- The impact of the movement of earth which can produce soil erosion and sedimentation of bodies of water
- Temporary increase in noise levels
- Limited impact to forest reserves
- Temporary impact to wetlands, mangroves and other surface water bodies
- Temporary impact to agricultural land
- Temporary impact to water, highways and (possibly) telephone infrastructure
- Temporary traffic increase and readjustment
- Potential impact to archaeological sites
- Acquisition of land by expropriation

Most of these impacts, in case the selected alternative is constructed, although they cannot be avoided due to the project's construction specifications, can be minimized and mitigated with engineering measures and sedimentation and erosion control measures, supervision and the support of agencies and municipalities, among other measures.

No Action is not indicative of no impact, because faced with the No Action alternative PREPA will have to continue the production of electric energy by burning petroleum products that generate a greater amount of air polluting emissions. The use of natural gas represents a significant reduction in the criteria pollutant emissions and others such as carbon dioxide. This reduction of emissions, acquires greater importance if we consider that the new regulation of the Environmental Protection Agency (EPA), which

cc. Mr. Osvaldo Collazo (CoE)
Eng. Francisco E. López (PREPA)
Via Verde Project File

19	Shoreline at Levittown	NA	4,495 ft	-55 ft
20	Shoreline at Levittown	NA	3,782 ft	-55 ft
21	Rio Hondo/Rio Bayamon	C95	1,831 ft	-80 ft

*NOTE: The "C" numbers show the crossing location as identified in Table 5 in the Joint Permit Application (JPA) and on the Impact Maps in Appendix B of the JPA

The pipe depth at each HDD crossing (none less than 40 feet) **will ensure no channel bed erosion will affect the pipe (and vice versa).** This technology will enable a "dry crossing" well below the river bed. These sections of the project will be built so the drilling begins at a safe distance from a waterway channel and extends below the bed at an appropriate depth, which was determined by subsurface exploration with geotechnical borings. In addition to the eighteen waterway crossings, three locations (18-20) are proposed to minimize the potential for liquefaction and coastal erosion. At these locations the pipe will be installed by HDD at depths of 50 feet or more, which protect the pipe from the action of the waves. For this reason, no impact will occur to the dunes and the coastline at Levittown.

Another approach aimed to reduce and minimize impact associated with the HDD are the use of temporary construction workpads. For these workpads, a 200 X 200 foot area will be used on both sides of the body of water at the entry and exit points of the pipeline. Once the HDD crossing is completed, these workpads will be immediately removed and preconstruction site conditions restored. At 14 of the 18 HDD waterway crossing locations the temporary workpads will be located in Palustrine Wetlands (previously disturbed by ranching or framing activities). None of the workpads are located in forested wetland habitat. More detailed information on these workpads will be provided soon.

As indicated previously, PREPA is committed to address any and all concerns presented by the US Army Corps of Engineers (USACE). In the event additional information related with the Joint Permit Application is needed by the Corps, please do not hesitate to contact us at 503-781-7930 at your earliest convenience.

Cordially Yours,

Andrew Goetz
President
BCPeabody
509 Guisando de Avila
Suite 100
Tampa, Florida 33613

The method of installing the pipeline in this areas will allow replacing the cattail vegetation that existed before the construction with a desirable aquatic species.

Cultural Resource Concerns:

Efforts are being undertaken by PREPA to complete the translation of the Archaeological Study 1A as requested by the USACE during the meeting held on February 1, 2011. Translation efforts are around 70% complete and final document will be presented before the USACE in the forthcoming week.

In the mean time, PREPA's consultants periodically meet with State Historic and Preservation Office (SHPO) in an effort to secure all data available to ensure that all data has been included in the efforts being undertaken by our consultants. In a meeting held at SHPO on February 23, 2011, an agreement was reached to have additional meetings between PREPA's consultants and SHPO personnel to discuss the progress being made in the implementation of the Phase 1B study initiated during the month of January 2011. These meetings will be also geared to address any particular information concerns that needed to be addressed as part of the consultation process performed by the USACE.

HDD Crossing Information:

At the PDT meeting the Corps, US Fish and Wildlife Service and National Marine Fisheries Service requested information on the proposed HDD crossing locations to include length of each crossing and depth the pipe would be placed at beneath the waterway being crossed. The following information is provided for the HDD crossing sites still proposed (due to site limitations three previous sites will no longer utilize the HDD construction method):

Number	Waterway	"C" No.	Length of HDD Crossing Entry to Exit	Depth of Pipe Under Waterway
1	Matilde River	C1	1,417 ft	-50 ft
2	Unnamed Canal	C3	1,100 ft	-58 ft
3	Rio Tallaboa	C5	1,298 ft	-58 ft
4	Grande de Arecibo	C34	1,185 ft	-40 ft
5	Grande de Arecibo	C36	1,850 ft	-60 ft
6	Grande de Arecibo	C37	1,200 ft	-45 ft
7	Rio Tanama	C39	1,360 ft	-65 ft
8	Grande de Arecibo	C43	1,838 ft	-55 ft
9	Rio Manati	C66	1,230 ft	-40 ft
10	Rio Manati	C72	1,200 ft	-48 ft
11	Rio Manati	C73	1,910 ft	-40 ft
12	Rio Indio	C74	1,387 ft	-41 ft
13	Rio Indio	C75	1,150 ft	-47 ft
14	Rio Indio	C79	1,145 ft	-40 ft
15	Rio de la Plata	C83	1,600 ft	-48 ft
16	Mangrove Slough	C90	1,300 ft	-50 ft
17	Rio Cocal mangroves	C93	4,531 ft	-55 ft
18	Uplands at Punta Salina	NA	3,588 ft	-50 ft

In addition to the information provided above, the translation of Chapter #6 of the State Environmental Impact Statement that covers impacts minimization has been included as Attachment #1.

Alternatives Analysis:

PREPA recently completed an extended Alternative Analysis aimed to address EPA concerns and guidelines as presented on December 22, 2010 letter. Attachment # 2 includes said Alternative Analysis.

