BROADWATER

Resource Report No. 11

Safety and Reliability

FOR A

PROJECT TO CONSTRUCT AND OPERATE A

LIQUEFIED NATURAL GAS RECEIVING TERMINAL

IN

LONG ISLAND SOUND

LONG ISLAND, NEW YORK

UNITED STATES OF AMERICA

JANUARY 2006

Sensitive Security Information has been removed from the Public Volume and is contained in the Sensitive Security Information Volume.

PUBLIC

RESOURCE REPORT 11 – RELIABILITY AND SAFETY

Minimum Filing Requirements	Location in Environmental Report
• • Describe how the project facilities would be designed, constructed, operated, and maintained to minimize potential hazard to the public from the failure of project components as a result of accidents or natural catastrophes. (§ 380.12(m))	Sections 11.2 through 11.8

Environmental Information Request
September 30, 2005

Request	Location in Environmental Report
1. Provide the following information on the planning, development, and completion of the Emergency Response Plan for the overall Project:	Section 11.6
a. Contact the appropriate state Fire Marshal in order to begin the development of an effective comprehensive Emergency Response Plan. Documentation of this coordination/correspondence should be included in Resource Report 11;	Appendix B
b. Specify the timeline for completing and submitting the Emergency Response Plan. Under the Energy Policy Act of 2005, this must be submitted prior to final approval to begin construction;	
c. Describe any shore-based emergency response capabilities to be provided by Broadwater, including types of equipment, level of staffing, locations, and other relevant information; and	
d. Identify the communities and officials that Broadwater will maintain contact with (as stated on Page 11-36).	

Environmental Information Request
September 30, 2005

Request	Location in Environmental Report
2. Provide simulation/modeling of LNG carrier transits from international waters to the FSRU which identifies the items listed below: a. Tides, currents, and wind; b. Passing vessel distance and direction from the LNG carrier, passing vessel size, and LNG carrier size; c. LNG vessel berthing/unberthing maneuvers; d. Tug requirements; and e. Allision with an LNG vessel at berth due to the loss of steering or propulsion on a passing vessel.	Section 11.4.1.3
3. Provide information on the number of new or existing tugs that will be required for the project, where the tugs will be based, what types of fuel they will use, and where they will be refueled.	Section 11.4.2.2
4. Provide average monthly meteorological data representing a 10-year period for wind speed, atmospheric temperature, humidity, and water temperature for the proposed location of the FSRU.	Appendix A
5. The text of the last paragraph on Page 11-9 should be revised to indicate that a Letter of Recommendation may be issued from the Coast Guard to the project applicant, rather than to FERC.	The indicated text has been revised.

Environmental Information Request
September 30, 2005

Request	Location in Environmental Report
6. In Section 11.3.1, FSRU Safety, provide a quantitative assessment of how comparable the FSRU would be to the vessels studied in the Sandia report. This assessment should compare the key design characteristics of the proposed FSRU with those of the vessels studied in the Sandia Report, including the following: a. The dimensions of the FSRU cargo containers; b. The maximum liquid capacity of each tank; and c. The maximum liquid level above the water line for a full cargo container.	Section 11.3.1.1
7. Describe the queuing plan for LNG carriers that arrive in the area when berthing space is not available at the FSRU.	Section 11.4.2.3
8. Provide evidence that the proposed membrane tanks of the FSRU can withstand the design sea states at various tank fill levels. This analysis should address the structural integrity of the FSRU, a sloshing analysis that includes applicable cargo sloshing requirements/limitations for the FSRU, and the cargo handling methods that would be used to avoid a damaging sloshing event.	Section 11.3.3
9. Provide information to validate the comparison of the FSRU to FPSOs, particularly with regard to storage tank structures, e.g., insulated membrane liners, and the mooring system integrity during storm events.	Section 11.3.4.2
10. In the “Fire Suppression” discussion on Page 11-18, specify which fire hazards would be covered by the fire suppression systems listed.	Section 11.3.3.7

Environmental Information Request
September 30, 2005

Request	Location in Environmental Report
11. Identify the hazards and associated safety measures for all hazardous substances which may be present on the FSRU. This information should include descriptions of safety systems, procedures, and equipment associated with receipt, storage and handling of all hazardous materials such as odorant, ammonia, and diesel fuel.	Section 11.3.2.3
12. Identify military activities and military installations (including distances from the FSRU and the LNG carrier routes) that could be affected by the FSRU or the transit of LNG carriers from international waters to berth.	Section 11.4.1.4
13. Provide information on the design storm for the Project, including the following: a. State what the design storm would be for the design of the FSRU mooring system and provide specific information on relevant conditions of the storm event, such as wave height and wind speed; and b. Provide an engineering analysis documenting the ability of the yoke mooring system and the mooring tower to withstand the design storm.	Section 11.3.4
14. Describe the maximum sea states and other relevant weather conditions that would be permissible during LNG carrier transit, berthing, and unloading in Long Island Sound and the procedures that the LNG carriers would follow when those sea states and weather conditions are exceeded.	Section 11.4.2.3
15. Resource Report 11 should include an analysis of environmentally sensitive areas and population densities along the proposed route of the LNG carriers transiting to and from the FSRU.	Section 11.4.1.3
16. Describe the logistics and potential safety risks to vessel traffic of installing the temporary pig receiver, performing pigging operations, and retrieving the temporary pig receiver.	Section 11.5.6.1

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List of Acronyms and Abbreviations

ABS	American Bureau of Shipping
API	American Petroleum Institute
ASD	azimuthing stern drive
bcf	billion cubic feet
bcfd	billion cubic feet per day
COMSUBGRU	Commander Submarine Group
COTP	Captain of the Port
DCS	distributed control system
ERP	Emergency Response Plan
ESD	emergency shutdown
ESDS	emergency shutdown system
FERC	Federal Energy Regulatory Commission
FPSO	floating production, storage, and offloading
FSRU	floating storage and regasification unit
GT	gas turbine
H_s	significant wave height (meters)
HSSE	Health, Safety, Security, and Environment
IGC	International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)
IGTS	Iroquois Gas Transmission System
INS	Immigration and Naturalization Service
IPS	instrumented protective system

ISPS	International Ship and Port Facility Security
km	kilometers
LNG	liquefied natural gas
m	meter
m^3	cubic meter
mph	miles per hour
MTSA	Maritime Transportation Security Act
NFPA	National Fire Protection Association
nm	nautical mile
NVIC	Navigation and Vessel Inspection Circular
OCIMF	Oil Companies International Marine Forum
O & M	operation and maintenance
PFSP	Preliminary Facility Security Plan
PPE	personal protective equipment
PPSAO	Preliminary Project Security Assessment and Overview
PSVA	Preliminary Security Vulnerability Assessment
RFP	Request for Proposal
SCBA	self-contained breathing apparatus
SCR	selective catalytic reduction
SIGTTO	Society of International Gas Tanker and Terminal Operators
SIRE	Ship Inspection and Reporting
SOLAS	Safety of Life at Sea
SSI	sensitive security information

SSSV	subsea safety valve
STV	shell and tube vaporization
T_p	time between peak periods (seconds)
USCG	United States Coast Guard
USDOT	United States Department of Transportation
WHRU	waste heat recovery unit
YMS	yoke mooring system

11. SAFETY AND RELIABILITY

11.1 INTRODUCTION

Broadwater Energy LLC, a joint venture between TCPL USA LNG, Inc., and Shell Broadwater Holdings LLC, is filing an application with the Federal Energy Regulatory Commission (FERC) seeking all of the necessary authorizations pursuant to the Natural Gas Act to construct and operate a marine liquefied natural gas (LNG) terminal and connecting pipeline for the import, storage, regasification, and transportation of natural gas. The Broadwater LNG Project (the Project) will increase the availability of natural gas to the New York and Connecticut markets through an interconnection with the Iroquois Gas Transmission System (IGTS). The FERC application for the Project requires the submittal of 13 Resource Reports, with each report evaluating project effects on a particular aspect of the environment.

Resource Report 11 describes the potential effects on the public that could result from the failure of Project components due to natural catastrophes, accidental failures, or deliberate harmful events, as well as the potential consequences of these types of events on the Project's ability to reliably supply natural gas to customers.

The proposed Broadwater LNG terminal will be located in Long Island Sound (the Sound), approximately 9 miles (14.5 kilometers [km]) from the shore of Long Island in New York State waters, as shown on Figure 11-1. The LNG terminal facilitates the sea-to-land transfer of natural gas. It will be designed to receive, store, and regasify LNG at an average throughput of 1.0 billion cubic feet per day (bcfd) and will be capable of delivering a peak throughput of 1.25 bcfd. The Project will deliver the regasified LNG to the existing natural gas pipeline system via a pipeline interconnection to the IGTS pipeline. Onshore facilities are discussed in the Onshore Facilities Resource Reports.

The proposed LNG terminal will consist of a floating storage and regasification unit (FSRU) that is approximately 1,215 feet (370 meters [m]) in length, 200 feet (60 m) in width, and rising approximately 80 feet (25 m) above the waterline to the trunk deck. The FSRU's draft is approximately 40 feet (12 m). The freeboard and mean draft of the FSRU will generally not vary throughout operating conditions. This is achieved by ballast system control to maintain the FSRU trim, stability, and draft. The FSRU will be designed with a net storage capacity of approximately 350,000 cubic meters (m^3) of LNG (equivalent to 8 billion cubic feet [bcf] of natural gas), with base vaporization capabilities of 1.0 bcfd using a closed-loop shell and tube (STV) vaporization system. The LNG will be delivered to the FSRU in LNG carriers with cargo capacities ranging from approximately 125,000 m^3 up to a potential future size of 250,000 m^3 at the frequency of two to three carriers per week.

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Source: ESRI StreetMap, 2002.

Figure 11-1
Proposed Broadwater Project
Location in Long Island Sound

The FSRU will be connected to the send-out pipeline, which rises from the seabed and is supported by a stationary tower structure. In addition to supporting the pipeline, the stationary tower also serves the purpose of securing the FSRU in such a manner to allow it to orient in response to the prevailing wind, wave, and current conditions (i.e., weathervane) around the tower. The tower, which is secured to the seabed by four legs, will house the yoke mooring system (YMS), allowing the FSRU to weathervane around the tower. The total area under the tower structure, which is of open design, will be approximately 13,180 square feet (1,225 square meters [m^2]).

A 30-inch-diameter subsea natural gas pipeline will deliver the vaporized natural gas to the existing IGTS pipeline. It will be installed beneath the seafloor from the stationary tower structure to an interconnection location at the existing 24-inch-diameter subsea section of the IGTS pipeline, approximately 22 miles (35 km) west of the proposed FSRU site. To stabilize and protect the operating components, sections of the pipeline will be covered with engineered backfill material or spoil removed during the lowering operation. Figure 11-1 presents the proposed pipeline route.

This Resource Report contains the following:

- A discussion of hazards and service interruptions that could reasonably ensue from failure of the proposed facilities due to accidents or natural catastrophes;

- A description of measures, including equipment training and liaison with local authorities, to be used to protect the public from failure of the proposed facilities as a result of accidents or natural catastrophes;

- A description of measures to exclude the public from hazardous areas, including a discussion of measures to minimize problems arising from malfunction and accidents;

- A discussion of design and operational measures to avoid or reduce risk associated with accidents or natural hazards such as violent storms, floods, landslides or earthquakes;

- A discussion of contingency plans for maintaining service or reducing downtime as a result of accidents or natural catastrophes; and

- A list of all publications, reports or other literature or communications which were cited or relied upon to prepare the report.

In view of the high population density of the region, Broadwater took considerable care in selecting the proposed Project location. The details of the site selection process are documented in Resource Report 10 (Alternatives). The safety and security of the facility were paramount among the siting considerations. The selection of an offshore location that lies approximately 9 miles from the shore of Long Island and 10 miles from the shore of Connecticut provides a very significant safety buffer. This, coupled with intensive security measures to be employed in the facility design and operation, will provide the highest levels of both safety and security to surrounding communities on the shores of Long Island Sound.

11.2 LNG SAFETY

This section describes the characteristics of LNG, the risks associated with handling the product, and the measures incorporated within the Project design to minimize the risk of accidents. The applicability of federal regulations and industry guidelines is also reviewed.

11.2.1 LNG Physical Characteristics and Potential Hazards

LNG is natural gas (predominantly methane) that has been cooled to its liquid state at atmospheric pressure: -260°F (-162.2°C). Currently, the LNG produced worldwide ranges from 85% to 97% methane, with the remainder consisting of a combination of ethane, propane, and other heavier gases. Other salient features of LNG include the following:

- LNG is transported and stored at ambient (atmospheric) pressures.
- Liquefying natural gas vapor reduces the gas volume for transportation and storage; the volume of gas compared to its liquid equivalent is more than 600 to 1.
- LNG is colorless, odorless, and non-toxic.
- LNG is not soluble in water and if spilled will float on the surface before vaporizing.
- LNG vapor (natural gas) is flammable.
- LNG vapor (natural gas) is colorless, odorless, and non-toxic.
- LNG vapor typically appears as a visible white cloud because its cold temperature condenses water vapor present in the atmosphere.
- The lower and upper flammability limits of methane, the main component of LNG, are 5.5% and 14% by volume at a temperature of 25°C.

For comparison purposes, Table 11-1 lists the flammability limits for methane, the main component of LNG, and other hydrocarbon gases. The other common gases are flammable at lower hydrocarbon-to-air ratios, and the flammable range of methane, although greater than the ranges of other commonly used hydrocarbon gases such as butane and propane, is less than that of other fuels that are transported in bulk.

Table 11-1 Hydrocarbon Flammability Limits

Fuel	Lower Flammability Limit (L_{fl}) % By Volume In Air	Upper Flammability Limit (U_{fl}) % By Volume In Air
Methane	5.5	14.0
Butane	1.6	8.4
Propane	2.1	9.6
Ethanol	3.3	19.0
Gasoline	1.4	7.8
Isopropyl alcohol	2.0	12.7
Ethyl ether	1.9	36.0
Xylene	0.9	7.0
Toluene	1.0	7.1
Hydrogen	4.0	75.0
Acetylene	2.5	85.0

Source: Sandia 2004, page 29.

The hazards associated with the handling and transportation of LNG are well-known and documented, based upon industry experience. Those hazards with the largest potential significance include the following:

- Pool fires;
- Flammable vapor clouds;
- Rapid phase transitions.

For a discussion of these potential hazards, with specific reference to LNG spills over water, refer to Sandia 2004, pages 34-39. In addition to these hazards, there are potential hazards on a smaller scale. Methane, the predominant component of LNG, while not toxic, could present an asphyxiation hazard if present in sufficiently high concentrations. In addition, the very low temperature of LNG represents a potential hazard in the event of a spill to both people and equipment, in the form of cryogenic burns or equipment damage from contact with the cryogenic liquid.

Since the industry commenced operation, there have been a small number of significant incidents involving LNG, which have been documented elsewhere (refer to Foss et al. 2003, pages 73-79 for such a summary).

11.2.2 LNG Supply Sources

There are currently 20 LNG export terminals in operation around the world, and others have been proposed to meet the growing global demand for natural gas. The LNG supply for the proposed Broadwater terminal has not been determined, but it will come from a portfolio of current and future LNG export terminals.

The composition of LNG varies according to the supply source, as can be seen from Table 11-2. As previously noted, methane is the principal hydrocarbon contained in LNG.

Table 11-2 Typical Compositions for Atlantic Basin Sources of LNG

Source	Egypt	Algeria	Nigeria	Angola Rich	Angola Lean	Trinidad	Snovhit Norway
Component							
Methane (%)	91.66	89.40	90.66	86.74	91.66	96.72	92.05
Ethane (%)	6.14	8.35	4.62	6.15	6.53	2.84	4.60
Propane (%)	1.84	1.08	2.91	4.44	1.18	0.35	2.00
i-Butane (%)	0.05	0.15	0.69	0.69	0.01	0.04	0.20
n-Butane (%)	0.06	0.17	1.00	1.34	0.02	0.03	0.10
i-Pentane (%)	0.00	0.08	0.03	0.00	0.00	0.01	0.15
n-Pentane (%)	0.00	0.00	0.01	0.00	0.00	0.01	0.00
n-Hexane (%)	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Nitrogen (%)	0.25	0.77	0.08	0.62	0.57	0.01	0.90
Carbon Dioxide (%)	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Density (kg/m^3)	450.76	456.85	463.25	478.15	449.00	432.82	452.20

Source: ioMosaic 2005, page 9.

11.2.3 LNG Marine Safety Performance

The marine transportation of LNG has a long record of safe operation. Few accidents have occurred since a converted freighter delivered the first LNG cargo in January 1959, none of which involved a fatality directly attributable to LNG or a major release of LNG. The LNG shipping safety record is attributable to continuously improving technology, safety equipment, comprehensive safety procedures, training, equipment maintenance, and effective government regulation and oversight.

The LNG industry has been operating for more than 40 years, and fewer than 20 marine accidents involving LNG have occurred worldwide, none of which resulted in a significant release of LNG (Foss et al. 2003). The Center for Liquefied Natural Gas (2005) reports there have been more than 33,000 LNG carrier trips, covering more than 60 million miles. Today, more than 150 LNG carriers safely transport more than 108 million tonnes of LNG annually to ports around the world. This amount is greater than the total volume of natural gas that is currently consumed annually by the entire U.S. residential sector (EIA 2005, p. 155).

According to the United States Department of Energy, over the life of the industry only eight marine incidents worldwide have occurred involving accidental spillage of LNG. In these cases, only minor hull damage occurred and there were no cargo fires. Seven additional marine-related incidents have occurred with no significant cargo loss. No explosions or fatalities have ever occurred in the marine environment (Sandia 2004, page 28).

11.2.4 Regulatory Framework

The Broadwater facility falls under the regulatory jurisdiction of the Federal Energy Regulatory Commission (FERC). However, due to the marine nature of the proposed import terminal, the United States Coast Guard (USCG) will have a significant review and advisory role in the project.

To ensure that appropriate codes, regulations and standards are applied to the design, construction and operation of the facility, the FSRU has been characterized as essentially an LNG carrier, with additional regasification equipment, moored at a fixed location.

Given the marine nature of the proposed facility and its similarities with LNG carrier design and operation, a ship classification society will be involved in the oversight of the project design process. Classification societies are organizations that establish and apply technical standards in relation to the design and construction of marine related facilities including ships and offshore structures. These standards are issued by the classification society as published Rules. As an independent, self-regulating body, a classification society has no commercial interests related to ship design, ship building, ship ownership, ship operation, ship management, ship maintenance or repairs, insurance or chartering. In establishing its Rules, each classification society may draw upon the advice and review of members of the industry who are considered expert in their field. Classification societies also maintain significant research departments that contribute towards the ongoing development of appropriate advanced technical standards.

LNG carrier design, construction, and operation are comprehensively covered by rules and guidelines and the legislative requirements of national and international authorities. An LNG carrier is typically constructed according to "Classification Society Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk," also known as the "Gas Ship Rules". Compliance with the Gas Ship Rules is ensured through design appraisal and survey during building and commissioning. Although legislative requirements are not, strictly speaking, a classification issue, it is usual for the Classification Society to make compliance with legislative requirements a prerequisite for compliance with its Rules.

Classification Society Gas Ship Rules incorporate the requirements of the International Maritime Organization's *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk* (generally known as the IGC Code). The IGC Code is a *de facto* international standard by virtue of its adoption by the industry and regulatory bodies.

Based on this approach, an extensive array of standards have been adopted based on federal and state standards. Classification Society Rules, and, as appropriate, international standards for design and construction that incorporate appropriate federal, state, national, and international requirements also will be adopted.

Broadwater engaged the services of the American Bureau of Shipping (ABS), one of the world's leading ship classification societies, to ensure that all applicable marine standards are met. On July 27, 2005, Broadwater received an "Approval in Principle" for the Broadwater FSRU from ABS. This document has been provided in an Appendix in Resource Report No. 1, General Project Description. ABS concluded that, while the combination of a FSRU with a yoke moored LNG hull would be a novel combination of systems, the technologies proposed to be employed are not novel and are covered under established Rule criteria.

A partial summary of key elements of the design framework established for the FSRU is as follows:

- U.S. federal requirements (e.g., Code of Federal Regulations, including 49 CFR Part 193 [Liquefied Natural Gas Facilities – Federal Safety Standards] and National Fire Protection Association (NFPA) 59A [Standard for the Production, Storage and Handling of Liquefied Natural Gas], as applicable).

- International Standards - Classification Society Rules as specified by ABS.

- Industry guidelines such as those of the Society of International Gas Tanker and Terminal Operators (SIGTTO) and the Oil Companies International Marine Forum (OCIMF).

The FSRU is designed and will be built in accordance with the provisions contained in the Classification Society Rules and Regulations for:

- The Classification of a Floating Offshore Installation at a Fixed Location;

- The Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk which incorporates the International Gas Code; and

- Rules and Regulations for the Classification of Ships.

Within U.S. waters, the USCG has responsibilities for the management of waterways, marine safety, and security. Broadwater filed a Letter of Intent with the Captain of the Port (COTP), New Haven, Connecticut, on November 9, 2004, to operate an LNG import facility in Long Island Sound. Consequently, the COPT is in the process of reviewing the safety and security aspects of the Project from a marine perspective. Approval of the proposal will culminate in a Letter of Recommendation from the USCG to Broadwater. Part of the USCG's review will be the determination of a safety and security zone around the proposed facility.

Marine safety for vessels and deepwater ports is regulated through a framework of overlapping international treaties and standards, national laws/regulations, and local-, port-, or area-specific rules. The primary enforcement agency for vessels in Long Island Sound is the USCG. The USCG currently boards foreign-flagged vessels under the Port State control program, and may board, inspect, and search any vessel entering a U.S. port.

In general, the purpose of these laws, rules, and regulations is to: prevent vessel collisions, groundings, and other accidents; allow for safe operations at port facilities; provide for the security of the United States; protect the environment; promote safety; and allow enforcement of other applicable laws. The laws, regulations, or rules that apply to a vessel are mainly a function of the vessel's location, flag of registry, and intended port of call, but also depend on the vessel type, size, purpose, and nature of work. Potentially applicable regulations are summarized in Table 11-3.

Table 11-3 Major Laws and Regulatory Requirements for Marine Safety

Law/Regulation/ Agency	Key Elements and Thresholds; Applicable Permits
General Protection	
Convention on the International Regulations for the Prevention of Vessel Collisions at Sea. 1972 (COLREGS) - International Maritime Organization	• Governs the actions of all vessels in international waters. These rules determine the actions a vessel must take to avoid collision, and include rules for following, joining and crossing traffic separation lanes, actions to be taken in conditions of reduced visibility, required lights and sound signals, and other rules designed to prevent collisions. • *Project Applicability:* - Project vessels, including those used in construction, operations, and decommissioning, would be bound by these rules.
14 United States Code (U.S.C.) 89	• Gives the USCG authority for the enforcement of all laws and regulations on U.S. flagged vessels on the high seas, and all vessels within U.S. waters; • *Project Applicability:* - Includes all Project vessels.
33 CFR 160 Port and Waterways Safety. - USCG	• Authorizes the USCG COTP to regulate nearly all vessel traffic within U.S. waters in his/her jurisdiction for safety and environmental reasons. • Authority includes forbidding a vessel's entry into port or operation in U.S. waters, holding a vessel in port for repairs, forbidding cargo transfers, or restricting all vessel operations due to weather, port congestion or other safety reasons. • Mandates LNG carriers give a Notice of Arrival 96 hours prior to arrival, giving their position, last port of call, next port of call, crew roster, cargo manifest, and time of arrival and reporting any equipment casualties that could affect safety. • *Project Applicability:* - All Project LNG carriers would have to give a Notice of Arrival and would be bound by COTP orders.

