Petro-Canada Jeanne d'Arc Basin Exploration Drilling Program, 2008-2016 Project Description

Prepared by

LGL LIMITED
environmental research associates

for

PETRO-CANADA

August 2008
LGL Project No. SA993

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Table of Contents

Page

List of Figures

Page

List of Tables

Page

1.0 Introduction

Petro-Canada, potentially with partners, plans to undertake a program of exploration well drilling at various locations in the Jeanne d'Arc Basin over the period of 2008 through 2016. The purpose of this Project is to drill likely oil and gas targets identified from interpretation of existing and new seismic survey data.

The western boundary of the area to be explored is approximately 250 km east of St. John's Newfoundland and Labrador (Figure 1.1) and encompasses water depths ranging from <100 m to 1,000 to 2,000 m. The approximate dimensions of the Project Area are 200 km east to west and 240 km north to south. The Project Area is defined to include four Exploration Licences (ELs), forty-three Significant Discovery Licences (SDLs), and eight Production Licences (PLs) in which Petro-Canada holds interest (Figure 1.1). The most likely first drilling prospect (i.e., for 2008-2009) is EL 1092 which is located east-northeast of Hibernia. Petro-Canada is the current Operator of EL 1092 (50% share).

Drilling operations are currently planned to begin in late 2008 or early 2009 depending on the availability, quality and economic viability of drilling targets, availability of drill rigs and regulatory approval. A number of single and/or dual side-track wells could be drilled during the 2008 to 2016 period. The Study Area as defined in the environmental assessment (EA) is depicted in Figure 1.1; this area is consistent with requirements under the *Canadian Environmental Assessment Act*. Other Project activities associated with the proposed drilling program include geohazard surveys, vertical seismic profiling (VSP), potential geotechnical testing (if jack-up rig is to be used), and seabed sampling associated with setting of MODU anchors.

The Project will require authorizations pursuant to Section 138 (1) (b) of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134 (1) (a) of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act.* Subject to Section 5 (1) (d) of the *Canadian Environmental Assessment Act (CEA Act)*, the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) is a responsible authority (RA) and federal environmental assessment coordinator (FEAC) and must undertake a screening level EA of the Project.

Legislation that is relevant to the environmental aspects of this Project includes:

- *Canada-Newfoundland Atlantic Accord Implementation Acts;*
- *Canadian Environmental Assessment Act;*
- *Oceans Act;*
- *Fisheries Act;*
- *Navigable Waters Protection Act;*

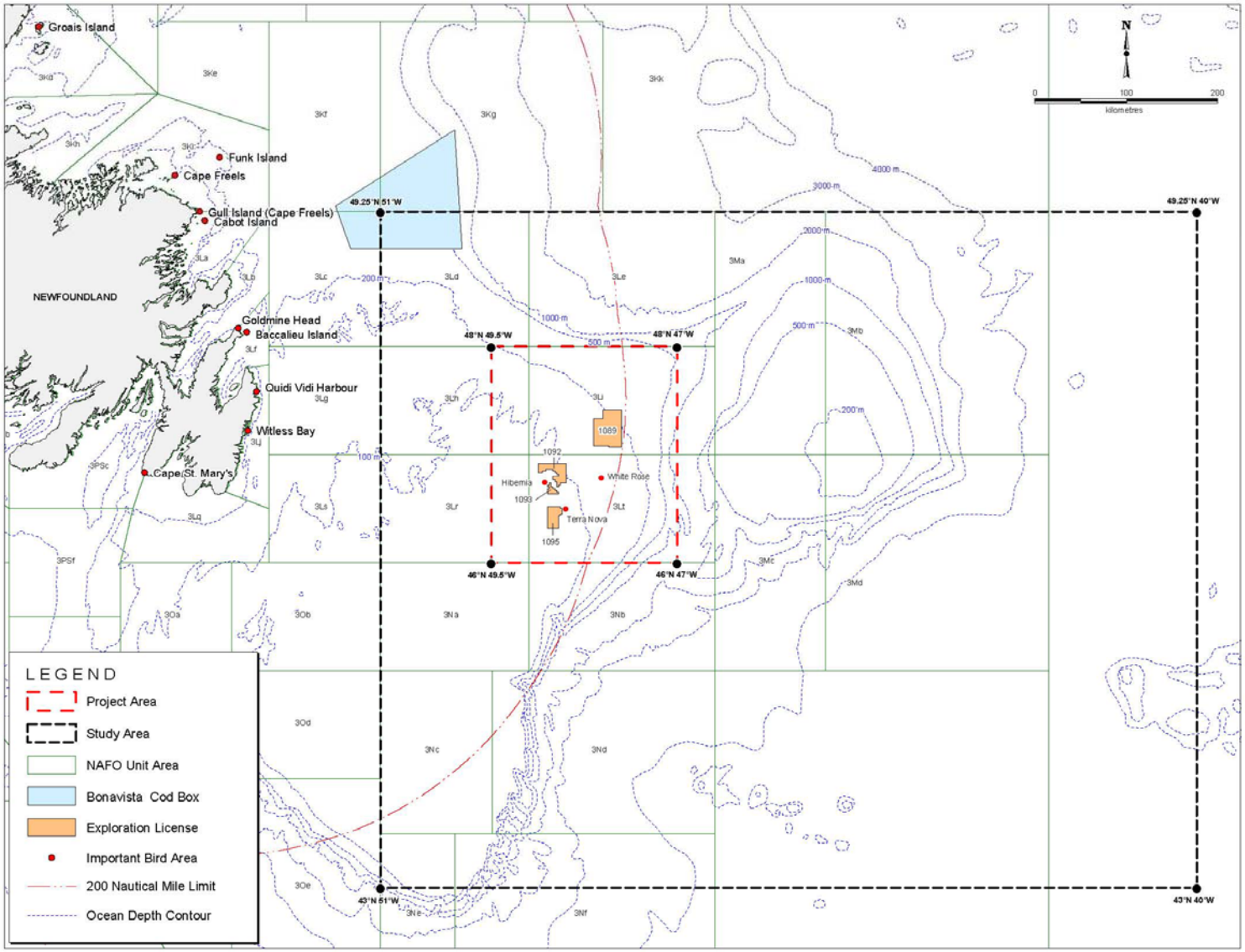

Figure 1.1. Project Area and Study Area in Relation to Some Important Ecological Areas (i.e., Bonavista Cod Box and Important Nearshore Bird Areas).