Alternative Fuels:

Attachment # 3 included a translation of Chapter # 4 of the State Environmental Impact Statement that covers the subject mentioned above.

Compensatory Mitigation:

In our previous letter we explained why an extensive compensatory mitigation plan was not submitted up front with the permit application. Since there will be no permanent fill of waters of the U.S., and secondary impacts to these same wetlands is expected to be minimal due to the size of the pipe and its method of placement, **temporal impacts to the aquatic resource is the remaining impact that may require compensation.**

PREPA is prepared to immediately work with the Corps to identify an appropriate goal for aquatic resource "lift" to offset temporal "loss". In terms of location, mitigation could be two types: 1) in situ enhancement or creation and, 2) land acquisition, preferably adjacent and identical or similar in ecological value. PREPA is ready to propose mitigation "on site", since it is difficult to get land with the characteristics necessary for successful mitigation.

As discussed at the PDT meeting on February 1, 2011, as the pipe is put in place the contractor will move forward and "walk" the construction along the corridor. As the pipeline trench is backfilled with the wetland hydric soil and topsoil, the wetland will be returned to its preconstruction topography. The vegetation in the areas of wetlands to be impacted with open trench will be allowed to immediately restore naturally. In wetlands that are active agricultural areas, landowners will be allowed to continue planting crops that do not have deep roots. In the rest of the project corridor, i.e. uplands, reforestation will occur naturally or through mitigation plans coordinated with Department of Natural and Environmental Resources (DNER), except for the growth of deep-rooted trees within the 50 foot construction easement (25 feet on either side of the pipe whenever possible.) A mitigation plan to include reforestation at a rate of 3:1 for trees to be removed is already required by the DNER and has been agreed to by PREPA. This mitigation plan will provide habitat compensation by acquiring land, reforestation of public areas or any combination the DNER deems necessary.

One mitigation opportunity PREPA is prepared to execute exists at the herbaceous Caño Tiburones wetland reserve, which has been significantly impacted by agricultural activities in the past. The dominating herbaceous species in this wetland is cattail (*Typha domingensis*), identified as an unwanted invasive species by federal agencies.

- **In those areas where steep gradients are encountered, slope stabilization (terraces) will be utilized** to reduce runoff velocity and minimize erosion. Geotextiles will also be installed in these areas to prevent rain or wind erosion.

- **Sediment traps** will be installed at points of discharge throughout the construction site to contain runoff. These traps will incorporate a catchment area with rocks of different sizes placed to control the discharge velocity of runoff.

- **Silt fence** will be installed along with rectangular hay bales along the perimeter of the 100-foot construction easement to contain any sediment and avoid transport to adjacent areas.

- **Hay bales** will be used to protect existing storm drains in impervious surfaces, where applicable, and will be kept in good conditions.

Another secondary impact would be effects to water quality from leakage of oils and other fluids from machinery. Although the possibility of groundwater contamination is considered remote, oil and fuel spills that are not addressed promptly could contaminate the water. To avoid this possibility, PREPA will implement a Spill Control Plan Environmental Coordinator project. This Plan will be prepared following the guidelines of the Code of Regulations Federal Regulations, Title 40, Protection of the Environment, Part 112, Oil Pollution Prevention. The plan will be submitted to EPA and the Environmental Quality Board (EQB) for evaluation. Each Operations Center will have a copy of the Plan. The Environmental Coordinator will provide briefings at each Center.

During construction, the resident engineer will be responsible for ensuring implementation of control measures in coordination with Environmental Coordinator. PREPA will do everything possible to ensure no vehicles are allowed to leak oil or other liquids that may affect water quality. If a vehicle develops leaks during the work, spill kits will be used to collect any leaks and the vehicle will be removed.

Secondary (temporal) impacts will also be mitigated by reducing construction time. PREPA will apply standards that require surface crossings of water bodies less than 10 feet wide to be completed in 24 hours or less. Water bodies of 10-100 feet wide will be crossed in 48 hours or less. These crossing will use one of the three "open" cut methods outlined in Appendix F of the Joint Permit Application. After installation of the pipeline, topographic contours will be returned to conditions that existed prior to construction to avoid affecting the hydrology and natural cycles or patterns of movement of water in the surface streams or ditches.

Finally, to reduce any secondary impacts to air quality water trucks will be used to spray the areas of construction. This includes the construction easement, any mounds of soil and all Centers of Operations. This will keep soil moist and minimize the amount of dust that might be dispersed. In addition, haul trucks will be required to use tarps to prevent dust emissions during transport of material on roadways. The tarps will be in good condition and shall properly tied to prevent loosening and the wind from moving it.

To minimize impact incidental to the effect of deforestation and temporary removal of topsoil, PREPA will implement a Plan for the Control of Erosion and Sedimentation (CES) and a Storm Water Pollution Prevention Plan (SWPPP) in compliance with Environmental Quality Board (EQB) regulations and regulations of the US Environmental Protection Agency promulgated for this purpose.

Changing the route of the proposed alignment in the Mogote Area of Manati to avoid impacts to the Mogotes. If any particular Mogote cannot be avoided by routing the pipeline around it, the pipeline will utilize the push/pull bore method (not HDD) to tunnel underneath the landscape.

Secondary Impacts:

The entire 92 mile length of the Via Verde project will be located underground, so secondary impacts are expected to be minimal. **Within the aquatic resource the pipeline trenches will be excavated 4-6 feet deep** and this will not adversely impact groundwater resources and aquifers. **There will be no permanent fill and no maintenance roads constructed** in waters of the U.S. **No secondary impact is expected to occur to surface sheet flow and/or ground water flow.**

Gas pipes could contaminate groundwater if the natural gas used during operation of the project contained dense contaminants (liquid natural gas) and there was a break in the bottom of the pipe where they can escape. Also contamination could occur where compressor stations are located to boost the gas flow. **It is important to mention that the gas to be used in the Via Verde project will <u>not</u> have the type of contaminant that is condensed (by specification), or have compressor stations.**

Open trench impacts include increased turbidity, sedimentation downstream from crossings, and direct impact to sessile wildlife and aquatic flora. To minimize any impact that potential erosion and sedimentation from land may have on the aquatic environment PREPA has taken the following measures:

- **An Erosion and Sedimentation Control Plan (CES) was developed** and will be submitted to the Environmental Quality Board for approval. This Plan will identify the construction easement to avoid impacting other areas; will identify water bodies that may be affected by construction to protect them; and will identify drainage patterns to a body of water and locate areas where control measures such as bales of hay and strainers will be installed. Also, a CES Plan inspector will oversee the development of the project, and will report its findings to the EQB.