Table 11-3 Major Laws and Regulatory Requirements for Marine Safety

Law/Regulation/ Agency	Key Elements and Thresholds; Applicable Permits
33 CFR 26, Bridge-to-Bridge Radio Telephone - USCG	• Requires most vessels and dredges in U.S. waters to carry radiotelephone equipment on their bridge capable of receiving and transmitting on the VHF marine band. These vessels are: all power-driven vessels more than 65 feet (20 meters) in length, all towing vessels more than 26 feet (8 meters) in length, vessels more than 100 tons carrying at least one person for hire, and dredges operating in or near a fairway or channel. This requirement greatly enhances a mariner's ability to avoid collisions through providing a means of instant communication. • *Project Applicability:* - Each LNG carrier's bridge would have a communications suite and would utilize these frequencies in conjunction with radar detection to communicate with vessels in the area. - Broadwater FSRU would have a similar communications suite.
Restricted Zones	
33 CFR 165 - USCG	• Designates naval protection zones, which include an area 500 yards (457 meters) around any U.S. naval vessel more than 100 feet (30.5 meters) in length. • All vessels must obtain permission to pass within this zone from the naval vessel or the USCG via VHF channel 16 or other designated frequency. • *Project Applicability:* - Project vessels would need to ask permission from a U.S. Navy vessel if transit within 500 yards (457 meters) is necessary.
33 CFR 165 Safety and Security Zones - USCG	• Establishes safety and security zones in harbors, around vessels carrying hazardous cargoes (including LNG) in specified areas, and at other places or vessels at the discretion of the COTP. • Safety zones protect enclosed areas or vessels for safety or environmental purposes. • Security zones are for the protection of their enclosed sites or vessels from terrorist acts or accidents. • Both can be either stationary or move along with a vessel. • A person or vessel may not enter either type of zone without permission from the COTP or cause anything to be left in such zones. The COTP has the authority to seize control of any vessel in any safety or security zone and may take action to remove anyone or anything from such zones. • *Project Applicability:* - The above security zones would apply to Project LNG carriers. - Enforcement of the security zones around Project LNG carriers would be at the discretion of the COTP. - Establishment of a security zone around Project LNG carriers moored at the FSRU would be at the discretion of the COTP.

11.3 FLOATING STORAGE AND REGASIFICATION UNIT (FSRU)

11.3.1 FSRU Safety

In December 2004, Sandia National Laboratories, at the request of the U.S. Department of Energy (DOE), released a report entitled "*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water.*"[1] In recognition of the potential increase in the number and frequency of marine LNG imports, DOE was interested in developing consistent methods and approaches to be identified and implemented to ensure protection of public safety and property from a potential LNG spill over water. Among other things, the Sandia Report evaluates:

- The potential for breaching an LNG carrier cargo tank, both accidentally and intentionally;
- For such breaches, the potential size of an LNG spill for each breach scenario; and
- An assessment of the potential range of hazards involved in an LNG spill.

The Sandia Report is the most recent analysis of LNG spills over water completed to date and is currently the definitive reference on the subject. From the study findings, three key conclusions (Sandia 2004, page 15) are of particular interest in considering the safety features of the Broadwater proposal:

- In terms of risk to public safety and property, the most significant impacts occur within approximately 500 m (0.31 mile) of a spill due to thermal hazards in the event of a fire. Lower public health and safety impacts were noted at distances beyond approximately 1,600 m (less than 1 mile).
- If a spill does not ignite, a large LNG vapor release is possible but unlikely. Hazard distances would depend upon the size of the breach and the volume of the LNG spill, site-specific conditions, and environmental conditions. The report concluded that a vapor cloud could potentially extend over distances greater than 1,600 m from a spill. For a typical accidental spill, the hazard range was assessed as extending to 1,700 m (1.06 miles). For an intentional spill, the hazard range could extend to 2,500 m (1.55 miles).
- The report also looked at the case of multiple cargo tank failures due to brittle fracture from exposure to cryogenic liquid or fire-induced damage. The report authors concluded that the failure of more than two or three cargo tanks for any single incident was unlikely. The failure of two or three cargo tanks was examined and was felt not to greatly increase (not more than 20-30%) the overall fire size or hazard ranges identified above.

[1] The report is available at http://www.fossil.energy.gov/programs/oilgas/storage/lng/sandia_lng_1204.pdf.

In comparison with these distances, the Broadwater facility is proposed to be located approximately 9 miles (14.5 km) from the nearest shoreline, providing a substantial buffer zone with a consequent reduction of risk to the public. The remote offshore location also allows scope for recreational and commercial marine activities between any proposed safety and security zone and the shoreline.

For comparison purposes, Table 11-4 compares the proximity of populations at existing onshore LNG terminals in the U.S. and the Broadwater proposal.

Table 11-4 Populations in Proximity to the Broadwater Project and Existing Onshore LNG Terminals in the United States

LNG Facility	Estimated Population[1] within 10 miles	Estimated Population within 20 miles
Broadwater (Long Island Sound)	3,443	947,970
Everett (Boston, MA)	1,745,898	2,758,510
Cove Point (MD)	49,014	135,779
Elba Island (Savannah, GA)	154,193	292,148
Lake Charles (LA)	136,825	202,081

Source: U.S. Census.

1 Estimates were obtained by analyzing populations within the census tracts that fell within each buffer zone. For census tracts that were partially traversed, an estimate of the percentage of the tract crossed was determined and the appropriate percentage applied.

11.3.1.1 Applicability of the Sandia Report to the Broadwater FSRU

As mentioned above, Broadwater contends that the results described in the Sandia Report are applicable to the proposed FSRU. Broadwater makes this assertion based upon the following points:

- Construction of the FSRU will follow the same principles as those used for an LNG carrier. The FSRU will utilize a membrane containment system, enclosed in a double steel hull. This construction technique is identical to that used for LNG carriers.

- The similarity in design and construction has been confirmed upon review by ABS, which has issued an Approval in Principle to Broadwater and have concluded that a yoke-moored LNG hull can be designed and constructed in accordance with its Classification Rules.

- The size of the storage tanks proposed for the FSRU are slightly larger than those analyzed in the Sandia Report. However, the design and construction methods for the FSRU hull and the installation of the membrane containment system are virtually identical to those for an LNG carrier.

Further details on the detailed design of the hull and containment system are contained in Resource Report 13 (Engineering and Design Considerations), Section 13.9.

Given that the construction techniques are the same, it is expected that the behavior of the FSRU hull and containment system in the event of a breach, whether accidental or intentional, would be similar in nature to an LNG carrier. In the event of an accidental collision between the FSRU and an LNG carrier or other ship, it is expected that hull breaches will be similar to those evaluated in the Sandia Report. The Sandia Report estimated that a high speed collision with an LNG carrier could produce a cargo tank breach ranging in size from 0.5 m^2 to 1.5 m^2 in area. For intentional breaches, a range of 2 m^2 to 7 m^2 was considered, with a breach of 5 m^2 taken as a representative case. The spill volume considered by Sandia for thermal hazards or vapor dispersion was 12,500 m^3, which was one-half of the assumed LNG carrier tank volume, but also compares favorably to the size of a potential spill from the FSRU.

From these similarities, it can be assumed that LNG release rates and durations similar to those postulated in the Sandia Report would result for the FSRU. Table 11-5 provides a comparison of the cargo tank for the FSRU with the Sandia Report assumptions.

Table 11-5 Comparative Tank Sizes

Item	FSRU	Sandia – LNG Carrier
Cargo Tank Dimensions	50.3 m wide (at widest point) 30.5 m height 33.9 m length	Not stated
Maximum liquid capacity	44,850 m^3	25,000 m^3
Maximum liquid level above the water line for a full storage tank	19.6 m to upper chamfer 21 m to top of tank	15 m

Note: FSRU tank is not rectangular in cross section; therefore, the liquid capacity will be less than the product of the tank width, length, and height.

11.3.2 Hazard Identification

Accidents could occur on the FSRU, on transiting or berthed LNG carriers, or during the performance of facility support operations. Despite the facility's remote location, such accidents could impact the public, facility personnel, or the facility itself. While the public located onshore are unlikely to be impacted by an accident at the FSRU location, the following broad categories of accidents were assessed:

- Accidents due to natural forces such as hurricanes, severe winds, tornadoes, and lightning strikes;
- Accidents due to system failures such as equipment malfunction, operator error, and vessel collisions; and

- Accidents resulting from intentional acts against the facility such as vandalism or terrorism.

These events could result in a variety of consequences that would be different from those associated with an accident at a conventional onshore terminal. For example, the hazards associated with an uncontrolled release of LNG on water are the same as those found onshore, but the duration and intensity are different due to the virtually unlimited heat capacity available for vaporization when spills occur in deep water.

11.3.2.1 Natural Catastrophes

The Broadwater FSRU concept is an expanded application for floating production vessels. A floating offshore facility similar to the FSRU is the Floating Production, Storage, and Offloading (FPSO) unit, which is used to produce, process, and store hydrocarbon products offshore. FPSOs have been employed around the world for more than 25 years and have a proven track record of operation. Currently, there are approximately 50 FPSOs in operation throughout the world, some of which operate continuously in even the most severe weather conditions.

The FSRU can be considered to incorporate the same safety features as an LNG carrier, particularly with regard to the hull and containment systems, which will be constructed according to the same standards as an ocean-going vessel.

The weather conditions within Long Island Sound are relatively benign compared to the locations where some FPSOs operate or where LNG carriers transit, but strong winds associated with hurricanes or other storms are a feature at this location. These winds may generate significant waves, depending on the direction and duration of the wind. As the FSRU is a floating structure, it is imperative that the mooring arrangement be such that the terminal is able to remain on station. For this reason, Broadwater has increased the survivability criteria for the yoke mooring system from the more typical design criteria of a 100-year storm event to credible storm scenarios well in excess of those experienced in the recent history of the region. By way of comparison, the hurricane experienced in the region on September 21, 1938, was equivalent to a 50-year storm event, based on Broadwater's analysis of historical weather data. Consequently, the yoke mooring system would be capable of surviving events of greater magnitude than this particular event, which had wave heights of approximately 12 feet (3.8 meters). The 100-year storm condition is typically used as design basis for offshore structures.

The ability of the FSRU to weathervane (rotate) around the stationary tower structure will reduce the loading on the mooring components, as the FSRU will align with the resultant vector of the interacting wind, wave, and current forces. In the event of strong winds, the FSRU will assume a heading into the wind, which presents the smallest windage profile.

Broadwater will develop procedures to be followed in the event of a hurricane warning, which may include a reduction in manning levels of essential personnel and a reduction or cessation of natural gas deliveries. The precise details of the applicable weather conditions and the phased response to specific severe weather conditions will be outlined in Broadwater's Emergency Response Plan, as discussed in Section 11.6. LNG carriers will not be allowed to enter the Sound when forecast weather conditions reach pre-determined limits and will remain at sea in open waters to await the passage of a hurricane. These limits are provided in Section 11.4.2.3.

Earthquakes of the magnitude expected in Long Island Sound (*see* Resource Report 6, Geological Resources) will not affect the FSRU, and the known seismic forces in the area will not significantly impact any part of the soft YMS design.

11.3.2.2 Broadwater Hazard Studies

Within the overall design of the terminal, a systematic process has been adopted to protect the public, Broadwater personnel, LNG carriers and crew, and the facility itself. This process is outlined below.

1. Hazard identification and understanding, e.g., through Hazard Identification Studies (HAZIDs).

2. Minimizing hazards through siting and design, e.g., by locating the facility in the middle of Long Island Sound, approximately 9 miles from shore.

3. Reducing the probability of an event, e.g., by incorporating emergency shutdown systems, including loading-arm release systems.

4. Minimizing the consequences of an event, e.g., by limiting the volume of LNG inventory in the process and unloading piping systems to reduce the size of potential spills.

5. Mitigation of events, e.g., by providing fire-fighting capabilities on the FSRU, which will be augmented by the use of tugs with fire-fighting capabilities.

Broadwater has completed two HAZIDs (one on November 3-4, 2004, and one on June 8-9, 2005) to identify all potential hazards associated with the Project. These structured evaluations are an essential component of any project development and will form a basis for later Hazard and Operability studies as the facility design is finalized.

The objectives of the HAZIDs were to:

- Comply with corporate policies of Broadwater's parent companies for the risk assessment of proposed facilities;

- Identify potential safety, operational, and environmental hazards or issues that need to be addressed in the facility design;

- Evaluate the safety of the facility layout; and

- Identify issues that require specific safety, environmental, or risk management strategies.

As a result of these studies and the experience of both Shell and TransCanada, Broadwater has incorporated measures in the project proposal to protect the public and the environment from potential accidents involving the facility or LNG carriers delivering cargoes. These measures are discussed in Section 11.3.3.

11.3.2.3 Hazardous Substances Used in FSRU Operations

A list of the hazardous substances used in FSRU operations is presented in Table 11-6. The table describes the substances, the potential risks associated with each substance, and procedures and equipment for dealing with the respective substances. These substances include aqueous ammonia, odorant, diesel fuel, and ethylene glycol.

An in-depth materials-handling study will be carried out at the detailed design stage. Other standard marine small parcel materials will also be subject to detailed storage and handling design.

11.3.3 Safety Features of the FSRU

Incorporated within the design of the facility is a layered approach to the safety of operations throughout the Project duration. Although the Broadwater terminal may be among the first FSRUs in operation, it does not rely on new technologies. For example, the recently commissioned Gulf Gateway terminal in the Gulf of Mexico has similarities to the proposed Broadwater facility (i.e., the Gulf Gateway facility is a conventional LNG carrier with vaporization equipment on board).

The Broadwater terminal consists of three main components, all of which utilize existing and proven technology.

- Hull and Containment System: this is the same technology used in existing LNG carriers.

- Process Equipment: the same types of vaporization and utilities equipment are currently in use at onshore terminals.

- Yoke Mooring System: this system has been used in open-water conditions for the mooring of FPSOs in international applications.

The main safety features of the FSRU design are outlined below.

11.3.3.1 Hull and Containment System

The FSRU hull incorporates the same features as an LNG carrier and will be designed and constructed in accordance with the *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk* (IGC code), other International

Table 11-6 Hazardous Substances Used in FSRU Operations

Substance	Description	Hazards	Systems and Equipment	Procedures
Aqueous Ammonia	• Industrial grade 19% solution. • Corrosive, non-carcinogenic. • Non-combustible but evolved ammonia gas flammable in 16 – 25% concentration range, non explosive, toxic. • Exposure limit 25 ppm.	Personal contact	• Capacity up to approximately 288 m3. • Minimize manual intervention. • Storage on deck. • Material Safety Data Sheet (MSDS), eyewash and safety shower available.	• Suitable handling and response plan according to MSDS.
		Spill	• Containment to include suitable valving, level measurement, pressure relief, drip pans and coaming.	• Suitable handling and response plan according to MSDS. Isolate leakage. Dilute and store in suitable containers for disposal. Self Contained Breathing Apparatus (SCBA) and Personal Protective Equipment (PPE) to be worn
		Fire	• Suitable fire fighting appliances available.	• In accordance with MSDS. Isolate and extinguish using CO2, water spray or fog. Suitable PPE to be worn.
		Corrosion	• Copper alloys and other non compatible metals not to be used in handling or response systems.	
Ethylene Glycol	• Clear liquid, odorless, miscible in water. • Irritant, non carcinogenic. Readily biodegradable. • Flammable - flash point 232•F (111•C). • Exposure limit 50 ppm	Personal contact	• Capacity approximately 300 m3. • Storage on deck away from heat sources. Minimize manual intervention.	• In accordance with MSDS. Suitable PPE to be worn.
		Spill	• General storage required with suitable valving, level measurement, vent, drip pans and coaming.	• Suitable handling and response plan according to MSDS. Isolate leakage. Contain and recover liquid using non-sparking tools.
		Fire	• Suitable fire fighting appliances available.	• Suitable handling and response plan according to MSDS. Isolate and extinguish using dry chemical, foam or CO2. SCBA and PPE to be worn.

Table 11-6 Hazardous Substances Used in FSRU Operations

Substance	Description	Hazards	Systems and Equipment	Procedures
Diesel fuel	• Clear liquid with petroleum odor. • Non corrosive, flammability LEL 0.5 flash point >55•C.	Fire	• Capacity approximately 3,000 m3. • Welded steel tank construction and integrated to hull for large capacities. Provided with necessary fittings such as inlet and outlet connections, quick closing valves, drain, air vent, manhole or handhole, overflow, thermometer pocket, heat resistant level gauge or sounding apparatus, etc. • Suitable fire fighting provision at all locations. All to be Class approved.	• In accordance with MSDS. • No hotwork at bulkheads. Hotwork policy and procedures established.
		Spill	• Transfer system to allow bulk loading or drum loading for small quantities of low wax diesel where required. • Spill containment equipment available.	• Suitable handling and response plan according to MSDS. Establishment of spill response plan. • Oil transfer procedures in accordance with USCG requirements.
Gas odorant	• Mercaptan mixture, flammable clear liquid, repulsive odor. • Mild irritant.	Fire	• Capacity approximately 23 m3. • Isotank storage on deck away from heat sources. • Suitable fire fighting appliances available.	• In accordance with MSDS. • Isolate leakage.
		Spill	• Storage area fitted with suitable coamings	• Suitable handling and response plan according to MSDS. • Oil transfer procedures in accordance with USCG requirements.
		Personal contact	• Minimize manual intervention.	• In accordance with MSDS. Suitable PPE to be worn.

Marine codes and regulations, and in compliance with ship Classification Society Rules. These standards result in a hull design that minimizes the potential for an accidental release of LNG. Marine accidents most likely to affect the FSRU would result from collisions with passing vessels, and the conclusions from the Sandia Report in this respect are similar for an FSRU as for an LNG carrier event (refer to Section 11.3.1). An analysis of potential collision scenarios and the results, for both accidental and intentional events, can be found on page 99 (Appendix B) of the Sandia 2004 report.

With respect to containment, forces produced by wave motion acting on the FSRU in its marine environment could cause sloshing of LNG in the cargo tanks on the FSRU, potentially damaging the membrane containment system. However, the FSRU will be designed and built to standards that apply to ocean-going vessels, even though less severe conditions in Long Island Sound are anticipated.

For the cargo tank membrane systems proposed for the FSRU, natural wave periods have been determined using the ABS Safehull LNG formulae for various loading conditions. These natural wave periods for the hull are an important parameter in the selection of the tank excitation period, since if the excitation period and tank natural period are similar, fluid resonance in the tank will occur, causing high sloshing loads. In addition, critical sea state conditions have been identified, which will be used during the detailed design phase to perform a detailed sloshing analysis to determine sloshing impact loads. These load factors will be incorporated into the final tank design to ensure the safety of the cargo containment system at all filling levels. Further, the analysis and modeling of sloshing loads will be verified by the Classification Society prior to commencement of construction. Using appropriate modeling and design procedures, sloshing loads can be safely managed on the FSRU.

The FSRU tank design will accommodate all tank filling levels, and there will be no special cargo handling requirements with respect to sloshing. The hull stress limitations will be monitored, as is the case for liquid bulk carrying vessels, and this is achieved via a "loadicator" stress monitoring system fitted to the FSRU and verified by the Classification Society. Additional cargo handling measures that can be taken to minimize the risk of liquid surface sloshing include maintaining the tanks either close to full or close to empty; however, this would always be subject to hull stress limitations as discussed above.

Further details on the sloshing analysis performed to date can be found in Resource Report 13 (Engineering and Design Considerations), Section 13.9.

11.3.3.2 Collision Avoidance

The FSRU will be equipped with a complete suite of communications equipment and navigational aids in accordance with USCG requirements. The proposed facility would include the following equipment to alert other ships of the presence of the facility:

- Radar Beacon: The facility will be equipped with a dual band radar beacon with a transponder operating at both air and marine frequencies to warn aircraft and vessels nearing the location of the FSRU. The beacon will meet federal standards for this equipment.

- Radar Systems: The facility will be equipped with two complete sets of long range radar, with range alarms for the detection of vessels in vicinity of the FSRU.

- Navigational Aids: The precise determination of specific aids to navigation will require USGC authorization. The proposed facility would be equipped with navigation warning lights and aviation warning lights, in accordance with federal standards. The facility will also have a main 2-mile and standby 0.5 mile USGC-approved foghorn located at each end of the facility.

11.3.3.3 LNG Spillage from Unloading and Process Areas

An analysis of LNG spill containment has been completed, and a spill containment philosophy has been developed. The recommended strategy is to direct major LNG spills safely overboard into the sea, where the majority of the LNG will vaporize on the sea surface, well away from the facility deck. The strategy is supported by the following measures:

- Leak prevention through material selection, minimization of leak paths, and integrity management.

- An automated emergency shutdown (ESD) system that includes detection, isolation, shutdown, and depressurization systems to minimize spill sizes.

- Deck curbing, stainless steel drip pans, and stainless steel drain systems to ensure that spills are directed overboard to protect important process equipment and structures.

- Structural cold protection for important structures at likely contact areas.

- Appropriate emergency response procedures.

The above spill containment strategy was developed based on the need to ensure the safety of personnel, the FSRU, and the LNG carrier. The intent is to minimize the potential for a gas cloud accumulation, fires, and explosions by allowing a release to disperse safely away from the installation and operating personnel.

11.3.3.4 LNG Offloading System

LNG will be transferred from an LNG carrier to the FSRU by means of mechanically coupled loading arms designed for cryogenic service. A vapor return arm will also be connected to return vapor from the FSRU to the LNG carrier in a closed system.

The LNG carrier and the FSRU will be connected to a linked ESD system, which will automatically stop the cargo transfer when certain abnormal conditions are detected on the carrier or FSRU, or when initiated by manual intervention. The abnormal conditions include high tank levels or pressures, fire detection, loss of electrical power or instrument air pressure, and detection of high pressure or low temperature within the unloading lines.

A second level of ESD protection will be provided to protect the loading arms in the event of an LNG carrier mooring failure, or when the carrier moves towards the extreme limits of the loading arm operating envelope. This level of protection is achieved by spatially monitoring the position and movement of each loading arm within the envelope, which initiates a cargo transfer shutdown when preset limits are approached. Further movement beyond these limits will cause valves within the arm to close and activation of the emergency release coupler. This coupler allows the loading arm to separate between the valves, preventing damage and effectively gives a dry break by limiting the amount of spilled LNG.

11.3.3.5 Thermal and Flammable Vapor Dispersion Exclusion Zones

The proposed location of the Broadwater FSRU is significantly distant from populated areas. For an onshore facility, exclusion zones are required to lie within the terminal controlled area, which is not possible in the case of a floating facility.

The USCG may require a Safety and Security Zone around the FSRU, but the dimensions of this zone will not be determined until the USCG review process is completed.

11.3.3.6 Hazard Detection

The facility hazard detection system will be in accordance with the requirements of NFPA 59A. A Distributed Control System (DCS) will provide the primary interface between the operators and process, storage, unloading, and utility systems. The DCS will be supplemented by independent safety systems to detect potentially hazardous conditions and protect personnel, assets, and the environment. An Instrumented Protective System (IPS) will be provided to safeguard personnel and the facility against process upsets, including equipment failures. An independent ESD system will be provided to bring the plant to a safe condition in the event of escalation.

11.3.3.7 Fire Suppression

The FSRU will have specific fire protection systems for different areas of the facility. Fire extinguishing systems will be provided in accordance with Classification Society Rules and IGC Code requirements. These fire suppression systems, which are specifically designed for differing fire hazards within the facility, include a fire water system complete with pumps and a distribution system, a dry-powder chemical system, a high expansion foam system, a low expansion foam system, a carbon dioxide fire protection system and a water spray system and a water mist system.

The fire system matrix in Table 11-7 details the fire protection systems deployed in different areas on the FSRU. In process areas, the strategy is primarily to control fires and minimize damage to other equipment and structures. The details of the various fire-extinguishing and fire-fighting apparatus are provided below in Table 11-8.

11.3.3.8 Emergency Shutdown

A loss of electrical power will not compromise the safety or security of the facility. In the unlikely event of a total power failure, the emergency generator will start automatically. This generator is designed to maintain critical facility systems until such time as normal power generation can be resumed.

11.3.3.9 Emergency Response

Fire-fighting and lifesaving arrangements on board the FSRU will comply with the Safety of Life at Sea (SOLAS) Convention supplemented by the IGC Code.

Long Island Sound has limited resources for dealing with offshore emergencies. For this reason, Broadwater will provide sufficient capabilities to respond to credible events at the terminal. A Preliminary Emergency Response Plan is currently being prepared that will identify the resources required and coordination requirements between Broadwater, the USCG, and onshore emergency responders. Broadwater will prepare this plan in consultation with the USCG, as well as state and local agencies.

The participation of local emergency services in dealing with an emergency on board the FSRU is unlikely, but their involvement in the onshore handling and coordination of casualties will be a critical component of the Broadwater Emergency Response Plan. Further details are provided in Section 11.6.3.

11.3.4 Safety Features of the Yoke Mooring System

11.3.4.1 Yoke Mooring System Design

To ensure that the yoke mooring system is designed for maximum safety, Broadwater reviewed historical wind, wave, current, and tidal data for the region. Analyses of the extreme weather conditions that may be experienced within Long Island Sound have been completed and form the basis for design (and survivability) criteria of the yoke mooring system. These conditions are summarized in Table 11-9 below.

