ENVIRONMENTAL EFFECTS MONITORING FOR EXPLORATION DRILLING

By

LGL Limited
environmental research associates

CEF

and

Oceans Ltd.

For

Environmental Studies Research Funds
444 7th Avenue S.W.
Calgary, Alberta
T2P 0X8

Solicitation No. ESRF – 018

3 December 2003
SA735

ENVIRONMENTAL EFFECTS MONITORING FOR EXPLORATION DRILLING

by

Robert A. Buchanan[1], Joanne A. Cook[2] and Anne Mathieu[3]

[1]LGL Ltd., environmental research associates
388 Kenmount Rd., POB 13248, Stn A, St. John's, NL A1B 4A5
(709) 754-1992; rbuchanan@lgl.com

[2]CEF Consultants Ltd.
5443 Rainnie Dr., Halifax, NS B3J 1P8
(902) 425-4802; ncollins@cefconsultants.ns.ca

[3]Oceans Ltd.
31 Temperance Street
St. John's, NL A1C 3J3
(709) 753-5788; amathieu@oceans.nf.net

for

Environmental Studies Research Funds
444 7th Avenue S.W.
Calgary, Alberta
T2P 0X8

Solicitation No. ESRF – 018

3 December 2003
SA735

Table of Contents

Page

List of Tables

Page

List of Figures

Page

Acknowledgements

A number of people contributed to the successful completion of this report. Mr. G. Hurley of EnCana served as Scientific Authority on the project. Other oil and gas industry personnel who contributed material included D. Taylor of Husky, C. Ross of ExxonMobil, R. Dunphy of Hibernia, and U. Williams of Petro-Canada (Terra Nova). Dr. J. Lawson of DFO provided preliminary bird and mammal survey protocols.

Mr. D. Thomson of LGL and N. Collins of CEF read the report and provided insightful comments. Ms. V. Moulton and M. Fitzgerald of LGL provided graphics assistance and Ms. R. Martin produced the report. Dr. R. Green critically reviewed some offshore EEM data for us.

Last but not least is the large number of industry, government, fisheries organizations, environmental groups, NGO's and knowledgeable individuals without whose input during consultations, this study could not have been completed.

Executive Summary

Introduction

This study was conducted for the Environmental Studies Research Funds (ESRF) by a Study Team composed of LGL Limited, CEF Consultants Ltd., and Oceans Ltd. The primary goal of the study was to develop a strategy for monitoring environmental effects at a single exploratory offshore well on the East Coast.

At present, there are no specific environmental effects monitoring (EEM) requirements for drilling exploratory wells offshore on the East Coast. In the Canadian Arctic, there may be requirements to conduct marine mammal monitoring depending upon location and season. For the most part, environmental protection is achieved through the environmental assessment/permitting process and a series of generic and project-specific mitigations.

The work consisted of consultations with scientists, regulators, and stakeholders, reviews of regulatory regimes, toxicity results relevant to exploratory activities, and East Coast production EEM programs, and development of a 'decision tree' for determining when to conduct EEM, and at what level of effort, and some suggested study design considerations.

Issue Scoping

Issue scoping was conducted by reviewing the results of previous East Coast environmental assessments and any associated comments by reviewers and stakeholders. Subsequently, a series of informal consultations were held with individuals from Fisheries and Oceans, Environment Canada, the Canada-Newfoundland and the Canada-Nova Scotia offshore regulatory boards, the fishing industry and environmental interest groups.

Results of consultations varied from 'monitor everything' to highly focused specific detail. There were a number of differences between the two regions in the perception of issues with the main ones perhaps being greater interest in benthos (e.g., shellfish and corals) and marine mammals (e.g., 'The Gully', a potential marine protected area) in Nova Scotia versus a greater interest in fish/fisheries and marine birds in Newfoundland. Nonetheless, there were at least eight general areas of commonality:

1. **Level of concern.** Most respondents had a much lower level of concern for the single exploratory well than for a production development.

2. **Assurance.** While a number of scientists argued for full statistical treatment of all data, there was a common thread with most people that some level of assurance was required that the marine environment was not being unduly harmed, with or without full statistical confirmation.

3. **Biological effects.** Most felt that the focus should be on biological effects rather than some trace chemical 'signals'.

4. **Seabirds and marine mammals**. Many agreed that birds and mammals deserved attention and that any existing supply boat or rig observations were viewed positively; however, concern was addressed about the value of the data in terms of actually monitoring the effects of exploratory drilling activities.

5. **Data availability.** Data availability was expressed as a concern with virtually everyone that we consulted.

6. **Site specifics.** Local and site-specific issues must be considered in the design of any EEM.

7. **Cumulative effects.** Many were concerned about potential cumulative effects with other industrial activities although no one had any particularly valuable insight into how to handle exploratory wells within this context.

8. **Testing EA.** A number of respondents suggested that test case (s) be established and monitored not only to test EA predictions but also to establish scientific rationale for inclusion or exclusion of specific variables in future EEM programs.

Information Reviews

Regulatory Regimes

Different jurisdictions regulate exploratory drilling differently but few jurisdictions have specific EEM regulations aimed at the single exploratory well. For example, in the Gulf of Mexico, regulators have relied on some large-scale research programs (i.e., 'case studies') and a zoning approach to protect the environment. In Alaska, permit requirements can be complex and there is often some form of marine mammal monitoring because of concerns related to endangered bowhead whale during the summer and ringed seal disturbance in the winter. There are few, if any, EEM requirements for an exploratory well in offshore West Africa, Brazil, or Indonesia. On the East Coast of Canada, there has been reliance on the EA and permitting processes and compliance monitoring to the *Offshore Waste Treatment Guidelines* to protect the environment during exploratory drilling. However, as of the 30th of October 2003, there is a *Canadian Environmental Assessment Act* (*CEAA*) requirement for some form of 'follow-up' to *CEAA* environmental assessments (including screening level ones), which could include EEM.

Toxicity Effects

Baring accidental events, the primary discharges of potential concern during exploratory drilling are drilling muds and cuttings which are regulated under the *Offshore Waste Treatment Guidelines*. On the East Coast, water-based-mud (WBM) is now the most commonly used drilling fluid; synthetic-based-mud (SBM) may also be used in certain situations. Modern muds are now essentially non-toxic although some pathological effects of barite (barium sulfate, a major constituent of drilling mud) have been reported during laboratory tests with scallops, shrimp, and flounder. The main environmental effects of the discharge of mud and cutting are probably some very localized smothering an/or alteration of benthic communities near the well. Cuttings with WBM tend to disperse more widely than those with SBM which tend to clump near the well.

State of the art methodology for monitoring the potential effects of drilling discharges include benthic community structure, sediment bioassays, mixed function oxygenase (MFO), and histopathology.

East Coast Production EEM

Large scale EEM programs for offshore production developments on the East Coast are being conducted for the Sable Offshore Energy Project (SOEP) and Cohasset Panuke off Nova Scotia, and Hibernia, Terra Nova and White Rose off Newfoundland. Variables measured, numbers of samples, intervals sampled, and study designs have varied somewhat between the projects. Common variables have included sediment and water chemistry, toxicity testing, benthic community structure, fish or shellfish taint, and fish health. The study design is normally some sort of radial design with sampling at increasing distances from the source, sometimes with provision made for prevailing water currents. In most cases, effects, if any, have been confined to within a 500 m radius of the rigs. This is consistent with the most recent reports from the North Sea and the Gulf of Mexico. The primary lessons for designing an EEM program for an exploratory well include (1) the 'signals' will be relatively weak and close to the rig, and (2) effects will likely be much less for the single well than for the multi-well development scenarios. In addition, there may be benefit in analyzing existing production baseline and EEM data with the sole intent of detection of effects (or lack thereof) from the original exploratory wells.

Potential Decision Process

A potential 'decision tree' has been suggested for different levels of EEM based on three different scenarios:

(a) Scenario 1—well known area with no sensitive issues. Compliance monitoring but no EEM would be conducted.

(b) Scenario 2—shallow or deep areas with no known sensitive issues. Opportunistic EEM surveys of sediments, benthos, seabirds and marine mammals would be 'piggy-backed' on existing logistics.

(c) Scenario 3—sensitive areas. Custom EEM surveys would be required.

Most EEM for an exploratory well can be 'piggy-backed' onto existing programs such as well site surveys in order to minimize costs.

'Special' EEM support studies of selected existing data and new data could be collected to further refine, and potentially maximize data return while lowering costs.

1.0 Introduction

This study was conducted for the Environmental Studies Research Funds (ESRF) by a Study Team composed of LGL Limited, CEF Consultants Ltd, and Oceans Ltd. The primary goal of the study was to develop a strategy for monitoring environmental effects at a single exploratory offshore well on the East Coast.

1.1. Objectives and Purpose of the Study

Exploration drilling occurs after geophysical (seismic) and other types of surveys have determined the location and extent of a possible hydrocarbon bearing geological formation. Formations identified with remotely collected data may contain commercially viable hydrocarbon deposits or they may contain only water or hydrocarbons in quantities that are uneconomic to develop. Exploration drilling is the only sure way to confirm the presence of viable quantities of hydrocarbons.

In the event that hydrocarbons are found during exploration drilling, testing may be required to further define a prospect's potential for development. Once the presence of hydrocarbons is confirmed by exploratory drilling and associated testing, further appraisal or delineation drilling may be required in order to establish the extent and commercial viability of a prospect.

A number of hydrocarbon exploration wells have been drilled offshore on the East Coast and several are planned in the next few years. Before granting approvals to drill, the Canada/Newfoundland Offshore Petroleum Board (C-NOPB) or Canada/Nova Scotia Offshore Petroleum Board (C-NSOPB) (i.e., the 'Boards') must evaluate the potential environmental effects of each well. Given that many aspects of offshore exploration wells are common to all such wells, a *generic assessment* of the common aspects of offshore exploration wells was conducted in 1999 for Nova Scotia waters (Thomson et al. 2000). In Nova Scotia, drilling applications for specific wells incorporate the generic assessment by reference and address site-specific aspects of the environment, impacts or project activities. In Newfoundland, generic assessments *per se* have not been done but exploration EAs (e.g., Husky 2002 and Husky 2003a) have built on other comprehensive assessments for major production developments such as Hibernia, Terra Nova and White Rose. In addition, a strategic environmental assessment (SEA) of exploration activities was recently completed for the Orphan Basin off Newfoundland and Labrador (LGL 2003).

Some research scientists, non-government organizations (NGOs), and stakeholders have expressed concern over the potential impact of exploration drilling. In addition, the *Canadian Environmental Assessment Act* (*CEAA*) generally requires some sort of follow up or monitoring to validate impact predictions, especially when the predictions are tenuous or viewed to be tenuous. Environmental effects monitoring (EEM) has been carried for large developments such as Hibernia, Terra Nova, Sable Island, Cohasset-Panuke, and White Rose. Simply, EEM can be defined as a test of impact predictions made in an EA or EIS. The purpose of this study was to determine if EEM is required, and if so, in what situations, as well as to provide some guidance in program design.

At present, there are no specific EEM requirements for drilling exploratory wells offshore on the East Coast. In the Canadian Arctic, there may be requirements to conduct marine mammal monitoring depending upon location and season. For the most part, environmental protection is achieved through the environmental assessment/permitting process and a series of generic and project-specific mitigations.

The design of EEM programs for single exploration wells presents a challenge in that a single exploration well is drilled over a short period of 40 to 100 days. The well may be a 'dry hole' and also may leave little or no 'footprint.' In addition, there may be relatively little lead-time for an exploratory well relative to a production well. In contrast, development wells certainly contain hydrocarbons, drilling may go on for a few years, and the development may be producing for many years. The EEM strategies designed for oil field development and operation, or at least parts of them, may not be applicable to exploration wells, although their results may be relevant in scoping the potential effects of a single well vs. a multi-well scenario.

1.2. Boundaries of the Study

This study focused on single exploration wells that could be drilled anywhere on the East Coast of Canada using currently available technology at any depth during any season. It concerns EEM strategies that could be used to test impact predictions made in EAs for exploration drilling and to address concerns about exploration drilling.

Wells drilled to date off the East Cost of Canada are shown in Figures 1.1 and 1.2.

1.3. Issue Scoping

There were several possible approaches to this project: (1) workshop, or (2) focused consultations. An informal consultation approach was chosen for logistical reasons and because it was felt that people would speak more freely. In addition, there were too many potential issues and concerns, each requiring technical expertise, associated with exploration drilling to use a one or two workshop approach for this study. Some of these *a priori* issues included:

- Effects of the cuttings pile on the benthos,
- Effects of drilling mud in the benthic boundary layer on scallops,
- Comparison of effects of water based, oil based and synthetic based drilling mud,
- Effects of mud and cuttings on deep sea coral,
- Effects of the presence of the platform on birds,
- Effects of the exclusion zone on fisheries,
- Effects of produced water during well testing,
- Effects of underwater noise on marine mammals, and
- Effects of routine discharges.

The above list is not intended to be all-inclusive nor intended to imply that all of these issues are necessarily scientifically or technically based. This list does, however, reflect the concerns of a number of stakeholders.