- **Submit a Notice of Intent to the US Environmental Protection Agency (EPA) and prepared a Storm Water Pollution Prevention Plan (SWPPP).** This Plan will be finalized using the EPA guidance, Developing a Stormwater Pollution Prevention Plan: A Guide for Construction Operators and staff that accompanies it.

- **PREPA will present written notification to the EQB on the initiation of activities.** Such notice shall be not later than five (5) business days following the commencement of any activity defined in the CES Plan.

b) **In the Rio Abajo State Forest,** no impact will occur because the pipeline alignment will use the existing PR-10 easement in that area. This forest was previously fragmented by the construction of PR-10. The Via Verde project proposes to use 8.4 miles of this road right-of-way to avoid further fragmentation of the forest, as well as to prevent additional impact to the karst area at said location.

c) **State Forest De La Vega** is the only forest the project will directly impact. However, the impact will be minimal (only 0.0086 square mile will be directly impacted). This 0.0086 square mile corresponds to a length of 0.43 mile of pipe located within the forest, by the 100 feet width of the initial construction area. This constitutes only 0.47% of the forest to be temporarily impacted. Minimizing fragmentation is an important factor to promote biodiversity. To mitigate this minor impact, PREPA intends to acquire land adjoining several sections in Forest De La Vega in order to connect isolated parts to further minimize fragmentation within this state forest. These lands will be devoted to conservation. The whole process will be done in coordination with DNER.

- **In the case of wetlands,** the impact is a temporary one, and will occur during installation of the pipeline. As proposed, the project does not involve any permanent impact to wetlands, so there is minimal, if any, cumulative impact in association with other actions. To further minimize wetland impacts the following measures will be taken:
  - Limit construction to a right-of-way of 50-feet,
  - Demarcate the easement to restrict the removal of vegetation and avoid impacts to the wetland outside of this area.
  - Implement control measures to prevent erosion and sedimentation or minimize sediment transport to other areas of the wetland.
  - No vehicles are allowed to leak oil or other liquids to pollute the wetland. If a leak occurs during construction, spill kits will be used to clean and remove material to a control workspace.

The project crosses north and northwest of San Pedro Swamp (Municipality of Toa Baja), where it is associated with the mouth of the Cocal River and in forested wetland areas of Punta Salinas. In these sections the pipeline will be installed utilizing Horizontal Directional Drilling (HDD) and cross at depths (over 60 Feet) well below the root zone of trees. The savanna areas of this swamp, which could be affected by pipeline construction, are (or have recently been) used for commercial planting of grass. It must be pointed out that Via Verde project was originally and is still designed and planned to comply with established USACE Nationwide Permits associated with the construction work covered under Section 404 of the Clean Water Act. The characteristics of this particular project are a clear indication of the limited impact of the pipeline to the bodies of water, mangroves, and wetlands located within the designated alignment.

Roads will be crossed by the pipeline project utilizing the cross boring technique to avoid impact to infrastructure and public transit. The pipeline will be installed at least 4 feet below the road, or as required by the Highway Authority, both state and federal, as applicable. These sections of the pipeline are designed to withstand the weights associated with road vehicles passing over it.

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February 24, 2011

Mr. Edgar Garcia
Regulatory Project Manager
Antilles Regulatory Section
US Army Corps of Engineers
400 Fernández Juncos Avenue
San Juan, Puerto Rico 00901-3299

Re: Additional information requested for Via Verde project
SAJ 2010-02881 IP-EWG

Dear Mr. Garcia:

To facilitate the evaluation of the data and responses previously provided in our letter of January 28, 2011, supplemental data and information are being presented. Specifically, where we previously referenced the Final Environmental Impact Statement, approved in November 2010, we are providing information to address the issues raised in your December 22, 2010 letter, and at the interagency project delivery team (PDT) meeting held on February 1, 2011.

Project Impacts:

Many actions have been taken, both in the preliminary planning for the project, and more recently, in adjustments to the proposed alignment and construction techniques, to minimize or avoid impacts. In addition to the information provided in our January 28, 2011 letter, these efforts aimed to avoid project impacts include the following:

- As previously discussed, the alignment entails a 150 feet easement, that includes 50 feet of the permanent operational Right of Way (RoW), a 50 feet construction RoW, as well as 50 additional feet of the maintenance RoW. Notwithstanding that, **when traversing near towns and communities**, every effort has been made to locate the pipeline alignment to avoid populated areas. Where this is not possible, the Puerto Rico Energy Power Authority (PREPA) will allow a 150-foot clearance distance from the actual pipeline location to any residential building, to provide as much setback as reasonable.

- After due consultation with the PR Planning Board, the proposed project was also rerouted **to avoid some commercial developments, as well as future residential areas** that had completed the required Planning Board process but construction has not been initiated yet. The alignment was altered to avoid both of those cases.

- In early designs, the pipeline originally crossed three forests (Bosque del Pueblo, Rio Abajo Forest and Forest De La Vega). To avoid impact to these forests, the design of the alignment was varied as follows:

    a) **El Bosque del Pueblo State Forest** was completely avoided by moving the original alignment more to the west and outside the boundary.

Classification: UNCLASSIFIED
Caveats: NONE

and the geologic and geotechnical information is documented. This has a double purpose: confirming that the conditions of the subsoil coincide with those on which the design was based, particularly in sections that require engineering controls, and it facilitates a rapid response to any finding of unfavorable conditions of the subsoil during this stage.