- *Canada Shipping Act;*
- *Species at Risk Act;*
- *Migratory Birds Convention Act; and*
- *Canadian Environmental Protection Act.*

There is no federal funding for this Project. Federal lands are involved and they are administered by the C-NLOPB, a federal-provincial agency operating under the *Accord Acts.* An Operations Authorization (OA), Approval to Drill a Well (ADW), Site Survey (Geohazard) and Vertical Seismic Profile Authorizations are presently required to conduct a drilling program in the Project Area.

The Project is aimed at drilling for potential oil and gas resources on any current or future Petro-Canada land holdings (including shared ones) within the Project Area. Futhermore, Petro-Canada anticipates that it may conduct exploration drilling activites on behalf of other operators with current or future land holdings in the Project Area should such opportunities arise and commercial agreements and regulatory approvals be in place. It is also possible, should a suitable opportunity arise, that Petro-Canada would opt for another operator to conduct drilling and/or seismic activities on its behalf on current or future Petro-Canada land holdings (including shared ones) within the Project Area.

This Project Description is based upon information available to Petro-Canada at the time of writing. Not all Project details are presently known because all necessary seismic survey information has not been collected and existing seismic survey data have not been fully interpreted. Furthermore, not all contractors and suppliers have been selected, the specific number and location of wells are yet to be finalized, and new leases within the Project Area (Figure 1.1) may be acquired over the coming years. However, all drilling operations will be carried out within the scope indicated in the EA. This document is an accurate reflection of the Operator's present level of knowledge.

To avoid the repetition of detailed information that has been presented in recent environmental assessments of proposed oil and gas activities in the same vicinity, the EA will summarize such information and cross-references sections of specific existing EAs. This approach is in accordance with previous Scoping Documents issued by the C-NLOPB for similar projects. The intention of this summary approach is to provide a concise document that contains all the salient details which can be efficiently reviewed by regulators and other interested parties .

The screening EA will be organized by the following major headings:

- Introduction;
- The Operator;
- Project Overview;
- Physical Environment;
- Biological Environment;

- Effects Assessment Methodology;
- Effects Assessment of Routine Activities;
- Effects Assessment of Accidental Events;
- Summary and Conclusions;
- Final Comment; and
- Literature Cited.

2.0 The Operator

Petro-Canada is one of the largest integrated oil and gas companies in Canada, with significant international interests. Headquartered in Calgary, Alberta, Petro-Canada (the Operator) is a Canadian-based integrated energy company serving global customers, committed to conducting its offshore oil and gas operations in an environmentally responsible manner.

The Operator is the management and operating company for its ten SDLs, three PLs, and two ELs on the northern Grand Banks. Petro-Canada is operator of the Terra Nova Field and is the major partner in Hibernia and White Rose developments.

2.1. Operator's Objectives

Petro-Canada's long-term goals are:

- To increase its equity interests in offshore Newfoundland;
- To plan for and execute Petro-Canada-operated exploration, appraisal/delineation, development, and production activities; and
- To increase its portion of total global production originating from Canada.

Petro-Canada's goals for the drilling activities described here include:

- Execute a cost-effective program from St. John's, while maintaining health, safety and environmental responsibilities and meeting all due diligence requirements;
- Establish and maintain cost-effective relationships with suppliers and contractors, creating long-term mutual benefits and local infrastructure; and
- Optimize synergy opportunities with other operators in the area.

Petro-Canada's East Coast activities are managed from its St. John's office and operations will be supported by local logistics infrastructure and resources to the extent possible.

Petro-Canada is committed to conducting its operations in a manner that respects the environmental characteristics of the immediate area. Petro-Canada will comply with all applicable laws, regulations, guidelines, and codes of practice as well as particular commitments made during the application and review process for which this Project Description is submitted.

2.2. Social Responsibility and Canada-Newfoundland and Labrador Benefits

Petro-Canada is committed to improving the communities in which it operates, including supporting charitable, cultural, and community organizations.

Petro-Canada is committed to supporting research and development, education and training, and technology transfer.

Petro-Canada is committed to employing qualified individuals without regard to race, religion, gender, national origin, or disability.

Petro-Canada is committed to the industrial and employment benefits objectives of the *Canada-Newfoundland Atlantic Accord Implementation Act* (the Act) and C-NLOPB guidelines dated February 2006, including full and fair opportunity and first consideration.

In the spirit of the Act, Petro-Canada actively seeks to enhance the participation of individuals and organizations from Newfoundland and Labrador and elsewhere in Canada in offshore oil and gas activity on the East Coast.

Petro-Canada encourages its suppliers and service providers to implement these principles.

2.3. Operator Contacts

Operator Contacts concerning this application are as follow:

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3.0 Project Overview

Between 2008 and the end of 2016, Petro-Canada plans to evaluate multiple oil and gas targets with a combination of vertical/slightly deviated and deviated (twin) wells in the Project Area. The typical well designs used for depths of between 2,000 and 3,500 m true vertical depth (TVD) are shown in Figure 3.1. Petro-Canada is also considering deep wells, in the order of 5,000 m TVD. The well design for the deeper targets is illustrated in Figure 3.2.

The Project Area (Figure 1.1) encompasses all of Petro-Canada's land holdings in the Newfoundland offshore that will be considered in the environmental assessment of the Project (Figure 3.3). Existing shore-based facilities will be utilized to support the drilling program.

3.1. Personnel

The overall Project will be managed by either the Petro-Canada Manager of Jeanne d'Arc Basin Subsurface and Exploration or Manager of East Coast Drilling, both located in St. John's. Day-to-day drilling operations will be directed by the Petro-Canada East Coast Drilling Manager. The shore-based drilling operations management team will also include the Drilling Superintendent, Well Design Team lead and supporting drilling engineers.

Offshore, the management team will include the Offshore Installation Manager (OIM) and the Drilling Supervisors.

3.2. Name and Location of Proposed Project

The official name of the Project is the Petro-Canada Jeanne d'Arc Basin Exploration Drilling Program, 2008-2016. It is generally located on the northeastern Grand Banks and in deeper waters immediately to the east of Hibernia (Figure 1.1). Exploration wells could be drilled on any current or future Petro-Canada land holdings in this area from 2008 through 2016 (Figure 3.3; Table 3.1). The corner coordinates of the Project Area (Figure 1.1) are 48° N 49.5^{o} W; 48° N, 47° W; 46° N, 47° W; and 46° N, 49.5^{o} W.

3.3. Alternatives to Project/Alternative Means within Project

Petro-Canada has been awarded rights to explore in the indicated offshore areas through a regulated competitive bidding process and is now seeking to fulfill commitments made as part of this process.