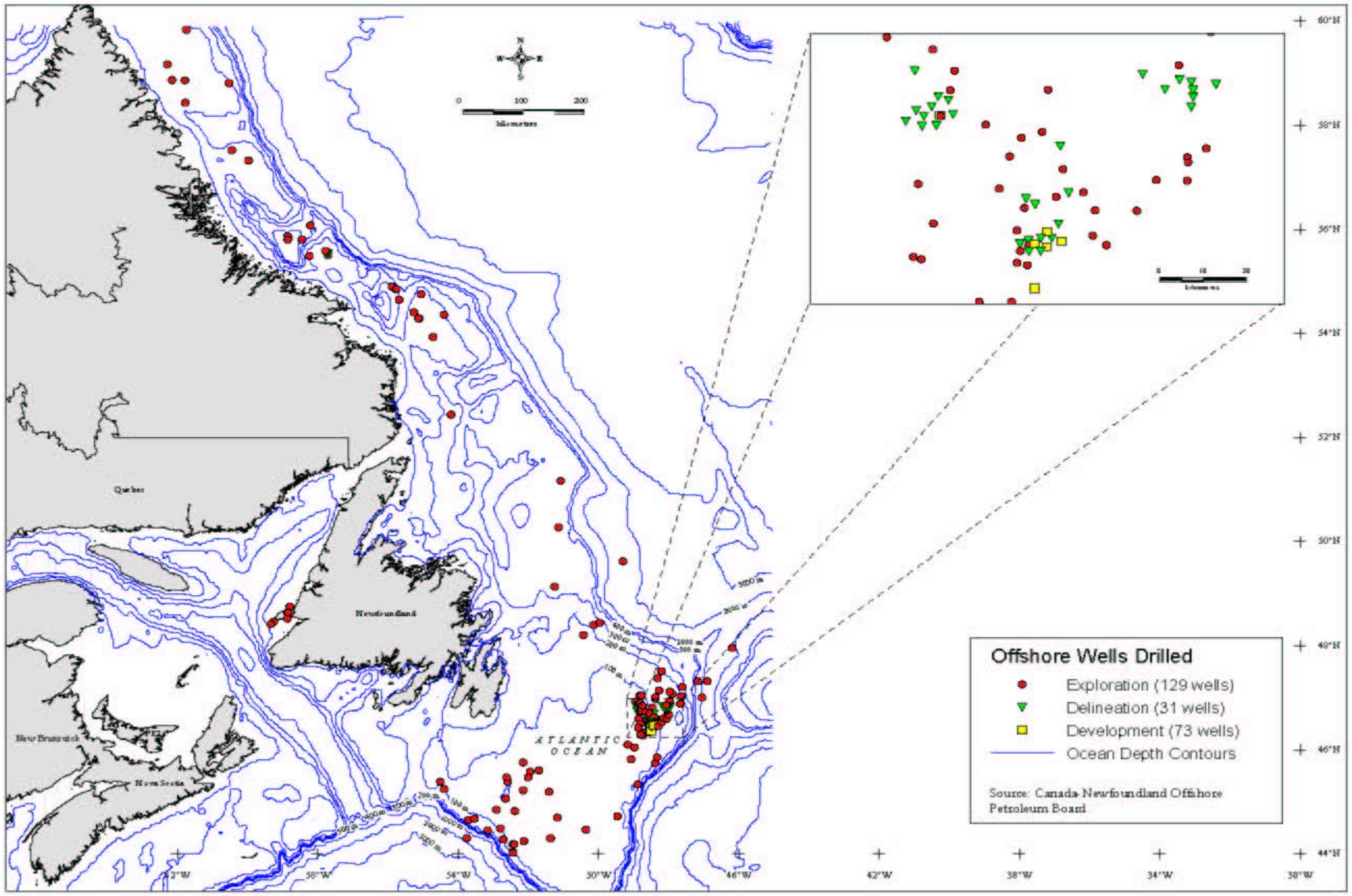


Figure 1.1. Offshore Wells Drilled in Newfoundland and Labrador Waters.

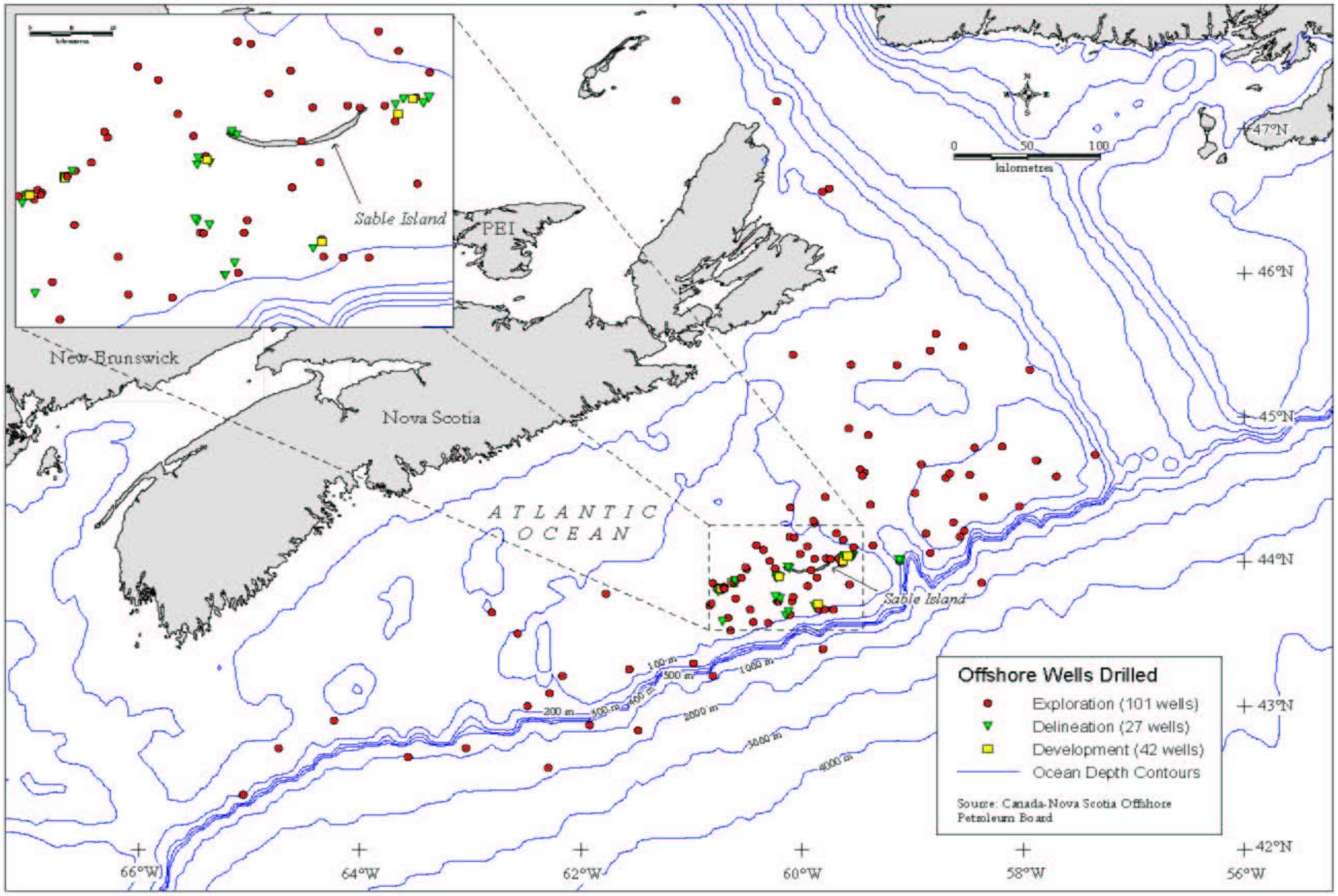


Figure 1.2. Offshore Wells Drilled in Nova Scotia Waters.

1.4. Development of an EEM Strategy for the East Coast

Once it has been determined that EEM is required, the methods used to monitor effects of exploration drilling on the East Coast should

- Address issues and concerns of stakeholders, regulators, scientists, NGOs, the oil and gas industry and interested parties,
- Test impact predictions made in EAs for exploration wells,
- Be effective in detecting effects,
- Be scientifically and statistically defensible,
- Be acceptable to the interested parties named above, and
- Be cost-effective.

In addition, EEM studies should determine:

1. whether or not there is an effect, and if not, consider if further studies should be discontinued. In some cases, in may be desirable to consider monitoring for reassurance purposes.

2. that if there is an effect, should studies be continued as mitigation measures are developed to reduce or eliminate the impact.

Some EEM studies may be applicable to all wells and some may be applicable to only certain types of wells. We used a scenario approach to determine the applicability of methods to specific kinds of wells and/or all wells. Type of drill rig, water depth, bottom type, currents, kinds of marine life present and predicted impacts, among other things, were considered in the application of methods to specific wells.

2.0 Background

2.1. Potential Issues and EEM Studies

One of the objectives of the study was to identify issues and potential EEM methods. Experience has shown that several key issues and concerns that may need to be addressed by EEM are common written and oral comments during public consultation for exploration wells or large production developments. Some of these are briefly reviewed below. Note that these are only a few recurrent issues and are not meant to be a comprehensive list. Additional issue scoping is contained in Section 3.0 based on informal local discussions with key informants.

2.1.1. Fish and Fisheries

Assessment of any potential impacts on fish and fisheries will continue to be of major importance for regulators and the oil and fishing industries with additional exploratory drilling off the East Coast.

Although valuable for assessing fish quality and marketability, chemical analyses of tissues are inadequate as a measure of fish health because

- Many chemicals do not accumulate in body tissues to any degree yet they can be quite damaging,
- Only a limited number of toxic chemicals in complex mixtures can be measured,
- The toxicity of many chemicals may not be due to the chemicals measured but by degradation products which are not readily measured, and
- There are few dose-response experimental studies linking body burdens of chemicals to effects; therefore, even knowledge about levels of chemicals in tissues can rarely be used to assess actual health effects (see Mathieu 2002, Appendix I).

Given the inadequacies of using chemical analyses as a measure of fish health and given that population level measures are both very expensive and unreliable for detecting change in the absence of major population level effects, there is increasing emphasis on use of biochemical and/or histopathological indicators of chemical stress to obtain an appreciation of the degree and severity of any potential health effects. These indicators are commonly referred to as bio-indicators or health effect indicators**.** Use of such indicators has the potential to identify adverse conditions in advance of responses at the population level and as such can provide early warning signals of any impending more severe problems.

It is equally important to stress that indicators are also a powerful tool for "disproving" as well as "proving" the deleterious effects of chemicals. For instance, perceptions or concerns about population level effects on fish stocks would have little scientific credibility in the absence of individual level effects.

Given regulatory and socio-economic concerns about potential impacts on fish and fisheries, a key component of the study was to "assess any potential impacts of exploratory drilling on the health and productivity of finfish and shellfish and recommend monitoring approaches and techniques if required".

2.1.2. Fisheries Exclusion Zone

The safety zone around a drill rig and its enforcement by standby vessels is frequently raised as a concern of the fishing industry in Nova Scotia. This issue was investigated during the collection of stakeholder views to assess the merits of monitoring the situation. It should be noted that the safety zone for a single exploratory well is much smaller than that for a production development.

2.1.3. Drilling Muds in the Benthic Boundary Layer

Individual fine particles in water based drill muds (WBM) settle slowly. However, fine particles interact with seawater and organic matter to form flocs (Munchenheim and Milligan 1996). This increases settling velocity and serves to retain the discharged material near the discharge point and hinders dispersal (Munchenheim and Milligan 1996). Material that is deposited can be re-suspended and transported (Neff et al. 1989). The accumulation of this material occurs within the benthic boundary layer, which is within a few metres of the sea bottom.

Accumulation of suspended drilling wastes in the benthic boundary layer has the potential to affect sensitive species such as scallops (Cranford and Gordon 1992; Cranford et al. 1999). Effects may include mortality at very high mud concentrations, negative growth and cessation of gonad growth. The benthic boundary layer transport model (referred to as the **bblt** model) has been used to model the fate of discharged WBM in the benthic boundary layer at exploration drilling sites. Some field testing of this model under ESRF auspices has been conducted by Hannah et al. (2003).

2.1.4. Benthos

Environmental effects monitoring programs in the offshore have commonly used benthic communities as indicators of impact, typically through use of community measures such as diversity indices and species richness, as well as patterns of occurrence and abundance of indicator species (e.g., capitellid polychaetes) (e.g., Kingston 1992; Olsgard and Gray 1995). Benthic community structure is also a key component of the Sediment Quality Triad approach to assessing impacts of industrial activities on aquatic ecosystems (e.g., Chapman et al. 1991; Green and Montagna 1996; Carr et al. 1996a; Borgmann et al. 2001), currently used in offshore monitoring programs for the Sable Offshore Energy Project, and Terra Nova on the Grand Banks.

2.1.5. Cuttings Pile

Cuttings and any remaining adherent mud are normally discharged subsurface from the drilling rig. The heavy particles settle near the discharge site and may form a pile on the bottom. An examination of three exploration well sites drilled with water-based muds in the Hibernia field revealed only slight accumulations of drilling materials (NORDCO 1983). However, accumulation depends on depth, water currents and frequency of storm surges. The concern is with smothering of the local benthos and potential loss of a small amount of fish habitat.