The geologic limitations that are being evaluated, and which were commented during the Public hearings at the JCA are:

1. Slide-prone soils[3]; several sections, which include the Cordillera Central, run through terrain whose geology and topography make them susceptible to slides.

2. Sinkholes - two sections of the alignment cross parts of Puerto Rico's Northern Karst Zone.

3. Liquefaction - a section in the south coast and one in the north cross through young soils (in geologic terms) which are saturated by the watertable. These include sandy soils of little compaction that are susceptible to liquefaction during a strong earthquake.

4. Geologic faults - the alignment crosses the Great Southwestern Puerto Rico Fault Zone.

5. Soft soils - along the section that runs south of Caño Tiburones and locally in alluvial valleys and costal plains of the route.

6. Erosion - The alignment crosses 10 named rivers and many secondary stream beds that are subject to erosion during rising waters. Likewise, the costal sections could be exposed to marine erosion, particularly considering the rise in the ocean level that started at the end of the last glacial period and which is compounded by global warming.

The potential impact of these limitations is variable and is described in the following paragraphs, together with a general discussion of available measures to minimize or eliminate its possible effects.

Slides

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3 To the effects of this document, the term 'slide' refers to all downslope movements of masses of soil, rocks and/or a mixture of both. A variety of types of slides occur in Puerto Rico which are distinguished by the velocity of the movement and by the manner in which the affected terrain is displaced, for example: falls, rolls, flows or translational movements.

The presence of deep residual soils, highly fractured rocks and a multitude of moderate to severe slopes are favorable conditions for the occurrence of gravitational movements, for which reasons slides are ubiquitous throughout the Cordillera Central, since it is the principal agent of geomorphic evolution in the region. For this reason any construction project in this area must take in consideration, in a greater or lesser degree, the potential for slides.

The greatest danger slides present to Vía Verde is a break in the pipeline due to the supporting ground giving way, and sliding, flowing or collapsing downhill. Since the pipeline will be buried at a depth of 4 feet at the minimum, which protects it from material that could fall from above, the impact of a slide occurring at a higher elevation of the alignment would tend to be limited to the pipeline access and maintenance works. At the same time, the project does not require the construction of significative cuts and once completed, it does not create a condition of increase in the susceptibility to slides, except in the measure the trench could affect the infiltration of water into the subsoil, a situation that is addressed through its design and construction. In fact, the pipeline weights less than the soil it displaces, so that contrary to most construction works, it does not produce an increase of the loads on the subsoil.

study of photointerpretation and field recognition to evaluate the potential for slides along the route of Vía Verde. This entails the identification of old slides, some of which could continue to be active or could reactivate, and sections whose geology and topography indicate the potential of instability if the project proceeds without adequate controls. The study will cover the following sections: the crossing of Saboruco Hills, the ridges and hills of the piedmont south of the Cordillera, and the mountains the Cordillera between Peñuelas and Utuado. Also to be evaluated stretches where the alignment crosses one of the limestone cliffs that form the banks of the Grande de Arecibo and Manatí rivers and Río Indio in Vega Baja.

In case any stretches were to be found on old slides or in terrain with potential for instability, we will proceed to evaluate the options of realigning the route or implement engineering measures to stabilize the soil. One variant of the realignment is to deepen the line with Horizontal Directional Drilling (HDD) to cross beneath the unstable soil. There will be cases in which the final decision will require additional geological evaluations and detailed geotechnical studies, which would in turn provide the criteria to implement the HDD option or to design stabilization measures. Regarding the latter, they seek to improve the balance between the forces that resist the movement of a mass of soil and/or rock and the forces that induce it to move. There is extensive literature on the diverse techniques and structures to achieve this improvement, many of which have already been applied in Puerto Rico. The decision on realignment and the stabilization works to be used will depend on the geologic and geotechnical characteristics particular to each section of interest.

Sinkholes

The Geotechnical, Geological and Geophysical Engineering techniques allow us to study sinkholes in depth and in consequence to make recommendations, be it for highways or rights-of-way (AAA or AEE). In this manner it is possible to design these projects so that the flow into the sinkhole is never blocked. Therefore, the soil where the sinkhole is located is never compacted or covered, rather it is habilitated to continue receiving stormwater runoff.

Usually the term 'compact' is used as a synonym for refilling with processed allochtonous material, which in typical cutting and filling projects has relatively low permeabilities. The case at hand is not a typical cut and fill project. The sinkhole is habilitated with filters designed to permit the flow of water whenever the project requires it.

Techniques in geotechnical, geologic engineering and geophysics allow us to model the sinkholes in two and three dimensions. This permits us to evaluate and analyze the sediments naturally accumulated in the bottom of the sinkholes and the limestone rocks underlying the sinkhole, which are at the same time the walls of the sinkhole.

Studies made during the 80's, 90's and 2000 decades have contributed to our knowledge of the formation and the hydraulic mechanics of sinkholes. This includes the detection of cavities in the sediments and cavities in the limestone rocks.

Regarding the publication "Karst Formation in Puerto Rico, a Vital Resource", the three problems they mention (differential compaction, suffusion and cavity collapse) have been considered in projects already made in Puerto Rico during the past 30 years (i.e.: PR-10 between Arecibo and Utuado) and will be considered in the Vía Verde project.

Hydrology and hydraulics techniques, added to water injection tests in water injection wells, all of it monitored by water flow and amount of precipitation gauges at different periods of recurrence, has allowed us (since the 1980's) to establish: a)the sinkhole's filtration capacity, and b)the filtration capacity of the same sinkhole after habilitating it with filters designed to permit (and not restrict) the flow of water into them.

This type of design is a multidisciplinary one in which Geotechnical Engineering is combined with the design of pipelines, highways, hydrology-hydraulics of each sinkhole, Geophysics (including surface seismic refraction, seismic refraction inside a drill-hole (Vertical Seismic Profiling, Down-hole Seismic Refractions, Cross-Hole Seismic Refraction)), electrical conductivity and resistivity, magnetism studies, micro-gravity studies, radar, dye tests between sinkholes, and studies of fractures in the Karst at a regional level (Fracture Analysis Using Remote Sensing Techniques).