Alternative means evaluated within the Project include the use of a semi-submersible drilling rig, a jack-up drilling rig or a drillship. Within the oil and gas industry, these rig types are all considered Mobile Offshore Drilling Units or MODUs because they move under their own power and/or can be towed between locations. The harsh environment jack-up rig types are typically limited to water depths of 122 m off the East Coast of Canada and presently have not been approved for operations during the ice season. More details regarding MODUs are in Section 3.4.

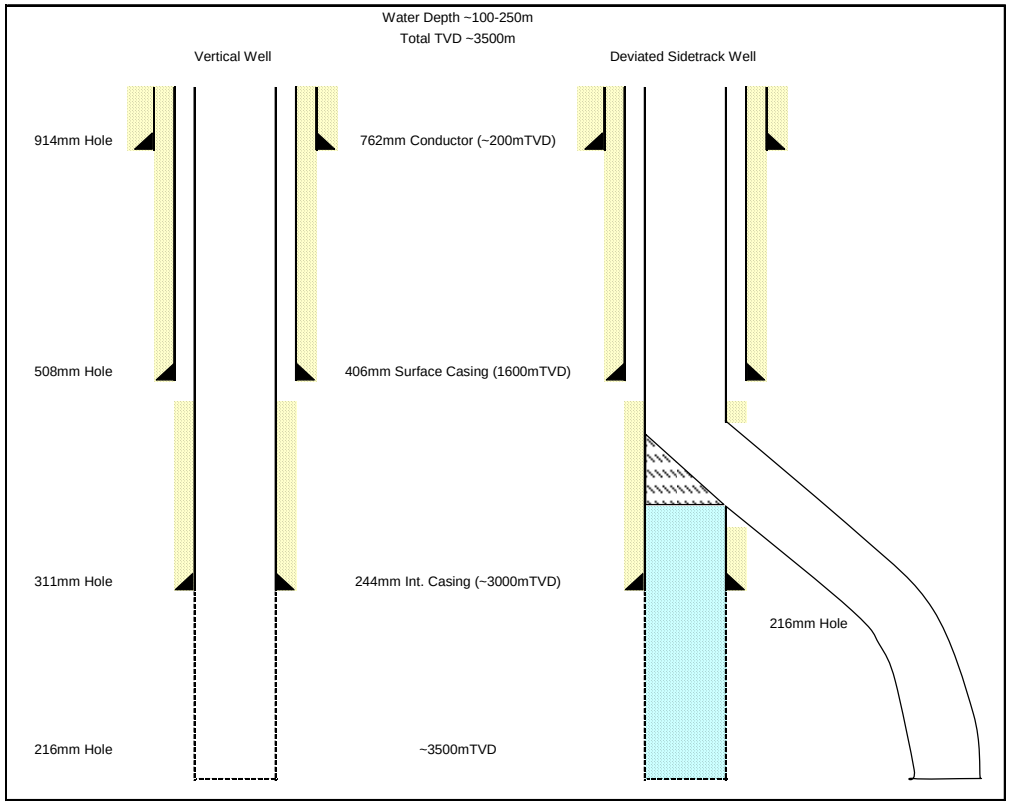

Figure 3.1. Schematics of Typical Shallow Well Scenarios – Vertical & Deviated.

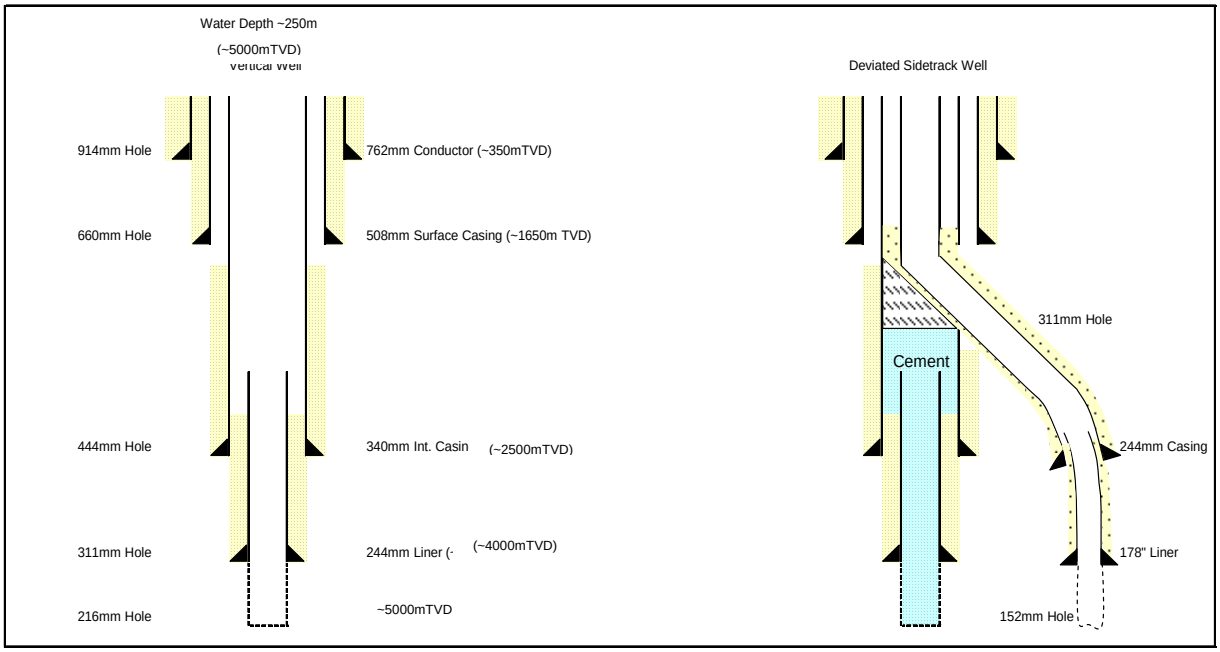

Figure 3.2. Schematics of Typical Deep Well Scenarios – Vertical & Deviated.