For design purposes, a review of extreme metocean climate conditions was conducted, considering both tropical and non-tropical storm events. Tropical events include tropical depressions, tropical storms, and hurricanes. For example, the 1938 hurricane was a Category 3 or 4 storm and is the strongest tropical cyclone to strike the Atlantic coast between Virginia and Massachusetts since at least 1869. For that storm, the observed maximum significant wave height was 12.4 feet (3.77 m) and the maximum 1-hour average wind speed was 70.2 miles per hour (mph) (31.4 m/s).

A list of the 15 most significant tropical storm events in the last 70 years is provided in Appendix A. The maximum significant wave heights ranged from 6.5 to 13 feet (2 to 4 m), with peak periods ranging from 4.8 to 7.1 seconds. The maximum 1-hour average wind speeds for these storms ranged from 39 to 89 mph (17.6 to 39.7 m/s).

Table 11-7 Fire Suppression System Deployment

Area	Fire-Water Hydrant	Dry Powder	Water Spray	High-Expansion Foam	Low-Expansion Foam	Water Mist	CO_2 Flooding	Fresh Water Hydrant
Exposed deck in the cargo area	X	X						
Loading arms and cargo tank domes	X	X	X					
Process Area			X					
Process Area (HP LNG pump and vaporizers)		X	X					
Machinery space and Process Heater Room (except specified rooms)	X			X				
No. 1 and No. 2 Low Voltage Switchboard Rooms							X	
No. 1 and No. 2 High Voltage Switchboard Rooms							X	
Emergency Generator Rooms						X	X	
No. 1 and No. 2 Essential Generator Rooms						X	X	
High Voltage and Medium Voltage Transformer Room							X	
Emergency Switchboard Room							X	
Inert Gas Generator Room	X			X		X		
Accommodation Area inside	X							X
Accommodation Area front wall			X					

Table 11-7 Fire Suppression System Deployment

Area	Fire-Water Hydrant	Dry Powder	Water Spray	High-Expansion Foam	Low-Expansion Foam	Water Mist	CO_2 Flooding	Fresh Water Hydrant
Life boat embarkation area and escape route from the Accommodation Area			X					
Paint storage, acetylene storage, oxygen storage							X	
Tower Soft Yoke Areas			X					
Helideck	X				X			
Forward Fire Pump Room	X						X	

Notes:
(1) The Process Area includes the HP LNG pump/vaporizer area, recondenser, BOG compressors, superheaters, odorization unit, and flare knockout drum.
(2) There is no dry chemical powder system on the yoke, but fire extinguishers are provided. This table lists only fixed extinguishing systems.

Table 11-8 Firefighting Systems Summary

Deck	Space (Room) Name	Fixed Fire-Fighting System
Cargo Area		
Trunk deck	Exposed cargo area	Dry powder hand hose/fire-water hydrant
	Tank domes	Dry powder hand hose/water spray/fire-water hydrant
	Loading arms	Dry powder monitor/water spray/fire-water hydrant
Topsides Area		
Trunk deck	Process area	Water spray/dry powder hand hose/fire-water hydrant
	Yoke Mooring System area	Water spray/dry powder hand hose/fire-water hydrant
Machinery Space		
All	Machinery space	High-expansion foam (total flooding)/fire-water hydrant
Third deck	Inert Gas Generator Room	High-expansion foam (total flooding)/fire-water hydrant/water mist
Accommodation Area		
All	Accommodation	Fire-water hydrant (located outside Living Quarters), freshwater hydrant (located inside Living Quarters)
Upper deck	Emergency Generator Room, No. 1 and No. 2 Essential Generator Rooms	Fire-water hydrant/CO_2/water mist
Upper deck	Emergency Switchboard Room, High Voltage and Medium Voltage Transformer Room	Fire-water hydrant/CO_2
Upper deck	Emergency Switchboard Room, High Voltage and Medium Voltage Transformer Room	Fire-water hydrant/CO_2
Upper deck	Acetylene storage, oxygen storage, paint storage	Fire-water hydrant/CO_2
C deck	Low Voltage and High Voltage Switchboard Rooms	Fire-water hydrant/CO_2
Helideck		Fire-water hydrant/low-expansion foam

Table 11-9 Yoke Mooring System Design Criteria

Design Factor	Design Condition	Design Criteria
Waves	Operational	95% of the time with Hs < 1.2 m Direction: east-northeast to west-southwest
	Extreme 1:100 year	Hs = 4.3 m and Tp = 7.4 s
	Extreme – Design Case	Hs = 5.7 – 7.0 m and Tp = 8.7 – 9.9 s
Wind	Operational	Speed: 99.5% of the time below 17.5 m/s Direction: towards northeast and southeast
	Extreme 1:100 year	41.9 m/s (93.7 mph)
	Extreme – Design Case	50.2 – 56.8 m/s (112.3 – 127 mph)
Tidal current		99.5% of the time < 0.45 m/s (0.9 knot) Direction: to east-northeast and west-southwest
Tide	CD + m	1.7 to 2.0 m, with an average of 0.94 m
Extreme water level		5.5 m storm surge plus long-term sea level rise
Air temperature	Operational	Minimum -18ºC Maximum +38ºC
Seawater temperature	Operational	0 to 27ºC
Ice		Rarely freezes

It should be noted from a review of this data that the extreme metocean conditions associated with these tropical storm events are significantly less severe than those recently experienced in the U.S. Gulf Coast during Hurricanes Rita and Katrina. In addition, due to the physical protection afforded by Long Island and related geologic structures, it is anticipated that the risk of exposure to potential Atlantic Basin tidal wave activity from the east is minimal.

As the data above demonstrates, the primary YMS design will safely accommodate the most severe weather that can credibly occur in the area, including hurricanes. The redundancy within the mooring system and the reduced environmental loadings resulting from the weathervaning FSRU reduce the risk of a mooring failure to as low as reasonably practicable. For this reason, a secondary mooring system has not been incorporated within the design. Additional mitigation measures are possible by using the azimuth thrusters to reduce the load on the mooring system during severe storm conditions and possibly the use of these thrusters to steer the FSRU or arrest progress in the extremely unlikely event of a mooring failure.

For further details on the design of the YMS, *see* Resource Report 13 (Engineering and Design Considerations), Section 13.16.

11.3.4.2 Existing Applications of Yoke Mooring Systems

While a yoke mooring system has not been used in conjunction with an FSRU application, there are eight similar systems currently installed worldwide. These are installed in Southeast Asia (mainly China) and West Africa. Broadwater's mooring system has a design that is typical of the majority of yoke mooring systems installed using a ballast tank and articulated linkage. The soft yoke mooring technology has been deployed in several projects, and is accepted as a proven design for shallow water mooring installations.

Shell currently operates an FPSO that utilizes a yoke mooring system that is located 9.3 miles (15 km) off the coastline of Nigeria. The mooring system is similar in design to that for Broadwater; however, the Broadwater design is somewhat larger. Table 11-10 provides a summary of the relative dimensions of the Shell FPSO and Broadwater. The design of the yoke mooring system in Nigeria is based upon a 1:100 year storm event, based on historical metocean conditions as evaluated for that specific location. As can be seen from Table 11-9 above, the Broadwater design is considerably in excess of the typical 1:100 year storm design convention.

Table 11-10 Comparison of Existing FPSO with Broadwater

Item	Shell FPSO	Broadwater FSRU
Displacement (tonnes)	213,762	278,500 (cargo tanks full)
Breadth (m)	50	60
Depth (m)	28	37
Length overall (m)	274	370

11.3.5 FSRU Security

Safety and security are considered paramount to Broadwater in the design and operation of the FSRU, not only to minimize potential hazards to the public from failures as a consequence of accidents or natural catastrophes, but also to minimize the potential hazards to the public from deliberate acts of sabotage and terrorism. Because any substantive description of the range of terrorism threats to the Broadwater Project and the security design and operating features intended to mitigate such threats are by their nature Sensitive Security Information (SSI), the following will only describe the methodologies that will be used to establish the threat, determine the consequences of a successful attack, and integrate the security design features and security operating procedures necessary to minimize potential hazards to the public. Detailed security vulnerability analyses and mitigating strategies, including specific security design features and security operating procedures, will be fully disclosed to the appropriate permitting agencies as "SSI Classified" information, separate and apart from these "unclassified" Resource Reports.

11.3.5.1 The Terrorism Threat

The tragic events of September 11, 2001, permanently and profoundly altered the way the world perceives international terrorism and terrorist acts. The scale and savagery of the attacks, the targeting of innocent civilians, the nature of the targets, and the terrible carnage shocked and horrified the world. These acts exposed the vulnerability of our open society to external attack by terrorists and their willingness to sacrifice their lives for their beliefs. The targeting of a country, its economy, and innocent civilians using that nation's own transport infrastructure led to a new appraisal of the terrorist risks. Subsequent terrorist actions in other areas of the world have only reinforced the need for all governments and industries to properly assess their respective risk profiles.

Broadwater understands this new security regime and is fully committed to undertaking a thorough terrorism threat assessment and consequence analysis as a fundamental and continuing responsibility. Integral to this assessment and analysis process is full coordination with all federal and state government agencies charged with the development of threat intelligence information and the development of consequence management modeling and planning. Indeed, Broadwater has already undertaken the production of an internal document entitled "*Preliminary Project Security Assessment and Overview*" (PPSAO) as a prerequisite to proceeding with the Project.

Information provided to Broadwater from both classified and open sources has enabled it to develop a menu of terrorism threat scenarios that describe in detail the vectors that could be employed to attack the FSRU and the ships supplying the FSRU. These scenarios range from the most likely and operationally easiest to undertake to the less likely and more operationally difficult to undertake. To deal with this range of attack scenarios, Broadwater will integrate into the design of the FSRU the operational procedures and mitigation measures necessary to minimize the risk of such attacks.

11.3.5.2 Preparation and Submission of the Preliminary Security Vulnerability Assessment (PSVA)

In compliance with the guidance provided by the USCG in "Navigation and Vessel Inspection Circular (NVIC) 11-02" and the American Petroleum Institute (API) in "Security for Offshore Oil and Natural Gas Operations," Broadwater prepared a Preliminary Security Vulnerability Assessment (PSVA). This PSVA, which uses a risk-based security analysis methodology, documents an in-depth assessment of the potential security threats to Broadwater operations and an analysis of the consequences that could result if such threats were successful. From this threat assessment and consequence analysis, the vulnerabilities of Broadwater operations to such threats and consequences will be derived and a mitigation strategy outlined. The PSVA was submitted to the USCG in early March 2005 and will be one of the documents upon which the USCG will rely when assisting FERC in conducting its review of the Broadwater application.

11.3.5.3 Development of Security Plans, Policies, and Procedures

Preparation and Submission of the Preliminary Facility Security Plan (PFSP)

Broadwater also prepared a Preliminary Facility Security Plan (PFSP) for the FSRU. While the FSRU is not expected to be in operation until 2010, Broadwater believes that the USCG and FERC should have the benefit of a review of the PFSP during the Broadwater application period. The PFSP contains all elements required by regulation and incorporates the findings and guidance contained in the PVSA. The PFSP was published in late April 2005 and will be one of the documents upon which the USCG will rely when assisting FERC in conducting its review of the Broadwater application.

Both the PFSP and PSVA are written and presented as "living documents" and are constructed in modular fashion so as to allow ease of modification over the course of the FSRU design and construction. It is intended that the PVSA and PSFP will be updated at least annually to ensure that changes in the potential threat to the Broadwater Project, as well as changes and evolution in operating concepts, can be incorporated and reviewed by appropriate agencies. Final submission of each document (without the "Preliminary") will occur in 2010 prior to commencement of Broadwater operations.

Development of Broadwater Security Policies

Broadwater will prepare Broadwater Security Policies, which will specify the security policies for Broadwater Energy LLC governing personnel security, information security, and physical security. The Broadwater Security Policies will be updated annually or more often, as necessary, and will be consistent with all USCG and Department of Homeland Security regulations and include "best industry practices" to the maximum extent feasible.

Input into Detailed Design. Broadwater will develop and incorporate into the detailed design of the FSRU any and all security design criteria. Such security design criteria will permit the naval architects and engineers working on the design of the FSRU to properly incorporate all necessary security features requiring engineering into the construction drawings and specifications for the FSRU.

Broadwater Security Standards and Procedures Manuals. During the period of FSRU construction, Broadwater will prepare and publish, in draft form, the following manuals:

Broadwater Information Security Standards and Procedures Manual
Broadwater Personnel Security Standards and Procedures Manual
Broadwater Physical Security Standards and Procedures Manual

Each of the above manuals will provide the specific guidance necessary to undertake Broadwater security programs consistent with Broadwater Security Policies. The subject matter of each manual will cover all Broadwater operations, not just security operations aboard the FSRU. All provisions of each manual will be consistent with current USCG and Department of Homeland Security regulations and include "best industry practices" to the maximum extent feasible. Each manual will be updated annually in draft form and will be published formally before Project commissioning.

Screen for Eligible Security Equipment and Services Vendors. Before construction, Broadwater shall screen and qualify eligible vendors for security equipment and services.

Prepare Requests for Proposal (RFPs) for Pre-Commissioning Security Services and for Security Equipment. During construction, Broadwater will prepare and publish RFPs for pre-commissioning security services and for security equipment. RFPs will be awarded over the next two years at such times as may be appropriate.

Pre-Commissioning Security Training and Certification Plan. During construction Broadwater will prepare and publish a Pre-Commissioning Security Training and Certification Plan. This plan will program the training necessary for all contract and employee security personnel scheduled to commence work on behalf of Broadwater prior to the commissioning date of the FSRU. In addition, the plan will include the certification processes necessary to ensure that the training provided is assimilated by the personnel receiving the training. The plan will be updated as necessary.

Prepare Draft Support Base Assessment and Plan. During construction, Broadwater will prepare a draft Support Base Security Vulnerability Assessment and a draft Support Base Security Plan. This assessment and plan will be developed with the same methodology used to develop the preliminary assessment and plan for the FSRU. This assessment and plan will be updated every six months and submitted in final form to the USCG before the support base commences operations.

Prepare RFPs for Arrival and Post-Commissioning Security Services and Security Equipment. During construction, Broadwater will prepare and publish an RFP for arrival and post-commissioning security services and for security equipment not already contracted for. RFPs will be awarded over the next year at such times as may be appropriate.

Emergency Services Coordination and Visits. During construction, Broadwater will coordinate with all incident and consequence first responders to ensure that each is aware of the arrival time of the FSRU to the proposed facility location and ensure that the authorities are prepared to respond as appropriate if called after arrival of the FSRU. Broadwater will arrange for liaison visits and inspections of the FSRU after its arrival.

Post-Commissioning Operations. After commissioning, Broadwater will conduct the following operations at such times as may be appropriate:

- Conduct monthly security drills aboard the FSRU and at the support base;
- Brief the Captain and Ship Security Officer of each LNG carrier of security protocols while alongside the FSRU;
- Conduct an annual internal FSRU and support base security exercise;
- Conduct an annual first responder exercise;
- Conduct periodic new employee training;

- Confirm LNG carrier and LNG port certifications at least annually;
- Prepare annual updates to all current security assessments;
- Prepare annual updates to all current security plans; and
- Prepare annual updates to security policies and to security procedures manuals.

Conclusion. At any time during the application and permitting process, Broadwater is fully prepared to address any and all issues of security with appropriate regulatory authorities. Broadwater is committed to ensuring that it undertakes all security measures necessary to minimize potential hazards to the public from acts of terrorism directed against Broadwater operations.

11.3.6 Training and Qualifications of Personnel

Detailed manning studies have not been completed for the Broadwater facility, but the following positions are contemplated for aspects of the operation.

11.3.6.1 Marine Operations

Port Superintendent. The Broadwater Port Superintendent would have overall authority over the terminal. This encompasses all personnel at the terminal, including contract personnel, and all vessel and helicopter operations at the terminal. Minimum requirements of the Port Superintendent are as follows:

1. Adequate experience managing an LNG transfer to demonstrate the capability of managing the Broadwater terminal;
2. Full understanding of the operational requirements of 33 CFR §150.200;
3. Familiarity with the hazards of each product handled at the terminal; and
4. Knowledge of all procedures in the Broadwater terminal's operations manual.

Vessel Traffic Supervisor. The Broadwater Vessel Traffic Supervisor would be responsible for all vessel movements into and out of the terminal, safety and security zone, and Broadwater navigation area. The minimum requirements of the Vessel Traffic Supervisor position are as follows:

1. Experience working with radar plotting and analysis of vessel movement for 1 of the previous 5 years, or successful completion of a marine radar operators school;
2. Familiarity with the procedures for using the terminal's radar equipment; and

3. Knowledge of all procedures in the Broadwater terminal's operations manual for vessel control and voice radio-telecommunications.

Mooring Master. All vessels entering and departing the Broadwater terminal would be under the direction of the Mooring Master. The minimum requirements of the Mooring Master position are as follows:

1. A current merchant mariner's license issued by the USCG under 46 CFR Part 10 as one of the following:
   (a) Master of ocean steam or motor vessels of any gross tons, endorsed as radar observer, and have 1 year of experience as:
      (i) A Master on tankers of 70,000 deadweight tonnage (DWT) or larger and satisfactory completion of a very large crude carrier (VLCC) ship handling course acceptable to the Commandant (Chief, Office of Marine Safety, Security, and Environmental Protection [G-M]); or
      (ii) A Mooring Master at any deepwater port servicing tankers of 70,000 DWT or larger.
   (b) Master of ocean steam or motor vessels of limited tonnage, endorsed as radar observer, and endorsed as first class pilot of vessels of any gross tonnage for at least one port, and have 1 year of experience:
      (i) Piloting ocean going vessels, including tankers of 70,000 DWT or larger; or
      (ii) As Assistant Mooring Master at the terminal and satisfactory completion of a VLCC ship handling course acceptable to the Commandant (G-M).
   (c) Master of ocean steam or motor vessels of limited tonnage or chief mate of ocean, steam, or motor vessels of unlimited tonnage with 1 year of experience in charge of an offshore crude oil lightering operation.

2. Knowledge of all procedures in the Broadwater terminal's operations manual and the Broadwater Spill Response Plan for:

   - Vessel control;
   - Vessel responsibilities;
   - Spill prevention, containment, and cleanup;
   - Accidents and emergencies; and
   - Voice radio-telecommunications.

11.3.6.2 Cargo Transfer Operations

Cargo Transfer Supervisor. The Cargo Transfer Supervisor would supervise the unloading of LNG to the terminal. The minimum requirements of the Cargo Transfer Supervisor position are as follows:

1. Sufficient experience managing cargo transfers at an oil or LNG transfer facility to demonstrate the capability of managing cargo transfers at the Broadwater terminal;

2. At least 1 year of continuous employment as supervisor at an oil or LNG transfer facility in charge of offloading tank vessels of 70,000 DWT or larger;

3. Supervision of at least 25 cargo transfer evolutions from tankers of 70,000 DWT or larger or service in a training capacity for cargo transfer supervisor at a deepwater port in the United States for at least 1 year;

4. Knowledge of the requirements for LNG transfer operations in 33 CFR 150 subpart E;

5. Knowledge of the LNG transfer procedures and transfer control systems, in general, of LNG carriers serviced at the Broadwater terminal;

6. Familiarity with the special handling characteristics of each product transferred at the Broadwater terminal; and,

7. Knowledge of all procedures in the Broadwater terminal's operations manual and the Broadwater Spill Response Plan for:

   - LNG transfers;

   - Spill prevention, containment, and cleanup;

   - Accidents and emergencies; and

   - Voice radio-telecommunications.

Cargo Transfer Assistant. The Cargo Transfer Assistant position must have:

1. One year of experience or must have performed 15 cargo transfer evolutions at an oil or LNG transfer facility servicing tankers of 70,000 DWT or larger;

2. Knowledge of the requirements for LNG transfer operations in 33 CFR 150 subpart E;

3. Knowledge of the LNG transfer procedures and transfer control systems, in general, of LNG carriers serviced at the Broadwater terminal;

4. Familiarity with the special handling characteristics of each product to be transferred;

5. Knowledge of all procedures in the Broadwater terminal's operations manual and the Broadwater Spill Response Plan for:

   - LNG transfers;
   - Spill prevention, containment, and cleanup;
   - Accidents and emergencies; and
   - Voice radio-telecommunications.

As cargo transfers between internal storage tanks on the FSRU are similar to transfers between cargo tanks on the LNG carrier and the FSRU, it is anticipated that the training and knowledge of the Cargo Transfer Supervisor and Cargo Transfer Assistant will also extend to FSRU internal operations.

11.3.6.3 Regasification Operations

In general, regasification operations will be similar in nature to those for onshore facilities. However, all staff working on the FSRU will be required to have familiarity with general marine safety procedures and the specific procedures related to emergency response for a marine facility. These safety procedures are similar in nature to those for LNG carriers.

11.4 LNG CARRIERS

11.4.1 LNG Carrier Safety

In response to public concerns, three studies were completed during 2004 to address the consequences associated with potential cargo releases from an LNG carrier during transit and while at the berth.

- FERC commissioned a study by ABS Consulting titled *Consequence Assessment Methods for Incidents Involving Releases from Liquefied Natural Gas Carriers*, which was released in May 2004.
- Det Norske Veritas Consulting completed a study sponsored by the LNG industry titled *LNG Marine Release Consequence Assessment* in April 2004.
- Sandia National Laboratories released a report in December 2004 titled *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*.

While the first two studies concentrated on consequence assessment, the Sandia Laboratories report identified the need to conduct a risk-based analysis for marine components of LNG handling. This approach focuses not only on the consequence of an event but also on the probability of an event occurring. For the Broadwater analysis, the Sandia Report has been used as the basis for risk elimination or mitigation.

11.4.1.1 Natural Catastrophes

LNG carriers, as with other oceangoing vessels, are designed and built to international codes and standards that take into account the potentially severe weather conditions that could be encountered when engaged in worldwide trading. These severe conditions are unlikely to be found within Long Island Sound, but conditions prohibiting LNG carrier transit, berthing, or unloading will occur. These include strong winds associated with storms or hurricanes, severe thunderstorms, and bad visibility. Weather-based parameters for marine operations are being established and will be formalized by the USCG under an Operations Plan. The forecasting of adverse weather conditions allows sufficient notice for these parameters to be strictly enforced.

Earthquakes of the magnitude expected in Long Island Sound (*see* Resource Report 6) will not affect LNG carriers.

11.4.1.2 Marine Accidents

Accidental events with the potential to cause an LNG release from an LNG carrier include:

- Vessel collision with an inbound LNG carrier;
- Inbound LNG carrier colliding with the FSRU and associated mooring or another structure;
- Another vessel colliding with a moored LNG carrier; and
- The grounding of an LNG carrier.

The Sandia Report (page 14) analyzed the risk arising from these scenarios and concluded:

> Risks from accidental LNG spills, such as from collisions and groundings, are small and manageable with current safety policies and practices.

Further to this, the report went on to state (page 21):

> Due to existing design and equipment requirements for LNG carriers, and the implementation of navigational safety measures such as traffic management schemes and safety zones, the risk from accidents is generally low.

In the unlikely event of an accident, LNG cargo tank damage could potentially cause a tank breach area of up to 0.5 to 1.5 m^2.

With respect to accidental spills, it was concluded that the most significant impacts to public safety and property would be found approximately 250 m (0.16 mile) of a spill, with lower impacts at distances beyond approximately 750 m (0.47 mile) from a spill.

The normal, nearest approach to land for LNG carriers transiting Long Island Sound will be when the vessels enter the Sound through the Race. This passage between Fishers Island and Valiant Rock requires the LNG carriers to pass approximately 1,850 m (1 nautical mile [nm]) (1.2 statute miles) to the south of the inhabited Fishers Island. The remainder of the inbound transit from the Block Island pilot station to the FSRU location normally follows a route that is not less than 2 nm (2.3 statute miles) from land. The FSRU location itself is located a maximum distance from the shore at a distance of 7.8 nm (9 statute miles) from the Long Island coastline.

In conjunction with the USCG and the authorized pilots in Long Island Sound, Broadwater will incorporate further measures to reduce the risk of a marine incident as discussed below.

11.4.1.3 LNG Carrier Routing Considerations

In addition to analyzing the onshore coastal regions in the immediate vicinity of the Project, Broadwater also conducted an analysis of major sensitive receptors on the shorelines that would be adjacent to LNG carrier routes entering into Long Island Sound from the Atlantic Ocean. The analysis covers shorelines and relevant offshore features from Point Judith, Rhode Island, and Montauk, New York, to the entrance into Long Island Sound at the Race and onward to the proposed FSRU location. This includes an analysis of the shoreline features of Rhode Island, the far eastern shorelines of New York and Connecticut, and Block Island.