Figures 1 and 2 show an example of projects designed and constructed in Puerto Rico. These studies were conducted during the 80's and 90's, with what was known as "State

of the Art". **Figures 3,4,5, and 6** show interpretations made with the same methods, but now with new techniques that allow us to visualize the sinkhole in three dimensions.

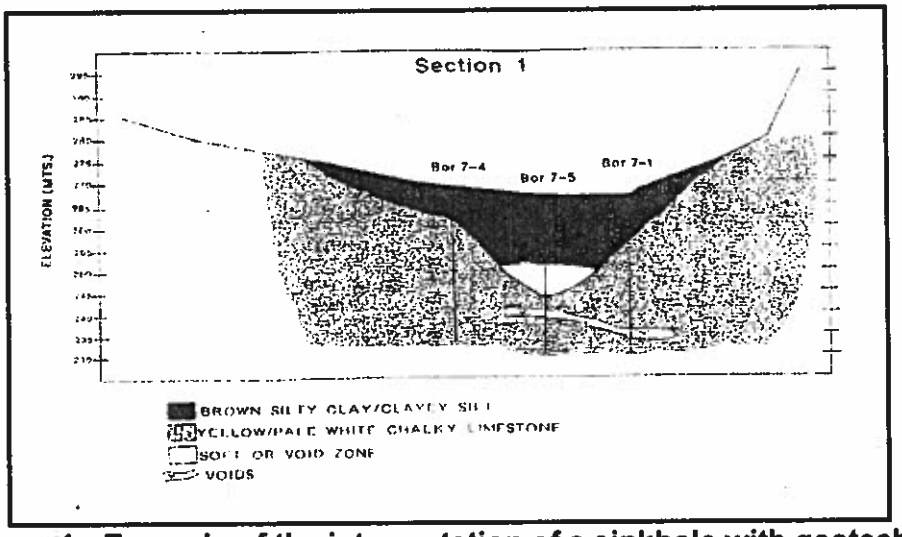

Figure 1 - Example of the interpretation of a sinkhole with geotechnics and geophysics.
1983 to 1990. (Rodríguez & Vázquez - 1999)

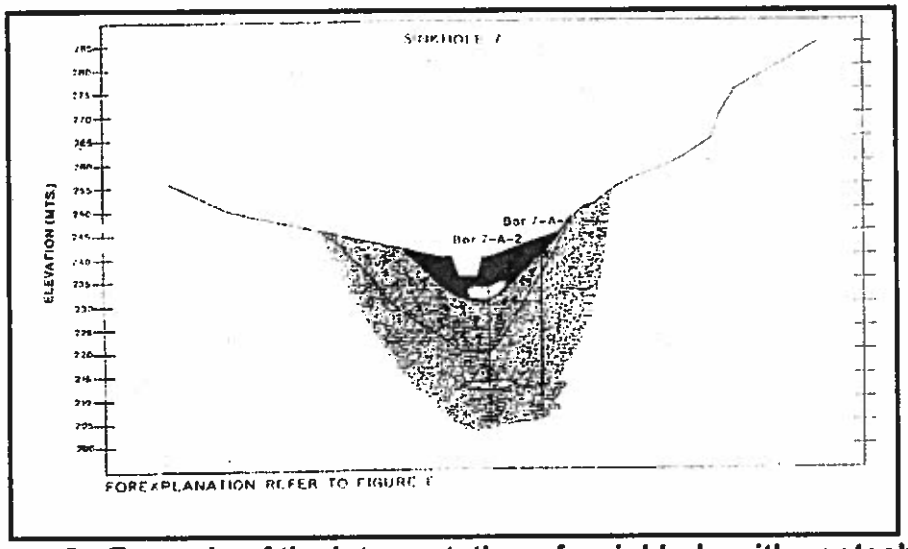

Figure 2 - Example of the interpretation of a sinkhole with geotechnics and geophysics.
1983 to 1990 (Rodríguez & Vázquez - 1999)

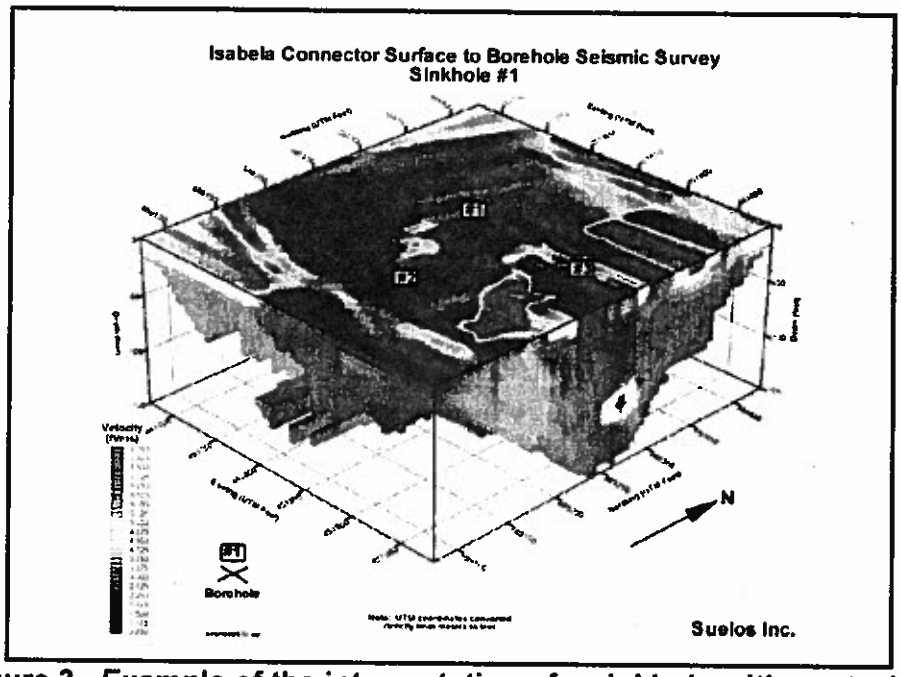

Figure 3 - Example of the interpretation of a sinkhole with geotechnics and geophysics. 2005