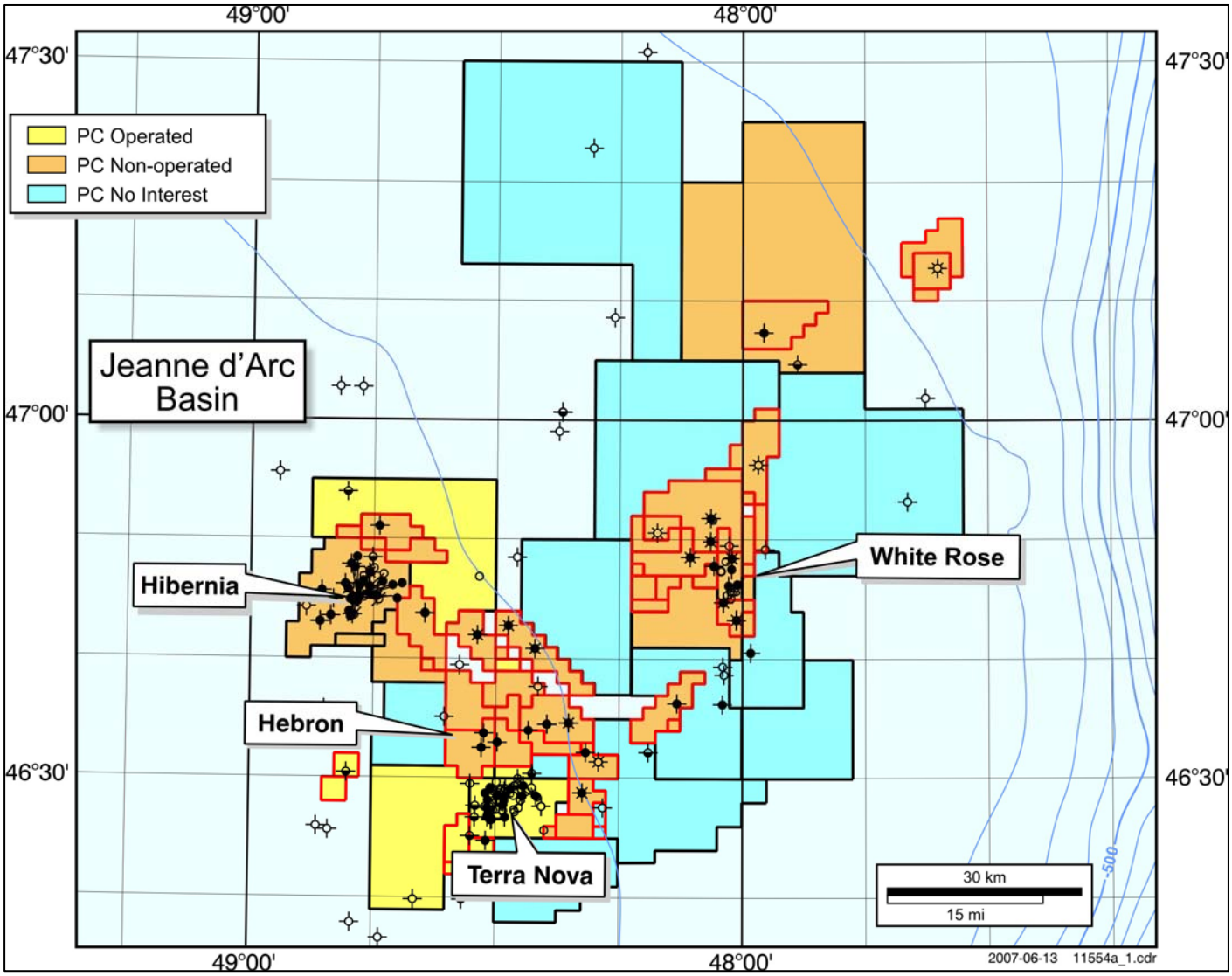

Figure 3.3. Current Petro-Canada Interests in the Jeanne d'Arc Basin Area.

Table 3.1. Current Petro-Canada Interests in the Jeanne d'Arc Basin Area.

License	Relevant Discovery	Operator	Gross Hectares	Petro-Canada (%)
PL 1001	Hibernia	HMDC	22 285	20.00
PL 1002	***Terra Nova***	***Petro-Canada***	***12 800***	***33.99***
PL 1003	***Terra Nova***	***Petro-Canada***	***355***	***33.99***
PL 1004	***Terra Nova***	***Petro-Canada***	***1 065***	***33.99***
PL 1005	Hibernia South Ext	HMDC	1 416	25.00
PL 1006	White Rose	Husky	2 828	27.50
PL 1007	White Rose	Husky	2 832	27.50
PL 1008	North Amethyst	Husky	2 124	27.50
SDL 197	South Tempest G-88	ExxonMobil	7 722	8.75
SDL 200A/B	North Dana I-43	ExxonMobil	8 765	17.50
SDL 208A	***Terra Nova K-08***	***Petro-Canada***	***1 424***	***33.99***
SDL 1001	Nautilus C-92	ExxonMobil	3 883	17.50
SDL 1002	Mara M-54	ExxonMobil	5 664	17.50
SDL 1003	South Mara C-13	ExxonMobil	3 894	17.50
SDL 1004	***South Mara C-13***	***Petro-Canada***	***708***	***26.29***
SDL 1005	South Mara C-13	ExxonMobil	354	17.50
SDL 1006	Hebron I-13	ExxonMobil	5 325	17.50
SDL 1007	***Hebron I-13***	***Petro-Canada***	***3 195***	***26.29***
SDL 1008	North Ben Nevis P-93	Husky	6 372	17.50
SDL 1009	***Ben Nevis I-45***	***Petro-Canada***	***6 390***	***26.29***
SDL 1010	***West Ben Nevis B-75***	***Petro-Canada***	***3 550***	***26.29***
SDL 1011	Fortune G-57	Husky	5 321	17.50
SDL 1012	Fortune G-57	Husky	355	10.50
SDL 1013	Springdale M-29	Imperial	2 136	11.02
SDL 1014	Springdale M-29	Imperial	2 487	11.02
SDL 1017	Springdale M-29	Husky	356	12.60
SDL 1018	Whiterose N-22	Husky	1 062	27.50
SDL 1019	Whiterose N-22	Husky	1 416	27.50
SDL 1020	Whiterose N-22	Husky	1 062	27.50
SDL 1023	Whiterose N-22	Husky	353	27.50
SDL 1024	Whiterose N-22	Husky	1 061	27.50
SDL 1025	Whiterose N-22	Husky	5 648	27.50
SDL 1026	Whiterose N-22	Husky	2 471	27.50
SDL 1027	Whiterose N-22	Husky	1 765	27.50
SDL 1028	Whiterose N-22	Husky	11 649	27.50
SDL 1029	Whiterose N-22	Husky	2 824	27.50
SDL 1030	Whiterose N-22	Husky	1 412	27.50
SDL 1031	Trave E-87	Husky	7 045	17.50
SDL 1035	***East Rankin H-21***	***Petro-Canada***	***1 420***	***36.75***
SDL 1036	***East Rankin H-21***	***Petro-Canada***	***1 420***	***35.00***
SDL 1037	***King's Cove A-26***	***Petro-Canada***	***1 065***	***63.94***
SDL 1038	***King's Cove A-26***	***Petro-Canada***	***356***	***63.94***
SDL 1039	***King's Cove A-26***	***Petro-Canada***	***2 492***	***64.87***
SDL 1040	West Bonne Bay C-23	StatoilHydro	3 195	10.00
SDL 1041	Nautilius	Chevron	3 883	23.34
SDL 1042	Ben Nevis I-45	Husky	3 897	17.50
SDL 1043	Whiterose	Husky	708	27.50
SDL 1044	Whiterose	Husky	2 124	27.50
SDL 1045	Whiterose	Husky	353	27.50
SDL 1046	Hebron I-13	Husky	5 320	17.50
EL 1089		Husky	91 107	50.00
EL 1092	***North Mara***	***Petro-Canada***	***35 674***	***50.00***
EL 1093	Hibernia south extension	ExxonMobil	7 080	20.00
EL 1095		***Petro-Canada***	***28 457***	***100.00***