2.1.6. Deep Sea Corals

Through interviews with fishermen, examination of museum collections, discussion with researchers and a literature review, Breeze et al. (1997) mapped the distribution of deep sea corals on the Scotian

Shelf and Georges Bank. The corals are distributed in canyons along the edge of the continental shelf and in the deep channels between fishing banks. These long-lived, slow-growing sessile filter feeders are extremely sensitive to changes in current, suspended sediment and temperature, and appear to be good bio-indicators of environmental deterioration. Fishermen have reported changes in coral abundance in several areas, largely due to the impact of mobile fishing gear. There is a concern that settled drilling waste could affect these corals.

2.1.7. Birds

There is a concern that night-flying birds, especially petrels, are attracted to lighted rigs. The birds become disoriented and land on the rig. Procedures have been developed for dealing with these birds and appear to work well, however, no formal monitoring results are available to date. There is some concern that birds could be burned in flares or fly into the structure. There is also a concern that birds could be attracted to the structure and be subject to predation or land on sheens on the water. The ESRF has issued RFPs aimed at studying these issues.

2.1.8. Scientific Credibility of Potential EEM Programs

EEM programs that are developed must be scientifically credible and acceptable to stakeholders. At the same time, the parameters to be measured need to be appropriate for measurement at reasonable cost. Scientific credibility can be assured by using state-of the-art techniques and by involving statisticians to review final designs. Studies should include appropriate provisions for analyses to determine optimum sample size and allocation of resources to give the best possible chance of detecting effects and *a posteri* power analysis to determine the power of the test to detect change. The study design should include provisions for modification based on the results of statistical power tests.

Scientific credibility would be of little value if stakeholders were not convinced that the results were valid. Thus, the programs must address their concerns and produce results that are credible to both scientists and the concerned public.

2.2. Typical Exploratory Drilling

Exploratory drilling on the East Coast is normally examined under an environmental assessment (EA). Typical issues addressed include:

- Noise and disturbance associated with support activities and drilling (e.g., supply vessels, helicopters)
- Effluents and emissions of the drill rig (sanitary, grey water, mud and cuttings, etc.)
- Accidental events
- Well abandonment activities

Drilling and testing the typical exploration well on the shelf may take about 40 days for drilling and an additional 20 days for testing if hydrocarbons are found.

Normally if there any concerns with the exploratory drilling, they tend to revolve around the disposition of mud and cuttings on the sea floor, accidental events such as spills or blowouts, and disturbance of marine birds and mammals, if the area is deemed to be an important area for these species. To date, all EAs for drilling have predicted that any environmental effects will be not significant with the possible exception of a major oil blowout (e.g., Petro-Canada 1996; Husky 2000, 2002, 2003a).

Compliance monitoring and EEM (in the case of development and production scenarios) focuses on effluents and emissions. Monitoring of spills is considered separately from compliance monitoring or routine EEM.

The following sections provide a brief description of typical exploratory drilling equipment, procedures and activities. Emphasis is on those aspects relevant to EEM.

2.2.1. Drill Rigs

Worldwide, there is a wide variety of drilling rig types in common use. Typically the offshore drill rig houses the drilling equipment, working and living quarters and is serviced by helicopters and supply vessels. To date, the most common drill rig in use on the Grand Banks has been the semi-submersible (e.g., the *Glomar Grand Banks*). Semi-submersibles are normally anchored but some can be dynamically positioned without anchors. Hibernia is the exception as drilling is conducted from the concrete, gravity base structure (GBS) that also houses the production facilities. In Nova Scotia, 'jack-up', bottom-founded rigs have been typical but as drilling moves into deeper water there is a trend toward semi-submersibles or drill ships.

There may be some minor differences between and within rig types in terms of capabilities, treatment facilities, effluent discharge depths, and so forth but, for the most part, each rig is fairly 'typical' in terms of characteristics, volumes and types of discharges. All must conform to the *Offshore Waste Treatment Guidelines* (*OWTG*) (NEB et al. 2002). Rig types do differ in terms of the noise emitted with dynamically positioned drill ships being the noisiest and the 'jack-up' being the quietest.

Drill mud handling is an important duty of the rig (see below). Other equipment and material includes casings, cement to bond the casings, risers and blowout preventers (BOP).

2.2.2. Drill Muds

Drilling muds are needed to convey the drill cuttings out of the hole and to keep formation fluids from entering the well. During the drilling of the top hole sections, the riser is not in place and drilling mud and cuttings (or sediments) from the top part of the hole are discharged from the hole to the seabed. [Drill muds and cuttings are no longer a potential issue with Hibernia, as that production facility will be re-injecting their cuttings. This approach is not presently feasible for the single offshore exploratory wells using existing drilling units on the East Coast.]

All exploratory drilling on the East Coast is conducted using either water-based drilling muds (WBM) or synthetic-based muds (SBM). It is debatable which type is more or less 'environmentally friendly.' For example, it can be argued that WBM is better because it is mostly water and cannot form a sheen on the surface whereas SBM may form one under certain conditions. On the other hand, SBM generally stays closer to the well site and does not disperse as widely as WBM. All drilling fluids should be handled and treated in accordance with C-NOPB and C-NSOPB policies and the *OWTG*.

After installation of the initial casing strings, the riser provides a conduit from the seabed to the rig that takes the drilling mud and cuttings back to the surface mud system. Once on board the rig, the drill cuttings are removed from the mud in successive separation stages and discharged. Some mud remains with the discharged cuttings. At several stages during drilling and at the end of the drilling process, WBM is discharged.

The main component of WBM is either fresh water or seawater. The primary WBM additives include bentonite (clay) and/or barite. Other chemicals such as potassium chloride, caustic soda, soda ash, viscosifiers, filtration-control additives and shale inhibitors are added to control mud properties. Low toxicity chemicals are used for the water-based drilling mud to reduce the effect on the environment.

From the top down, a typical exploratory hole involves a conductor, surface and progressively smaller casings, perhaps as many as five. Mud and cuttings cannot be returned to the rig until the surface casing is in place and thus mud and cuttings from the conductor and surface parts of the hole are initially discharged directly to the seabed. Once the surface casing is complete, the risers are installed, and the mud and cuttings are returned to the rig through a closed system for recycling and cleaning before cuttings and any residual mud are discharged. The discharge is treated and exits via shute to just below the water's surface subject to Board approval. The mud and cuttings are dispersed in the water column and settle on the sea floor with the heavier particles near the hole and the fines at increasing distances from the rig. [One industry respondent interviewed during the course of the present study offered the following observation. "Muds/cuttings emanating from drill rigs located near Sable Island have been observed to form into a long, tendril-like plume on the ocean surface extending several kilometres from the source, presumably in the predominant direction of the surface current."]

The conductor setting depth is site-specific and subject to Board approval but a typical depth on the Grand Banks might be about 250-m as measured from the rotary table (i.e., MD). The typical surface casing setting depths may be on the order of 1,200-m MD. Estimated volumes of water-based mud and cuttings discharges associated with initial casings for a typical Grand Banks (White Rose area) well are shown in Table 2.1. It should be noted that the muds/cuttings from the production casing phase are passed through the solids control system that consists of shale shakers and centrifuges.

Drilling muds and cuttings, and their potential effects were discussed in detail in the White Rose Comprehensive Study (Husky 2000) and Supplement (Husky 2001a). Modeling of the fate of drill mud and cuttings discharges was conducted for the White Rose EA. The White Rose EA analyzed the effects of the discharge of drilling wastes from development drilling of 25 wells using SBM at multi-well drilling sites. As such, the White Rose scenario can be considered a 'much worse case' than the exploratory drilling of one individual well. The White Rose development drilling was deemed to create no significant effect on fish and fish habitat, the fishery, seabirds, marine mammals, or sea turtles. Additional relevant documents not available during the White Rose EA include MMS (2000); CAPP (2001a,b), NEB et al. (2002), the White Rose baseline studies (Husky 2001b, 2003b), and Husky exploratory drilling EAs (Husky 2002, 2003a) all of which discuss the discharge of mud and cuttings and associated effects. These recent reports have further confirmed the conclusions of the White Rose work that routine drilling, particularly small scale drilling, has no significant effect on the marine environment of the Grand Banks. The salient points are briefly summarized in the two following sections and the results of baseline and monitoring studies related to offshore drilling programs are presented in Sections 2.5 and 3.0.

Table 2.1. Typical Mud Components and Cuttings Discharge Volume for a Grand Banks Exploration Well.

		Casing Strings		
	Unit	**Conductor**	**Surface**	**Production**
Hole Section	inch	36	16	12 1/4
DF System		Gel/SW	Gel/SW	WBM
Depth (See Note 4)	Meter (brt)	220	1200	3600
Volume Usage	bbl	897	4199	5246
Wash Out	%	50%	30%	10%
Products				
Barite	MT		58	115
Bentonite	MT	16	65	
Calcium Carbonate	kg			
Caustic	kg	116	482	138
Fluid Loss Agent	kg			2385
Inhibitor	kg			4769
Fluid Loss Agent	kg			9538
Potassium Chloride	kg			100153
Lime	kg	116	482	
Glycol Inhibitor	L			25024
Soda Ash	kg	116	482	238
Viscosifier	kg			3577
Biocide	L			72
Drilled Cuttings	kg	192032	429562	521786
Volume of Cuttings	m^3	74	165	201

Notes:

1. Three scenarios were taken into account. The 12 ¼" hole section varies in depth with each scenario.
2. 36" and 16" hole sections–Near seabed discharge.
3. WBM used for complete well.
4. All depths are measured below rotary table (brt). The rotary table is 145-m above the seafloor.

Source: Husky (2003a).

2.2.2.1. Water-Based Muds

At present, and for the near future, most exploratory wells at least on the East Coast, will be drilled with WBM unless unexpected, difficult or highly deviated conditions are encountered and then, with the approval of the Board, they may use SBM (discussed in a following section). Composition of one typical WBM formulation for an exploratory program is shown in Table 2.1.

The following points are relevant to the discharge of WBM and cuttings.

- WBM are essentially non-toxic. The main component of WBM is seawater and the primary additives are bentonite (clay), barite and potassium chloride. Much previous literature (e.g., the North Sea) on the effects of mud/cuttings deals with field where oil-based muds (OBM) were used for a number of years. The OBM literature is not very relevant to WBM or SBM usage.
- Chemicals such as caustic soda, soda ash, viscosifiers, and shale inhibitors are added to control mud properties. All constituents are normally screened using the *Offshore Chemical Selection Guidelines* (NEB et al. 1999).

- Discharge of WBM and associated cuttings is regulated by the C-NOPB and C-NSOPB. Spent and excess WBM and cuttings can be discharged without treatment (NEB et al. 2002).
- The discharge of WBM may increase metals in sediments such as barium, arsenic, cadmium, copper, mercury, lead, and zinc, generally within 250 to 500-m of the drill site but occasionally farther (usually zinc and sometimes chromium) depending upon mud volumes and environmental conditions. However, these metals are not in a bioavailable form and few if any biological effects have been associated with these increases in metals from drill rig discharges (CAPP 2001b).
- The primary effect of WBM appears to be smothering of benthos in a small area near the hole. The exact area of effect cannot be predicted because animals' reactions will range from simply avoiding the immediate area of deposition to direct mortality of sessile organisms. Nonetheless, the White Rose EA indicated a worst-case scenario of an area of less than 1-km^2 around each well would have a depth sufficient to result in some smothering (Husky 2000, 2001a). The exploratory drilling for one well would be well below the worst-case scenario used for the White Rose EA. The benthos can be expected to recover in anywhere from several months to several years (and most likely within one year) after the drilling ceased, based upon the published literature (reviewed in Husky 2000, 2001a; MMS 2000; CAPP 2001b). Actual monitoring data from other operators indicate that the actual area of smothering appears to be much less than predicted (Fechhelm et al. 2001; Marathon, unpubl. data).

2.2.2.2. Synthetic-based Muds

Synthetic-based muds (SBM) are not used in the typical exploratory program unless difficult or unexpected hole or reservoir conditions are encountered. Synthetic muds were developed to replace oil-based muds which were considered toxic to varying degrees and which appeared responsible for the longevity of cuttings piles. In general, SBM is essentially non-toxic, has the potential to biodegrade relatively rapidly, and less mud is required than for WBM for the same distance drilled. SBM tend to 'clump' cuttings together more than WBM thus SBM cuttings tend to disperse less and fall closer to the rig.

The following points concerning SBM are relevant to an exploration drilling program EA on the East Coast.

- In other jurisdictions, biological effects have been attributed to smothering under the patches of mud/cuttings from physical and/or chemical (i.e., anoxia caused by rapid biodegradation) conditions (e.g., EPA 2000).
- In Nova Scotia, SBMs have been handled in a number of ways including shipping to shore, injection, and discharge.
- In the deepwater (500+-m), Gulf of Mexico, organic enrichment with attendant increases in biota, including fishes and crabs, has been reported after a two year multi-well drilling program (Fechhelm et al. 2001). No large cuttings piles were observed by ROV during that study.

- Biological effects are not normally found beyond 250-500-m from the drilling platform (Husky 2000, 2001a, 2002, 2003a; MMS 2000; CAPP 2001b; C-NOPB 2002). The Husky EAs (White Rose, Jeanne d'Arc Basin, and South Whale Basin) concluded a total area of impact of less than 1-km^2 from multi-well drilling based upon a modeling exercise and published literature. It can reasonably be expected that a single exploratory well would affect a much smaller area.
- In the event that SBM must be used, the cuttings are treated prior to discharge. All discharges are subject to approval by the Boards and discharge of whole SBM is not permitted.