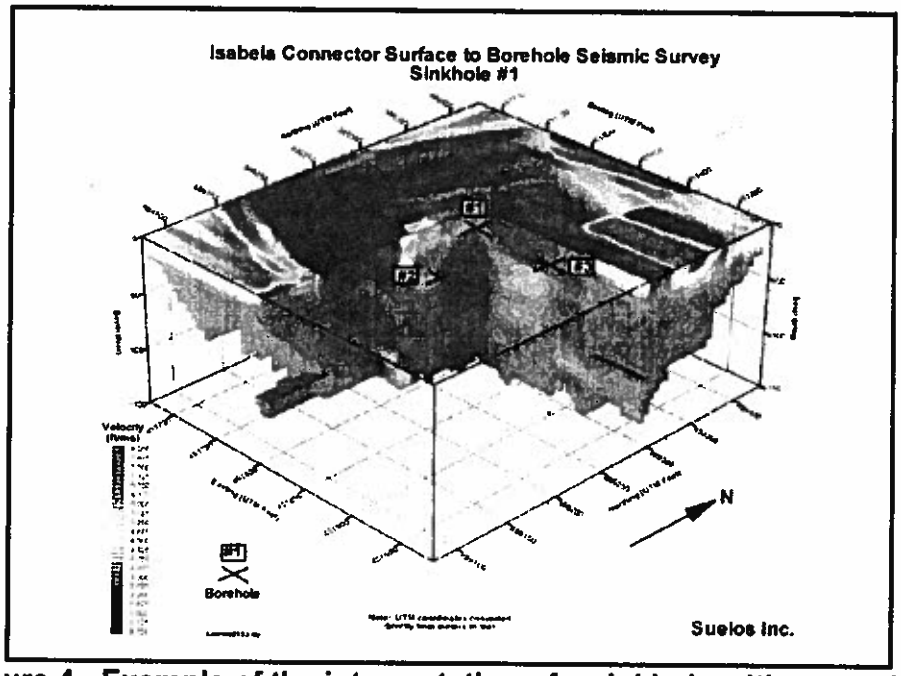

Figure 4 - Example of the interpretation of a sinkhole with geotechnics and geophysics. 2005

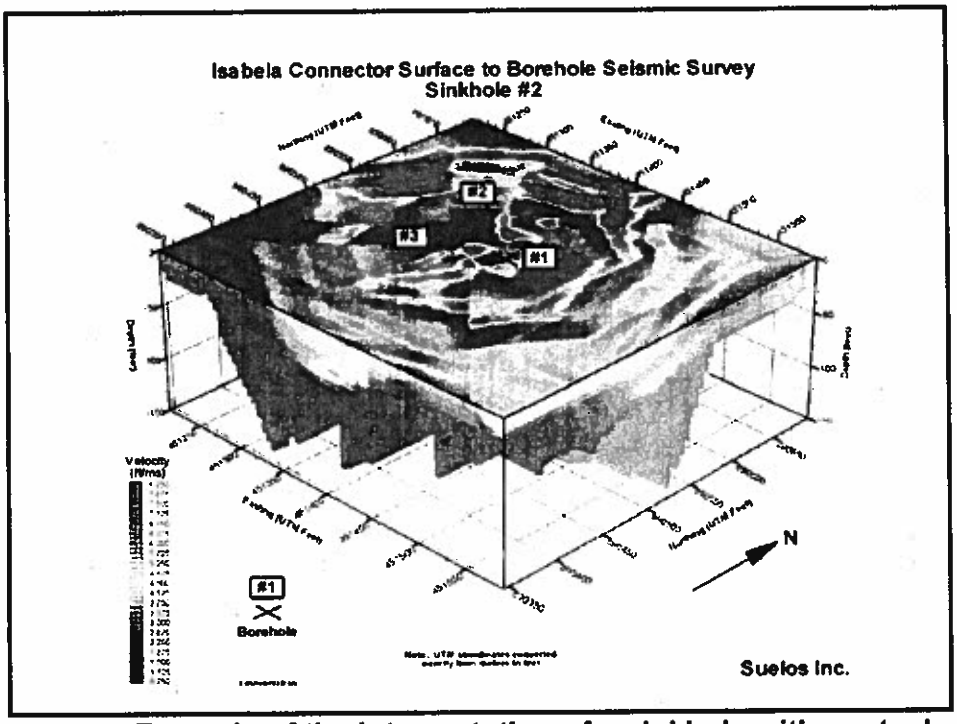

Figure 5 - Example of the interpretation of a sinkhole with geotechnics and geophysics. 2005

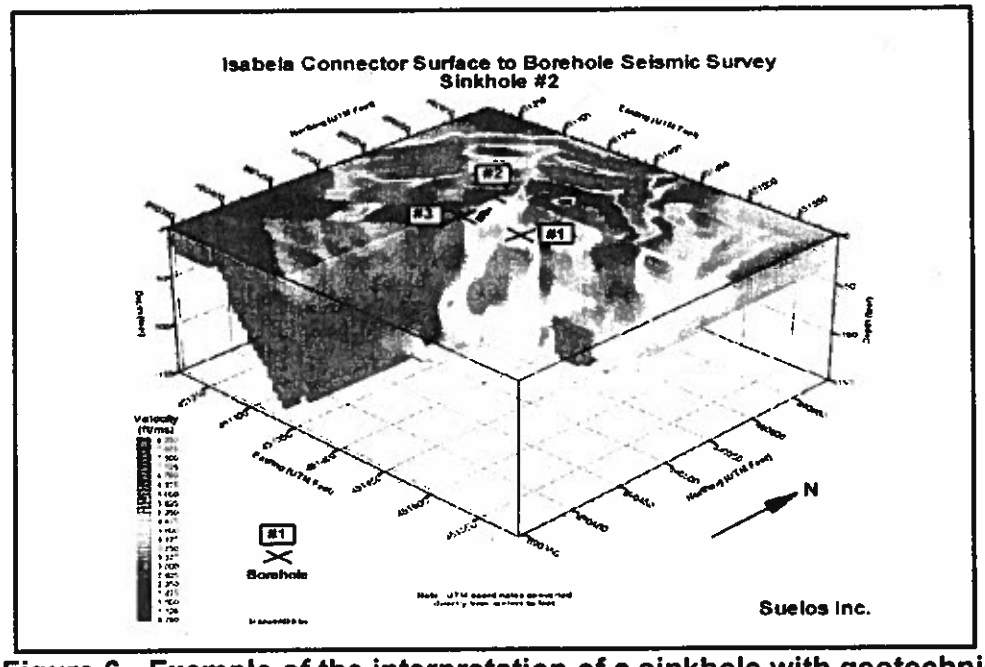

Figure 6 - Example of the interpretation of a sinkhole with geotechnics and geophysics. 2005