Another evaluation to be used within the Project is the use of vertical/slightly deviated wells (i.e., one well per one hole) versus dual side-track wells where there are two wells drilled per one hole. Figures 3.1 and 3.2 provide schematics of these well configurations for both typical shallow and deep drilling targets.

3.4. Mobile Offshore Drilling Units

MODUs will be used to carry out the proposed dtilling program. MODUs can be considered to fit into one of the following three general categories:

- Semi-submersible drill rigs that are either moored to the seafloor with anchors while they are operating (e.g., *SSDU Henry Goodrich*), or use a thruster or dynamic positioning (DP) system to assist in maintaining position or in transiting (e.g., *Erik Raude*);
- Jack-up drill rigs that have extending legs that rest on the seafloor while operating (e.g., *Rowan Gorilla VI*), and
- Drill ships that are either moored to the seafloor with anchors while they are operating or use a thruster or DP system to assist in maintaining position or in transiting (e.g., *Deepwater Millenium*).

The lengths of anchor chains used by the MODUs (excluding jack-up rigs) during this Project will vary in size up to a maximum of approximately 1,600 m. Therefore, the anchor patterns and total area they may encompass will vary depending on the MODU used, water depth and technical considerations. For safety and efficiency reasons, it is possible that anchors may be preset on location for a period of weeks prior to MODU arrival.

In the case of a rig using DP, the drill stem and riser are the only connections with the seafloor. The DP rigs are often used in water depths exceeding 500 m. They are virtually the same as anchored rigs in terms of drilling and discharge treatment equipment. Although generally noisier than anchored rigs, maintaining the DP vessel in position does not disturb the seabed. A jack-up rig may be used in water less than 150-m deep during ice-free periods.

In this Project Description, it is necessary to describe and consider typical rigs because all contracts are not yet in place and there is potential for change during the nine years of the Project. Of the potential MODUs, the appropriate ones will be selected through a technical and competitive process, with consideration given to synergies with other operators and partners. Thus, the EA will consider the three MODU types listed above as offshore drilling rigs typical for East Coast Operations. Drilling and abandonment procedures, and emissions associated with all these rigs are similar. While there are differences between rig types, their overall environmental “footprints” are similar. Any differences are clearly noted in the EA.

3.5. Logistic Support

St. John's will be the base of operations and support centre for the work to be addressed by the assessments described in this Project Description. Petro-Canada will engage drilling rigs, supply vessels, helicopters, and related goods and services on a direct-hire or contractual basis. To support those resources, Petro-Canada will acquire marine supply base, logistics, and telecommunications services, including vessel-following, flight-following, personnel onboard (POB), meteorological and oceanographic, ice management, and emergency response services from third party service providers. All such goods and services will be acquired by means of formal competitive tendering processes to the extent possible that will be executed over a period of several months.

Petro-Canada will establish related safety plans and bridging documents with the service providers.

3.5.1. Marine Support Vessels

Anchor Handling Tug Supply (AHTS) and Supply/Standby vessels are planned to be Canadian-flagged and Canadian-crewed and will be managed from St. John's. Letters of Compliance for each chartered standby vessel will be in place prior to Project commencement.

3.5.2. Helicopter Support

Typical helicopter support for the Project may involve AS-332L Super Puma and/or Sikorsky S92 and/or Sikorsky 76 aircraft based in St. John's. Auxiliary flight services including First Response Equipment and technicians, alternate landing site facilities, weather station, aviation fuel, helicopter passenger transportation suits, aircraft maintenance, passenger loading terminal, and flight following services will be arranged.

3.5.3. Shorebase Facilities

Dock facilities to support Project activity will be established in St. John's. Requirements include office space, crane support, bulk storage and consumable (fuel, water) storage and delivery capability. Warehouse facilities will be arranged as required and will consist primarily of storage for tubular goods, and the equipment belonging to the drill rig which can be stored onshore.

Arrangements will be made for operation and co-ordination service of all aeronautical and marine voice and data communication from a central facility in St. John's. The primary communications link between the drill rig and the Project Operations office in St. John's will be via a dedicated C-Band satellite service. Independent backup communications systems will be provided by high quality HF radio service, available through the coastal radio station.

3.5.4. Ice Management

As part of the preparations for drilling, an ice management plan will be prepared by Petro-Canada with the assistance of local resources. Petro-Canada will coordinate its ice management efforts with other operators in the area (e.g., ExxonMobil, Husky, Chevron, and StatoilHydro).

3.6. Project Components/Structures/Activities

3.6.1. General

For most wells, the current plan is to use a semi-submersible drilling rig which is typically moored using an eight or twelve point anchoring system (e.g., Stevin NK3 anchors). For other wells, a jack-up, which does not require anchors, may be used. There is also the option of using a drillship, depending on the drilling situation and rig availability during the 2008 to 2016 period.

It is planned that the drilling rig will be supplied and supported by two or three supply boats operating from St. John's. The supply boats (anchor-handling type) will have a range of 12,000 to 15,000 HP and be capable of storing and delivering drilling fluids, casing, deck cargo, water, cement, diesel fuel, and other bulk commodities. On average there will be two or three supply boat trips per week between the shore base and the drilling rig.

Helicopter support may consist of about six trips per week ferrying personnel and light supplies and equipment.