In general, the analysis indicates that no major coastal features would be significantly impacted by the proposed LNG carrier or associated USCG-identified safety and security zone that likely will be enforced around the carrier as it transits to the FSRU location. (*See* Resource Report 3 [Fish, Wildlife, and Vegetation] for potential impacts on marine ecological resources.)

Broadwater is currently engaged in consultation with the USCG concerning the preferred routing that LNG carriers would take to enter and transit Long Island Sound, as well as the requirements for any safety and security zone that would surround the LNG carrier as it made its transit through the Sound.

An LNG carrier would transit to the proposed FSRU on average once every two to three days. Based on preliminary routing, there are two optional routes that LNG carriers may take when entering Block Island Sound prior to entering Long Island Sound through via Race. These two entry routes include:

- The Northern Route, which runs between Block Island and Point Judith, Rhode Island; and

- The Southern Route, which enters Block Island Sound via the Montauk Channel.

For both routes, the LNG carriers would be nearest the shoreline as they enter/exit Long Island Sound via the Race. A further description of the Northern and Southern routes is provided in Appendix C.

Scheduling of LNG carrier arrivals will take into account use of the area by other marine traffic and will require close cooperation between Broadwater, the USCG, pilots, and other operators. Scheduling of carrier arrivals is a very important issue for Broadwater with respect to limiting impacts on other users of the Sound because a traveling, USGC-imposed safety and security zone will likely be enforced around the LNG carrier, which may limit use of the area adjacent to the carrier. It is important to note that, based on an anticipated carrier speed of 12 knots, the approximate duration of a traveling safety and security zone at any single point would be only approximately 15 minutes. Based on review of existing NOAA charts, the transiting LNG carrier would not result in any bottlenecks that would prevent other commercial or recreational traffic from transiting the Race.

In general, onshore/coastal land uses along the assumed LNG carrier routes do not differ substantially along the New York, Connecticut, or Rhode Island shorelines (*see* Figure 11-2). The majority of the coastal land uses along these shorelines are a mix of forested and agricultural land, with some residential uses interspersed within this overall pattern. In addition, the overall population densities encountered along these routes are fairly consistent for all three states, with a majority of the population densities ranging from 0 to 500 people per square mile (*see* Figure 11-3). The exception to this is the coastal area around New London, Connecticut, and Westerly, Rhode Island, where densities increase substantially. As shown on Figure 11-3, population densities in this area can exceed 3,000 people per square mile. Near New London and Westerly, however, it is expected that the LNG carrier would be a minimum of 4.3 to 6.1 nm (5 to 7 statute miles) from the Rhode Island and Connecticut shorelines.

An LNG carrier's closest approach to inhabited land would be 1.2 nautical miles as it transits south of 3,200-acre Fishers Island (*see* Figure 11-2). This 7-mile-long, 0.75-mile-wide island is located about 10.4 nm (12 statute miles) northeast of Orient Point, New York, and 3.5 nm (4 statute miles) south of Connecticut. Fishers Island has a permanent population of 269 people. The island is accessible only by boat or plane and is characterized as a high-end residential resort community with a small village, residential homes, and recreational amenities such as golf courses and resorts.

Montauk Point State Park is the largest coastal park occurring along the LNG carrier routes. The park, situated on the eastern tip of Long Island near the historic Montauk Lighthouse, is primarily forested. At its closest approach, the LNG carrier would be

Source: USGS, 1990;ESRI, 2002..

Figure 11-2 Land Use in the Vicinity of the Project Area

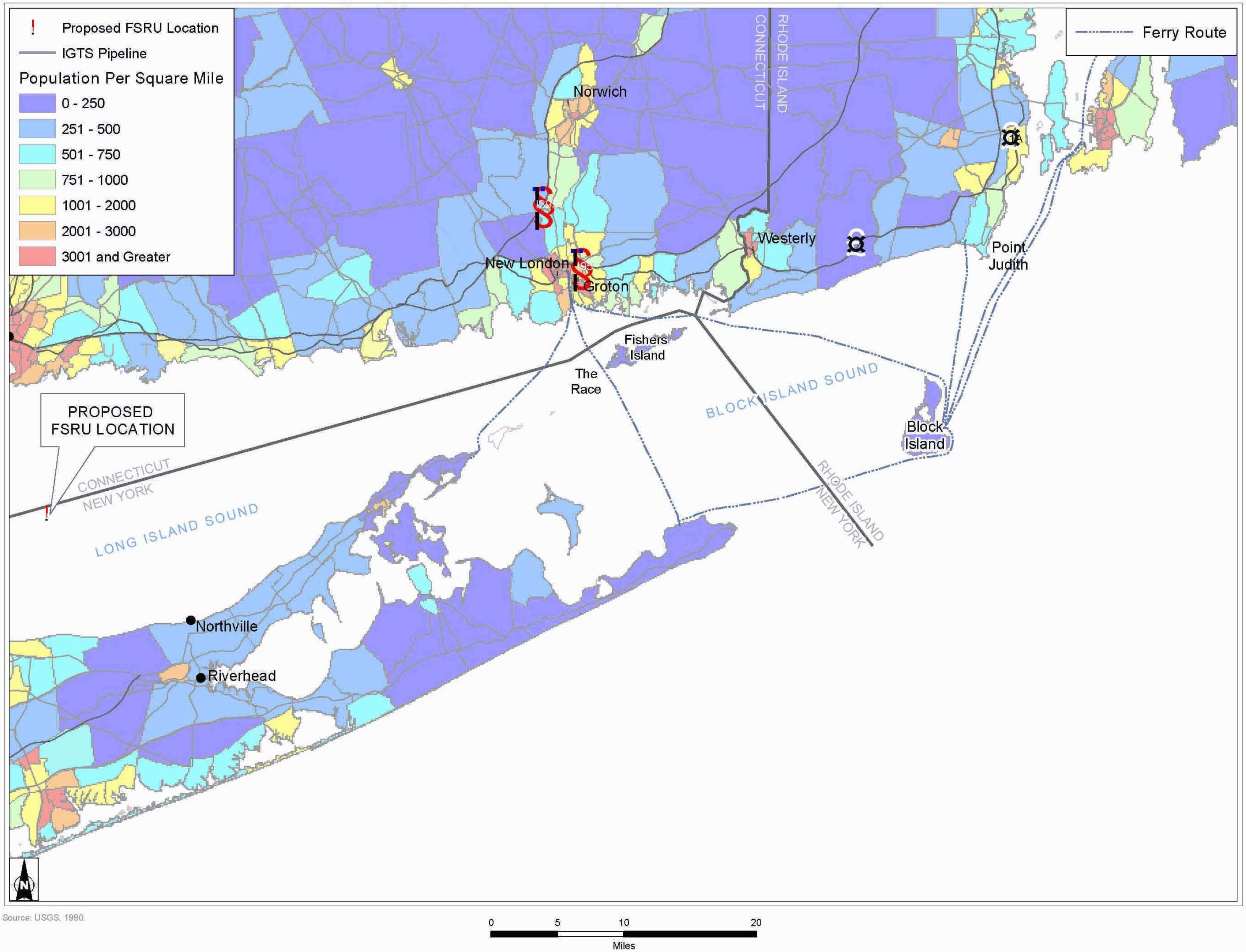

Figure 11-3 Population Densities in the Vivinity of the Project Area

approximately 6.1 nm (7 statute miles) from Montauk Point. However, because of its topography the park offers wide-open, unobstructed views of the water at various points, and the LNG carrier may be visible from these locations. Because of the number of larger commercial vessels that currently utilize the Sound, users of this park would be accustomed to offshore vessel traffic and would not be adversely impacted.

In addition, several smaller parks and open-space areas are located on the Connecticut shorelines; however, at its closest approach the LNG carrier would be over 3.5 nm (4 statute miles) from these coastal parks. As with Montauk State Park, users of these parks would already be accustomed to large commercial vessel traffic on the Sound and would likely not be impacted.

In addition to traversing along coastal areas, the LNG carrier would also cross several existing ferry routes, specifically the Montauk-to-Block Island High Speed Ferry and the New London-to-Orient Point ferry routes. Potentially impacted ferry services and routes are discussed in more detail below.

As mentioned previously, a discussion of impacts on marine ecological resources is provided in Resource Report 3, Fish, Wildlife, and Vegetation.

11.4.1.4 Proximity to Military Facilities

The FSRU, due to its central location in Long Island Sound, is not proximate to any military facilities. The proposed LNG carrier route through Long Island Sound will pass by the Navy's submarine base in Groton, Connecticut. This is the home base of Commander Submarine Group (COMSUBGRU) TWO, which exercises command of North Atlantic attack submarine forces administratively assigned, as well as operational control of Atlantic submarine units and other forces when assigned.[2]

COMSUBGRU TWO has responsibility for Submarine Squadrons TWO, FOUR, and Submarine Development Squadron TWELVE in Groton, as well as other responsibilities related to squadrons in Norfolk, Virginia, and the naval shipyards in Portsmouth, New Hampshire.

Based upon the proposed carrier routing described above, which is subject to USCG approval, the nearest approach of an LNG carrier to the Groton submarine base would be a distance of 8.9 nm (10.2 statute miles). This is well outside the area of potential concern identified in the Sandia Report. Broadwater has had preliminary communications with U.S. Navy staff concerning the Project and understands that a briefing has also been conducted by the USCG. The distance from the FSRU to the Groton submarine base is 42.1 nm (48.5 statute miles).

11.4.2 Safety Features of LNG Carriers

LNG carriers are designed and constructed in accordance with the IGC Code, other international maritime codes and regulations, and in compliance with Classification

[2] Data source: Commander Submarine Group TWO website: http://www.csg2.navy.mil/index.htm

Society Rules. These standards result in a vessel design that minimizes the potential for an accidental release of LNG. Unlike most vessels, all LNG carriers have a double hull, with the location of the cargo tanks at a prescribed distance from the outer hull. Although severe LNG carrier groundings have occurred, including grounding at 14 knots, none have resulted in a release of LNG. Collisions have also occurred, including a submarine surfacing beneath an LNG carrier, but a breach of a cargo tanks has not resulted.

The safety of marine operations is not due solely to the rigid, double-hull construction of the vessels; other systems are implemented to minimize potential accidents that may result in LNG spills. These include:

- Vessel traffic management (scheduling);
- LNG carrier procedures (strict compliance);
- Shipboard safety systems (including automatic shutdown systems);
- Enhanced navigation equipment (vessel identification, collision avoidance, radar, global positioning systems);
- Crew training; and
- Inspection and verification of vessel conformance by the USCG and Classification Society and ship owners, and oil company inspectors under the OCIMF Ship Inspection Reporting (SIRE) system.

A Vessel Traffic Service currently operates in the Port of New York area but does not extend to Block Island Sound or Long Island Sound. LNG carriers associated with Broadwater will not enter the mandatory reporting area for the Vessel Traffic Service. Scheduling of LNG carrier arrivals will take into account other marine traffic and will require close cooperation between Broadwater, the USCG, pilots, and other operators.

11.4.2.1 Safety Features of Marine Operations

Depending on the size of LNG carrier utilized, it is currently anticipated that two to three vessels will be unloaded each week. The FSRU is designed to accommodate carriers with cargo capacities ranging from 125,000 m^3 up to a potential future size of 250,000 m^3.

A Letter of Recommendation from the USCG is required for the Project to commence operations. The analysis to support this letter is currently underway and is based on the USCG's Risk-Based Decision Making Process. The USCG invited marine stakeholders to participate in a Ports and Waterways Safety Assessment on May 3 and 4, 2005. This workshop, which focused on Long Island Sound, considered the full spectrum of marine activities in the area and included the proposed Broadwater project. The workshop will be followed by USCG-arranged public meetings and discussions with other stakeholders to determine concerns related to the Broadwater proposal. Following further internal analysis, USCG will deliver a Letter of Recommendation to Broadwater.

Conditions arising from the Letter of Recommendation will be incorporated within a Vessel Management and Emergency Plan (Operating Plan). The USCG plan will contain specific requirements for the LNG carrier, pre-arrival notifications, scheduling, Long Island Sound transits, escorts, marine operations, cargo transfer operations, USCG inspection and monitoring activities, and emergency operations. There may be other requirements for the transit and discharge that differ from other vessels operating in Long Island Sound. These conditions are still to be determined, but Broadwater anticipates, at a minimum, the following marine procedures:

- All LNG carriers destined for the terminal will be in possession of valid certification as required for international trade, including a USCG Certificate of Compliance for all non-USA-flagged vessels.

- All LNG carriers destined for the terminal will be thoroughly reviewed by Shell following inspection under the OCIMF Ship Inspection Report program.

- An LNG carrier on passage to the Broadwater terminal will notify the terminal, the USCG, the Immigration and Naturalization Service (INS), and appropriate pilots, tug operators, and shipping agents at least 96 hours before arrival. Advance notice will include validation that all onboard safety-related systems and equipment are operational.

- The LNG carrier will remain at sea prior to an agreed arrival time at a location designated for a USCG security boarding, if required, or at the pilot station. It is not intended for LNG carriers to anchor in Block Island Sound to await pilots or other formalities.

- USCG inspectors may conduct a pre-arrival security inspection of the LNG carrier and crew before it enters U.S. territorial waters or before it enters Long Island Sound.

- A state-licensed pilot will board each LNG carrier for the transit through Block Island Sound and Long Island Sound. The same pilot will complete the berthing and unberthing operations at the FSRU and remain on board throughout the discharge operation. The Broadwater terminal will confirm readiness to receive the LNG carrier prior to the pilot boarding.

- Coordinated scheduling of LNG carrier transits will take into consideration other marine users and avoidance of peak congestion at the Race.

- Broadwater will ensure that an adequate number of suitable tugboats are available for each LNG carrier operation. It is anticipated that each tug will be purpose built to support Broadwater's operations and have a bollard pull capacity of 60 metric tons (132,000 pounds). The tugs will be equipped with water fire-fighting equipment classed ABS Firefighting 1, and have an escort notation. Expected tug utilization is described below (subject to USCG review):

- One or two tugs may be used to escort LNG carriers through the Race and during the transit of Long Island Sound.
- Three or four tugs (depending on vessel size) will be required to assist the LNG carrier when berthing alongside the FSRU.
- Two tugs will remain on standby in the vicinity of the FSRU whenever an LNGC is berthed. The duties of the standby tug will be to prevent other vessels from approaching the moored LNG carrier and to assist the vessel in the event of an emergency departure.
- Two or three tugs (depending on vessel size) will be required to assist with unberthing operations.

- After berthing, an INS Officer will board the vessel to complete arrival formalities, including verification of the crew against the previously supplied crew list.

- Following confirmation by the INS Officer to proceed, USCG personnel will complete safety inspections of both the FSRU and LNG carrier. In conjunction, a pre-discharge meeting will be held between the terminal and carrier staff to confirm discharge procedures and review of the safety checklist. Concurrent with these activities, a hard-wired communications system will be established and tested between the carrier and the FSRU.

- On confirmation of the discharge procedures being agreed upon, the loading arms and Emergency Shutdown System (ESDS) will be connected. The ESDS allows either the terminal or LNG carrier to automatically or manually stop the unloading process whenever an abnormal condition occurs.

- After a successful test of the ESDS, LNG transfer may proceed according to the agreed upon procedures with the approval of the USCG.

- On completion of unloading, the loading arms are drained, purged with nitrogen, and then disconnected.

11.4.2.2 Tugboat Support Considerations

Broadwater has assessed the requirements for tugboat support, based upon berthing simulations conducted on the Marine Safety International simulator in Rhode Island. These analyses concluded that for the majority of cases, two azimuthing stern drive (ASD) tugs rated at 60 metric tons (132,000 pounds) bollard pull are sufficient for the majority of berthing and unberthing operations. When the upper ranges of operating environmental conditions are approached, particularly for the largest LNG carriers, a third tug would be required. Based on observations during the simulations, it is recommended that tugs be employed as summarized below in Table 11-11.

Table 11-11 Assessed Tug Support Requirements

	Winter	Summer
Small LNG carrier berthing	3 tugs	3 tugs
Small LNG carrier unberthing	2 tugs	2 tugs
Large LNG carrier berthing	4 tugs	3 tugs
Large LNG carrier unberthing	3 tugs	2 tugs

"Small" and "large" refer to LNG carriers of 138,000 m^3 and a potential future size of 250,000 m^3 capacity, respectively.

The number of tugs employed for berthing was established using an "n + 1" philosophy to ensure that sufficient reserve towing capacity is available in the event of a single tug failure. This is particularly important for an offshore location. Tug utilization will be further investigated when pilot simulator training is completed before Broadwater commences operations.

Although tug deployment is a contractual agreement between the LNG carrier operator and the towage provider, Broadwater will arrange contracts to ensure suitable tugs are available for all marine operations at the facility. This effectiveness arrangement has already been proven at the Cove Point terminal in Maryland.

Tug Boat Specifications

It is anticipated that the tug boats to be utilized for Broadwater will be manufactured specifically to provide support for the Project. These tugs will be constructed at an existing shipbuilding facility within the U.S. The functional requirements of the tugs required for Broadwater have not been formalized but it is expected a 5,000-horsepower ASD tug with a bollard pull of 60 metric tons will be required. This type of tug has been built for the Cove Point LNG terminal operations as detailed in the specification below in Table 11-12. The tugs will use fuel oil as their primary fuel.

The tugs deployed at Cove Point are not used for escort purposes; therefore, the cruising speed would need to be increased to 15 knots if this becomes a requirement for Long Island Sound transits, as previously discussed.

The Broadwater tugs will be equipped with fire-fighting equipment that meets the "Fi-Fi 1" standard. This classification was originally introduced for offshore oil production support vessels and is often incorporated in the tug requirements for LNG marine terminals. These tugs would provide support either in the event of a fire on either the FSRU or LNG carrier, or to extinguish a pool fire on the water surface adjacent to either the FSRU or LNG carrier. The main components of Fi-Fi Class 1 are as follows:

Table 11-12 Illustrative Tug Boat Configuration

EMILY ANNE McALLISTER
#1137521

GENERAL		**MACHINERY**	
Built:	2003 Eastern Shipbuilding Panama City, FL	Main Engines:	(2)EMD 12 - 645-E7B with Remote Control Start/Stop capability
Flag:	U.S.A.	Propulsion System:	(2) Shottel SRP 1212F Steerable Kort Nozzle Rudder Propellers
Type of Equipment:	Tug	Towing Gear:	(1) Fwd. / (1) Aft Jon Rie Hawser Winches 450' of 7" Amstel Blue synthetic
Radio Call Sign:	WD5443	Automation:	Full Engine Room Monitoring System w/ Remote Monitoring Capability at Main Helm
DIMENSIONS			
Length:	96'		
Breadth:	34'	**NAVIGATION & COMMUNICATION**	
Depth:	14.9'	Radar:	(2) Furuno FR7062/4
Registered Gross Tonnage:	189	Gyro Compass:	Simrad Robertson RGC50
Registered Net Tonnage:	124	VHF Radio:	(3) ICOM M-502
		DGPS:	(2) Furuno GP-37
CAPACITIES		Fathometer:	Furuno RD-30 Digi-Depth
Fuel Oil:	28,280 gal.		
Lube Oil:	500 gal.	**SAFETY**	
Potable Water:	6,700 gal.	Fire Fighting:	(2) 12V-92TA w/ Nijhuis HGT1 Pumps @ 11,600 GPM (2) Skum MK-250EL/VR Remote Controlled Monitors with Foam Injection Capability with 1,100 GPM Deluge system
Free Running Speed	12 Knots		
H.P:	5,000		
AFF Foam gal	3,000		
ABS CLASS:	+A-1 Towing; +AMS, +A-1 Fire Fighting (FiFi 1) ABS Escort	EPIRB:	ACR 5850 Cat. 1

- Two marine water/foam monitors capable of delivering a minimum combined total of 2,400 m^3 of water per hour at a minimum range of 394 feet (120 m) and a minimum trajectory height of 148 feet (45 m); capable of producing a total of 15,000 litres per minute of foam solution at a minimum range of 213 feet (65 m); and geared for both vertical and horizontal movement from a remote station. Each monitor will be served by a dedicated pump and prime mover of commensurate capacity. The pump and prime mover serving one monitor will be independent of the pump and prime mover serving the other. The vertical pivot point of the monitors will be not less than 56 feet (17 m) above the water.

- A fog nozzle of adequate capacity to fit one of the monitors.

- A water spray system for self-protection. The system will be capable of delivering a spray of water over all the exposed external vertical surfaces of the hull, superstructure, deckhouses, and monitor positions. The minimum rate of application will be 10 litres per m^3 per minute.

- Fire hydrants, branches, nozzles, and hoses in accordance with Flag State or Classification Society requirements.

- Capability and equipment to supply water to the FSRU in the event of malfunction of the fire pumps.

The tugs will be based at an existing shore base on Long Island, New York. They will be refueled at this shore base.

11.4.2.3 LNG Carrier Berthing Considerations

Broadwater completed a simulation evaluation of the marine operations for the Project. The purpose of this study was to determine limiting weather conditions for mooring LNG carriers on the FSRU's starboard side when assisted by up to four ASD tugs rated at 60 metric tons bollard pull.

The study was conducted on a full mission simulator without visual graphics. A participating Block Island Sound Pilot made conning decisions based on observing the LNG carrier, the FSRU, and tug outlines on a monitor. Ships used for the study were two membrane LNG carriers, one with a capacity of 138,000 m^3 and the other with a capacity of 250,000 m^3. As trial data for the 250,000 m^3 LNG carrier does not exist, a proven model of an actual 138,000 m^3 carrier was used to assess the appropriateness of handling characteristics of the 250,000 m^3 model. The weather conditions simulated were winds of up to 33 knots, currents of 1.2 knots, and significant wave heights of 6.6 feet (2 m).

The study found that only four of the 25 simulations resulted in less than acceptable safety margins. All four simulations were conducted at upper-end weather conditions (i.e., winds of 33 knots, currents of 0.8 knot, and significant wave heights of 5.25 feet [1.6 m] or higher). While four tugs were available, two thirds of the simulations were satisfactorily completed with two tugs, under the following weather limits, which are the basis for actual operational limitations:

- Winds: 33 knots (17.0 m/s)
- Tidal Currents: 0.9 knot (0.45 m/s)
- Waves: 6.6 feet (2 m).

In a similar manner to the berthing simulations, the on-berth conditions also were assessed to determine the limiting criteria for an LNG carrier to remain alongside the FSRU. A series of environmental combinations of wind, waves, and current, based on 10 years of operating metocean data, were considered in a time-domain analysis. These operating environmental conditions were divided into the same three major categories based on the relative wind-wave headings: parallel-wind cases, oblique-wind cases, and cross-wind cases. The selected current speed was 0.45 m/s; the selected wind speeds were 17.5 m/s and 19.5 m/s; and the selected significant wave heights were 6.6 feet (2.0 m), 8 feet (2.5 m), and 9.8 feet (3.0 m).

The time-history analysis results can be summarized as follows:

- For the parallel- and oblique-wind cases, the safe environmental limits for the LNG carrier moored alongside the FSRU are a combination of 9.8-foot (3-m) waves, a wind speed of 19.5 m/s, and a current speed of 0.45 m/s, under which all peak mooring line loads, fender loads, and manifold motions are within the maximum allowable limits.

- For the cross-wind cases, the environmental limits for the LNG carrier moored alongside the FSRU are reduced to a combination of 8-foot (2.5-m) waves, a wind speed of 19.5 m/s, and a current speed of 0.45 m/s.

In summary, operational limits were assessed as being the combination of wind, wave, and current conditions presented in Table 11-13.

Table 11-13 Summary of Operational Limits

	Significant Wave Height		Wind Velocity		Current Velocity	
Operational Limit	**(m)**	**(ft)**	**(knots)**	**(mph)**	**(knots)**	**(ft/sec)**
Approach Limits	2	6.6	33	38	0.9	1.5
Side-by-Side Mooring Limits	3	9.8	39	45	0.9	1.5
Departure Limits	2	6.6	33	38	0.9	1.5

LNG Carrier Queuing

Prior to entering Long Island Sound, communications will take place between the FSRU and the LNG carrier to assess forecast weather conditions and for the FSRU to confirm that conditions are suitable for berthing operations. Upon confirmation of suitable weather conditions and completion of the procedures outlined in Section 11.4.2.1 (subject to USCG approval and confirmation), the LNG carrier will proceed to the FSRU.