Figures 7 and 8 show sections of recommendations for said sinkholes. The objective was to issue the free flow of stormwater runoff using inverted filters and instrumentation to monitor the behavior of the filter during the construction of a highway.

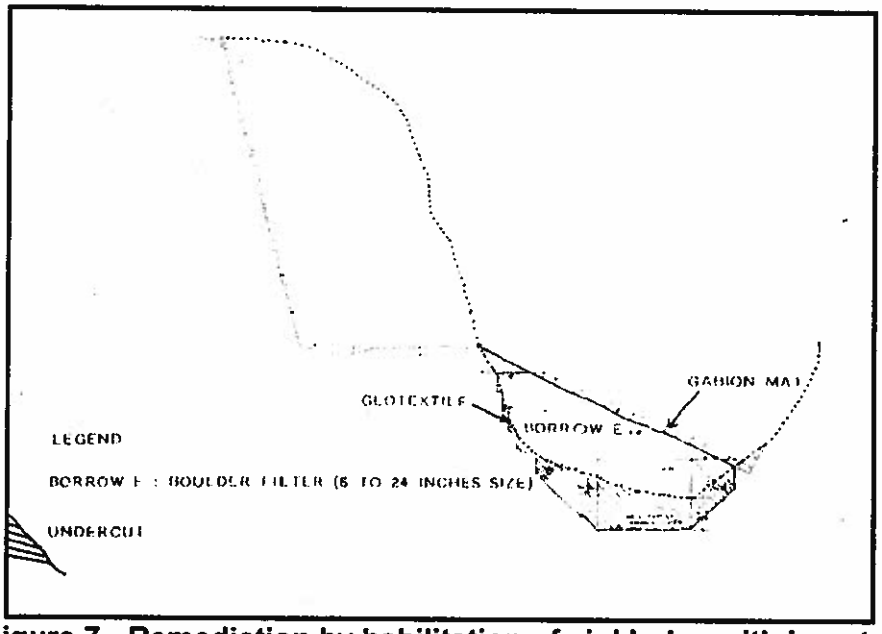

Figure 7 - Remediation by habilitation of sinkholes with inverted filter. (Rodríguez & Vázquez 1999)

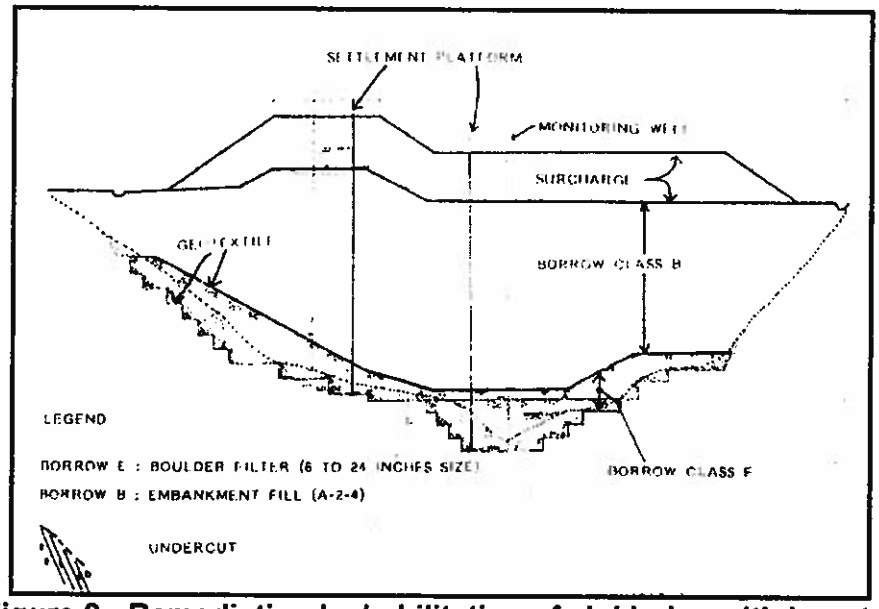

Figure 8 - Remediation by habilitation of sinkholes with inverted filter. (Rodríguez & Vázquez 1999)

These are some of several alternatives that will be evaluated to optimize the installation of the pipeline and reduce to a minimum the impacts on sinkholes.

The Vía Verde project does not compare with PR-10 between Arecibo and Utuado in the magnitude of Vía Verde. While earth movements of great magnitude were made in PR-10 to accommodate the highway and the embankments, in the case of Vía Verde the construction is for the installation of a 24-inch diameter pipeline. The habilitation of sinkholes would be considerably much less than that of a highway like PR-10 or the Isabela Connector (where 5 sinkholes adjacent to the already constructed and operating Connector were habilitated).

Another alternative to be evaluated is moving the alignment around the edges of the mogotes. Also, the use of the HDD installation method can be combined with a layer of filter. In that way we can explore the alternative of drilling through the walls of t he sinkhole at a minimal elevation which would allow us to install a minimum of filters.

The alternative selected after all the required studies mentioned before will be evaluated including the technical and the economical aspects.