In the Jeanne d'Arc Basin area, shallow well designs will include final total well depths (TVD) ranging up to 3,500 m TVD, and deep well designs will include total well depths (TVD) that may exceed 5,000 m (Figures 3.1 and 3.2). The actual hole size and casing setting depth will vary on the individual well design and reflect the specific well requirements and design criteria.

Well abandonment procedures will consist of the removal of any wellhead and associated equipment. Offshore wells are abandoned in two stages. During the first stage, the wellbore is isolated using mechanical and cement plugs in accordance with existing regulations. During the second stage the wellhead and any associated equipment items are removed at least one metre below the sea floor. Removal of the wellhead will routinely involve the use of mechanical cutters. However, some circumstances require subsurface cutting (i.e., below the seabed) using shaped charges, in which case additional mitigations will be employed

On some occasions the wells may be suspended for future re-entry in accordance with C-NLOPB regulations. This is similar to the abandonment process described above, but the wellhead is not removed. A suspension cap is installed to protect the wellhead connector.

3.6.2. Project Phases

For the purposes of the EA, the Project will consist of three phases for each well:

1. Geohazard or site survey(s) at MODU anchor and drilling sites. These surveys may include seabed sampling (coring, grabs, ROV surveying) and/or the use of a small seismic survey array, sub-bottom profiler and multi-beam equipment, etc. at and adjacent to the site being surveyed. Geotechnical testing, including boreholes, would likely be conducted if a jack-up MODU was to be used;
2. Drilling of exploration or delineation well(s), inclusive of routine activities such as pre-setting of anchors, vertical seismic profiling (VSP), and production testing; and
3. Abandonment or suspension of the well.

3.6.3. Project Scheduling

The first well is planned for late 2008 or early 2009. The drilling of a well will require approximately 80 to 100 days to drill, complete, test and abandon. In general, the scheduling window for drilling will be year-round. Over the temporal scope of the Project, 2008 to 2016, there is a possibility that Petro-Canada will use two MODUs for concurrent exploration and appraisal/delineation drilling in the Project Area.

All wells will either be suspended or abandoned in accordance with regulatory requirements.

3.6.4. Description of Waste Discharges, Air Emissions and Treatment

Waste discharges will include drill muds and cuttings, produced water, grey and black water, ballast water, bilge water, deck drainage, discharges from machinery spaces, cement, blowout preventer (BOP) fluid (not released when using a jack-up rig), and air emissions.

All discharges will be in compliance with the Offshore Waste Treatment Guidelines (*OWTG*) (NEB et al. 2002). Brief descriptions of the expected discharges are provided in the following sections.

Petro-Canada will institute its fluid management system (TFM). TFM early assessment is important because it allows time for proper technology adjustments required to collect the total benefits resulting from fluid cycling and drilling waste management. Key elements of TFM are described below.

3.6.4.1. Fact Finding Process

- Review the drilling program to calculate quantities of mud and drill cuttings that will be produced (number of wells, well length, and other well data). Calculate the mentioned quantities vs. period of time.

- Explore the opportunity to use different drilling /completion fluid systems by calculating the difference in type of waste and amount of wastes generated (fluid and solids).
- Estimate the cost impact from drilling waste handling / treatment required.
- Does restriction connected to use of fresh water source apply (Statoil aims to minimize consumption of fresh water resources); and if so what impact will it have on the fluid cycling and drilling waste management?
- Use the information to calculate cost impacts with respect to:
  - Use/consumption of fluids.
  - How much fluid can be recovered for reuse and recycling and how much will be wasted, including disposed of?
- Calculate cost benefits and compare the different fluid alternatives.
- Cross check with Environmental Impact and Social Assessment reports to identify criticalities in drilling waste management.
- Review available infrastructure required for logistics involved in fluid and waste handling (treatment facilities, access roads, transportation, etc.)
- Check with relevant service companies to collect experience and learn about criticalities and prepare for local challenges.

3.6.4.2. Fact Management

- Extract information valuable for decision making: quantities/volumes and fluid life cycle cost impacts.
- Identify process modifications required (techniques, rig equipment, waste treatment, handling and transport, etc.).

3.6.4.3. Evaluate

- **Contract**
  - Check with contract department to see if any existing contracts can be applied.
  - Evaluate possible Key Performance Indicators (KPIs) that can be applied to assist increased performance in waste minimisation efforts. A minimum of KPIs that apply relate to cost and volume/weight benefits, for both fluids and drill cuttings.
  - Strategy for contract management; packing of services, synergies, compensation arrangement for waste minimisation, etc.

- **Technology**
  - New technology or process modification? Is there a need for R&D work to optimize total fluid and waste management performance? Is rig surface equipment modification necessary?
  - Changes that influence the technical conditions for the operational TFM plan will be limited after DG2 is completed.

- **Plan**
  - Briefly describe disposal solutions.
  - Implemented waste minimisation measures.
  - Reuse/recycling incentives in contracts, other physical measures or methods applied.
  - Describe measurements and reporting routines.
    - Cost-efficient measures focused:
      - Reuse and recycling of:
        - Fluids (including freshwater where relevant).

3.6.4.4. Drilling Cuttings and Completion Fluids

If technically feasible, the wells will be drilled to depth using water-based muds (WBM). In cases of wellbore instability and concerns with formation damage, the use of synthetic-based muds (SBM) will be more effective, efficient and safer than WBM and thus this assessment also considers the use of SBM.

The total volume of cuttings and drill mud discharged will depend on the depth of the hole section being drilled and drilling conditions that are encountered. Drilling of conductor and surface hole sections will be completed with WBM. Intermediate and production hole sections will be drilled with SBM to ensure wellbore integrity and safe drilling practices. Deviated and directional drilling situations may also require the use of SBM.

Drill mud components and additives will differ somewhat by well, the specific conditions encountered in drilling, and by the depth and purpose for drilling. Surface and conductor hole sections are drilled without the riser in place and thus the WBM and associated cuttings are discharged directly to a predetermined site on the seabed.

While drilling the hole sections required for the intermediate casing, the riser and associated BOP are in place where the mud and drill cuttings are transported back to the rig. Cuttings are then removed from the drilling mud in successive separation stages through shakers, hydrocyclones and/or centrifuges. After passing through the solids control system the cleaned cuttings are then discharged overboard through a cuttings shute. The recovered mud is then reconditioned and reused. Minimum typical treatment equipment is outlined in Table 3.2.

Table 3.2. Typical Mud/Cuttings Treatment System.