Only one LNG carrier will be resident within Long Island Sound at any given time. This will include approach, berthing, unberthing, and departure operations. An LNG carrier will be deemed to have left Long Island Sound at the point where the local pilot will depart from the LNG carrier. If a second LNG carrier were to arrive prior to completion of these operations, that carrier would delay arrival at the Pilot's station until the first LNG carrier had exited Long Island Sound. It should be noted that this proposed queuing procedure applies only to LNG carriers serving Broadwater.

11.4.3 LNG Carrier Security

The introduction of mandatory compliance for all internationally trading ships with the International Ship and Port Facility Security (ISPS) Code on the July 1, 2004, ensures a consistent, worldwide standard for the management of security in ports and on board ships. In the U.S., the ISPS Code has been legislated under the Maritime Transportation Security Act (MTSA), and the USCG has been identified as the leading federal agency for ensuring maritime security. To implement the security requirements of the MTSA, the USCG is required to review and approve the security plans for all U.S.-flagged ships and marine facilities. For foreign flagged vessels, including LNG carriers, arriving for the first time, the USCG will board each vessel before entry into U.S. waters to review the Vessel Security Plan, ensure that all the requirements of the security plan are fully met, and verify that the standards set by the country where the ship is registered are commensurate with MTSA requirements. Failure to satisfy the MTSA requirements will result in a vessel being denied entry into U.S. territorial waters. On subsequent calls, the USCG will conduct verification inspections of the vessel's security plan according to the security threat level and an evaluation of security risk.

11.4.3.1 Emergency Response

Fire-fighting and lifesaving arrangements on board the LNG carrier will comply with the SOLAS Convention and as supplemented by the IGC Code and applicable federal codes. LNG carriers are required to have an Emergency Response Plan for dealing with a wide range of potential scenarios (e.g., grounding, collision, or LNG spillage), and the crews are required to conduct regular drills to test the effectiveness of these plans. As an oceangoing vessel, the plan has to be sufficiently robust to be effective without the aid of immediate third-party assistance. Broadwater will work to develop emergency response procedures complementary with those of LNG carriers unloading at the facility.

Long Island Sound has limited resources for dealing with offshore emergencies; for this reason, Broadwater will provide sufficient capabilities to respond to credible events at the FSRU. A Preliminary Emergency Response Plan is currently being prepared that will identify the resources required and coordination requirements between Broadwater, the USCG, and onshore emergency responders. The participation of local emergency services in dealing with an emergency onboard the FSRU is unlikely except in the case of post-event analysis of criminal intent, but their involvement in onshore handling and coordination of casualties will be a critical component of the Broadwater Emergency Response Plan. Further information on the development of the Emergency Response Plan can be found in Section 11.6.

11.5 NATURAL GAS TRANSMISSION PIPELINE

11.5.1 Introduction

A new 30-inch-diameter Broadwater natural gas connecting pipeline will deliver the vaporized natural gas from the FSRU to the existing IGTS pipeline, from which it will be delivered to end users. The natural gas pipeline will be installed beneath the seafloor from the FSRU mooring structure to a subsea interconnection location at the existing 24-inch-diameter subsea section of the IGTS pipeline, approximately 22 miles west of the proposed FSRU site. The proposed pipeline route and IGTS interconnection location are indicated on Figure 11-1.

This section addresses how accidents or natural catastrophes would affect reliability of the subsea natural gas pipeline, what procedures and design features will be used to avoid undue hazards or effects, and what measures, including equipment, training and emergency notification procedures, will be implemented to protect the public from failure of the pipeline due to accidents or natural catastrophes.

This section also addresses how Broadwater will comply with the U.S. Department of Transportation (USDOT) Minimum Federal Safety Standards specified in 49 CFR Part 192 that requires pipeline operators to:

- Develop an emergency plan with local fire departments and other agencies to identify personnel to be contacted, equipment to be mobilized, and procedures to be followed to respond to a hazardous condition caused by the pipeline;
- Establish and maintain liaison with the appropriate fire, police, and public officials to coordinate mutual assistance during emergencies; and
- Establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation to recognize a natural gas pipeline emergency and report it to appropriate public officials and the company.

Finally, this section addresses surveillance of the pipeline, leak detection surveys, internal pipeline inspection with pigging equipment, cathodic protection, and odorization of the gas in the pipeline.

The transportation of natural gas by pipeline involves some risk to the public in the event of an accident and subsequent release of gas. The greatest hazard is damage caused by a major pipeline rupture. Methane, the primary component of LNG, is colorless, odorless, tasteless, and lighter than air. It is not toxic but is classified as a simple asphyxiate, posing a slight inhalation hazard. If methane is inhaled in high concentrations, oxygen deficiency can occur, resulting in serious injury or death. Unconfined mixtures of methane in air are not generally explosive. Methane has an ignition temperature of 1,000 degrees Fahrenheit and is flammable at concentrations between 5.0 and 14.0 percent in air. Unconfined mixtures of methane in air are not generally explosive. Methane is buoyant at atmospheric temperatures and disperses rapidly in air.

11.5.2 Natural Gas Transmission Industry Safety Record

Overall, the natural gas transmission industry has an excellent record of safety and reliability. Safety and reliability are closely related because the measures that enhance safety also decrease the risk of pipeline shutdown and interruption of service.

The transportation of natural gas by pipeline involves some risk to the public in the event of an accident and subsequent release of gas. The greatest hazard is damage caused by a major pipeline rupture. Any gas escaping from the subsea pipeline would bubble to the surface, expanding as it rises through the water. Upon reaching the surface, the gas—being lighter than air—would continue to rise in the air and quickly dissipate.

The USDOT has been collecting and maintaining statistics on natural gas pipeline incidents and accidents since 1970. Table 11-14 summarizes incidents and accidents, by category, from 1986 to 2004. As seen in this table, the category accounting for the highest percentage of pipeline incidents is caused by damage from external forces (38%).

External forces include third-party damage from construction equipment, earth movements (e.g., landslides), weather damage, or purposeful damage (e.g., deliberate damage made to the pipeline). The most likely cause of potential damage to the Broadwater pipeline would be external forces. The potential for damage of the pipeline caused by earth movement, weather, or purposeful damage is considered low in the proposed Broadwater Project area.

Table 11-14 Natural Gas Pipeline Incident Summary (by cause) – 1986 through 2004

Year	Number of Incidents	Construction Material Defect	Corrosion	Third Party and Outside Damage	Other	Fatalities	Injuries
1986	83	15	12	32	24	6	20
1987	70	5	22	26	17	0	15
1988	89	9	19	39	22	2	11
1989	102	11	31	39	21	22	28
1990	89	22	16	39	12	0	17
1991	71	4	16	41	10	0	12
1992	74	9	12	32	21	3	15
1993	96	15	15	36	30	1	18
1994	80	9	33	23	15	0	19
1995	64	13	9	27	15	2	10
1996	73	7	13	37	16	1	5
1997	67	8	21	28	10	1	5
1998	98	19	22	36	21	1	11
1999	54	8	14	18	14	2	8
2000	80	7	31	20	22	15	18
2001	87	12	16	37	22	2	5
2002	82	0	22	27	33	1	5
2003	98	0	25	27	46	1	8
2004	117	0	37	38	42	1	3
Total	1,574	173 (11%)	386 (25%)	602 (38%)	413 (26%)	61	233
Average	83	9	20	32	22	3	12

Source: USDOT, Office of Pipeline Safety, internet site: http://ops.dot.gov

For offshore pipelines, two significant third-party accidents occurred within the 25 years up to and including the year 2000. One accident involved a large fishing vessel in the Gulf of Mexico severing a pipeline in shallow water, and the other involved a gas production platform. Over the 35-year period prior to 2000, 42 incidents of pipeline damage by anchors have been reported. The 42 incidents involved both oil and gas pipelines, but none of the incidents involve interstate gas transmission lines such as Broadwater (Garber et al. 2000).

Older pipelines have a higher frequency of external force incidents, partly because their location may be less well known or less well marked than newer lines. In addition, the older pipelines comprise a disproportionate number of smaller diameter pipelines, which are more easily affected by external forces.

The category accounting for the next most frequent cause of pipeline incidents is corrosion (25%). The frequency of corrosion-related incidents is largely dependent on pipeline age. While pipelines installed since 1950 exhibit a fairly constant frequency of corrosion incidents, pipelines installed before that time have a significantly higher rate. Older pipelines have a higher frequency of corrosion incidents because corrosion is a time-dependent process. The corrosion potential for new pipe is further reduced by use of more advanced coatings and cathodic protection. Prior to 1971, pipelines were not required to use cathodic protection and protective coatings.

Broadwater will fully implement standards and procedures as discussed in the following section to prevent pipeline corrosion.

11.5.3 Historical Pipeline Operating Record in the Region

Broadwater is a joint venture between TCPL USA LNG, Inc., and Shell Broadwater Holdings LLC. The ultimate parent company of TCPL USA LNG, Inc., is TransCanada Corporation (TransCanada). TransCanada owns, operates, and has interests in natural gas pipelines in both Canada and the U.S., which combined comprise 30,426 miles of pipeline with a total average throughput of 30.5 bcfd (2003). This includes TransCanada's interest in IGTS.

IGTS commenced partial operations in December 1991 and full operations on January 28, 1992, creating an important pipeline link between eastern North American markets and western Canadian natural gas supplies. Supported by expansions on its system, IGTS has since more than doubled the amount of gas that flows through its pipeline on an annual basis. In 1994, a compressor station was constructed in Wright, New York; in 1995, a second compressor station was constructed in Croghan, New York; and in 1998, IGTS added a third compressor station to its system in Athens, New York. In 2004, IGTS completed its Eastchester Extension Project, which involved new compressor stations in Boonville and Dover, New York, and the extension of its pipeline to Hunts Point, the Bronx, New York City. The IGTS pipeline currently comprises 411 miles of interstate pipeline extending from its connection to the TransCanada Canadian Mainline system at the U.S.-Canadian border at Waddington, New York, through western Connecticut to its terminus in Commack, New York, and from Huntington to the Bronx. IGTS interconnects with many facilities along the way, including other transmission systems and local natural gas distributors throughout New York, New England, and New Jersey.

The Iroquois Pipeline Operating Company, headquartered in Shelton, Connecticut, is the agent for and operator of the IGTS pipeline. Since the pipeline commenced service, no pipeline or equipment failures have occurred that have resulted in significant property damage or serious personal injury. Broadwater will employ similar system design, construction, operation, and maintenance practices to ensure that this record of pipeline safety in the region is maintained.

11.5.4 Pipeline Design

The proposed Broadwater pipeline will be designed and constructed to meet or exceed the safety standards established by the USDOT in 49 CFR Part 192. The project will be built in accordance with regulations that govern material selection and qualification, minimum design requirements, general construction, pipe joining, testing, protection from corrosion, and operations and maintenance.

ASME B31.8 "Gas Transmission and Distribution Piping Systems" will be used to supplement the requirements of 49 CFR Part 192. Codes from the following organizations are incorporated into the design as applicable:

- American Gas Association (AGA)
- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Society of Mechanical Engineers (ASME)
- Instrument Society of America (ISA)
- International Standards Organization (ISO)
- Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
- National Association of Corrosion Engineers (NACE)
- Occupational Safety and Health Act (OSHA)
- Uniform Building Code (UBC).

Public safety is further ensured in that the pipeline comes no closer to shore than 3.7 miles (6.0 km), thereby minimizing potential interaction with shore-based property or individuals.

Class locations specified in 49 CFR Part 192 will be used to determine minimum pipe wall thickness, shutoff valve spacing, and depth of cover required. High-strength carbon steel per API Specification 5L will be used for the pipe. Construction will be performed by qualified pipeline contractors in accordance with Broadwater's specifications. Contractor activities will be monitored by inspectors hired by Broadwater to ensure compliance with company specifications. Non-destructive examination of each pipeline weld will meet or exceed the minimum requirements of 49 CFR Part 192, with weld acceptance in accordance with the latest edition of API 1104.

Before placing the pipeline in service, hydrostatic testing of the piping will be conducted to verify the integrity of the pipe and welds. Any pipe segment that does not pass the hydrostatic test will be repaired and retested. The piping will be designed to allow for the use of electronic in-line tools to determine wall thickness and the presence of detectable corrosion or defects.

The pipeline will only transport non-corrosive natural gas suitable for end use; thus, internal corrosion does not present a risk. The gas will be odorized to match IGTS specifications for odorization of its system in the Long Island Sound area. To resist corrosion of the pipeline exterior, the pipeline will be externally coated with a coating material such as fusion-bonded epoxy (FBE).

In addition to an external coating, the pipeline will incorporate sacrificial anodes with a minimum 30-year design life. This secondary cathodic protection system will supplement the pipeline coating, should it be damaged during installation or operation. An insulating joint will be installed in the IGTS spool piping to isolate the Iroquois pipeline cathodic protection from the Broadwater pipeline cathodic protection. An above-water isolation flange kit also will be considered in the riser and topside design of the yoke mooring system.

Title 49 CFR Part 192 also defines area classifications, based on population density in the vicinity of the pipeline. The class location unit is an area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline. The four area classifications are defined as follows:

- Class 1: An offshore area, or a class location unit having 10 or fewer buildings intended for human occupancy;

- Class 2: A class location unit having more than 10 but less than 46 buildings intended for human occupancy;

- Class 3: A class location unit having 46 or more buildings intended for human occupancy or where the pipeline lies within 100 yards of any building or small, well-defined outside area occupied by 20 or more people during normal use; and

- Class 4: A class location unit where buildings with four or more stories above ground are prevalent.

Title 49 CFR Part 192 defines *offshore* to mean "beyond the line of ordinary low water along that portion of the coast of the United States that is in direct contact with the open seas and beyond the line marking the seaward limit of inland waters." Due to its remote location in Long Island Sound, the proposed Broadwater pipeline is considered a Class 1 location.

Title 49 CFR Part 192 sets out minimum requirements for pipe wall thickness and pipeline design pressures, hydrostatic test pressures, maximum allowable operating pressure, inspection and testing of welds, and frequency of leak surveys by class location. Broadwater will meet or exceed the minimum requirements for a Class 1 location.

The pipeline material will be high-strength steel manufactured in accordance with the latest edition of API 5L Standard Specification for Line Pipe. The wall thickness of the 30-inch-diameter pipeline will be designed to resist the combined loads that may be experienced during pipeline installation, testing, and normal operation. Limitations imposed by regulatory requirements and design codes also will be accounted for in the pipeline design. The pipeline will be designed for a maximum allowable operating pressure (MAOP) of 1,440 psig. Pipeline fittings will conform to ANSI 900 specifications, and the line pipe will be of one of the following or comparable material specifications:

- 30" O.D. x 0.720" W.T. API 5L Gr. X60;
- 30" O.D. x 0.665" W.T. API 5L Gr. X65; or
- 30" O.D. x 0.617" W.T. API 5L Gr. X70.

Weight coating required for negative buoyancy and on-bottom stability will be steel-reinforced concrete (140 to 205 lb/ft^3 densities, as required) applied over the FBE corrosion coating. During the detailed design phase, the concrete coating thicknesses will be determined through an on-bottom stability analysis, and the use of adhesive between the FBE coating and concrete weight coating for additional adhesion during lay operations will be evaluated. Preliminarily, the thickness of the concrete weight coating is approximately 3 inches.

The pipeline will be lowered below the seafloor along its entire length such that the top of the pipe is a minimum of 3 feet below the pre-disturbed natural bottom, wherever sediment conditions permit. Settling of the trench walls and natural sedimentation will be allowed to in-fill the excavated trench for the majority of the pipeline between MP 2.0 and MP 21.7.

The send-out gas stream from the FSRU will enter the connecting pipeline at temperatures between about 90 ^{o}F to 120 ^{o}F. To prevent overstressing the Broadwater connecting pipeline by thermal expansion, the FSRU tie-in spools and approximately the first 2 miles of the pipeline from the FSRU (MP 0.0 to MP 2.0) will be lowered below the seafloor to a depth of 5 feet, and the trench will then be mechanically backfilled. The sediment cover will help restrain the pipeline and maintain thermal stresses within acceptable limits.

If minimum depth cover cannot be achieved based on the sediment conditions, rock, concrete mats, or sand bags may be utilized to provide protection and pipeline stability based on site-specific conditions encountered at the time of construction. The following locations will have additional protection and/or stabilization measures:

- The two cable crossings may need concrete mats placed over the installed pipeline where the pipeline bridges over the cable and if the top of the pipeline is less than 3 feet below the natural seafloor; and

- The tie-in locations at the FSRU and IGTS locations will have protective structures and/or protection materials in addition to some rock backfill and sand/cement bags or grout bags.

The pipeline will also be noted on future navigational charts as a designated pipeway, minimizing potential for anchor strikes on the pipeline. Nevertheless, protection from the potential effects of inadvertent impacts from vessel anchors and fishing gear will be incorporated into the pipeline design. A previous study for IGTS' 24-inch outside diameter pipeline crossing of Long Island Sound (Kenny 1986) showed that pleasure vessel anchors and fishing gear cannot damage the pipeline. This is due, in part, to the diameter of the line, the pipe wall thickness, and the concrete outer coating of the pipe. The Broadwater pipeline will be of a larger diameter (30 inches) than the IGTS pipeline but designed to the same standards, and it will be as resistant to damage from the anchors and fishing gear typically associated with Long Island Sound vessels, as is the IGTS pipeline.

The potential for damage from large vessel anchors is mitigated by the fact that vessels will be in transit over the pipeline, and marine regulations restricting vessels from anchoring will be imposed, i.e., anchoring will be prohibited within a corridor (specified on all nautical charts) along the pipeline route. LNG carriers calling on the FSRU will not drop anchors; however, methods to protect the Broadwater pipeline from inadvertent LNG carrier anchor drops and other objects dropped within the area of FSRU berthing operations and weathervaning circle will be developed during the detailed design phase of the Broadwater pipeline. If necessary, the pipeline protection design may be augmented by using one or more of the following: a thicker pipe wall, thicker concrete coating, rock armor, or concrete slabs. In addition, the pipeline route in the immediate vicinity of the stationary tower structure will be oriented such as to avoid the prevailing orientation of the FSRU due to wind, waves, and current in Long Island Sound. This will minimize the exposure of the pipeline to FSRU activities and the potential risk of dropped objects impacting the pipeline.

Facilities will be attached to the proposed pipeline interconnection with the Iroquois pipeline to allow the attachment of a pig receiver. A permanent pig launcher will be installed on the stationary tower structure to accommodate inspection of the pipeline at regular intervals throughout the life of the facility. Many internal inspection tools are commercially available that are capable of detecting external and internal pipe corrosion and other anomalies. This type of inspection provides for early detection and correction of conditions that might result in a pipeline incident.

11.5.5 Pipeline Equipment and Control

The Broadwater pipeline will include many equipment features that are designed to increase the overall safety of the system and protect the public from a potential failure of the system due to accidents or natural catastrophes.

Pipeline facilities on the FSRU that will be integrated into the FSRU operations, maintenance, safety and emergency systems described earlier include:

- Metering station (on FSRU deck);
- Odorization injection unit (on FSRU deck);
- Gas chromatograph (on FSRU deck);
- Flexible jumpers (between FSRU and stationary tower structure);
- Pig launcher station (on stationary tower structure); and
- An ESD and isolation valve upstream of the pipeline riser (all on stationary tower structure).

ESD and isolation systems on the pipeline will be comprised of various valves packaged into pipeline spools and include:

- Subsurface Subsea Safety Valve and umbilical: This valve assembly located near the base of the YMS will consist of a Subsurface Safety Valve (SSSV) and a gear-operated maintenance valve. The SSSV will be a 30-inch full-opening ball valve fitted with an actuator and an umbilical connection. The SSSV will be controllable from the YMS and from the FSRU for remote, automatic, and ESD activation.
- Check and Isolation Valve: This valve assembly will be installed approximately 2,000 feet downstream of the YMS riser. These valves are included in the design to isolate the section of pipeline adjacent to the FSRU from the rest of the Broadwater pipeline and contain gas downstream if there is a failure in the pipeline system inside the weathervaning circle of the FSRU.
- IGTS Hot Tap Connection: This spool assembly contains the subsea shutdown and isolation systems at the pipeline end of line. This "T" shaped spool incorporates a check valve, which will isolate the Broadwater pipeline from the IGTS pipeline by preventing a backflow condition from the IGTS pipeline, as well as manually operated block valves that are normally open.

This will enable the IGTS pipeline to continue operating in the unlikely event of a shutdown of the Broadwater pipeline in an emergency.

The day-to-day operations of the FSRU, the Broadwater pipeline, and the IGTS pipeline will be integrated and coordinated. The existing gas control center for the IGTS system in Shelton, Connecticut, will be in continuous, uninterrupted communication with the control center on the FSRU. Together, the FSRU and IGTS control centers will monitor pipeline system pressures, flows, and deliveries into the IGTS system. Both control centers will be manned 24 hours a day, 365 days a year.

As a fail-safe measure, the existing integrated system of remotely controlled, onshore mainline block valves at each side of the IGTS pipeline crossing of Long Island Sound, together with the Broadwater SSSV, will allow the combined Broadwater and Iroquois pipeline systems in the Sound to be quickly shut down in an emergency. This does not, however, imply that these systems must operate together in the event of a requirement to shut down flows from the Project. Broadwater will work with IGTS to develop an operating pan that will address potential interruptions in operations.

A list of contractors who are available to respond to Broadwater's needs in the event of an emergency will be available in the Emergency Procedures Manual. Broadwater will employ qualified and licensed field personnel who can be immediately dispatched to the scene of an emergency if needed.

11.5.6 Pipeline Operation and Maintenance

Operation of the connecting pipeline will be dictated by natural gas flow rates that will vary in accordance with delivery requirements. The metering station on the FSRU will serve as part of the safety and leak detection systems for the pipeline. The pipeline facilities will be monitored using supervisory control and data acquisition (SCADA) systems by the Broadwater FSRU Command and Control facility and the IGTS Gas Control Center, both manned 24 hours per day. Operation and maintenance records will be maintained per the requirements of 49 CFR Part 192.

Broadwater will operate and maintain the proposed FSRU and connecting pipeline in an integrated manner. Regular pipeline maintenance will include maintenance and pigging at interval lengths specified by the USDOT, the applicant's standard operating procedures, NYSDEC regulations for pipelines, or as conditions warrant. Broadwater will prepare and implement an Operation and Maintenance (O & M) Plan based on 49 CFR Part 192. This O & M Plan will include all of the following activities, which meet or exceed the minimum requirements of 49 CFR Part 192:

- In-line tool inspections, as required, to determine the internal condition of the pipeline, and inspections of the cathodic protection systems to ensure proper operating conditions for corrosion mitigation;

- Routine contact with Long Island Sound users, utilities, local government agencies, contractors, and other interested parties to inform them of procedures to be followed in reporting and responding to a pipeline emergency;

- Periodic pipe-to-sediment electric potential surveys to maintain the cathodic protection of the pipeline;
- An annual in-house training program for operations personnel to maintain skill levels and review safety procedures in case of a pipeline emergency; and
- Annual testing of relief valves and emergency shutdown systems.

11.5.6.1 Temporary Pigging Operations

Pig traps will be constructed for the various pigging operations required, ranging from post-construction cleaning and caliper pigging to the periodic operational maintenance running of intelligent pigs for pipeline integrity assessment. The traps are designed in accordance with applicable codes and regulations for fittings and connections to the pipeline. The launching trap will be placed on the stationary tower structure. The receiving trap will be a temporary trap installed near the tie-in to the IGTS pipeline.

The IGTS hot tap connecting spool will contain a flange connection for attaching the pig receiver spool. The flange will normally have a blind attached that will be removed only when a pigging operation is scheduled. The receiver will be mobilized with a support diving crew when the pigging operations are performed. The receiver will be lowered to the tie-in spool, flanged into position, and then receive the pig. Prior to removing the blind on the pig receiver flange, a pollution dome will be installed over the connection area to capture any hydrocarbon leaks that may occur during operation. During the pigging operation, a NPS 24 valve that is part of the subsea connection assembly to the IGTS pipeline will be closed to direct gas flow through the receiver barrel. An 8-inch flexible pipe will be connected from the pig receiver to the NPS 24 valve assembly to allow the gas to continue through the pipeline as the pig is being received.