2.2.2.3. Mitigation

Mitigation measures for the drilling include the selection of non-toxic or low toxicity chemicals and muds and treating any oil-contaminated cuttings to meet the *OWTG*. Hibernia now re-injects cuttings as a mitigation for production (not exploration) drilling. However, the Hibernia situation is atypical for the East Coast being a very large development that does all its drilling from a centrally located gravity-base structure.

2.2.3. Discharge of Other Fluids and Solids

Other fluids associated with the drilling include cement slurry and BOP fluid. Mitigations include careful selection and use of chemicals in order to minimize any potential toxic effects.

Based on experience with previous exploratory wells, approximately 33-t (26.4-m^3) of excess cement may be released to the marine environment per well (Husky 2000), and may smother or displace some benthos locally. If the cement remains in a pile, it will act as an artificial reef, be colonized by epifaunal animals and attract fish. The effects (either negative or positive) of the cement on benthos are likely negligible.

Blowout preventer (BOP) fluid is used in the blowout preventer stacks during drilling. The fluids are normally glycol-water mixes. Periodic testing of the blowout preventer is required by regulation. Approximately 1-m^3 of the fluid is released per test. Periodic releases of this small amount of glycol likely have a negligible effect on marine biota.

In some cases, small amounts of produced water may be released during testing, if hydrocarbons are discovered. Sometimes this is released but it may also be burned, or if present only in small quantities, disposed on shore.

Concerns about birds and mammals are normally related to accidental events (beyond our mandate here) and/or the perceived importance of a particular area. For example, bird (particularly petrels) attraction to rigs was an issue during both Terra Nova and White Rose hearings because the areas are known to support large numbers of petrels, which may be particularly sensitive to this type of disturbance. Similarly, noise of drilling and support activities may be an issue near known concentrations of whales (e.g., bottlenose whale population in the Gully, offshore Nova Scotia).

2.3. Exploratory Drilling – Cumulative Effects

On the Grand Banks to date, there have been over 233 exploration, delineation, and production wells (C-NOPB data) (see Figure 1.1). The Canadian Association of Petroleum Producers (CAPP) has predicted that there will be between one and four drill rigs per year operating on the Grand Banks over the next 10 years (CAPP 1999). CAPP's scenario for a moderate level of activity predicts two rigs drilling exploration, delineation and production wells on the Grand Banks over the next ten years.

In Nova Scotia waters, over 170 wells have been drilled to date (C-NSOPB data) (see Figure 1.2). It is likely that there will be at least one or two rigs operating in Nova Scotia waters over the next 10 years.

2.4. Regulatory Regime

Different jurisdictions have different approaches to environmental protection for offshore drilling which range from no EEM to custom programs. Some of these approaches are briefly described below.

2.4.1. International

2.4.1.1. Gulf of Mexico

There are have been many thousands of exploration, delineation and production wells drilled in the Gulf of Mexico, mostly in relatively shallow water on the shelf. The present trend is to drill in the deeper water of the slope and basin of the Gulf.

There have been extensive studies of the biota in the Gulf under many auspices and there have been numerous research studies conducted for specific developments. While there are some specific EEM programs such as the Flower Garden Banks that have been monitored every year since the 1980's and some deepwater (1,000-m) research studies of two exploration and two production platforms using sidescan profiling and biological mapping, there are no EEM requirements for single exploratory wells (G. Boland, MMS, pers. comm.).

Because there is a large body of evidence for the Gulf that effects, even in deepwater, of exploratory drilling, occur within 1,000-m of the rig, emphasis is on a type of zoning to avoid sensitive areas and compliance monitoring to EPA effluent guidelines once the project goes ahead. Sensitive areas include topographic features that may contain coral reefs or other hard substrates that constitute limiting habitat in the predominately soft-bottomed Gulf. Buffer zone widths ranging from 1,000-m to four miles may be used as a protective measure. Thus, zoning and mitigation techniques are used for oil and gas exploratory drilling in the Gulf as opposed to a case-by-case EEM program.

2.4.1.2. Alaska

Regulatory requirements concerning EEM in Alaskan waters can be complex because a number of regulators (e.g., federal such as National Marine Fisheries Service, US Biological Service or EPA; state such as Alaska Fish and Game and Division of Oil and Gas; local such as North Slope Boroughs, and others) may take an interest in a particular project depending upon the location, water depth, time of year and type of drill rig, and so forth. The primary line of defense is the permitting process and compliance monitoring; the ultimate goal for effluents is 'zero discharge' offshore.

There are no 'hard and fast' rules for EEM but it is very likely that marine mammals (e.g., whale migrations and possibly ringed seals in summer, and seals in winter), and noise would have to be monitored for an offshore exploratory well drilled in Alaskan waters (B. Wilson, LGL, pers. comm.). However, strictly speaking, it could be argued that this type of monitoring can be considered mitigation as opposed to EEM because precautionary shutdowns may occur because of the monitoring.

2.4.1.3. Other

Very few, if any, jurisdictions have EEM requirements for exploratory drilling. For example, the Canadian oil company Nexen operates offshore exploration internationally in West Africa, Brazil (with Petrobras), Indonesia, Australia, and the Gulf of Mexico. Of these areas, Australia is the only jurisdiction that has some requirement for EEM depending on location and timing of drilling (W. Robson, Nexen, pers. comm.). On the other hand, there may be certain circumstances where a company might voluntarily conduct 'before' and 'after' surveys in order to address liability issues (W. Robson, pers. comm.).

2.4.2. Canadian

At the time of writing the first draft of this document there were no specific EEM requirements for drilling exploratory wells offshore on the East Coast. However, it should be noted that as of 30 October 2003, the revised *Canadian Environmental Assessment Act* states that some form of 'follow-up' is required for projects that have undergone any *CEAA* process including screening. It remains to be seen if this is an actual EEM 'requirement' in all cases. In the Canadian Arctic, there may be requirements to conduct marine mammal monitoring depending upon location and season. For the most part, environmental protection is achieved through the environmental assessment/permitting process and a series of generic and project-specific mitigations.

On the East Coast, the C-NOPB and C-NSOPB require that effluents and discharges be monitored (i.e., compliance monitoring) according to the *OWTG* (NEB et al. 2002). Effluents and discharges that fall under these guidelines include:

1. Air emissions
2. Produced water
3. Drilling muds
4. Drill cuttings
5. Well treatment fluids
6. Storage displacement water
7. Bilge and ballast water
8. Deck drainage
9. Cooling water
10. Produced sand
11. Desalinization brine
12. Fire water
13. Sewage and galley waste

14. Monoethylene glycol
15. Naturally occurring radioactive materials (NORM)
16. Other wastes (solid waste, residues, etc.)

Of these, in the case of exploratory drilling, items 2 to 4, and 7 and 8 would be routinely monitored. Other items may be specified on a case-by-case basis.

2.5. Review of Effects

A detailed review of effects reported from various relevant research and EEM studies worldwide is contained in Mathieu 2002 (Appendix I). A brief summary is provided below.

2.5.1. Toxicity Potential of Drilling Fluids and Cuttings

Drilling fluids (muds) and cuttings have potential for both lethal and sublethal effects on marine organisms (mostly sedentary ones) through introduction of contaminants from chemical additives or from the downhole geology or by physical smothering, mostly of sedentary benthic organisms. Most offshore drilling worldwide is now conducted using water-based or synthetic-based muds; these fluids range from non-toxic to low toxicity compared to previous fluids that utilized diesel oil as the base. Literature on the topic must be treated with caution because effects from older wells that used oil-based mud must be separated from the newer ones. It also should be noted that care must be taken in interpreting benthic data near offshore platforms because the reef effects caused by the presence of the platform may be equal to, or even greater than, those caused by contaminants (see Montagna et al. 2002).

As discussed previously, it is debatable as to the level of environmental effects of WBM versus SBM. In a typical offshore situation, WBM tends to disperse more widely whereas SBM tends to clump together closer to the well site. Both contain ground barite and/or bentonite, dispersants, viscosifiers, fluid control agents, and corrosion inhibitors. Most additives are practically non-toxic as measured by 96-h acute toxicity testing (e.g., concentrations >10,000-ppm with most ≥100,000-ppm), and most drilling wastes can be considered only slightly toxic (1,000-10,000-ppm) or practically non-toxic (>10,000-ppm) (GESAMP 1993). A variety of SBMs have passed the US criteria for toxicity from suspended particles to mysid shrimp (LC50's >30,000-mg/L) and an SBM used offshore Newfoundland (a synthetic isoalkane, IA-35) has been tested and found to have a very low toxicity (see Neff et al. 2000; Payne et al. 2001a,b). Synthetic fluids can be categorized as synthetic alkanes, ethers, esters, or olefins; the most rapidly degrading ones can create localized anaerobic conditions in the underlying sediments (EPA 2000). Chemicals used off the East Coast of Canada are screened and selected for lowest toxicities (see NEB et al. 1999).

Smothering from mud and cuttings discharge from a single exploratory well is likely confined to a very small area and should not be an issue, although benthic communities may be affected by physical alteration of the sediments (e.g., Cantelmo et al. 1979). However, concern has been expressed that barite or bentonite can become suspended in the benthic boundary layer (Muschenheim and Milligan 1996) and may affect scallop growth (Cranford et al. 1999).

Barite (barium sulfate) is an insoluble, relatively low toxicity form of barium which in ionic form is quite toxic. Pathological effects of barite have been reported for bivalves (Cranford et al. 1999), shrimp (Conklin et al. 1980), and flounder (J. Payne, DFO, pers. comm.). WBM and SBM are generally of low toxicity but that there are potential effects from mud and cuttings other than changes to benthic community structure that should be examined for an EEM program, for example, effects on flatfish as determined by mixed function oxygenase (MFO) and histopathology.

2.5.2. Biological Effects: Single or Low Number of Wells

Results of an extensive literature review of developments involving one or few exploratory or production wells are in the tables contained within Appendix II.

The review considered worldwide results from 18 locations using WBM with water depths ranging from eight to 410-m and 17 locations using SBM (a few with LTMO) with water depths ranging from 30-m to 565-m. In addition, seven locations from the East Coast with depths ranging from 20 to 90-m were examined; some used WBM, SBM or low toxicity mineral oil (LTMO).

In summary, effects as measured by various biological indices on sediment communities generally ranged somewhat farther using WBM than SBM but in most cases were within a few to 500-m of the well or set of wells and most commonly within a 200-m radius.

2.5.3. Perspective on Exploratory Drilling Versus Other Industrial Activities

It is useful to place the risk to the environment and the scale of effects created by exploratory drilling compared to other industrial activities such as commercial fishing and shipping. To date, exploratory drilling, in so far as can be determined, has had a relatively mild effect on the marine environment of the East Coast. Monitoring of large-scale offshore oil developments, involving multiple wells (e.g., Hibernia, Terra Nova, and White Rose) has failed to discover any significant impacts on those elements of the ecosystem that have been measured. It should be noted that care should be taken in extrapolating effects from other oil fields such as the Gulf of Mexico or the North Sea because those areas contain many thousands of producing oil wells that were drilled over a number of years. Furthermore, while there has been a gas blowout off Nova Scotia, there have been no oil blowouts off Newfoundland. In contrast, chronic illegal release of oily water by disreputable ship captains on freighters and tankers continues to result in the mortality of thousands of seabirds off the south coast of Newfoundland (W. Turpin, CWS, pers. comm.).

The fishing industry has caused major significant effects off the East Coast (e.g., the failure of the Atlantic cod fishery, and others). The scale of effects created by routine fishing industry activities is potentially much greater than those from routine petroleum exploration activities. For example, the combined biological effects of petroleum activities in the North Sea affected an area of about 106-km^2 in 1989 whereas other UK waters such as the Irish Sea (2-3,000-km^2 in area) are completely trawled over 2.5 times per year (GESAMP 1993). The effects on benthic habitat of fishing dredges and trawls are well recognized (Veale et al. 2000; Watling et al. 2001; Wassenburg et al. 2002, and others). The National Academy of Science (1983) noted in their review of drilling discharges that while a single well may deposit 442-m^3 of cuttings, a single fishing vessel, dredging for surf clams, cuts an average swath about 1.5-m wide and 46-cm deep, potentially impacting 4,300-m^3 of sediment per day.

The attempt of the above comparisons is intended to place a perspective or scale on the drilling issues under discussion and not disparage the fishing or any other industry.

2.5.4. Biological Monitoring State of the Art

Environmental quality is ultimately biological in nature and over the past number of years there has been increasing emphasis on the use of biological techniques in monitoring programs in order to supplement more traditional chemical approaches, which were commonly used alone. There are a number of reasons for this shift in emphasis towards biological monitoring. For instance, reliance on chemical analysis alone presupposes that the contaminants of concern are known and dose-response relationships have been established for effects on various ecosystem components. This is rarely the case for any chemical or any species. Furthermore, only representative contaminants can be measured, and chemical analyses cannot consider factors of biological significance such as the combined effects of contaminants, their degradation products and their interaction with environmental factors. The International Commission for the Exploration of the Seas (ICES) has recommended biological monitoring techniques for the marine environment under the framework of the Olso and Paris Commissions (Table 2.2). The list of techniques is not unlike those which are being used already in many "informal" as well as more formal monitoring and assessment programs (e.g., studies by the National Oceanic and Atmospheric Administration in the United States).