The route presently is located over large part of the Karst platform in the north of Puerto Rico from where it crosses PR-10 near the Dos Bocas Reservoir. From then on, it will be located along the highway's right-of-way. The highway and the right-of-way were treated during the 90's during the construction of PR-10 between Arecibo and Utuado, through the habilitation of 12 active sinkholes. These 12 active sinkholes were treated and habilitated as in the examples shown in **Figures 1 thru 4**.

There will be no negative effect in the already constructed treatment of these 12 sinkholes. In those portions in which it crosses over the filter treatment, the pipeline's effect on the sinkholes' filtering capacity will be practically negligible. This effect can be calculated and balanced over the capacities for which they were originally designed.

The project will not affect the mitigation measures taken for the construction of PR-10 in what concerns the Karst zone. Geotechnical and geophysical studies will be conducted to avoid impacting sinkholes or aquifers, or the integrity of the project. Projects of the magnitude of PR-10 were constructed under the full-time supervision of geotechnical engineers, geologists and biologists. Vía Verde will also have that type of full-time supervision on the critical zones.

Liquefaction

The stretch of Vía Verde that runs from the EcoEléctrica terminal to the Tallaboa River valley in Peñuelas and that extends from the area known as El Cocal to the Bayamón River in Toa Baja, traverse over land that contains sandy soils susceptible to become liquefied during a strong earthquake. Liquefaction is a phenomenon that occurs mostly in fine loose sands (poorly compacted) that are saturated, that is, that have the spaces

between the grains (voids) full of water. What happens is that during the earthquake, the grains of sand tend to be compacted and rearranged. The collapse of the soil compresses the water present in the voids, which not being able to drain quickly, exerts an opposite pressure against the grains. Where this pressure is equated to the weight of the grains, the sand loses all frictional resistance and behaves like a fluid. The greatest danger this represents to Vía Verde is the dislocation of sections of the pipeline in stretches in which the soil surrounding it liquefies, or if it sinks or slides over a deeper deposit of liquefied sand.

In the Levittown Coast stretch, the pipeline will be installed through the HDD technology. This will permit locating it at depths greater than 50 to 60 feet. Soil at these depths exhibits greater compaction, therefore they are more stable and not prone to liquefaction. In this way, the risk of a possible liquefaction of the costal soils affecting the pipeline's stability is eliminated.

Geological Faults

Between Peñuelas and Adjuntas, the route crosses the Great Southwestern Puerto Rico Fault Zone, one of the principal structural features of the geology of the Island. Comments have been raised about the possible activity that the faults comprising this system, and the impact they could have on the pipeline, both in the sense of some fault breaking the ground surface and/or producing an earthquake near the pipeline.

The concept of the activity of geological faults is one of which there is no precise definition. On the contrary, there are multiple definitions, many of which are codified in regulations and protocols of governmental entities. Most of them are based on the following criteria:

1. That there is historical and/or geological evidence of a break along the fault in recent times, for which different entities specify different periods, such as the Holocene Epoch (the past 10,000 to 20,000 years) or the Quaternary Period (the past 2 million years, which includes the Holocene). The geological evidence can be of several types, including Holocene or Quaternary soil or rock that has faulted, and a range of geomorphic traits produced by movements along the faults, such as fault scarps, lineal valleys and river or coastal terraces, among others.
2. Seismic information of adequate precision that relates the seismic activity with the fault in question.
3. That the fault has a structural relationship to another fault that complies with one of the previous criteria.

It is instructive to look at the time some regulators use in the definition of activity. The Federal Government's Nuclear Regulatory Commission uses the past 500,000 years as the evaluation criteria for the construction of nuclear power plants, structures on which

the impact of a fault movement could be catastrophic. The U.S. Army Corps of Engineers uses a term of 35,000 years for the construction of dams, another type of structure whose stability is critical for thousands of citizens. On the other hand, the State of California stipulates a term of 11,000 years (Holocene) as a zoning element. The construction of most structures for dwelling or extended use by humans is prohibited within a 30-meter strip of any active fault, but the construction of other types of structures is not restricted as long as they are designed and constructed with the necessary provisions to insure the safety of citizens.

The Great Southwestern Puerto Rico Fault Zone consists of a series of geologic faults generally oriented from southeast to northwest that were identified by the Federal Geologic Service (USGS) in the 60's and 70's when the region's geologic quadrangle maps were prepared.[4] The maps illustrate the traces of the faults with thick lines whose continuity indicates the reliability of the location shown: a continuous line represents a fault located with a fair amount of certainty, a broken line indicates an approximate location and a dotted line, which means that the presence of a fault is inferred, which fault is presumed to be buried by soil or rocks of lesser age and cannot be observed directly. Throughout the Great Southwestern Fault Zone, the continuous and broken lines occur in rocks that date from the Cretaceous to the Miocene, that is, rocks that were formed more than 5 million years ago. Where the trace crosses alluvial sediments of the Quaternary period (which comprises the past 2 million years), the faults are identified with dotted lines. This indicates that the faults have not impacted the recent sediments. Nor is there geomorphic or seismological evidence that points to some recent activity, for which reason the faults are considered as inactive or incapable of seismic movement. Nevertheless, and to ensure the safety of the people, the AEE will evaluate and document the geology of the excavation in the stretches that cross the charted faults to confirm their inactivity.

On a related matter, the evaluation of the seismicity of the Vía Verde route in relation with the pipeline's seismic-resistant design, has been questioned. Regarding this, the pipeline will be designed and constructed in accordance with the requirements of the Puerto Rico Construction Code and the applicable state and federal rules. It bears pointing out that typically, the cases of damage to underground pipelines that have occurred during earthquakes are due to some type of flaw in the soil in which they are

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One of the comments made during the Public Hearings questions the validity of the geologic maps because they were prepared 50 to 60 years ago. Although they suffer changes related to meteorization or possible erosion or sedimentation, the soils and rocks present in a place are generally the same as those that were there 50 or 60 years ago, unless the site had been impacted by a major event such as a great landslide or a break and displacement along a geologic fault, events we know have not occurred since the maps were made (we could also include human activities related to the excavation and fill as possible agents of change). On the other hand, the USGS maps are official documents used for planning processes by the concerned state and federal governmental entities.