Pigging during operations will be performed every five to seven years. The pigging process would take place over a 10- to 14-day period, depending on weather conditions and type of inspection being undertaken. The process will have the following general sequence of activities:

- With the support of a Dive Support Vessel (DSV) and diving crew, in order to access the IGTS tie-in, any protective devices will be removed and set aside on the bottom, and then backfill will be removed and set aside or recovered to a barge on the surface;
- A temporary pig receiver will be mobilized with the support of the DSV and diving crew, lowered down to the IGTS tie-in spool, and flanged into position to receive a pig;

- The permanent pig launcher facilities are located on the deck of the stationary tower structure. A launcher barrel will be pre-loaded with a pig on shore and flanged into position on the deck of the stationary tower structure, or the pig will be transported offshore where it will be loaded into the pre-installed launcher barrel;

- The pig will be propelled by the send-out gas stream from the FSRU. Pig speeds will be controlled at the launcher barrel and by adjusting send-out gas flow rates;

- When the pig has been received at the IGTS interconnect, valves located at the receiver will be closed and the receiver barrel containing the pig will be recovered to the DSV. A pollution dome will also be utilized during recovery operations and will be brought to the surface for draining at an approved location;

- Following completion of the pigging operation, the blind at the receiver will be reinstalled, protective coverings will be re-established, and backfill will be replaced using backfill procedures similar to those used during the original construction, potentially supported by other vessels or barges; then

- The DSV and any support craft will demobilize.

Risk to vessel traffic will be minimal during pigging operations. Surface vessels will be confined to the immediate area over the IGTS interconnect. Public notification of pigging operations will be provided, including notice to mariners. Consideration will be given to providing an escort vessel to monitor traffic during pigging operations, much the same way as the escort vessel will function during pipeline construction.

11.6 BROADWATER EMERGENCY RESPONSE PLAN

11.6.1 Contact with Local Authorities

Broadwater met with the State Fire Administrator, James Burns, on November 7, 2005. The project was described, as was the requirement to prepare an Emergency Response Plan. A copy of the minutes from the meeting is attached as Appendix B.

11.6.2 Scope of Development for the Emergency Response Plan

As required under the Energy Policy Act of 2005, Broadwater will complete and submit an Emergency Response Plan for the FSRU and pipeline prior to receipt of final approval to begin construction. Development of emergency preparedness, response and incident analysis is an integral part of Broadwater's overall Health, Safety, Security & Environmental (HSSE) Management System, which is discussed in Section 11.7. Emergency Management Plans are discussed as Element 6 of the overall Management System Framework for HSSE, provided in Appendix D.

Table 11-15 provides the timetable for development of Broadwater's Emergency Response Plan.

11.6.3 Shore-Based Emergency Response

Detailed plans for shore-based emergency response will be developed as part of the overall Emergency Response Plan preparation, discussed above. The facility operator will be primarily responsible for providing initial emergency response, with the appropriate regulatory authorities and emergency response providers being notified that an emergency condition exists. Considerable resources will be available on the FSRU to enable facility personnel to deal with emergency situations.

It is anticipated that Broadwater's shore-based office facilities will serve as an alternative emergency response command center in the unlikely event that the FSRU is unable to manage a specific emergency situation. Extensive communications capabilities will exist at Broadwater's shore-based facility.

All tugs associated with the Project will have fire-fighting capabilities, which have been described in Section 11.4.2.2. To the extent that tugs are not already deployed in facility operations, there will be an adequate number of tugs available to assist in emergency response.

The participation of local emergency services in dealing with an emergency aboard the FSRU is unlikely except in the case of post-event analysis of criminal intent; however, their involvement in onshore handling and coordination of casualties will be a critical component of the Emergency Response Plan.

11.6.3.1 Pipeline

Broadwater will prepare and implement an Emergency Response Plan for the pipeline facilities. In case of an emergency, Broadwater's operating personnel will implement the appropriate emergency plan, depending upon the facilities involved.

11.6.4 Community Liaison

Broadwater will undertake a liaison program with the public authorities and local utilities. Key components of the Broadwater liaison program will include:

Table 11-15 Timeline for ERP Development

Step	Activity	Responsible	Process	Timeline for Completion
1	Emergency identification	Broadwater Emergency Response Team (ERT)	1.1 Identify situations, on site and off site, where an emergency may occur. Consider: • Human activities, • Equipment reliability, • Natural peril, • Temporary activities. 1.2 Evaluate probability and consequence of each situation (Hazard Identification Studies). 1.3 Evaluate past emergencies.	June 2006
2	Emergency prevention	ERT	2.1 Develop and implement a program to prevent emergencies. Include in the program: • Training and awareness, • Operational controls, • Monitoring and inspections, • Preventive maintenance, • Regulatory requirements.	June 2006
3	Emergency preparedness	ERT	3.1 Develop and document emergency response plans: • Determine responsibilities, • Develop preplanned responses with routing maps, • Identify medical and first aid resources, • Identify fire suppression and spill response materials and equipment, • Develop response and reporting forms, • Develop internal and external communication procedures, including contact lists. 3.2 Align program with existing internal and external programs and management system. 3.3 Plan for procurement and maintenance of necessary emergency equipment and materials.	December 2006

Table 11-15 Timeline for ERP Development

Step	Activity	Responsible	Process	Timeline for Completion
4	Contingency planning	ERT	4.1 Develop and document contingency plans to manage: • Persons dislocated by the emergency, • Business disruption, • Critical incident stress.	December 2006
5	Documentation	ERT	5.1 Prepare initial draft documentation, including the following: • Spill Prevention Control and Countermeasure Plan, • Spill Response Plan, • Hurricane Procedures Manual, • Integrated Contingency Plan, • Risk Management Plan, • Emergency Evacuation Plan, • Project Security Assessment and Overview, • Facility Security Plan, • Crisis Management Plan.	February 2007
6	Consultation	ERT	6.1 High-level review and coordination of plans with local emergency response providers	March - May 2007
7	Submission		7.1 Submission of Emergency Response Plan documentation	June 2007

- Periodic visits with municipal safety officials to inform them of the nature of Broadwater facilities and to coordinate emergency response in the event of an accident; and

- Special informational meetings and training at the initiation of the municipality, and periodic literature distribution listing emergency telephone numbers and other pertinent information.

Broadwater will maintain contact with the police, fire departments, and public officials of all communities that contain Broadwater facilities in order to:

- Ascertain how the officials may be able to assist Broadwater during an emergency, including determination of the jurisdiction and/or responsibility, with resources that may be involved in a response to an emergency;

- Acquaint the officials with how Broadwater will respond to an emergency on the terminal or pipeline system;

- Notify the officials of the types of terminal or pipeline emergencies for which they will be contacted; and

- Inform the officials how Broadwater will cooperate with their departments to protect life and property during an emergency.

Emergency response services and public officials will be given charts that show the locations of Broadwater's pipeline facilities within Long Island Sound. In order to enable Broadwater to quickly establish contact with emergency response services and public officials in the event of an emergency on the pipeline system, a current list of their telephone numbers will be maintained. This list will be reviewed and revised on a periodic basis or as necessary.

Table 11-16 provides an initial list of emergency response providers for which ongoing liaison is anticipated. Final determinations will be based on a careful analysis of the location of the facility, its supporting facilities, and the regional emergency command structure, as well as the specific requirements of different potential types of emergencies. This list will be refined during development of the Emergency Response Plan.

Broadwater will continue to participate in meetings with emergency response services in communities adjacent to the Broadwater facilities. The following subjects will be emphasized at these meetings:

- Broadwater's role in emergencies with respect to the terminal and pipeline system;

- The properties of natural gas and precautionary measures to be taken in the event of an emergency; and

Table 11-16 Preliminary Contact List for Ongoing Emergency Response Liaison

Region	Emergency Response Provider
New York State	New York State Emergency Management Office
	New York State Director of Homeland Security, Public Security
	New York State Police
	New York State Fire Administrator
	Adjutant General of New York, Division of Military and Naval Affairs
	Federal Emergency Management Agency, Regional Director
Nassau County	Police Department
	Office of Emergency Management
Suffolk County	Police Department
	Department of Fire, Rescue, and Emergency Services
	Suffolk County Emergency Management
Connecticut	State Police
	State Emergency Management and Homeland Security Office
	Division of Fire, Emergency and Building Services
	Shoreline Fire Chiefs
Hospitals	Stonybrook Hospital
	Yale/New Haven Hospital
USCG	Sector Long Island Sound, New Haven
Long Island North Shore Fire Departments	Centreport, Cutchogue, East Marion, East Northport, Eaton's Neck, Fishers Island, Greenport, Halesite, Huntington, Jamesport, Kings Park, Mattituck, Miller Place, Mt. Sinai, Nissequogue, Northport, Orient, Port Jefferson, Riverhead, Rocky Point, St. James, Setauket, Sound Beach, Southold, Stony Brook, Yaphank

- Emergency response services' participation in the event of an emergency on the Broadwater system.

In order to maintain such liaison, the following steps will be taken on a periodic basis:

- Broadwater will work with the USCG to ensure that Notices to Mariners are issued promptly throughout the construction process, and that regional marine charts are appropriately updated to reflect the location of the FSRU and the associated pipeline. This information will be available to all users of Long Island Sound.

- A current list of IGTS and all regional emergency response services telephone numbers and key personnel will be maintained by Broadwater.

11.7 BROADWATER HSSE MANAGEMENT SYSTEM

Broadwater developed a Health, Safety, Security and Environment (HSSE) Management System to demonstrate the company's commitment to protecting health, safety, and the environment. The HSSE Management System is presented in Appendix D.

11.8 RELIABILITY

11.8.1 Effect of Project Shutdowns

The potential exists for incidents of short-term duration to occur at the facility. The measures described in this Resource Report with respect to safety and security are designed to protect the facility from accidents, terrorist threats, and natural disasters. The implementation of these measures will minimize the frequency and duration of Project shutdowns.

While Broadwater will be a key component of the gas supply picture in the region, there are many other potential supply points in the regional pipeline infrastructure that would be capable of providing additional gas supply should the Project temporarily shut down. In the event of an unscheduled shutdown, impacts on downstream customers should be minor and temporary.

11.8.2 Measures for Maintaining Service and Minimizing Downtime

Metocean conditions within Long Island Sound are relatively benign. Downtime due to weather conditions is expected to be less than 1% of Project facility operations. Further, Broadwater analyzed the historical weather and current conditions in Long Island Sound and established weather parameters for safe approach to the FSRU and for remaining berthed at the FSRU.

General Terminal Design Features

The following general design features will provide high operational availability:

- Hull design: The hull of the FSRU will be designed for continuous operation for a minimum of 30 years, without having to be disconnected from the YMS and taken to a shipyard for refurbishment.

- Equipment selection: All equipment selected for the Project will meet applicable codes and standards, and will have proven reliability when operating in a marine environment.

- Peaking design: The Project is capable of peak operation at 1.25 bcfd, which affords a high level of reliability at the design flow of 1.0 bcfd.

- The FSRU is completely self-contained and does not rely on outside services to support its operation (e.g., power generation facilities).

- The ability of the FSRU to weathervane (rotate) around the stationary tower structure reduces the loading on the mooring components as the FSRU will align with the resultant of the wind, wave, and current forces. In general, the FSRU will assume a heading into the wind, which presents the smallest windage profile and the best line of approach for the LNG carrier.

- An inventory of spare parts will be maintained on the FSRU and ashore.

Specific Equipment Design Features

The FSRU will be constructed and outfitted with equipment of well-proven design, incorporating feedback from operational experience, resulting in an overall availability of the send-out facility from the technical perspective of around 99% at base load send out. The high reliability is due, in part, to the Project sparing philosophy of "N+1" based on peak send out for all critical items. This means that for critical equipment items, an extra piece of equipment is provided that is capable of sustaining the operation in the event of equipment failure.

- Multiple LNG storage tanks: The availability of eight tanks provides flexibility and continued operation in the event of a problem with one or more tanks. Each tank is equipped with one removable LP pump that allows change out of the pump without decommissioning of the tank. Pumps are sized such that only three pumps and three tanks are required to meet peak send out. An inert gas generator is provided to allow inerting and aeration of any one tank to allow entry with the appropriate isolation arrangements in place.

- Spare liquid/vapor loading arm: Four arms are provided with only two liquid arms and one vapor arm required for the base rate loading of the FSRU from an LNG carrier. The spare arm can be used for liquid or vapor duty and would be utilized only in the peak rate loading case.

- Spare regasification train: There are eight trains in total with only seven trains required to provide the peak send out rate. Each train consists of one high pressure pump and one shell and tube vaporizer.

- Spare process heater: The five process heaters provide the major heat for the glycol water heating medium for the regasification plant and although of robust design, static and operating under ideal conditions, as fired by gas, they follow the N+1 philosophy as only four are required to meet peak send out.

- The YMS toroidal gas swivels are duplicated, each one being capable of accommodating the maximum send out rate of 1.25 bcfd. In addition, the swivels are supplied with spare seals mounted in protective enclosures around each swivel that can be replaced in situ. The sparing philosophy is also reflected in the flexible jumpers between the FSRU and the YMS. Attention has been paid to ensure that principal parts of the system can be cross-connected and isolated as required.

- Spare boil-off gas compressors: There is a combination of reciprocating (3 x 33%) and centrifugal compressors (1 x 50%) to meet the peak throughput, with a spare reciprocating compressor based on peak send out. For many operating scenarios, two spare compressors may be available.

- Spare superheaters: Two superheaters are provided, with one being a spare based on peak send out.

- The nitrogen injection system for natural gas heat content adjustment of the gas is based on membrane technology and consists of 4 x 25% trains to meet the peak rate requirements with maximum nitrogen injection. Each train has spare membrane modules.

- Spare metering is provided by having a spare metering run in addition to the two metering runs required to meet the peak send out case. The spare meter run is provided to facilitate maintenance and calibration of the meters as well as redundancy.

- Main power generation sparing: There are three aero derivative gas turbines providing the main power requirements. Two of these gas turbines will satisfy the requirements to meet the electrical demand for peak send out. In addition one generator will be dual fueled so that it may operate when natural gas is not available and can be run on diesel oil.

- Essential and emergency power generation: In addition to the above gas turbine (GT) -sourced power, three identically sized diesel generators are provided to satisfy upset conditions if they arise when the GTs are not available. Two of the generators will meet the essential and emergency power arrangements of approximately 4 MW; the other generator, although a spare, is the designated emergency generator.

- Each waste heat recovery unit (WHRU) is dedicated to a particular GT exhaust system so redundancy is achieved by changing over GTs. Each WHRU is fitted with one spare circulation pump.

- Selective catalytic reduction units (SCRs) utilized for emission reductions from the GTs and the process heaters will not be spared but will have redundancy in that they are directly attached to the exhausts of equipment that is spared. The same sparing philosophy will, however, be applied to the ammonia vaporization unit of each SCR.

Pipeline Design Features

Reliability in the design and operation of the pipeline will be achieved by the following features:

- The pipeline will be designed to meet all applicable codes, regulations and standards.

- No compression facilities will be required for the pipeline, as the natural gas exiting the shell and tube vaporizers will be at the required pressure and temperature for pipeline operations. The availability of eight regasification trains, one of which is a spare, ensures that gas can be provided reliably at the required operating pressure.

- Explicit provision will be made for protection of the pipeline from dropped objects and anchors, as discussed in Section 11.5.4.

- In-line tool inspections, as required, to determine the internal condition of the pipeline, and inspections of the cathodic protection systems to ensure proper operating conditions for corrosion mitigation.

Contingency Planning

In addition to the design features outlined above. Broadwater will develop procedures for responding to mechanical failures or Project shutdowns. Once operations commence, Broadwater will implement a preventive maintenance program to ensure that all equipment remains in good working condition. Regular maintenance of equipment used in ongoing operations will occur on a scheduled basis, with appropriate documentation generated to monitor the execution and completion of the work.

As a further step to ensure reliability, an inventory of spare parts critical to the operation will be maintained on the FSRU and ashore.

11.8.3 Conclusions

The Broadwater facility is designed to operate safely, securely, and reliably. The steps outlined above will ensure that facility downtime and service interruptions are minimized.

11.9 REFERENCES

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APPENDIX A

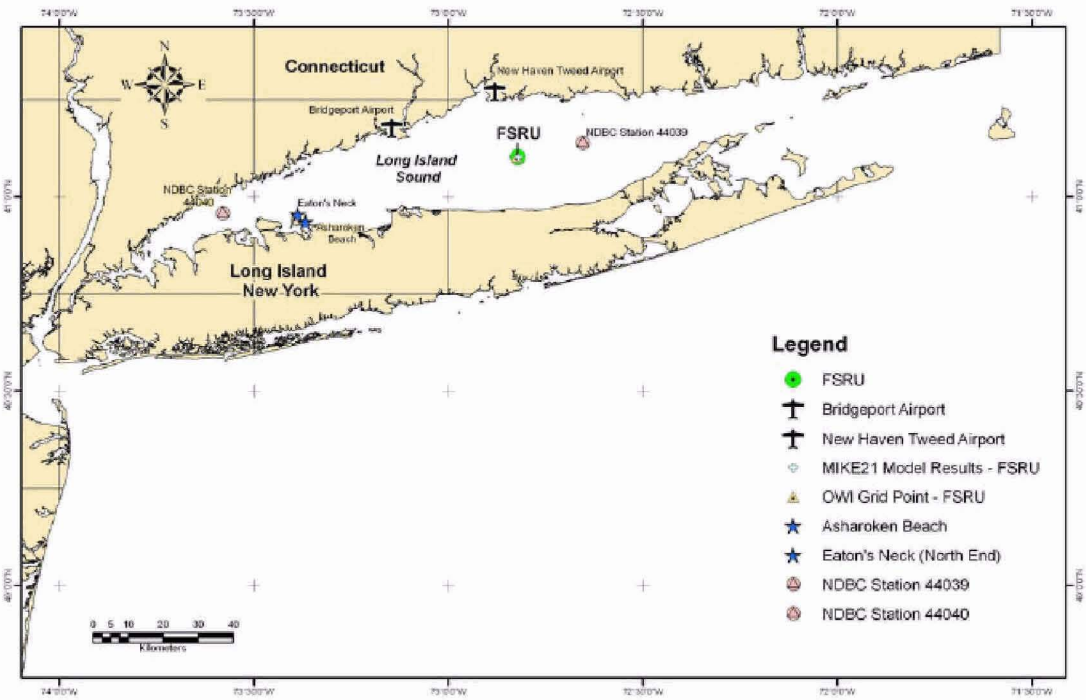
HISTORICAL CLIMATOLOGICAL INFORMATION

A.1 Historical Climatological Data

Air Temperature and Relative Humidity

Dew point and temperature data for the 1990 through 1999 period were obtained from the Bridgeport Sikorsky Airport in Bridgeport, Connecticut. The dew point and temperature data were used to compute relative humidity. The location of the airport is indicated on Figure A-1. There were a number of time periods when the instruments were not reporting, and those periods were excluded from any subsequent analysis.

Figure A-1 Weather Data Locations



Tables A-1 and A-2 show the maximum, minimum, and average values at Bridgeport for air temperature and relative humidity, respectively.

Water Temperature

Water temperature data for the entire 10-year operational time series were not available for Long Island Sound. However, the University of Connecticut deployed buoys affiliated with the National Data Buoy Center (NDBC) in 2004. NDBC 344039 is located closest to the FSRU site (*see* Figure A-1), and NDBC 44040 is located in western Long Island Sound. Water temperature data spanning the period of January 2004 to March 2005 were obtained from these two buoys. Both buoys measured the sea temperature at 1 meter (m) below mean sea level. During some periods, water temperatures were not reported, and those periods were excluded from analysis. Table A-3 presents the monthly maximum, minimum, and average water temperatures during

January 2004 to March 2005 for NDBC 44039, and Table A-4 presents those data for NDBC 44040.

Table A-1 Monthly Maximum, Minimum, and Average Air Temperatures

Month	Maximum (ºC)	Minimum (ºC)	Average (ºC)
January	16	-18	0
February	19	-17	1
March	28	-12	4
April	31	-6	10
May	36	3	15
June	36	9	21
July	38	13	24
August	34	12	23
September	32	4	19
October	29	-1	14
November	25	-7	8
December	23	-13	3

Table A-2 Monthly Maximum, Minimum, and Average Relative Humidity

Month	Maximum (%)	Minimum (%)	Average (%)
January	100	5	66
February	100	15	64
March	100	13	64
April	100	13	62
May	100	15	67
June	100	22	70
July	100	17	69
August	100	18	71
September	100	20	71
October	100	17	69
November	100	18	66
December	100	19	67

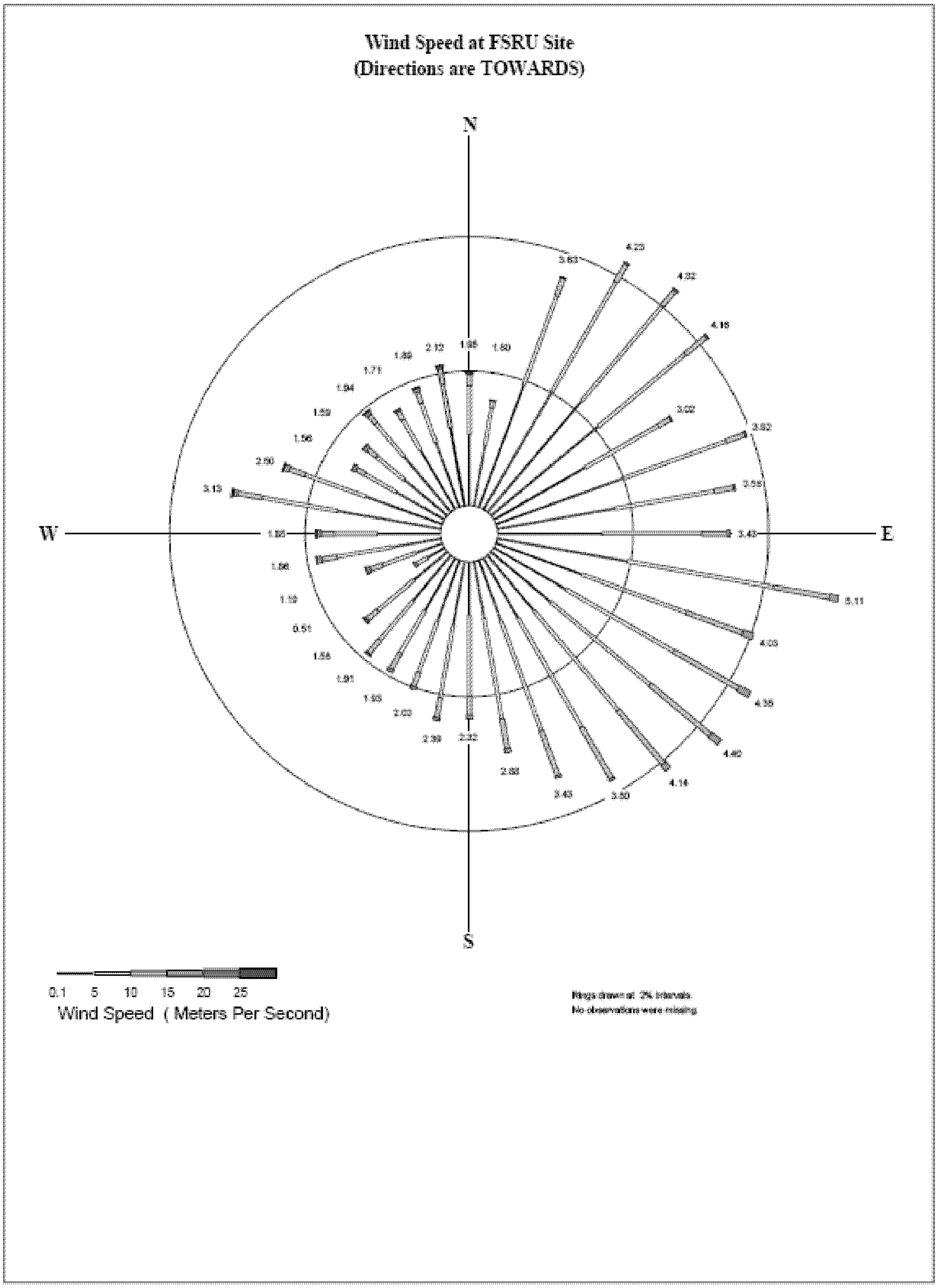
Table A-3 Monthly Maximum, Minimum, and Average Water Temperatures at NDBC 44039

Month	Maximum (ºC)	Minimum (ºC)	Average (ºC)
January	5.6	1.1	3.9
February	3.0	0.7	1.5
March	4.5	1.2	2.5
April		NO DATA	
May		NO DATA	
June		NO DATA	
July	24.0	20.1	22.1
August	25.5	21.0	22.6
September	25.5	20.8	22.2
October	21.4	12.5	19.8
November		NO DATA	
December	8.8	5.1	6.6

Table A-4 Monthly Maximum, Minimum, and Average Water Temperatures at NDBC 44040

Month	Maximum (ºC)	Minimum (ºC)	Average (ºC)
January	5.4	0.0	2.9
February	3.1	0.0	0.7
March	6.2	0.7	2.3
April	12.2	3.7	7.1
May	18.5	8.1	13.7
June	23.7	14.7	18.3
July	24.8	18.2	21.1
August	26.2	20.2	22.0
September	24.7	19.9	21.4
October	27.0	18.5	19.8
November		NO DATA	
December	8.3	4.0	6.3

Figure A-2 Historical Wind Speed



A.2 Tropical Events

Tropical events (or tropical cyclones), including tropical depressions, tropical storms, and hurricanes, generally occur during the late summer and fall. The term "tropical cyclone" refers to a non-frontal, synoptic-scale, low-pressure system over tropical or sub-tropical waters with organized convection (i.e., thunderstorm activity) and definite cyclonic surface wind circulation. Approximately 25 storms were found to affect Long Island Sound from 1938 to 2003. Not knowing exactly which storms would generate the highest significant wave heights at the Project site, data for all 25 storms were run through a wave model, and the top 15 storms that generated significant wave heights above 2 m were selected. Table A-5 identifies the selected tropical storms.