Table 2.2. Biological Effects Techniques for Monitoring as Recommended by the Oslo and Paris Commissions (Stagg 1998).

Type of monitoring	Purpose	Monitoring methods
General biological effects monitoring	• Monitor general quality status	• *Early warning indicators:* Cytochrome P-450 1A, lysosomal stability, liver histopathology (e.g., preneoplastic changes), reproduction in viviparous blenny • *Indicators of long-term change:* External fish diseases, benthos community structure studies, the occurrence of liver nodules
	• Identify known or suspected areas of impact	• *Bioassays:* Sediment, Pore water and water column • *Biomarkers:* Cytochrome P-450 1A (EROD), lysosomal stability, liver pathology/nodules in caged or sedentary organisms • *Population/community responses:* External fish diseases, reproduction in viviparous blenny, benthos community structure studies, liver histopathology
Contaminant-specific effects monitoring	• Effects of PAHs	• PAHs in sediment, PAH metabolites in bile, EROD in liver, DNA adducts in liver, liver pathology
	• Effects of Hg, Cd, Pb	• Metals in sediment and liver, metallothionein in liver, ALA-D in blood, antioxidant defenses in liver
	• Effects of TBT	• TBT in flesh, imposex/intersex in gastropods or shell thickening in *Crassostrea*

Analysis of benthic community structure or benthic community structure in combination with sedimentary microtoxicity tests is recognised, including by ICES, as a valuable approach for assessing impacts on sediment habitat. Analysis of benthic community structure has also been one of the most widely used techniques for assessing sediment habitat impact around petroleum exploration and development sites. This is the case for developments in the North Sea and the Gulf of Mexico and more recently in Canada and Australia (Mathieu 2002, Appendix I). Studies indicate that any potential for significant impacts on sediment habitat around single exploratory or development wells through use of synthetic, or water base muds should generally be confined to within a few to 200-m of rig sites, if at all, (with impact zones being possibly somewhat shifted away from the immediate area of rig sites in deeper waters with fast currents). Impacts associated with multiple wells can also fall within the <200-m range. Also, benthic impacts associated with petroleum development are indicated to be quite small in comparison with other impacts such as those produced by fishing activities.

Considerable emphasis has been placed on studies of sediment communities around relevant well sites and the scale of impacts is fairly well known to be quite limited or negligible. However, there is a general lack of data on effects on fish and shellfish or other component which may be at some risk. Since population level effects in species such as fish would be both highly expensive to investigate and difficult to detect in the absence of major impacts, there is increasing emphasis on use of biochemical and histopathological indicators of chemical stress to obtain an appreciation of the degree and severity of any potentially impending problems in the marine environment. These indicators are commonly referred to as early warning or health effect bioindicators. Relevant indicators for monitoring effects in fish and shellfish such as induction of MFO enzymes and histopathology are noted in the list of techniques recommended by the Oslo and Paris Commissions (see Mathieu 2002, Appendix I).

Assessment of any potential impacts on fish and fisheries can be of considerable socioeconomic importance for regulators and the oil and fishing industries alike; bioindicators can provide a powerful tool for assessing if effects are occurring and if so, whether they might be of regulatory or socio-economic importance. For instance, perceptions/concerns about population level effects would have little scientific credibility in the absence of continuing evidence for individual level effects some distance from rig sites.

Laboratory studies indicate a potential for localised effects on fish and shellfish around petroleum development sites (e.g., Cranford et al. 2001 and references therein). Studies in the UK sector of the North Sea have demonstrated induction of MFO enzymes in fish around some platforms (Davies et al. 1984; Stagg et al. 1995). Histopathological lesions have also been found in finfish (Gallaway et al. 1981; Grizzle 1986) and shrimp (Wilson-Ormond et al. 1994) around some production platforms in the Gulf of Mexico. Recognising that most of the biological monitoring programs carried out to date in association with oil development have primarily emphasized investigations on impacts on sediment habitat, and given the potential for effects on fish and other pelagic organisms around rig sites, studies have recently been carried out under the auspices of ICES around a development site in the North Sea. These studies have confirmed a potential for effects on fish and shellfish around platforms (ICES Workshop 2002).

It is noted that the bioindicator studies carried out to date with fish and shellfish have been in association with production sites and the effects observed may primarily be linked to produced water. However, chronic effects associated with other potential contaminants including these found in drilling fluids cannot be discounted. As for impacts on benthic communities, any potential for impacts on fish around exploratory sites and especially these involving single wells some distance apart would seem to be quite low. It is of interest in this regard that Terra Nova has carried out fish health studies on a commercially important flatfish (American plaice) around their site in advance of development (JWE Ltd. 1998). No differences were noted in the bioindicators studied between their predevelopment site, where a number of wells have been drilled, and the reference site. Similar observations on bioindicators of fish health have also been made with respect to the predevelopment site at White Rose where a number of wells have been drilled (JWE Ltd. 2000). These field results are consistent with observations by Payne et al. (1995) who found little evidence for health effects in flounder chronically exposed to levels of drilling fluids (aliphatic hydrocarbon based) similar to those commonly found beyond 200-m or so from rig sites. The laboratory studies of Cranford et al. (1999) with scallops and Conklin et al. (1980) with shrimp also indicate that any significant potential for localised effects should be more or less in association with deposits from multiple, not single wells. However, in the absence of evidence and with due regard for unknown chronic toxicity potentials, effects on fish, shellfish or other ecosystem components could be greater than those on sediment communities. It is also recognised that it is often important to provide assurance that effects are not occurring in some species. This could apply for instance to commercially important fish, “species at risk” or other high profile species.

2.5.5. General Approach to Biological Effects Monitoring Around Exploratory Wells

Organisms (fish, shellfish, etc.) which might be of importance for assessment would depend on the exploratory site. Candidate indices for monitoring effects in the marine environment have been recommended by the Oslo and Paris Commissions (see Mathieu 2002, Appendix I). These include well known indices such as benthic community structure, sediment bioassays, MFO enzymes, and histopathology. With respect to determination of health effects in individual organisms, concepts such as growth and histopathology can be applied to a large variety of animals in addition to fish. However, the nature of environmental effects monitoring, precludes being too prescriptive since new techniques are always evolving or novel environmental observations may be made requiring a change in approach. For instance, specific cytochemical changes in bivalves (peroxisomal proliferation) are evolving as a novel technique for assessing pathological effects produced by hydrocarbons and other organic chemicals in bivalves. Similarly, depending on purpose, caged or resident organisms could be studied. For instance, concerns about potential for effects on general environmental quality could be addressed in part by caging selected animals near discharge sites. However, such an approach could greatly exaggerate exposure conditions and produce highly misleading results should the question be related to whether resident organisms such as commercial fish species are being affected to any degree around rig sites.

3.0 Environmental Effects Monitoring Programs for Production

The following sections provide more detailed reviews of EEM programs conducted on the East Coast for offshore oil and gas production developments. The most detail has been provided for the Sable Offshore Energy Project (SOEP) which can be considered a 'case study' (see below).

This project was selected as the primary case study because at the time of this writing more detail was available for SOEP whereas mostly summary material was available for the other East Coast projects. In general, study designs and results for all of the projects have been similar, with the exception of a number of minor differences.

Most EEM data collected off the East Coast to date has been for monitoring large production developments. As such, the data should be treated with the cautions that there are other potential environmental stressors at work other than drilling activities. Other stressors could include glory hole excavation, produced water discharge, and so forth. Nonetheless, offshore drilling for exploration wells entails essentially the same equipment, muds and cuttings and activities as drilling for delineation, injection, or production wells. Thus, both baseline and EEM data collected for such projects as Hibernia or SOEP are definitely relevant to EEM for exploratory drilling.

3.1. The Scotian Shelf

There have been three environmental effects monitoring programs on the Scotian Shelf, two for production developments and one for an exploratory well. To date, monitoring for each project has focused on the valued ecosystem components (VECs) identified in the environmental impact statements (EIS) prepared by the proponents. VEC selection is individualized for each proposed project, but the broad potential impact categories are quite similar, and these broad categories are used as the basis for monitoring program design.

Production EEM programs on the Scotian shelf were for the Sable Offshore Energy Project (SOEP) and Cohasset/Panuke (CoPan). Common monitoring elements included effects on local fishing communities, effects on bottom communities through sediment transport, and effects to seabird and marine mammals.

3.1.1. Sable Offshore Energy Project

Sable Offshore Energy Inc. (SOEI), operators of SOEP, divided their effects monitoring programs into two components, (1) near shore environments and (2) offshore environments. The near shore component focused on installing the pipeline to shore, so only the offshore components potentially relevant to drilling activities are considered here.

Offshore monitoring included VECs and associated concerns identified through the EIS, included:

– water and sediment quality;
– suspended particulate matter in the benthic boundary layer;

- benthic habitat and community;
- shellfish body burden and taint;
- marine mammals, and
- seabirds.

The sampling protocol used a gradient approach. A radial grid with eight axes was centred over the platform and samples were taken along the axes at increasing distances, between 250-m and 20-km from the platform. Water samples were taken in the direction of the prevailing current and Microtox™ testing was used to determine shellfish taint. The monitoring programs are ongoing throughout the project lifetime. SOEI has requested the program be modified to meet ongoing logistical and analytical limitation and to ensure it remains practical.

To date there have been no public releases of procedures or data, an issue of ongoing controversy. It is known that hydrocarbons were detected in mussel samples taken from the jacket legs, but no tainting was found. It was also observed that SBM did not disperse as modeling had predicted, but clumped, moving out only to about 75-m rather than 750 as had been forecast. The resulting "blob" persisted for some time, but then abruptly disappeared, possibly as the result of a storm.

3.1.1.1. Sable Offshore Energy Project Environmental Effects Monitoring Advisory Group (SEEMAG) Results

Review of Tier 1 EEM for SOEP

As a condition of the Development Plan approval by C-NSOPB, SOEI was required to develop and conduct both an offshore and a nearshore EEM program for its offshore natural gas and condensate project near Sable Island. There were four general objectives:

1. improve environmental understanding of cause-and-effect relationships between Project activities and the receiving environment, including both habitats and organisms,

2. provide early warning of undesirable change in the environment,

3. test earlier predictions in order to lower uncertainty or risk, and

4. provide feedback to SOEI, the regulatory authorities, stakeholders and the interested public in order to enhance adaptive management programs and guide environmental protection decisions.

The EEM programs have been overseen by the Sable Offshore Energy Project Environmental Effects Monitoring Advisory Group (SEEMAG).

The SEEMAG had five goals:

1. assist in scoping the EEM program,

2. focus the EEM program on significant issues identified through scientific inquiry, public consultation, or regulatory requirements ,

3. review monitoring studies and comment on their scientific and statistical validity,

4. evaluate program results and recommend improvements to the program and further mitigation measures as necessary, and

5. comment on linkages between the EEM program and Environmental Compliance Monitoring, as appropriate, in the interests of effective environmental management contribute to the understanding of the environmental impacts of the offshore oil and gas industry.

SEEMAG is an advisory body, with members potentially drawn from government, academic institutions, the fishing and aquaculture sector, First Nations, environmental or other relevant organizations.

The Tier 1 offshore EEM program focused on activities at Venture, Thebaud, and North Triumph, before, during, and after drilling. Specific objectives included:

- incorporate public concerns, regulatory concerns and scientific concerns,
- examine the potential impacts of produced water and the potential for tainting ,
- monitor accumulation and movement of drill wastes around the platforms, in particular towards the Gully,
- monitor traffic noise and noise-related SOEP effects on marine mammals,
- monitor nesting and young birds of the Roseate Tern population on Sable Island,
- monitoring:
  - water quality
  - suspended particulate matter (SPM) in the benthic boundary layer (BBL)
  - sediment toxicity and chemistry
  - shellfish body burden and taint.

Results for these over time are summarized in the tables provided in Appendix II. Effects on benthic habitat and megafaunal communities, marine mammals, and seabirds were also reviewed. Sets of questions were defined for several of the key parameters. An overall summary of conclusions for the Tier 1 EEM program, presented to SEEMAG in April of 2001, is provided below:

Drilling Wastes

- Overall much thinner deposits of drilling wastes than predicted were found at each distance from the rig. Drill waste flocs were not spread out as much as the model had predicted, and the drill waste tended to be cohesive and clumped, staying in a narrow pile within 70 to 100-m of the source.

- No tainting or toxicity was found in the survey array close to the platforms (40-150 m), and hydrocarbon levels were consistently very low. Hydrocarbons are detectable at 250-m and 500-m in the direction of prevailing currents at Thebaud and North Triumph but at concentrations approaching background levels.

- Cuttings piles under some rigs lasted longer than predicted; synthetic drilling mud proved very sticky, giving the mounds a plasticine-like consistency and holding them in place.

- Overall, the EIS model overestimated the impact of drilling waste. The input into the model should be adjusted to ensure that the information is appropriate.

Benthic Boundary Layer

- Bentonite-sized particles were not detected in suspended particulate matter extracted from the BBL water samples. The maximum concentration of barium in the suspended particulate matter was two orders of magnitude lower than levels known to cause sub-lethal effects on scallops.

Epifauna and Infauna Communities

- No effect was observed on these communities at any of the survey stations within the Venture, Thebaud or North Triumph fields.