Equipment	No.	Type	Characteristics
Shale Shakers (Primary)	3 (minimum)	Thule VSM 300 or equivalent	1,000 gpm design flowrate or more
Desilter	1	Swaco or equivalent	16 x 4 in cones
Cuttings Dryer System	1	Verti-G Dryer	To be determined
Centrifuges (Decanting)	2 or more	518 & 414	To be determined

Note: Enhanced cuttings cleaning equivalent to the Henry Goodrich for SBM only.

A typical WBM system would be composed of barite, potassium chloride, a viscosifier, a polymer fluid loss additive and whole mud loss additives (such as nut shells, grape seeds, and/or inert fibres), an encapsulator (a polymer used to coat cuttings) and glycol (i.e., polyethylene glycol).

A typical SBM system would be composed of barite, a synthetic base fluid such as Puredrill LV or equivalent, lime, a viscosifier, calcium chloride, an asphaltine fluid loss additive, and whole mud loss agents such as graphite, calcium carbonate, grape seeds, and/or inert fibers.

For typical 3,500 m TVD (Jeanne d'Arc Basin) wells drilled with WBM, up to 483 m^3 of cuttings and 3,474 m^3 of WBM would be discharged. For the intermediate and production hole sections, SBM is utilized for drilling where 336 m^3 of cuttings would typically be discharged. Refer to Figure 3.1 for a typical well design for a Jeanne d'Arc well and Table 3.2 for typical discharge volumes on potential drilling scenarios.

Exploration wells in the Jeanne d'Arc Basin area may approach 5,000 m TVD and require more hole sections and casing to reach total depth (TD) (Table 3.3). Due to the anticipated duration of this well type, WBM may not be an option in intermediate and production hole sections due to time dependent wellbore instability where shales open to the wellbore tend to react with water based fluids over time. Therefore, it is anticipated that the use of WBM may not be appropriate for drilling vertical hole sections open for extended periods of time and SBM will be used. Furthermore, if used, SBM will be recycled and reused or brought to shore for disposal when spent. As well, a deviated twin well approach (sidetrack) uses less drill mud and results in lower total volumes of discharged drill mud and cuttings than individual vertical/slightly deviated wells.

Table 3.3 provides preliminary estimates of the discharges to the environment that may be expected for some typical potential drilling scenarios. These estimates are subject to change during final planning but are believed to represent a "reasonable worst case". For example, these discharge estimate tables assume that treatment will recover synthetic base fluids from cuttings to ensure compliance with the 6.9% discharge target in the *OWTG* (August 2002) (actual percentages may be less) and that all water based muds would be discharged.

Table 3.4 provides cuttings estimates for sidetrack well.

All drilling fluid and solid discharges will be in accordance with the *OWTG* and subject to approval by C-NLOPB. Petro-Canada will have a Total Fluids Management Plan in place for the proposed drilling.

Table 3.3. Drill Mud and Cuttings Discharges Asscociated with Typical Jeanne d'Arc Basin Drilling Scenarios.

Discharges estimated with water-based drilling fluid:

Hole Size	Cuttings Volume Generated m^3				Equivalent Tonnage
	Gauge Hole	Washout factor %	Washout volume	Total Volume	
1067	31.3	50	15.6	46.9	122.1
660	290.8	50	145.4	436.2	1134.1
406	176.7	20	35.3	212.0	466.4
311	101.4	20	20.28	121.68	267.7
213	26.9	10	2.69	29.59	65.0

Discharges estimated with synthetic based-drilling fluid:

Hole Size	Cuttings Volume Generated m^3				Equivalent Tonnage
	Gauge Hole	Washout factor %	Washout volume	Total Volume	
1067	31.3	50	15.6	46.9	122.1
660	290.8	50	145.4	436.2	1134.1
406	176.7	5	18.1	194.8	506.6
311	101.4	5	10.4	111.8	290.7
213	26.9	5	2.8	29.6	77.0

Table 3.4. Cuttings Estimate for Sidetrack with 216mm hole, Approximate Length of Section 3400m MD.

Discharges estimated with water-based drilling fluid:

Hole Size	Cuttings Volume Generated m^3				Equivalent Tonnage
	Gauge Hole	Washout factor %	Washout volume	Total Volume	
216	124.61	20	24.9	149.51	328.9

Discharges estimated with synthetic-based drilling fluid:

Hole Size	Cuttings Volume Generated m^3				Equivalent Tonnage
	Gauge Hole	Washout factor %	Washout volume	Total Volume	
216	124.61	5	6.2	130.81	287.78

3.6.4.5. Produced Water

If hydrocarbons are present and well testing is performed, small amounts of produced water may be discharged by atomizing with hydrocarbons and flared. If the flare capacity is exceeded, then small amounts of treated produced water will be brought ashore for disposal by a certified waste handler.

3.6.4.6. Grey/Black Water

The rig will accommodate about 85 to 150 personnel. It will discharge about 50 m^3 grey water per day. Black water or sewage will be macerated to 6 mm particle size or less and discharged as per the *OWTG*. Estimated amounts of black water are up to 19 m^3 per day.

3.6.4.7. Bilge Water

Bilge water will be treated and discharged in accordance with the *OWTG* (15 mg/L or less).

3.6.4.8. Deck Drainage

Any deck drainage such as the rotary table floor and machinery spaces will be treated and discharged in accordance with the *OWTG* (15 mg/L or less).

3.6.4.9. Ballast Water

Water used for stability purposes in both supply boats and drilling rigs is stored in dedicated tanks and thus does not normally contain any oil. If oil is suspected in the ballast water it will be tested and if necessary treated and discharged in accordance with the *OWTG* (15 mg/L or less).

3.6.4.10. Cooling Water

Top drives and draw works on rigs are cooled by pumping water through a set of heat exchangers; the water is then discharged overboard in accordance with *OWTG*. Other equipment is cooled through a closed loop system which may use chlorine as a biocide. Water from closed systems will be tested prior to discharge and will comply with the *OWTG*. Any requirement for biocide use will be covered by the Environmental Protection Plan submitted to C-NLOPB.

3.6.4.11. Waste

All trash and garbage, including organic waste from galleys, will be containerized and transported to shore for disposal in approved landfills. Combustible waste such as oil rags and paint cans will be placed in hazardous materials containers for transport to shore. The rig will have a recycling program. All waste will be treated in accordance with Petro-Canada's Waste Management Plan.

3.6.4.12. Blowout Preventer (BOP) Fluid

When drilling with semi-submersibles or drillships, BOP test fluid (glycol/water) is released at intervals. A typical BOP function test or pressure test releases approximately 1.0 m^3 of fluid. Function or pressure testing is conducted approximately once per week. Leakage and intermittent BOP troubleshooting will increase the volume of BOP fluid discharged. A typical annual discharge is approximately 100 m^3.