Table A-5 Significant Tropical Storm Events

Name	Date	Waves			Winds	
		Max Hs (m)	Tp (sec)	Direction Towards (deg)	Max 1-hour Average Wind Speed (m/s)	Direction Towards (deg)
n/a	9/21/1938	3.77	6.9	258	31.4	235
n/a	9/15/1944	4.02	7.1	256	32.4	250
Carol	8/31/1954	3.69	6.7	265	34.7	279
Edna	9/11/1954	2.27	6	259	17.6	254
Hazel	10/16/1954	2.06	4.8	299	30.7	327
Connie	8/13/1955	2.30	5.6	276	22.4	301
Donna	9/12/1960	3.44	6.5	265	33.4	278
Esther	9/21/1961	2.85	6.5	256	21.4	247
Doria	8/28/1971	2.25	5.4	289	29.7	324
Agnes	6/22/1972	3.29	6.6	269	30.4	284
Belle	8/10/1976	2.81	5.8	286	39.7	328
Gloria	9/27/1985	2.65	6	76	38.2	310
Bob	8/19/1991	2.21	5.6	255	19.2	177
Bertha	7/13/1996	2.13	5.3	289	26.7	318
Floyd	9/17/1999	2.18	5.4	282	23.5	313

The maximum significant wave heights range from 2 to 4 m, with peak periods from 4.8 to 7.1 seconds (s). The maximum 1-hour average wind speeds for these storms ranged from 17.6 to 39.7 m/s. All of the storms generated maximum waves propagating from east to west with the exception of Hurricane Gloria, during which the waves traveled from west to east. Hurricane Gloria passed directly over Long Island Sound, very close to the FSRU site. Note that the peak waves and winds were not oriented in the same direction, indicative of the complex processes near the eye of the storm. Hurricane Bob's peak wave and wind directions were approximately 80 degrees apart. That storm passed east of the Sound, and the waves propagated along the direction of the Sound's orientation while the peak winds were blowing from north to south. The remaining storms had peak wave and wind directions that were approximately coincident.

APPENDIX B

MINUTES OF MEETING

NEW YORK STATE FIRE ADMINISTRATOR

Record of Meeting

Meeting with New York State Fire Administrator

Date: November 7, 2005

Location: Office of the New York State Fire **Administrator**
Office of Fire Prevention and Control
New York Department of State
Albany, New York

Participants:

Broadwater

- John Hritcko, Regional Project Director
- David Thomson, Project Marine and Security Advisor
- Richard Sheirer, Giuliani Partners

Office of Fire Prevention and Control

- James Burns, NY State Fire Administrator
- Daniel Caffrey, Deputy State Fire Administrator
- Ronald Dunn, Chief, plus one other attendee from the Hazardous Materials Bureau

Purpose of Meeting: To initiate coordination with the State Fire Marshal toward the development of a comprehensive Emergency Response Plan for the Broadwater LNG Project.

Summary:

This was an introductory meeting with Mr. Burns and his staff. There was a brief discussion of the status of the attempts to develop state regulations for LNG in New York; however, it was recognized that these regulations were aimed at smaller peak shaving facilities and transportation of LNG, not import facilities such as Broadwater. The group then turned to the specifics of the Broadwater proposal, where it would be located, how it was anticipated to be operated, some of the marine and safety aspects associated with the FSRU concept, and the anticipated timing of the regulatory process.

Mr. Burns explained that while he understood under the federal requirements that the project is to consult with the "State Fire Marshall," the State of New York does not have such a position, but that he would act in that capacity, de facto, to discuss and assist in the development of the emergency response plans. Additionally, since Mr. Burns is the President of the National Association of State Fire Marshals, he is very familiar with LNG and the related fire codes and all aspects of responding to incidents involving the product. Finally, he indicated that he would assist Broadwater to ensure that the project contacted all of the appropriate local emergency response organizations on Long Island (fire, medical, and police) when we begin the development of the emergency response plans.

APPENDIX C

LNG CARRIER ROUTE ANALYSIS

Sensitive Security Information has been removed

from this Public Volume and is contained in the Sensitive Security Information Volume.

APPENDIX D

HSSE MANAGEMENT SYSTEM FRAMEWORK DOCUMENT

BROADWATER

HSSE Management System Framework Document

August 2005

Table of Contents

Broadwater HSSE Management System Framework Document

1.0 Introduction

This document reflects the Health, Safety, Security & Environmental (HSSE) Management System Framework for development of a comprehensive Broadwater HSSE program.

This framework is the foundation for the development and implementation of HSSE management systems for the Floating Storage & Regasification Unit (FSRU) and related facilities.

Any activity important to an organization must be managed and the importance of HSSE management systems is well established. Broadwater's comprehensive HSSE Management System, once developed, will form the basis for decision-making at all levels of Broadwater. This framework provides a broad-based set of expectations integrated into 11 elements. It assists leadership focus on critical HSSE issues, allocation of resources, and ultimately delivery of improved HSSE performance.

2.0 Scope

Broadwater's HSSE Management System is intended to cover all operational aspects and activities that have the potential to affect, positively or negatively, the health, safety and security of people, the environment, or the community. The System will cover the entire life cycle of operations, from concept and planning through to operation, closure, and decommissioning.

The HSSE Management System Framework provides documented evidence of Broadwater's commitment to Health, Safety, Security and Environment. It serves to establish minimum requirements for the HSSE Management System and to act as a guiding document for its implementation. Implementation will be achieved by ongoing HSSE programs, practices and procedures. Review processes will be in place to assess the effectiveness of implementation.

3.0 Objectives

The objectives of the Management System are to:

•Provide a risk-based HSSE management system framework, consistent with the ISO 14001, and other internationally recognized Standards, that supports the implementation of the HSSE Policy across the Broadwater organization;

•Set out and formalize expectations for the progressive development and implementation of more specific and detailed HSSE management systems for the Broadwater facility;

•Provide auditable criteria, against which HSSE management systems for Broadwater can be measured; and

•Provide the basis from which to drive continuous improvement.

4.0 Application

The HSSE Management System applies to all Broadwater operations. These include:

•Activities associated with FSRU;

•Activities associated with the connecting pipeline; and

•Activities by contractors on Broadwater facilities or under Broadwater management.

5.0 Review and Document Control

The HSSE Management System will be reviewed periodically by the Broadwater HSSE Leadership Team and, if required, revised and reissued in accordance with document control requirements.

6.0 Element Implementation

The Broadwater Management System Framework consists of a series of eleven elements. Each element has two tables. The first table describes the set of objectives for each management system element plus management's expectations associated with meeting those objectives. The second table outlines the activities, responsibilities and the processes necessary to implement the element requirements.

6.1 Element 1 - HS&E Policy and Strategic Objectives

HSSE Policy and Strategic Objectives describes in broad detail the company's overall direction and with respect to Health, Safety and Environmental issues.

Element 1		**HS&E Policy and Strategic Objectives**
Objectives	**A**	Management provides a strong and visible leadership model to promote a culture in which all employees share a commitment to HSSE as a core value. The important objective for continuous improvement is the concept of 'zero harm' – this is our ultimate goal and applies to all areas of the policy.
	B	HSSE Management System is developed, documented, implemented and supported by Broadwater. The System addresses potential health, safety, security, environmental, technical integrity and operational risks associated with the facility and is consistent with internationally recognized standards.
Expectations	**1.01**	Senior Broadwater Management endorses the HSSE Management System and these elements, seeks assurance of compliance and regularly reviews HSSE performance, risks and strategic issues. This demonstrates a top-down commitment and company culture necessary for success in the systematic management of HSSE issues.
	1.02	To demonstrate leadership and commitment, management must show informed involvement in HSSE issues.
	1.03	Management is proactive in target setting. It recognizes that impacts from Broadwater activities have the potential to cause safety/environmental harm. The aim is to progressively reduce these impacts and the consequent risk of harm, and achieve overall improvements in safety/environmental performance. HSSE 'results' and 'activity' targets are included in management appraisals.
	1.04	Management establishes clear strategic HSSE objectives and targets. In setting objectives, management considers the overall risk levels of its activities and identifies those critical operations and installations that require a fully documented demonstration that risks have been reduced to as low as reasonably practicable (ALARP).
	1.05	Management, employees and contractors understand their accountabilities and demonstrate leadership and commitment to HSSE.

Element 1		HS&E Policy and Strategic Objectives
	1.06	Management is accountable for the HSSE performance as well as the implementation and communication of the HSSE objectives and meeting the expectations of the management systems, which are designed to measure and drive continual improvement in HSSE performance.
	1.07	Management demonstrates commitment to implementing the HSSE Management System by ensuring that the necessary resources, milestones and reviews are allocated within the Business Plan.
	1.08	Management is fully aware of the high priority areas for improvement identified in the HSSE Management System, particularly in relation to legal compliance and the status of the follow up actions.
	1.09	Management develops a risk management plan that ensures that all potential risks are assessed and unacceptably high risks are reduced using a hierarchy of strategies of elimination, prevention, mitigation and recovery.
	1.10	Management communicates the importance of HSSE considerations in business decisions and by the inclusion of HSSE matters at business meetings.
	1.11	All levels of management are regarded as being fully committed to HSSE by all staff and contractors. They provide leadership toward constant improvement and action planning.
	1.12	Management makes an immediate and visible response and maintains personal involvement in case of incidents or other abnormal events related to HSSE.
	1.13	Management demonstrates active personal participation in HSSE activities such as training, reward and recognition schemes, industry/contractor workshops, conferences and audits.
	1.14	Employees and contractors jointly develop and discuss HSSE 'result' and 'activity' improvement targets and indicators with their managers.

Element Implementation Requirements			
Element 1 HSSE Policy and Strategic Objectives			
Step	**Activity**	**Responsible**	**Process**
1	Define policy requirements	HSSE Committee	1.1 Define policy requirements. Ensure: • Wording and content are applicable to this business; • It is written in a framework that is measurable and contributes towards setting and reviewing health, safety, security and environmental objectives and targets; 1.2 Indicate a commitment to: • Comply with regulatory requirements; • Prevention of pollution; • Health, safety and security of employees, contractors and members of the community; • Continual improvement. 1.3 Review policy content with employees
2	Gain approval of policy content	HSSE Committee	2.1 Attain management approval and endorsement for the policy. 2.2 Assign responsibility for review and maintenance of the policy. 2.3 Define and document approved policy.
3	Communicate	Management HSSE Committee	3.1 Identify parties to which the policy must be communicated. Consider: • Specific policy audience (contractors, regulators, etc.); • Suitable communication means and medium; • Appropriate communication schedule. 3.2 Communicate the policy.
4	Review	Management HSSE Committee	4.1 Identify suitable schedule for review of the policy and strategy. 4.2 Evaluate whether current policy/strategy meets requirements. 4.3 Develop suitable changes to the policy and strategy if required. Ensure: • Both align to business goals; • Both align to core values; • Achievement of objectives and targets. 4.4 Attain management approval and endorsement for a revised policy. 4.5 Communicate the revised policy and changes in strategy.

6.2 Element 2 - Structure & Responsibility

The Structure and Responsibility Element ensures that adequate resources are available at all levels of the organization, with clear allocation of responsibilities to ensure proper focus on HSSE matters.

Element 2		Structure & Responsibilities
Objective		Management ensures that sufficient resources are available to maintain the effective operation of the HSSE Management System and the effective management of risks.
Expectations	**2.01**	Broadwater has developed an organizational structure and assigned responsibilities for fully implementing the HSSE program. Responsibilities for HSSE management are integrated throughout the organization to ensure that all employees understand their role in achieving Broadwater's objectives.
	2.02	The organizational structure, roles, responsibilities, authorities, accountabilities and interrelations (e.g. partners, contractors, regulators) necessary to implement the HSSE Management System are defined, documented, communicated and reviewed at regular intervals.
	2.03	The HSSE Manager has a clearly defined role, responsibilities, authority and resources for ensuring that HSSE Management System requirements are established, implemented and maintained for all operations. That person shall regularly report on the performance of the HSSE Management Systems to senior management for review and will use performance as a basis for improvement.
	2.04	All Broadwater employees and contractors are bound by the requirements of this policy. Business partners, suppliers and visitors are to uphold the spirit of this policy while at any Broadwater facilities and in their dealings with Broadwater.
	2.06	All HSSE Critical Activities are identified and recorded in the HSSE Management System.
	2.07	Responsibilities are assigned to every HSSE Critical Activity and inputs and outputs necessary for its control recorded.
	2.08	Employee (company and contractors) competencies for HSSE Critical Activities are defined and responsibilities and requirements associated with the control of the activities are understood by the employee.
	2.09	Resourcing levels are sufficient to meet the requirements for staffing all HSSE critical roles and are regularly reviewed.

Element 2		Structure & Responsibilities
	2.10	Procedures ensure that any changes in resource level do not increase HSSE risk, e.g. leave rotations ensure resourcing do not compromise HSSE Critical Activities.
	2.11	HSSE responsibilities are updated and revised in conjunction with employees (company and contractor) performance assessments.

Element Implementation Requirements			
Element 2 Structure & Responsibility			
Step	**Activity**	**Responsible**	**Process**
1	Identify roles and activities	HSSE Committee Management	1.1 Identify key roles and activities required to support the HSSE Management System include: • Accountability for the HSSE Management System • Planning and coordination of HSSE work; • Reporting on the performance of the HSSE Management System
2	Provide appropriate resources	Management HSSE Committee	2.1 Evaluate resource needs. Include: • Human resources; • Specialized skills; • Technology; • Financial needs. 2.2 Determine resource availability. 2.3 Ensure employees and contractors have appropriate training and education to meet company and HSSE requirements.
3	Align resources with identified roles	Management HSSE Committee	3.1 Align resources with key roles. 3.2 Assign specific responsibilities for each role. 3.3 Gain approval for required resources. 3.4 Document the organization by means of a suitable organizational chart.
4	Communicate	Management HSSE Committee	4.1 Communicate to all affected parties. Include: • Employees; • Contractors; • Public. 4.2 Ensure employees and contractors are aware of and understand defined roles and responsibilities.

6.3 Element 3 - Risk Assessment & Hazard Management Process

Risk Assessment & Hazard Management Process is the process for understanding of risks so that they can be properly managed. The risks include risk to people, the environment, assets and community/reputation.

Element 3		Risk Assessment & Hazard Management Process
Objective	**A**	Management of risk is a continuous process and the cornerstone of all the HSSE elements. Broadwater management regularly reviews identified HSSE hazards and evaluates HSSE risks for all activities, and develops plans for the effective implementation of measures to control these risks and to recover in case of control failure.
	B	Broadwater management is committed to identifying the root causes of risks and the potential consequences. These consequences may relate to health, safety, security, environment, community/reputation and/or Broadwater's assets. Broadwater aims to manage and control identified risks to a level that is as low as reasonably practicable (ALARP).
Expectations	**3.01**	Management is in place to promote the use of hazard assessment processes to identify hazards and those systems critical for managing the hazards and ensuring that risk levels are acceptable.
	3.02	The hazard assessment process with appropriate risk analyses is conducted throughout the complete lifecycle of the asset. Hazards associated with Broadwater's operations are identified, prioritized and assessed using appropriate methods. New or proposed changes to processes or services are assessed for potential HSSE risks and managed to ensure HSSE performance is maintained at an acceptable level.
	3.03	HSSE hazards identified are assessed based on their risk potential. All major hazards are evaluated using specialized techniques for identifying how a hazard is controlled.
	3.04	Identified risks are evaluated by the appropriate level of management, consistent with the significance of the risk. Risk management decisions are clearly documented and the implementation of resulting actions tracked until implementation is complete.
	3.05	Key aspects of the risk assessment program are regularly measured and audited with the aim of continuous risk reduction.

Element 3		Risk Assessment & Hazard Management Process
	3.06	People with relevant knowledge and experience, including employees, contractors and specialists as appropriate are involved in the risk assessment process.
	3.07	Environmental assessments are conducted prior to all new activities and significant facility modifications.
	3.08	Health risk assessments are used periodically to address physical, chemical, biological, ergonomic and psychological health hazards associated with operations and maintenance activities.
	3.09	Effective controls are place to manage the identified hazards. Critical equipment and procedures are known and their effectiveness in controlling the hazard are assessed and monitored.
	3.10	Risk assessment documentation and actions are kept readily available and maintained up-to-date through periodic reviews and the management of change process.
	3.11	Systems are in place to ensure only authorized employees or contractors approve changes, either permanently or for a defined period, once the level of HSSE risk has been demonstrated to be acceptable following the change. The duration of a temporary change is not exceeded without review and approval.
	3.12	Systems are in place that ensure all change management actions have been completed and documentation is updated, including the preparation of 'as built' plans, to appropriately reflect the change.
	3.13	HSSE hazards and their risks are recorded and maintained in a hazard register. The Hazard Register is reviewed and updated periodically.
	3.14	Risks are communicated to all relevant staff and contractors, highlighting their roles in managing and maintaining critical controls.
	3.15	An HSSE Case is available to demonstrate how the major hazards at this facility are being properly managed.

Element Implementation Requirements			
Element 3 Risk Assessment & Hazard Management Process			
Step	**Activity**	**Responsible**	**Process**
1	Identify impacts of business activities	Management HSSE Committee	1.1 Identify business activities that may have an impact on the health, safety and security of employees, contractors, the public or the environment. Include: • Engineering and construction • Day to day operations and maintenance activities; • Acquisitions or divestitures of properties; • Hazardous products (air emissions, raw materials, existing products); • Decommissioning of facility.
2	Evaluate risk of business activity	Management HSSE Committee Employees	2.1 Determine the potential severity of the impact and the frequency of occurrence using available risk assessment tools and processes. 2.2 Ensure the selected tool or process is suitable for the scale of the activity and complexity of the site. 2.3 Document results of the assessment. 2.4 Communicate risks for the purpose of awareness and consideration when developing business and strategic plans and when setting HSSE objectives and targets.
3	Determine legal requirements	HSSE Committee Legal/ Regulatory Affairs	3.1 Identify and monitor regulatory and industry requirements on an ongoing basis, including: • Legislation; • Regulations: • Codes of practice; • Recommended industry practices; 3.2 Influence the development of laws and regulations applicable to Broadwater operations. 3.3 Provide access to identified regulatory and industry requirements. 3.4 Ensure programs, procedures and practices are modified to reflect regulatory changes. 3.5 Ensure appropriate tracking and compliance plans are in place. 3.6 Communicate to affected stakeholders.

6.4 Element 4 - Legal and Other Requirements

Legal and Other Requirements describes the commitment Broadwater management has made to meeting all of its legal and regulatory requirements.

Element 4		Regulatory Requirements
Objective		The HSSE Policy includes a management commitment to comply with all relevant and applicable legislation, regulations and other requirements, and provides a framework for setting and reviewing environmental objectives and targets. The policy is documented, implemented, maintained and communicated to all employees.
Expectations	**4.01**	Broadwater management is committed to complying with all applicable laws, rules and regulations.
	4.02	Systems are in place to assemble and maintain a register of relevant legal, regulatory and other HSSE requirements applicable to Broadwater operations. The register can be either electronic or paper. The register is accessible to personnel. An effective HSSE document control system is in place to ensure information provided is accurate and up-to-date.
	4.03	A documented procedure for the periodic evaluation of compliance with relevant HSSE legislation and regulations is maintained.
	4.04	A signed statement of fitness is made to demonstrate that operating facilities and future modifications are designed constructed and commissioned in accordance with applicable standards, codes and regulations.
	4.05	Open consultation and communication with government agencies and other organizations is maintained in order to contribute to the development of public policy, relevant legislation and educational initiatives.

Element Implementation Requirements			
Element 4 Legal and Other Requirements			
Step	**Activity**	**Responsible**	**Process**
1	Identify regulatory/ legal requirements	To be determined.	1.1 Identify regulatory and industry requirements, including: • Regulations • Legislation; • Codes of practice; • Recommended industry practices
2	Provide access to regulatory and industrial codes of practice	To be determined.	2.1 Provide access to the identified regulatory and industry requirements.
3	Ensure procedures and practices meet current requirements	To be determined.	3.1 Ensure programs, procedures and practices are modified to reflect regulatory changes.
4	Monitor and implement changes to legislation, regulation or other requirements.	To be determined.	4.1 Identify, monitor and ensure compliance with current regulatory and industry requirements, including: • Regulations; • Codes of practice; • Recommended industry practices; • Changes or amendments to existing legislation

6.5 Element 5 - Design, Construction, Commissioning and Operational Control

Design, Construction, Commissioning and Operational Control describes the company's requirements for ensuring that the facilities will be designed, built, operated and eventually abandoned within the current design envelope to meet the safe, secure, healthy and environmentally sound performance standards (includes contractors/suppliers). This also includes the management of change whenever temporary or permanent changes are necessary.

Element 5		Operational Control, Procurement & Contract Management
Objective	**A**	Systems are established, documented and maintained to ensure the ongoing integrity of the facility and equipment.
	B	All facilities and equipment are operated, maintained, inspected and tested using systems and procedures that manage HSSE risks.
Expectations	**5.01**	Systems and written procedures are established, maintained, reviewed and updated to ensure that operations and maintenance activities are managed to minimize HSSE risks. Qualified personnel follow the written work procedures and instructions.
	5.02	Applicable regulatory requirements are met or exceeded and operational/mechanical integrity is maintained by use of clearly defined and documented operational, maintenance, inspection and asset integrity (corrosion/erosion) control systems.
	5.03	Procedures covering both operations and maintenance activities are established and maintained to control all pertinent risks.
	5.04	Work procedures and instructions are understood and readily accessible to the workforce. Critical tasks are identified and emphasized throughout all written procedures.
	5.05	Responsibilities for all activities that are critical to HSSE performance are assigned to job functions and all interfaces with supplier and contractors are clear.
	5.06	Interface between Broadwater and suppliers of products and services are properly managed. Pre-qualification and selection criteria, including competence, are established for the work performed by contractors and suppliers.
	5.07	Suppliers and contractors are subject to HSSE evaluation prior to making contractual commitments.

Element 5		Operational Control, Procurement & Contract Management
	5.08	Contracts specifically require contractors to implement systems consistent with the Broadwater HSSE Management System and in compliance with relevant regulations.
	5.09	Systems are in place to ensure that the HSSE performance of suppliers and contractors meets their contractual obligations.
	5.10	Reporting relationships, lines of communication and responsibilities are established and documented between Broadwater and its suppliers and contractors.
	5.11	Critical equipment, systems, and procedures are identified and documented. The systems and procedures are reviewed regularly to ensure that they continue to be applicable, accurate and effective in controlling the hazards they were prepared for.
	5.12	Key operating parameters and their limits are identified and communicated. Personnel understand the importance of operating within the acceptable limits.
	5.13	Deviation from the safe limits established for key operating parameters, when authorized, is assessed and properly managed.
	5.14	The reliability and availability of protective systems is properly managed. Systems are in place to test and maintain the availability and effectiveness of protective systems. This includes by-pass authorization (disarming/ deactivating), maintenance and testing.
	5.15	All changes (temporary or permanent) to organization, personnel, management systems, equipment or procedures are evaluated to ensure that risks remain at an acceptable level.
	5.16	Risks introduced by simultaneous operations are assessed and managed.