- Video surveys around the platforms show an abundance of juvenile gadoids, mussels and crabs. Colonization of large epibenthic organisms such as starfish, sea urchins, and sea anemones was evident along the exposed portions of the main pipeline. Snow crabs were observed on and along the sides of the gas pipeline and in high densities around the North Triumph platform. Protective mattresses near Thebaud showed numerous sea cucumbers.

Biogenic Hydrocarbons

- Positive odour and taste results were found to be caused by biogenic hydrocarbons occurring naturally in phytoplankton.

Marine Mammals

- Marine mammals observed from fixed platforms were within acoustic range of the sound spectra radiating from the project. Project activities did not seem to affect them.

Seabird Observations

- Flaring has caused no large-scale bird fatalities, and no oiled seabirds on Sable Island contained hydrocarbons attributable to the Tier 1 project.

Monitoring continued at the Tier 1 sites in 2001, although sampling frequency was reduced for a number of parameters. Snow crab sampling began. In 2002, EEM continued, but on a more limited basis. The use of sentinel species was introduced, like snow crab, and, potentially, the Jonah crab found around Venture and Thebaud.

Sampling Design

The initial sampling design consisted of a radial grid with eight axes, with sampling conducted along transects at increasing distances from each platform: 250-m to 20-km. Sampling was initially planned to be carried out quarterly.

Baseline surveys were undertaken in June and July of 1998. Three of the fields were visited: Venture, South Venture and Thebaud, all part of the first tier of gas field development. At Venture, 37 stations were established; the design took into consideration the direction of the currents, toward the Gully. At South Venture there were 35 sites, and at Thebaud 38 stations. There were an additional five Gully sites on the top of the shelf by feeder canyons, not on the slope.

A fall survey in November/December of 1998 collected drilling period data from these three fields, and baseline data for North Triumph. A second drilling survey originally scheduled for February/March was cancelled due to poor weather and the shortage of suitable boats; plans for more winter surveys were dropped. The second drilling survey was conducted in June 1999. Certain parameters, like BTEX, were consistently undetectable. It was noted, however, that BTEX is found in produced water and should be a component of production monitoring.

The main conclusion of the 1998–99 program was that the EIS models considerably overestimated impacts from the discharge of drilling waste. Based on the results of the 1998 and 1999 surveys, trends were identified in the behaviour, distribution, and effects of drilling wastes. A number of issues were re-evaluated as a result: sampling design, water quality, sediment toxicity, and inorganic particle spectral analysis.

Given the evidence of drill waste attenuation along certain axes, sampling location and frequency changes were recommended by SOEP consultants for drilling and operational monitoring in 2000:

- Eliminate far-field minor axes (no significant difference was found)
- Add an extra 500-m to minor axis to improve resolution
- Maintain far field 15-km stations at Venture, and 20-km stations at North Triumph and Thebaud as reference stations
- Eliminate far field stations at 6-km, 7.5-km, and 10-km.
- Maintain 36 to 24 stations at Venture (plus 5 Gully stations)

- Maintain from 39 to 26 stations at Thebaud
- Maintain 38 to 26 stations at North Triumph
- In all three locations, focus sampling within 3-km.

This strategy was said to meet both statistical power analysis requirements, and a recommendation of randomized sampling within a ring which does not give directionality. In 2001, a radial survey array was established for Venture, Thebaud, North Triumph and a remote reference site.

Water Quality and BBL

Water quality issues included:

- Does the BBL flocculate occur in pre-drilling conditions?
- Can BBL flocculate be consistently identified and sampled with existing and available technology?
- What is the spatial and temporal extent of BBL flocculate after drilling operations?
- Has the BBL transport modeling in the EIS accurately predicted the spatial and temporal extent of BBL flocculate?

A baseline program in summer, 1998 analyzed BBL for metals, hydrocarbons, and BTEX at each of the sites on each field and the Gully. An important question was whether barium could be used as a tracer for drilling mud; baseline indications were that barium was randomly scattered around all of the sites. As well, concerns were raised that barium is heavier than other fractions of suspended material and its distribution might not reflect that of the drilling waste as a whole.

An important issue throughout was the validation of the **bblt** model, which predicts drilling waste concentrations with distance. Sample locations were selected on the basis of model predictions.
The model predicted that:

- Drilling fines would be carried significant distances at a relatively high concentration (7-mg/L of suspended solids).
- At the Venture and Thebaud fields, for a one-week discharge of SBM, a concentration of 7-mg/L would extend 10-15-km from the discharge.
- Under the conditions of a continuous daily release model scenario, a concentration of 0.1-mg/L of drilling mud fines (measured as barium) would be found 5-15-km from the discharge.

Water quality sampling was completed in fall of 1998 and summer of 1999 at the surface, mid-water and near-bottom at 250-m, 500-m, 800-m, 1000-m and 2000-m along the prevailing current direction. Analyses were undertaken for Total Suspended Solids (TSS); Chlorophyll *a*, Benzene, Toluene; Ethyl Benzene, Xylene (BTEX); and C_6 - C_{32}.

Measurements from the first survey indicated that TSS values were lower than predicted by an order of magnitude. No plumes were visible, and fine particulates settled out at Thebaud within 500-m of the platform. Although not entirely clear, it appeared that the **bblt** model predictions had assumed a continuous discharge of drilling wastes. It was assumed that since suspended particulate matter (SPM) was being measured it must be continuous discharge rather than repeated bulk discharges.

Questions were raised in SEEMAG discussion about the relative merits of continuous water quality monitoring versus tracking of the plume from bulk discharges of WBM. It was agreed that while the model had to be tested, it may eventually be determined that the water quality testing is not worth continuing and that monitoring effort should focus on tracking of the bulk discharge plume. It was also noted, however, that water quality cannot be ignored because of its potential impact on fish.

SEEMAG recommended in November, 1999, that:

SOEI should revisit the **bblt** model to:

- ensure it is up to date,
- clarify whether the model parameters assume bulk or continuous discharge conditions,
- ensure it takes into account the use of SMB and WBM rather than OBM,
- includes produced water, and
- see how much it over-predicts the outcome and whether more realistic results can be obtained.

It was noted that the **bblt** model had undergone further development since the version used for the SOEP EIS. Changes affected the biological interpretation and understanding of sediment rates.

At the same meeting, SEEMAG also recommended that SOEI should evaluate linking water column, BBL and sediment samples in time. SOEI should re-examine the 'snapshot' sampling approach for water quality and determine whether it is worth continuing in the next round of monitoring. There were several conclusions: (1) it would be improved by collecting information about concurrent operational activities, and (2) it only seemed to provide useful information for hydrocarbons in the sediments.

In May of 2000, it was reported that the periodicity shown in the **bblt** tables was tidally-related, and that the key determinant in drilling waste distribution was more likely settling velocity than how drilling waste was released. The model may be overestimating the sedimentation rate; if sediments stay suspended they would not show up in the BBL. The model was designed to give conservative but credible values and not to reflect storm driven environments, which affect the results for shallow water. The monitoring results show that the modeling does not reflect reality, especially in terms of distance from the rig, and the model should be re-examined for Tier 2 monitoring.

It was recommended in 2000 that water quality sampling be reconsidered. No discharges, even of WBM, were planned after January 2000. In 2001, the BBL program became annual, rather than semi-annual, after three years of study had resulted in next to no evidence of drill waste muds.

Sediment Chemistry

A baseline program in summer, 1998 analyzed sediment baseline chemistry for metals, hydrocarbons, and BTEX at each of the sites on each field and the Gully. Grab samples were used; local sediments were very compacted, and a heavy sealed sampler was needed. The challenge was to ensure that the sample did not wash out, losing the flocculant. THC and barium contamination reduced over time at the 250 and 500-m sites, reaching background in 2001 at Venture and North Triumph, although Thebaud still showed some residual elevated THC and barium.

In 2002, sediment chemistry was limited to TPH and barium. Thebaud showed elevated TPH and barium at 250-m, reflecting recent drilling activity, and elevated barium was found at 250-m at North Triumph. Venture samples remained at background levels for both. Overall, much thinner deposits of drilling wastes than predicted were found at each distance from the rig. Drill waste flocs were not spread out as much as the model had predicted, and the drill waste tended to be cohesive and clumped, staying in a narrow pile within 70 to 100-m of the source.

The cuttings piles had different textures, apparently due to the use or non-use of SBM. For example, the cuttings pile at Thebaud, where SBM was used, had a plasticine texture and appeared almost like an artificial reef. It persisted into 2001. The Venture cuttings pile was similar, but persisted even longer, into 2002. It had a decidedly plastic texture, and was covered by protective mattresses. Cuttings of this type may not have been taken into account during EIS modeling. At North Triumph, on the other hand, drill cuttings were much more friable, and no persistent pile developed.

Piles were sampled and bacterial analysis carried out in 2001 and 2002. At Venture, the cuttings pile persisted, with sulphide-reducing bacteria blanketing the sediment close to the jacket. The cause was unclear. Algal growth was seen on the cuttings, sea cucumbers on the mattresses, and crabs on or by the pile.

Sediment Toxicity

Sediment toxicity samples were taken from grabs and submitted to Microtox™ tests. Echinoid fertilization and amphipod survival studies were also undertaken. Echinoid fertilization was tested using pore water, exposing sea urchin gametes and checking for the percentage of complete fertilization. During baseline studies, positive results were found at a number of stations, for unknown reasons. During drilling, the pronounced toxicity predicted to occur within 150 to 300-m did not generally occur, although toxicity was found at two Venture 250-m stations during the June 1999 sampling period, with a fingerprint match of the toxic substance to SBM. However, recurrent problems were found with echinoid fertilization testing, and it was abandoned in favour of the use of amphipods. Echinoid fertilization tests showed no correlation with obvious drilling waste effects, and in general the suite of sediment toxicity tests required review in 2000. Even the amphipods did not provide sufficiently reliable results on their own, although they were useful as a sentinel species. In 2001, sampling frequency was reduced to annual from semi-annual. No amphipod mortality was seen at Venture in 2001, though there was some at Thebaud, along the prevailing current direction. In 2002, amphipod toxicity testing continued, with ammonia and sulphide used to establish cause and effect linkages. Amphipod mortality was found at 250-m and 500-m at Thebaud; no correlation was found with natural ammonia.

Body Burdens

There were no scallop beds in the drilling area, so caged mussels were used for monitoring close to the drilling sites. However, baseline work was carried out on scallops taken from sites north of Venture and south of Thebaud, and at a reference site on Middle Bank. Scallops were analyzed for taint and HC body burden, and some for metal content. No taste difference was found between the samples and a control bought at the Atlantic Superstore. The only odour difference found was between the reference site and Thebaud, thought to stem from the release of dimethyl sulphide due to excessive phytoplankton ingestion. Arsenic, mercury, and cadmium were found at significant levels, but no HC.

In August of 1998, shellfish mooring sites were installed in a progression out from the drilling site, e.g., at Venture at "ground zero", 500-m, 1,000-m, 2,000-m, 4,000-m, 10,000-m, and 15,000-m, stopping when the water depth increased beyond 60-m. Mussels were set out on the moorings. On each one, two sediment traps were installed to catch any flocculant, and a turbidity meter to tie in storm event and sediment transport data. However, the mussel moorings proved to be highly susceptible to loss through vessel interference; for example, only three of eight baseline sets were retrieved in summer of 1998. This loss of gear proved to be an ongoing problem for tainting evaluations. As well, sand tended to inundate the bottoms of the cages if the moorings were left in place too long.

Concentrations of HC detected in mussel tissues were not solely attributable to SOEP HC releases. The highest concentration of aliphatic HC in the base mud oil region was 3.04-mg/L, at 500-m sites. However, flavour and odour was found to be no different from the control samples or those from other sites. In general, finding any correlation between body burden and sensory tests proved problematic. Data seemed to consistently show taste differentiation at 250-m, very little at 500-m, and none at 1000-m, but taste and odour did not seem to relate to body burden.

The review of Tier 1 monitoring at SEEMAG in April 2001, stated that positive odour and taste results were found to be caused by biogenic hydrocarbons occurring naturally in phytoplankton. However, at Venture between November 1999 and February 2000, a change of flavour was detected that at the time had not appeared to be biogenic; SBM and produced water had been discharged at the time. Pre- and post-spawning mussels taste considerably different, so this may have been a confounding variable. Snow crab were added to the tainting and body burden studies in 2001 and 2002, reducing the focus on mussels and scallops. Instead of separate mussel moorings, mussels attached to rig legs were scraped and analyzed; one mooring was retained at the 1000-m site at Venture.

Hydrocarbons and biogenic hydrocarbons were detected in October 2001 and again in 2002. The Venture platform mussels had high levels of interfering material, and Thebaud mussels showed lower level peaks in C_{12} and C_{17} ranges of the same material as at Venture. No taint was detected. The leg muscles of crab sampled in July 2002 showed *Nova Plus* drill mud profiles. Hepatopancreas showed traces of *Nova Plus* as well as unidentified interfering material in the mussels.

Benthic Habitat and Megafaunal Communities

Benthic video and still photography were used to document conditions around the drilling sites. A periodic survey beneath the Venture rig was undertaken by ROV after significant storms. No evidence of drilling muds was found at 250-m from the Venture and Thebaud platforms. Sediments were clean and of consistent grain size at each of 250-m and 500-m axis stations.