3.6.4.13. Air Emissions

Air emissions will be reported in accordance with *OWTG* and the National Pollution Release Inventory.

3.6.5. Geohazard and VSP Surveys

Geohazard/wellsite surveys and VSP using an airgun array may be conducted as part of the drilling activities. Geohazard surveys may also be conducted at areas where anchors are to be set. The VSP is used to assist in further defining a petroleum resource in relation to the well bore. The array is similar to that employed by 2-D or 3-D seismic surveys but typically is smaller and deployed in a smaller area (several km^2 vs. thousands of km^2) for a shorter (12 to 18 hours vs. days) survey period. Well site or geohazard surveys may also deploy a small array and sonar; they are used to identify and avoid hazardous areas prior to drilling. Geohazard/well site surveys might also include seabed sampling which may be comprised of sediment coring, sediment grabbing and/or ROV surveying.

3.6.6. Geotechnical Testing

Geotechnical testing would be conducted to gather information on the seabed if a jack-up rig was to be used. A typical geotechnical survey involves shallow drilling (e.g., 100 m) to sample the types of materials in the sea bed. This ensures that the jack-up rig will be stable and safe. Geotechnical drilling uses a ship-based drill rig smaller than the ones used to conduct exploratory drilling.

3.6.7. Onsite Environmental/Ice Observers

An onsite environmental observer will also be on board the drilling unit to record and report 24-hour weather, oceanographic, and ice conditions. During the potential ice-infested water periods, two environmental/ice observers will be stationed on the drilling unit to assist the drilling operations personnel in strategic and tactical planning and to record and report the weather and oceanographic conditions. As part of these duties these personnel will also assist in vessel monitoring under the Collision Avoidance Procedures.

The environmental observers will also conduct seabird and marine mammal observations on a daily basis in accordance with established protocols. The data compiled from these observations will be provided to the C-NLOPB, Canadian Wildlife Service and Fisheries and Oceans, Marine Mammals Section.

In addition, an Oceanographic Monitoring Program will again be conducted in accordance with the C-NLOPB *Guidelines Respecting Physical Environment Programs* (NEB et al. 1999) depending on the location of the drilling.

3.6.8. Project Site Information

3.6.8.1. Environmental Features

The Project has the potential to affect air, water, plankton, fish and fish habitat, fisheries, marine birds and mammals through emissions and discharges, both routine and accidental. There are no known special or unique areas in the Project Area; however, the Bonavista Cod Box is located proximate to the northwest portion of the Project Area (Figure 1.1) and deep-water corals likely occur in the Flemish Pass area. A description of the physical and biological environment of the northeastern Grand Banks and potential Project interactions and effects are provided in the EA. A valued ecosystem component (VEC) approach is used in the EA. Typical VECs in the area include seabirds, marine mammals/sea turtles and commercial fisheries. Effects on VECs including cumulative effects (within the Project and with existing and planned projects) are assessed in the EA. Focus of the EA will be on sensitive species, areas and times, including species listed under the *Species at Risk Act* (*SARA*) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

3.6.8.2. Listed Species at Risk

Species listed under Schedule I of the *SARA* that may occur to varying degrees in the Study Area include:

- Blue whale (*Balaenoptera musculus*) (*endangered*);
- North Atlantic right whale (*Eubalaena glacialis*) (*endangered*);
- Leatherback turtle (*Dermochelys coriacea*) (*endangered*);
- Northern wolffish (*Anarchichas denticulatus*) (*threatened*);
- Spotted wolffish (*Anarchichas minor*) (*threatened*);
- Atlantic wolffish (*Anarchichas lupus*) (*special concern*);
- Ivory Gull (*Pagophila eburnea*) (*special concern*); and
- Fin whale (*Balaenoptera physalus*) (Atlantic population) (*special concern*).

Other species that are listed as *endangered*, *threatened*, *special concern* and *candidate* under COSEWIC are also considered in the EA.

3.6.8.3. Other Users

Current and past uses of the area include marine shipping, oil and gas activity, defence-related ship traffic, and commercial fisheries. Hunting of murres, waterfowl, and seals has occurred for many years further inshore from the Project Area.

There is a continuing problem on the Grand Banks and the approaches to the Gulf of St. Lawrence with oily discharges (i.e., mystery spills) from marine vessels in international shipping lanes. Previous disturbance of the seabed may have occurred from bottom trawling activity associated with commercial fisheries.

The closest seabird-related protected areas are Cape St. Mary's and Witless Bay which are located approximately 380 and 270 km, respectively, to the west of the Project Area (see Figure 1.1). In addition, the offshore region of the Grand Bank is heavily used by migratory seabirds. The closest urban centre is St. John's, located about 325 km to the west of the Project Area.

3.6.8.4. Navigable Waters

The physical presence of the rig and supply boats affects navigable waters on the Grand Banks to a small degree. The Project Area is close to major North Atlantic shipping lanes and may receive ship traffic from fishing vessels, tankers, freighters, naval vessels, private yachts and others. The detailed physical characteristics of the waterway are provided in Section 4.0.

3.6.8.5. Fish and Fish Habitat

The proposed Project Area is on the Grand Banks, a region known to support large and diverse commercial fisheries. In recent years, the most valuable commercial species in the vicinity of the Project Area is snow crab. Bottom fish habitats appear typical of that area of the Grand Banks. Fish and fish habitat, and fisheries will be covered in detail in the EA.

The closest fish-related protected area, the Bonavista Cod Box, is located approximately 30 km from the Project Area (Figure 1.1). The northwest corner of the defined Study Area overlaps with part of the Bonavista Cod Box.

3.6.9. Effects of the Environment on the Project

Effects of the physical environment on the Project include those caused by wind, ice, waves, and currents. Descriptions of these components, including extreme events, are contained in the EA.

Effects of the biological environment on the Project are primarily those related to biofouling which may affect rig stability and corrosion, and the interior of pipes and water intakes and outlets.

3.7. Consultations

For the proposed program, the following organizations will be contacted during the preparation of the environmental assessment:

- Natural History Society;
- Environment Canada;
- Fisheries and Oceans;
- ONE OCEAN;
- Fish, Food and Allied Workers (FFAW) Union;
- Fish processors with interests in the Project Area; and
- Others with relevant information, interests and concerns as appropriate.

Relevant issues and concerns that arise during the consultations will be addressed in the EA.