Element Implementation Requirements			
Element 5 Operational Control, Procurement & Contract Management			
Step	**Activity**	**Responsible**	**Process**
1	Identify activities	Management HSSE Committee Employees	1.1 Review identified business activities where lack of control could lead to risk. Consider: • Design, construction, operation and decommissioning of facilities; • Change in business operations (including modification or substitutions of specified materials, hazardous materials and/or equipment); • Management of waste; • Emissions to air, water, and soil; • Transportation and distribution of product or service; • Use of personal protective equipment; • Fitness to work; • Disability Management; • Health and Wellness; • Regulatory Management; • Incident Reporting; • Emergency Management. 1.2 Establish pre-qualification and selection criteria, including competence, for the work performed by contractors and suppliers. 1.3 Identify critical activities that could lead to increased risk if not properly completed.
2	Define and develop programs, procedures to manage risk and to achieve targets and objectives.	Management HSSE Committee Employees	2.1 Identify whether an existing program, process, procedure or industry practice is available to contribute to managing risk and/or toward the defined objective. 2.2 Align existing programs, process, procedures or practices to defined objectives. 2.3 Identify opportunities to standardize and link programs and/or procedures, where appropriate (format and content). 2.4 Identify where there are no programs and/or procedures available contributing to the achievement of the objective. 2.5 Define and document new programs and procedures, where required. Requirements for new programs and procedures may include: • Change of an existing process or procedure; • Implementation of new technology; • Employee training or awareness. 2.6 Determine operational responsibilities to implement the program and/or procedure. 2.7 Emphasize critical tasks throughout all written procedures 2.8 Identify suppliers and contractors requiring HSSE evaluation prior to making contractual commitments.

Element Implementation Requirements			
Element 5 Operational Control, Procurement & Contract Management			
Step	**Activity**	**Responsible**	**Process**
3	Test	HSSE Committee Employees	3.1 Where appropriate, test program or procedure in a controlled environment. 3.2 Assess and document success and failures of defined program or procedure. 3.3 Modify the defined program or procedure.
4	Approve	HSSE Committee	4.1 Seek formal approval of program or procedure. 4.2 Define and document controlled program or procedure.
5	Communicate	Management HSSE Committee	5.1 Communicate program or procedure to all appropriate stakeholders (i.e. employees, contractors, and the public). 5.2 Train regarding: • Defined roles and responsibilities within the program or procedure; • The impact of deviation from the defined controls. 5.3 Ensure competency. 5.4 Provide leadership support for programs, processes and procedures.
6	Maintain	HSSE Committee Employees	6.1 Define appropriate review periods for all programs and procedures. 6.2 Review program and procedure documents according to defined review periods to maintain the integrity of the information.
7	Supplier/ Contractor pre-qualifications	HSSE Committee Management	7.1Review identified HSSE risks and regulatory compliance requirements pertaining to proposed contractor scope of work or supplied product. 7.2 Develop criteria of competencies and training required, as a minimum, to perform the proposed scope of work or supplied product. 7.3 Develop criteria for equipment and materials required to ensure regulatory and other compliance. 7.4 Integrate HS&E criteria into all tender documents, as applicable. 7.5 Review submitted proposals for adherence to HS&E criteria. 7.6 Evaluate HS&E criteria adherence (including past HS&E performance), before binding contract. 7.7 Integrate HS&E criteria into all contracts. 7.8 Record successful proposals, including terms-of-reference.
8	Supplier/ Contractor management planning	HSSE Committee Employees	8.1 Develop and document plans to manage contractor/supplier activities. Include: • Project/product specific monitoring protocol and schedule; • Contingencies for necessary changes to scope of work or product changes.

Element Implementation Requirements			
Element 5 Operational Control, Procurement & Contract Management			
Step	**Activity**	**Responsible**	**Process**
9	Supplier/ Contractor training	HSSE Committee Employees	9.1 Provide contractors/supplier orientation: • Communicate specific hazards and applicable HS&E procedures for contractors; • Communicate HS&E expectations and consequences of non-conformance; • Develop measures to ensure understanding. 9.2 Train employees with oversight responsibilities.
10	Supplier/ Contractor performance evaluation	HSSE Committee Employees	10.1 Inspect contractor activities or supplier products in accordance with monitoring plans and schedule. 10.2 Assess contractor/supplier compliance against HS&E criteria and develop corrective action plans as required. 10.3 Corrective actions may include termination of contractor or contract employee. 10.4 Maintain contractor/supplier evaluation records. 10.5 Implement changes as required.

6.6 Element 6 - Emergency Preparedness, Response & Incident Analysis

Emergency Management Plans are required for major hazards and other unexpected events. The plans detail the personnel, equipment, and training necessary to protect the workforce, the public, the environment, assets and the company reputation. It also includes incident follow-up activities.

Element 6		**Emergency Preparedness, Response & Incident Analysis**
Objective		A process is in place to identify and document credible safety, security, operational, and environmental incident scenarios. Contingency and emergency response procedures (including medical, operational, environmental, and security emergencies) shall be developed and maintained to identify responses to incidents and emergency situations and for preventing and mitigating the HSSE impacts that may be associated with them.
Expectations	**6.01**	Emergency response plans including procedures and resources are in place to effectively respond to crisis and emergency situations including security threats.
	6.02	There are systems in place that document and maintain plans for responding to abnormal situations and potential emergencies. Plans that define responses (including the mitigation of HSSE impacts) to foreseeable potential emergency scenarios are documented, accessible and communicated. The plans define roles and responsibilities for employees and contractors.
	6.03	The Emergency Response Plan defines Broadwater's incident command structure. This comprehensive tiered emergency response system is fully integrated in the response plans. Emergency Response Plans are periodically tested where applicable.
	6.04	The incident command structure (command and control personnel) organization and responsibilities are identified.
	6.05	Resource requirements for emergency response are identified, maintained, tested and available.
	6.06	Systems and measures for minimizing potential HSSE effects, such as the mobilization of support and evacuation procedures, are defined.
	6.07	Communications are made to command and control personnel, emergency services, employees and contractors who may be affected, and others likely to be affected, such as passing ships.

Element 6		Emergency Preparedness, Response & Incident Analysis
	6.08	Broadwater maintains systems for the reporting and investigation of hazardous situations, near misses and appropriate communication of all HSSE incidents.
	6.09	Employees are aware of the near miss and incident reporting procedures and participate in incident investigations.
	6.10	There is a system for addressing the management of a crisis. A crisis in this context is a relatively infrequent event that covers any significant disruption to the normal business routine and requires an immediate response from senior management.
	6.11	Accidents and incidents are thoroughly investigated and analyzed to identify root causes so that corrective and preventive actions can be taken with accountabilities assigned, and progress on recommended actions monitored until close out.
	6.12	Any corrective or preventative action taken to eliminate the causes of potential incidents shall be appropriate to the magnitude of problems and commensurate with the HSSE risks encountered.
	6.13	Broadwater implements and records any changes in the documented procedures resulting from corrective and preventative action. Lessons learned from accidents and incidents shall be disseminated to relevant personnel and contractors.

Element Implementation Requirements			
Element 6 Emergency Preparedness, Response & Incident Analysis			
Step	**Activity**	**Responsible**	**Process**
1	Emergency identification	HSSE Committee Management ERT (emergency response team) Employees	1.1 Identify situations, onsite and offsite, where an emergency may occur. Consider: • Human activities; • Equipment reliability; • Natural peril; • Temporary activities. 1.2 Evaluate probability and consequence of each situation. 1.3 Evaluate past emergencies.
2	Emergency prevention	Management HSSE Committee ERT Employees	2.1 Develop and implement a program to prevent emergencies. Include in program: • Training and awareness; • Operational controls; • Monitoring and inspections; • Preventive maintenance; • Regulatory requirements.
3	Emergency preparedness	ERT HSSE Committee Management Employees	3.1 Develop and document emergency response plans: • Determine responsibilities; • Develop pre-planned responses with routing maps; • Identify medical and first aid resources; • Identify fire suppression and spill response materials and equipment; • Develop response and reporting forms; • Develop internal and external communication procedures; including contact lists. 3.2 Align program with existing internal and external programs and management system. 3.3 Procure and maintain necessary emergency equipment and materials. 3.4 Plan, conduct, participate in, and review mock emergency situations (drills, tabletop exercises, etc.). 3.5 Provide employees, contractors, and visitors with orientation.
4	Contingency planning	HSSE Committee Management ERT Employees	4.1 Develop and document contingency plans to manage: • Persons dislocated by the emergency; • Business disruption; • Critical incident stress.

Element Implementation Requirements			
Element 6 Emergency Preparedness, Response & Incident Analysis			
Step	**Activity**	**Responsible**	**Process**
5	Emergency response	ERT HSSE Committee Management Employees	5.1 Follow procedures in emergency response plans. 5.2 Follow procedures in contingency plans. 5.3 Develop and maintain emergency response documentation including event summaries and the results of response critiques. 5.4 Revise plan requirements, if necessary, to reflect improvement opportunities identified in the evaluation.

6.7 Element 7 - Training, Awareness, Competence & Behavior

Personnel and their actions are critical to ensuring a safe facility. The workforce will be carefully selected, trained and routinely assessed from both a competency and behavioral standpoint.

Element 7		Training, Awareness, Competence & Behavior
Objective		Broadwater has the right people in the right jobs with the skills, competencies and financial and physical resources to achieve internal health, safety, security, environment and community objectives and to ensure alignment with Broadwater's values and policy commitments.
Expectations	**7.01**	A documented orientation program that addresses HSSE objectives, hazards, controls and behaviors is conducted for new employees, contractors and visitors at the commencement of their employment or facility visit.
	7.02	Employees, contractors and visitors are aware of relevant hazards and controls, are competent to conduct their activities and behave in a responsible manner.
	7.03	HSSE competency requirements for all positions are identified, documented and regularly reviewed.
	7.04	Employees and contractors responsible for HSSE critical activities have the necessary knowledge, skills and abilities to perform required tasks.
	7.05	Systems are in place to identify, prioritize, plan, and document training needs for all employees and contractors involved in critical activities.
	7.06	HSSE roles, responsibilities and accountabilities are developed and used to define individual performance targets. Personal performance feedback is provided and the results documented.
	7.07	Broadwater management monitors and records contractor HSSE performance.
	7.08	A system is provided to ensure that personnel or visitors to the facility are not impaired by alcohol or drugs.
	7.09	Appropriate medical support is available to promote health and wellness for employees.
	7.10	An on-the-job behavior observation process is in place that reinforces desired behaviors and corrects undesired behaviors.

Element 7		Training, Awareness, Competence & Behavior
	7.11	Data from behavioral observations are analyzed and used to plan future training, awareness, competence and behavior improvement initiatives.

Element Implementation Requirements			
Element 7 Training, Awareness, Competence and Behavior			
Step	**Activity**	**Responsible**	**Process**
1	Program development	HSSE Committee Management	1.1 Identify persons whose work has a significant impact on HSSE: • Employees; • New Employees; • Contractors; • Visitors. 1.2 Identify, document and communicate training required: Consider: • Legal and other requirements; • Objectives and targets; • Job function changes; • Operational changes. 1.3 Determine existing training & competency. 1.4 Identify gaps. 1.5 Design and implement training program to fill gaps.
2	Program maintenance	HSSE Committee HR Management	2.1 Review training program effectiveness and employee competency annually: • Course content; • Trainer qualifications; • Training requirements. 2.2 Identify and implement changes.
3	Program documentation	HSSE Committee Employees	3.1 Document and maintain training requirements. 3.2 Document and maintain training completed. 3.3 Document training statistics.
4	Awareness	HSSE Committee Employees ERT Employees	4.1 Enhance awareness through ongoing communication. 4.2 Monitor employee, contractor and visitor performance to ensure awareness of relevant hazards and controls, are competent to conduct their activities and behave in a responsible manner.

6.8 Element 8 - Document & Record Management

Document management includes the system to securely manage drawings, design data and other documentation as well as controlling the document distribution and retention systems.

Element 8		Document & Record Management
Objective		Relevant legal, regulatory and other HSSE requirements are complied with and are identified, accessible, and understood. An effective HSSE document control system is in place to ensure that documents are available to appropriate parties as required.
Expectations	8.01	A system is in place to manage and control documents in paper and electronic format. This includes formal administration, custodianship for technical accuracy, and communication of correct use.
	8.02	Controlled HSSE documents are: 1. Current, legible, dated, maintained in an organized fashion, and available to appropriate personnel. 2. Periodically reviewed, revised, and approved by appropriate personnel. 3. Removed when obsolete and suitably archived if required.
	8.03	HSSE documents and records are securely stored, readily retrievable, and have established retention times based on legal requirements and/or knowledge preservation. They shall be stored and maintained to prevent loss and unintended use.
	8.04	Systems are in place to identify and access all applicable HSSE laws, regulations, approvals, licenses, permits, and other requirements, and to document them in an HSSE compliance register.
	8.05	Records are maintained to demonstrate conformance to the HSSE Management System, Broadwater requirements, and international standards. Records are used in HSSE improvement planning.

Element Implementation Requirements			
Element 8 Document & Record Management			
Step	**Activity**	**Responsible**	**Process**
1	Document identification	HSSE Committee Management Employees	1.1 Identify documents required within the HSSE Management System (Commitment statement, HSSE Management System Document, programs, procedures, training materials, forms, etc.). 1.2 Identify those materials already documented. 1.3 Identify gaps. 1.4 Modify documents already in place, as appropriate. 1.5 Develop new documents, as appropriate. 1.6 Create master list of all documentation required and their location.
2	Document control development	HSSE Committee HR Management	2.1 Develop and implement document-control procedures. Include: • Document production; • Document labeling; • Document location and security; • Document distribution; • Document maintenance and revision; • Document archiving and disposal; • Document retrieval.
3	Document control	HSSE Committee Management Employees	3.1 Identify gaps in document control between requirements and existing documentation. 3.2 Modify documentation to align with document control procedures.
4	Records identification	HSSE Committee Management Employees	4.1 Identify records required under the HSSE Management System, including environmental permits, waste management documentation, Transportation of Dangerous Goods TDG manifests, Material Safety Data Sheets MSDS's, occupational exposure records, etc. 4.2 Identify information already recorded. 4.3 Identify gaps in record management. 4.4 Rectify gaps, as appropriate.
5	Records control development	HSSE Committee HR Management	5.1 Develop and document records control procedures. Include: • Record labeling; • Record linking; • Record storage; • Record security; • Record confidentiality; • Record retrieval; • Record distribution; • Record archival and disposal.

Element Implementation Requirements			
Element 8 Document & Record Management			
Step	**Activity**	**Responsible**	**Process**
6	Records control	HSSE Committee Management Employees	6.1 Ensure records management complies with record control procedures.

6.9 Element 9 - Internal/External Communication and Participation

Communication management includes the system for communicating with all interested parties. This includes employees, regulatory bodies, public organizations, partners and other stakeholders.

Element 9		Internal/External Communication and Participation
Objective	A	Broadwater has established an effective system of communication between customers, management, employees, contractors and partners. Effective communication and consultation is maintained with stakeholders associated with Broadwater activities, and they are encouraged to participate in and commit to HSSE performance improvement initiatives.
	B	Broadwater's objective is to bring a clean, reliable source of energy to its target market. Constituencies, which include customers, suppliers, government and society, are encouraged to participate in ongoing dialogue with Broadwater to ensure that their needs are adequately addressed.
Expectations	9.01	There is clear communication on HSSE issues and a system in place to verify effectiveness. Regularly scheduled health, safety, security and environment meetings are held.
	9.02	Communication within Broadwater takes many forms – written, oral, and visual – and uses many techniques – one-on-one dialogue, town hall meetings, position papers, facility tours, technical demonstrations, brochures, interviews, information packets, etc. Many times, the message is communicated in a variety of ways to a number of different stakeholders over an extended period of time.
	9.03	Broadwater has systems in place for communicating environmental information both internally and externally. Broadwater's commitment for external communications and reporting of its significant environmental aspects is recorded in its HSSE Policy.
	9.04	Leadership Teams and Committees provide a means of cascading health, safety, security and environmental information from management to all levels of staff and contractors. They also provide a mechanism to give upward feedback to management on HSSE issues and concerns.
	9.05	Broadwater management actively participates in the review of all HSSE 'result' and 'activity' indicators.

Element Implementation Requirements			
Element 9 Internal/External Communication and Participation			
Step	**Activity**	**Responsible**	**Process**
1	Internal communication & reporting	HSSE Committee Management	1.1 Determine formal and informal HSSE communication and reporting requirements. Consider: • HSSE commitment; • Regulatory requirements; • Contractual requirements; • Broadwater requirements • HSSE meetings; • HSSE performance. 1.2 Develop and document plans and schedules for applicable communication and reporting, and include communication aimed at awareness. 1.3 Implement plans.
2	External communication & reporting	HSSE Committee Legal/ Regulatory Affairs Management	2.1 Identify external parties with an HSSE related interest in the business. Consider: • Industry associations; • Shareholders; • Regulators and policy makers; • Citizen and non-profit groups; • Contractors; • Other stakeholders. 2.2 Develop and document plans for receiving, recording and responding to communication from stakeholders. 2.3 Develop and document plans and schedules to communicate and report applicable HSSE related information to stakeholders. 2.4 Implement plans.

6.10 Element 10 - Implement & Monitor

Plans critical to hazard management are fully implemented and action items monitored until they are closed.

Element 10		Implement & Monitor
Objective		Management ensures that HSSE is an integral part of business planning with goals and targets established to drive continuous improvement in performance. The Broadwater approach is broadly consistent with the requirements of internationally recognized standards, such as ISO 14001. Broadwater will continually monitor changes in the marketplace to ensure that it is up to date.
Expectations	**10.01**	Setting and achieving targets is an important step in the process of continuous improvement towards the ultimate goal of zero harm. Management regularly reviews performance and reassesses targets, continually striving to stretch capabilities and improve the way Broadwater operates. Targets are set at all levels of the organization.
	10.02	Employees and contractors participate in consultation and participation processes. Development and implementation is regularly reviewed in the context of improvement of HSSE stakeholders' initiatives and programs, the establishment of HSSE goals and targets, and the verification of HSSE performance. External stakeholders are encouraged to participate in relevant activities.
	10.03	Data is collected on a routine basis to develop targets and to measure performance against Key Performance Indicators KPIs. Regular reports are prepared for management review.
	10.04	Management regularly measures, records, tracks and reports HSSE performance against targets set in the HSSE Plan. The key targets are: • HSSE performance; • Sustainable development performance; • Regulatory compliance; • Community/vendor/supplier/contractor relationships; • Asset integrity; • Personnel competency and well being; • Operating and maintenance performance.
	10.05	Proactive measures of performance are in place to measure the implementation of the HSSE Management System and the evaluation of stakeholder concerns. This includes the monitoring of HSSE performance and systems to identify trends, measure progress, assess compliance and drive continuous improvement.
	10.06	Proactive measures such as 'unsafe act auditing', 'site inspections', and 'self-assessments' are in use to monitor performance and identify shortcomings.

Element 10		Implement & Monitor
	10.07	Employee and contractor performance are measured and recorded to assure competence and for personnel assessment.
	10.08	Standard operating procedures and recommended practices are used. If changes/modifications are required, they must be approved through the management of change procedure.
	10.09	All plans critical to the management of hazards are implemented.

Element Implementation Requirements			
Element 10 Implement & Monitor			
Step	**Activity**	**Responsible**	**Process**
1	Measurement identification	HSSE Committee Management	1.1 Determine activities to be monitored and/or measured. Consider: • Regulatory requirements; • HSSE objectives and targets; • Program and department specific objectives; • Business objectives. 1.2 Develop and document meaningful metrics and monitoring techniques: • Review operational controls; • Assess existing monitoring/measurement practices; • Link to business metrics; • Include both leading and lagging indicators.
2	Program development	HSSE Committee Management	2.1 Develop and document monitoring and measurement plans. 2.2 Communicate plans.
3	Monitoring and measurement implementation	HSSE Committee Employees	3.1 Implement monitoring and measurement plans. 3.2 Record measurements and assessments: • Collect data; • Identify trends. 3.3 Communicate findings.
4	Incident and non-conformance identification	HSSE Committee Management	4.1 Develop criteria to identify incidents and non-conformances. 4.2 Classify and document incidents and non-conformances.
5	Incident and non-conformance response preparation	HSSE Committee Management	5.1 Develop and document incident and non-conformance response plans. 5.2 Develop and document root cause analysis procedure. 5.3 Communicate plans.

Element Implementation Requirements			
Element 10 Implement & Monitor			
Step	**Activity**	**Responsible**	**Process**
6	Incident and non-conformance response	HSSE Committee Management	6.1 Initiate incident and non-conformance response plan. 6.2Record and report response information both internally and externally.
7	Incident and non-conformance investigation	HSSE Committee Management Employees	7.1 Perform root cause analysis and record findings. 7.2 Implement corrective actions. 7.3 Communicate result of analysis and corrective actions.
8	Follow-up reporting	HSSE Committee	8.1 Develop and document statistics based on apparent cause and root cause analysis. 8.2Report statistics both internally and externally.
9	Incident and non-conformance corrective/ preventive actions.	HSSE Committee Management	9.1 Develop corrective / preventive actions based on trend analysis of statistics. 9.2 Implement appropriate changes. 9.3 Align with training and awareness program. 9.4 Communicate findings and results of implemented changes.

6.11 Element 11 - Audit & Review

This process compares the actual performance with HSSE Performance Indicators (KPIs). This shows the strengths and weaknesses of the systems and if there are shortfalls, improvements are developed. The objective is to reinforce and further develop the company's ability to control and reduce risk while ensuring that the systems in place continue to be effective.

Element 11		Implement & Monitor
Objective	**A**	Broadwater management is committed to continuous improvement. It regularly reviews progress in order to set and achieve improvement targets. An audit program is in place to review and verify effectiveness of the management system. This is undertaken in an open and transparent way.
	B	Broadwater's overall management systems ensure a consistently high standard of operational performance. Those systems provide a basis against which to measure and review performance. Contractors who want to work with Broadwater are required to meet those standards.
Expectations	**11.01**	Broadwater has developed and maintains an audit program and procedure for HSSE audits to be carried out in accordance with international standards and regulatory requirements. Only personnel who have received adequate training lead audits.
	11.02	Broadwater's audit plan is in place. Management reviews the HSSE Management System annually, at a minimum to ensure HSSE performance objectives and targets are being met.
	11.03	Broadwater maintains a control process to ensure that audit findings are recorded and prioritized, corrective actions are identified, action parties are assigned, targeted completion dates are identified, and findings are tracked to final close-out.
	11.04	Management periodically reviews audit findings/trends; performance improvement plans are prepared and executed to address non-conformances.
	11.05	A documented system for variance/change control is in place to minimize non-compliance with standards and procedures. Systems are also in place to respond to and manage non-conformances, should they occur. Employees are aware of and trained in the proper use of these systems.
	11.06	Broadwater maintains procedures for defining responsibility and authority for the handling and investigating of non-conformances with legislation, regulations, HSSE MS policies, procedures and standards.

Element 11		Implement & Monitor
	11.07	Any corrective or preventative action taken to eliminate the root causes of actual and potential non-conformances is appropriate to the magnitude of problems and commensurate with the HSSE risks encountered. The process confirms the effectiveness of corrective and preventative action taken.
	11.08	Contractors hired by Broadwater provide senior personnel to participate in Broadwater led integrated HSSE audits of the operations contracted to them.
	11.09	Contractors shall have an HSSE Audit process and schedule for audits, which includes audits of their systems carried out by independent auditors. Results from audits, findings and corrective actions are retained by the contractors for review by Broadwater.

Element Implementation Requirements

Element 11 Audit & Review

Step	Activity	Responsible	Process
1	Information collection	HSSE Committee Management	1.1 Collect HSSE Management System metrics. Include: • Monitoring and measurement metrics; • Incident / non-conformance metrics; • HSS&E review metrics. 1.2 Compile information.
2	HSSE Management System evaluation	HSSE Committee Employees Management	2.1 Evaluate HSSE Management System considering: • Objectives and targets; • Applicable HSSE regulations; • HSS&E program requirements; • Applicable industry standards and/or practices; • Other requirements. 2.2 Develop recommendations for system improvement. 2.3 Document system evaluation and recommendations.
3	Management communication	HSSE Committee	3.1 Communicate findings and recommendations to management.
4	Management review	Management HSSE Committee	4.1 Evaluate HSSE findings and recommendations considering: • Broadwater's HSSE Commitment; • HSS&E objectives and targets; • Business objectives; • Organizational and process changes. 4.2 Modify system as appropriate. 4.3 Document and communicate modifications.

Element Implementation Requirements			
Element 11 Audit & Review			
Step	**Activity**	**Responsible**	**Process**
5	HSSE Management System modifications	HSSE Committee Management Employees	5.1 Implement modifications.