At the review of Tier 1 EEM at the SEEMAG meeting in April 2001, it was decided to add snow crab surveys around the rigs, to determine whether they were aggregating there, and what effects this might have, particularly on females. Crab traps were also set at North Triumph.

It proved difficult to evaluate possible changes in benthic diversity; it was hard to measure diversity, and annual sampling did not allow definition of spatial change. North Triumph and Thebaud appeared to have some variability, and diversity was limited at Venture when assessed in 2001. A survey in 2002 detected no significant effects on the benthos beyond the cutting pile.

Marine Mammals

Some noise measurements were carried out via subsurface hydrophones with 10-day storage capacities. The hydrophones were put in place in 1998 just before pile driving began. Detectors were saturated at the nearfield receiver. At two km from the source the peak reading had attenuated to 155 dB, slightly below the threshold for detectable behavioural response of whales, 160 dB. At the far-field, the level was 110-140 dB, just above background of 105-110 dB, but below whale behaviour threshold level. The zone of impact appeared less than two km; noise attenuated faster than the model had predicted.

The model was refined, and additional noise data collected during two jacket installations confirmed the new accuracy. The area of influence on mammal behaviour did not extend beyond 0.5-km from the pile-driving site. Measurements at the Gully, 20–30-km, showed that the noise was detectable, but probably below levels that would affect behaviour.

Observation platforms were set up on the *Rowan Gorilla II*, MV *Magellan Sea*, the helicopter, *Seipem 7000*, and *Galaxy II*. The best sightings came from the *Rowan Gorilla II* and *Galaxy II*. Cetaceans and pinnipeds were observed close to the platforms. Single and social groups of whales were seen, some with calves. A pod of minke whales seemed to be using the platform to concentrate prey for hunting. The platforms did not seem to be detrimental to marine mammals. Daily monitoring and recording of marine mammal observations continued through 2002.

Sea Birds

Observations were made during drilling in 1998 and 1999 from three platforms, one at Venture (*Rowan Gorilla II*), and two at Thebaud (*Seipem 7000* and *Galaxy II*). The data were consistent for the three locations. Four or five species of gulls represented 90 to 98 percent of the sightings. It was hypothesized that the lights might have attracted the gulls, but no conclusion was reached as to whether sightings represented a concentration of birds or not. Some land-based birds were also observed. The number of species varied from 20 at *Seipem 7000* to one at *Galaxy II*. Daily monitoring and recording of seabird observations continued through 2002.

3.1.2. Cohasset Panuke

The Cohasset Panuke (CoPan) program was initiated by EnCana, formally PanCanadian, in 1989, and was completed in December 1999. The EEM program for this project focused on benthic communities, oiled bird and debris surveys of Sable Island and shellfish tainting. The methodology for the program included grab samples to examine the benthos, and surveys on Sable Island; however, only the shellfish tainting methodology has been published. The entire EEM project ran for seven years. The shellfish tainting study used a gradient approach. Two mussel buoys were deployed at each of 250-m, 500-m, 1000-m, 1500-m and 10-km from the rig. One buoy was placed 10-m above the seafloor and one 10 below the sea surface. Testing for qualitative and quantitative effects was completed at an independent lab two to four times a year.

Oil-based muds were used during CoPan drilling. Some tainting effects were detected in mussels, but were limited to within the 500-m safety exclusion zone. A detailed synopsis of CoPan is not provided here due to its limited relevance to exploratory drilling using WBM or SBM.

3.2. Monitoring Programs for Exploratory Wells

There has only been one exploratory well off Nova Scotia which has had an EEM program in place (H-08). The monitoring program was similar to those designed for production projects, as it was based on VECs and the gradient approach.

3.2.1. H-08

The H-08 well was drilled by EnCana between May and June of 2000. The EEM project was designed to examine chemical, physical and biological features of the seafloor in the areas around the well. The EEM program was carried out during the time of drilling. No data were gathered prior or subsequent to the drilling. Based on the gradient approach, four or eight radia 2,000-m in length and centered on the well were sampled. For comparison, reference stations outside the predicted zone of influence were established.

The emphasis was on testing for a wide variety of potential contaminants, including metals. Tests focused on physical chemistry and cutting piles versus biological analysis. Similar to other EEM results elsewhere, any effects seemed to be limited to within about 500-m of the rig. Fingerprinting of residues also showed some residual Ba detected from Deep Panuke drilling.

3.3. Grand Banks EEM

To date, EEM on the Grand Banks has only been conducted for production developments. Baseline studies have typically preceded the actual EEM. A comparison of the various baseline/EEM studies is contained in Table 3.1. The following sections briefly describe programs for Hibernia, Terra Nova and White Rose. Hibernia baseline data are relevant but were collected a number of years after the initial wells were drilled. It also should be noted that Hibernia is now injecting cuttings and produced water so that there waste streams will be virtually non-existent from now on so that EEM results should be improving for that project. Terra Nova baseline and EEM data were not available to us at the time of writing for this project although we were provided a very brief summary through CAPP. White Rose baseline studies may be the most relevant to the present study because sampling was done after recent drilling activity. Husky kindly provided all necessary baseline data and associated documents for the purposes of this study.

3.3.1. Hibernia

A brief history of Hibernia offshore EEM is encapsulated in Figure 3.1. The study design and preliminary results of baseline studies are briefly outlined below.

Table 3.1. Variables Monitored in Current Grand Banks EEM Programs[1]

Variables	Hibernia Operational	Terra Nova Operational	White Rose Design Phase
Sediments			
Physical/Chemical			
Metals	✓	✓	✓
Hydrocarbons, incl. PAHs	✓	✓	✓
Ammonia and Sulphides	✓	✓	✓
Grain size	✓	✓	✓
TIC/TOC	✓	✓	✓
Toxicity			
Microtox™ screening	✓	✓	✓
Amphipods	✓	✓	✓
Juvenile polychates	✓	–	***to be determined***
Biota			
Benthic Community Diversity	–	✓	✓
Fin/Shell fish Body Burden			
Metals	✓	✓	✓
Hydrocarbons (incl PAH)	✓	✓	✓
Fin/Shell fish Taint			
American Plaice	✓	✓	✓
Scallop	–	✓	–
Crab	–	–	✓
Plankton/ Chlorophyll *a*	–	✓	✓
Fish Health			
MFO induction	✓	✓	✓
Gill/liver Histology	✓	✓	✓
Blood tests	✓	✓	✓
Seabirds/Marine Mammal Observations[2]	–	✓	✓
Water Quality			
CTD/TDS/TSS	–	✓	✓
Hydrocarbons, Total Oil and grease, PAHs, metals	–	✓	✓

Source: Courtesy of D. Taylor, Husky

[1] Note that this listing does not consider potential Spill EEM programs.
[2] Not, strictly speaking, EEM.

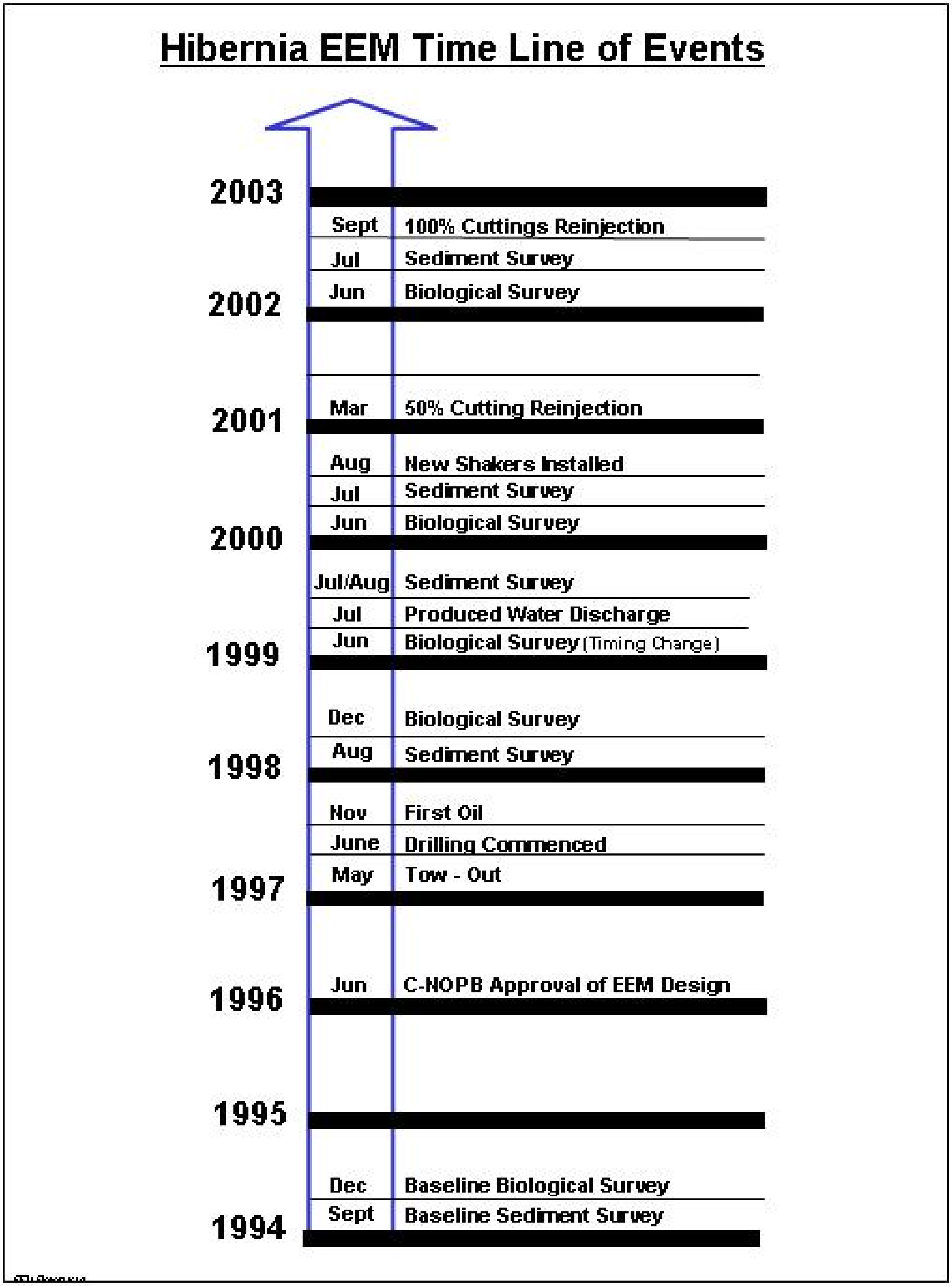


Figure 3.1. Hibernia EEM Time Line.

Source: Courtesy of R. Dunphy, Hibernia.

3.3.1.1. Study Design

Sediment sampling was conducted along eight radii at geometric progressive distances from the GBS and at some random locations (Figure 3.2). Sampling was more intensive close to the GBS. A total of 45 locations were chosen within the concentric circles around the GBS with a maximum radius of eight km. Two 'control' stations were established on the north and west radials at 16-km distance for a total of 47 sediment sampling stations.

Sampling was conducted for the following variables:

- Trace metals (mercury, chromium, copper, lead, zinc, cadmium, arsenic, barium)
- Petroleum hydrocarbons
- Polynuclear aromatic hydrocarbons (PAHs)
- Sediment particle size distribution
- Total organic/inorganic carbon
- Sediment toxicity tests (Microtox™, Toxi-Chromotest™, Amphipod Survival, Echinoid Fertilization (subsequently dropped due to technical difficulties), and Juvenile Polychaete Growth Test)

Sediment was sampled using box cores. Two or three box cores were conducted per station; each one was subsampled three times to create 441 samples. The three subsamples from each core were composited to yield 162 samples for chemical analyses. Material from box core samples was combined to create 54 samples for sediment bioassays. Strategy for the toxicity testing is shown in Figure 3.3.

The biological survey for American plaice (*Hippoglossoides platessoides*) and Icelandic Scallop (*Chlamys islandica*) was conducted within a fishing zone of 500-2,000-m around the GBS and at a reference site 50-km northwest of the GBS. Fishing was not conducted to the south east of the GBS in order to accommodate flowlines and the offloading system. [Note: problems with getting enough of either species; scallops subsequently dropped]. Fish were tested for contaminant body burden and sensory organoleptic analysis (i.e., taint).

Additional detail on methodology and results of the baseline surveys is contained in HMDC (1995) (now publicly available after seven years).

3.3.1.2. Hibernia EEM Results

In some respects, the initial baseline monitoring at Hibernia can be considered a type of check on the effects of exploratory drilling (10-14 years after the drilling) as at least 11 wells were drilled in the area of the baseline sampling. The results of the Hibernia baseline (HMDC 1995) are outlined below.

There were no detectable differences (including statistical) between the GBS and reference ('control') areas in:

- Both lethal and sublethal toxicity testing

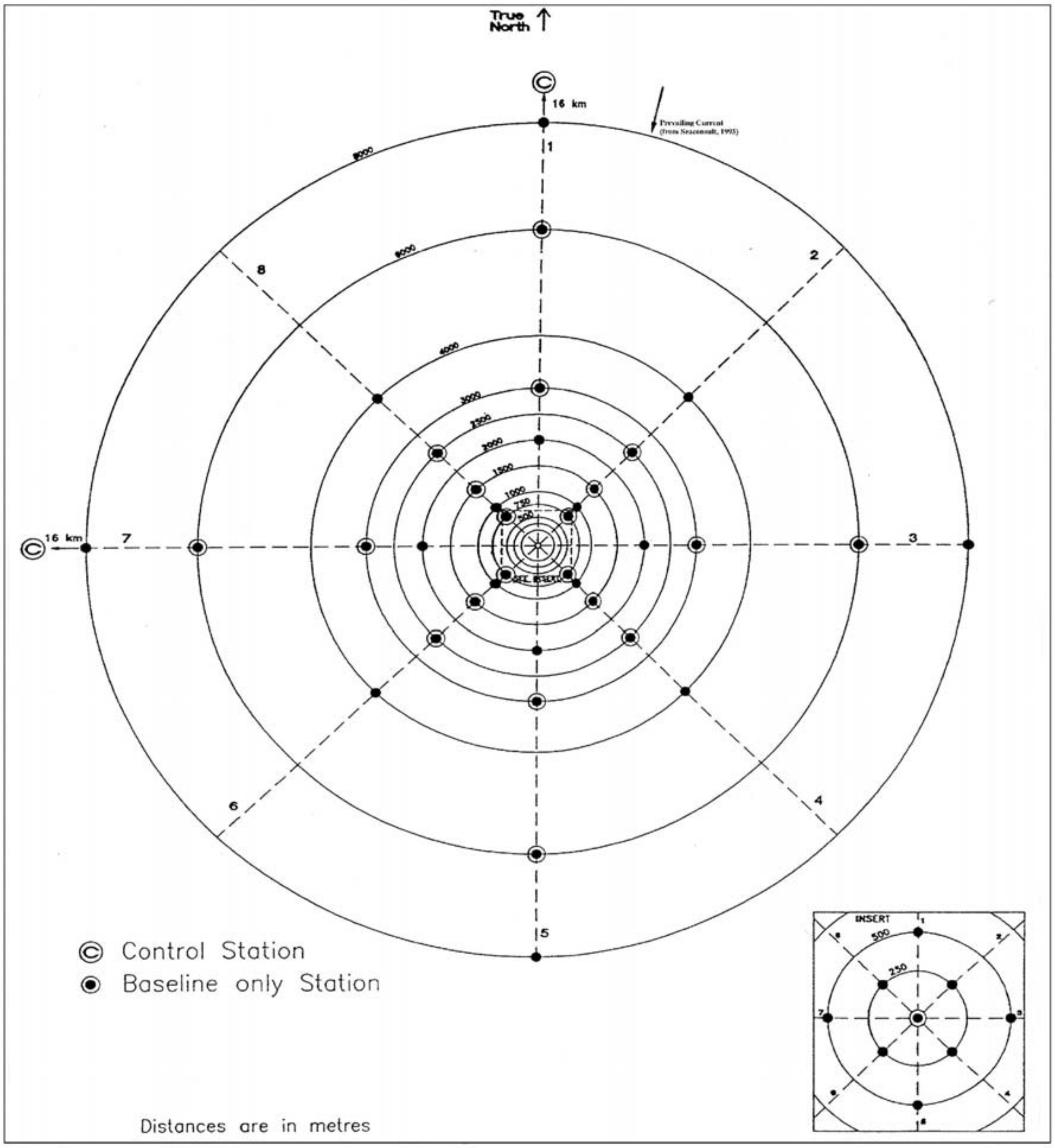


Figure 3.2. Hibernia Sampling Pattern.

Source: HMDC (1995).

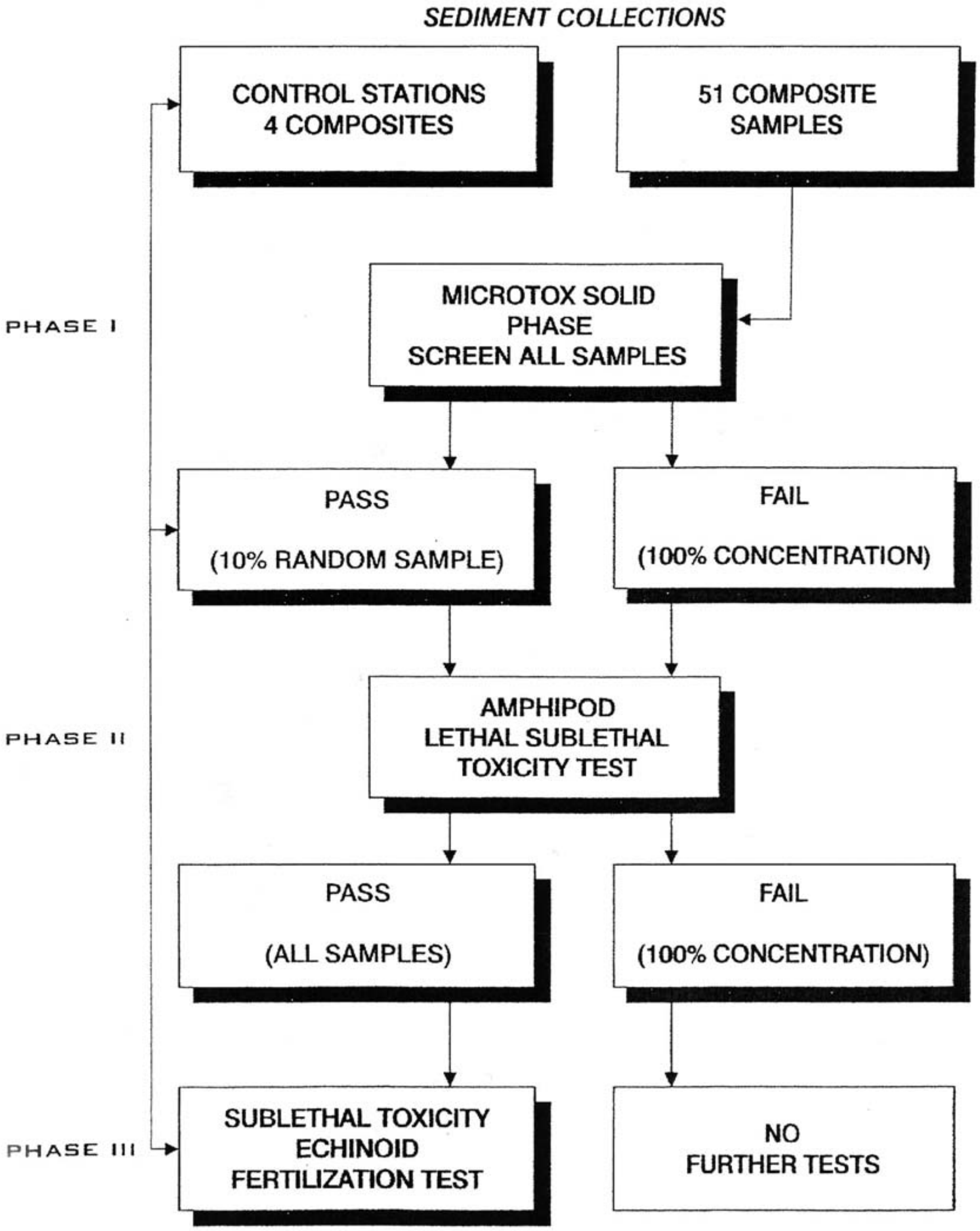


Figure 3.3. Sediment Testing Protocol.

Source: HMDC (1995).

- Tainting in fish and scallops
- PAHs or petroleum hydrocarbons (actually undetectable in both GBS and reference areas at the level of analyses used)
- Contaminant body burdens were generally low for plaice and scallop but insufficient sample sizes precluded definitive statements on body burdens of contaminants.

'Sediment chemistry data show generally low concentrations of all potential contaminant metals. Only two elements, barium and lead, were consistently above analytical detection limits. Slightly anomalous concentrations of barium, lead and, possibly copper were detected at locations 7-2000, and 7-3000' (HMDC 1995). These 'high' values are likely attributable to past drilling activity; for example, the baseline sampling overlies an area where 11 wells had been drilled prior to the 1994 baseline sampling effort. Station 7-3000 is very close to Hibernia Well O-35.

Twenty wells have been drilled from the GBS as of 2000. All upper holes were drilled with water based drilling mud (WBM) whereas 65% of the lower hole sections have been drilled with synthetic based mud (SBM). Hibernia (R. Dunphy, pers. comm.) kindly provided the following synopsis for this period. The EEM program detected elevated barium and hydrocarbons in some sediment samples out as far as 8,000-m from the GBS, but most samples with elevated levels occurred within 500-m of the GBS. Toxicity tests found no acute effects on amphipods beyond 1,000-m and no sublethal effects (as measured by Microtox™ and/or juvenile polychaete growth assay) beyond 4,000-m. There was no significant increase in body burdens of contaminants in American plaice and no tainting was detected. As noted above, Hibernia started 50% cuttings re-injection in 2001 going to 100% in 2003 and thus concentrations of contaminants and any associated effects are expected to decrease.

3.3.2. Terra Nova

The Terra Nova development has planned a total of 24 wells. The Terra Nova baseline and EEM results were not available at the time of writing. The EEM study design is briefly outlined below.

3.3.2.1. Study Design

The basic design is composed of sampling gradients along three transects passing through the drill centres and the FPSO. Stations were placed 250, 500, 1,000, 2,000, 4,000, and 8,000-m from the drill centres in two directions

Variables monitored include:

Commercial species (Icelandic scallop and American plaice)

- Tainting
- Body burden (metals, PAH, petroleum hydrocarbons)
- Health (MFO, liver and gill histopathology, haematology)

Water quality

- Chemical (TSS, metals, PAH, oil and grease)
- Physical (temperature, salinity)
- Phytoplankton (chlorophyll)

Sediment quality

- Chemical and physical characteristics (metals, hydrocarbons, particle size, TIC and TOC)
- Toxicity (sublethal – bacterial luminescence test; lethal – amphipod test)
- Benthic communities (species, enumeration, total biomass) for diversity

Seabirds and marine mammals are also surveyed under a different program (not strictly speaking EEM).

Commercial species are collected within the Terra Nova area and from two reference areas 20-km to the southeast and southwest. Water quality sampling is conducted at four stations around each drill centre and the FPSO. Sediment quality is collected from 50 stations along gradients from the FPSO and each drill centre.

To aid in developing the EEM design, Petro-Canada undertook a Baseline Characterization Program in the fall of 1997 (Petro-Canada 1998 *in* Petro-Canada 1999). The results of this program were as follows.

- Most metals and hydrocarbons were below the limits of quantification (LOQ).
- Sediments were generally non-toxic; some toxicity was observed but this was attributed to natural anoxic conditions at a few stations.
- Benthic communities were patchy and variable in nature, at least partly attributable to substrate characteristics.
- The sediment quality triad (SQT) approach was used whereby synoptic data on sediment characteristics, toxicity, and benthic infauna are analyzed together.
- Water column profiles and water quality variables (few above the LOQ) were similar between the Terra Nova study area and the 'controls'.
- Biological attributes were similar between Terra Nova and controls. Most body burdens were below LOQs and there were no indications of tainting.
- Mixed function oxygenase (MFO) activity was similar between Terra Nova and controls. Fish gills and livers appeared normal in terms of pathology.

3.3.2.2. Terra Nova Results

Sampling for Terra Nova EEM occurred in 1997 (Baseline) (about nine exploration and delineation wells drilled prior to sampling), in 2000 (an additional three development (plus several abandoned) wells drilled prior to sampling), in 2001 (six development wells plus three abandoned drilled prior to sampling), and in 2002 (two or three development wells drilled prior to sampling).

Results (2000, 2001) are summarized below (*per* d'Entremont 2003).

- No tainting detected
- No PAHs detected in sediments, scallops or plaice
- Hydrocarbons (fuel range) and barium in sediments slightly higher near drill centres but still orders of magnitude lower than those required to cause biological effects. No detectable other physical or chemical effects on sediments.
- Slightly elevated hydrocarbons and barium in scallops near development. No other metals elevated in scallops or fish.
- No Terra Nova hydrocarbons detected in plaice
- No differences in fish health variables, water column, or phytoplankton biomass between development site and reference sites
- Benthic community structure appeared similar between baseline and 2000 but slight change in 2001
- Overall EEM results similar to baseline

3.3.3. White Rose

Husky has not yet conducted an EEM program for White Rose because production has not yet begun and thus the EEM design has not yet been finalized. Husky conducted a Baseline Characterization Program in 2000 (Husky 2001b; Husky 2003b) that had many of the components likely to be in the final design. The White Rose baseline results are highly relevant to the present study because much of the sampling was conducted amongst recently drilled wells (Figures 3.4 and 3.5).

3.3.3.1. Study Design

The White Rose study design included a series of grids centered on the future FPSO location and proposed glory hole locations. A total of 50 stations were used for sediment sampling (Figure 3.5). [Note there appear to be discrepancies in the report where the text states 50 or 48 stations, their Figure 2-1 shows 46 stations, sediment toxicity is reported for 48 stations and their Appendix A lists 49.] Sediment sampling included variables for physical, chemical and biological characteristics. Sampling was done using a box corer. One sample was analyzed from each station.

American plaice and snow crab were collected by trawl from the White Rose study area and the northwest reference area (plaice only in 2000) in 2000 and 2002 (Husky 2001b, 2003b). These samples were used to analyse body burdens, histopathology, MFO, tainting and other biological variables.

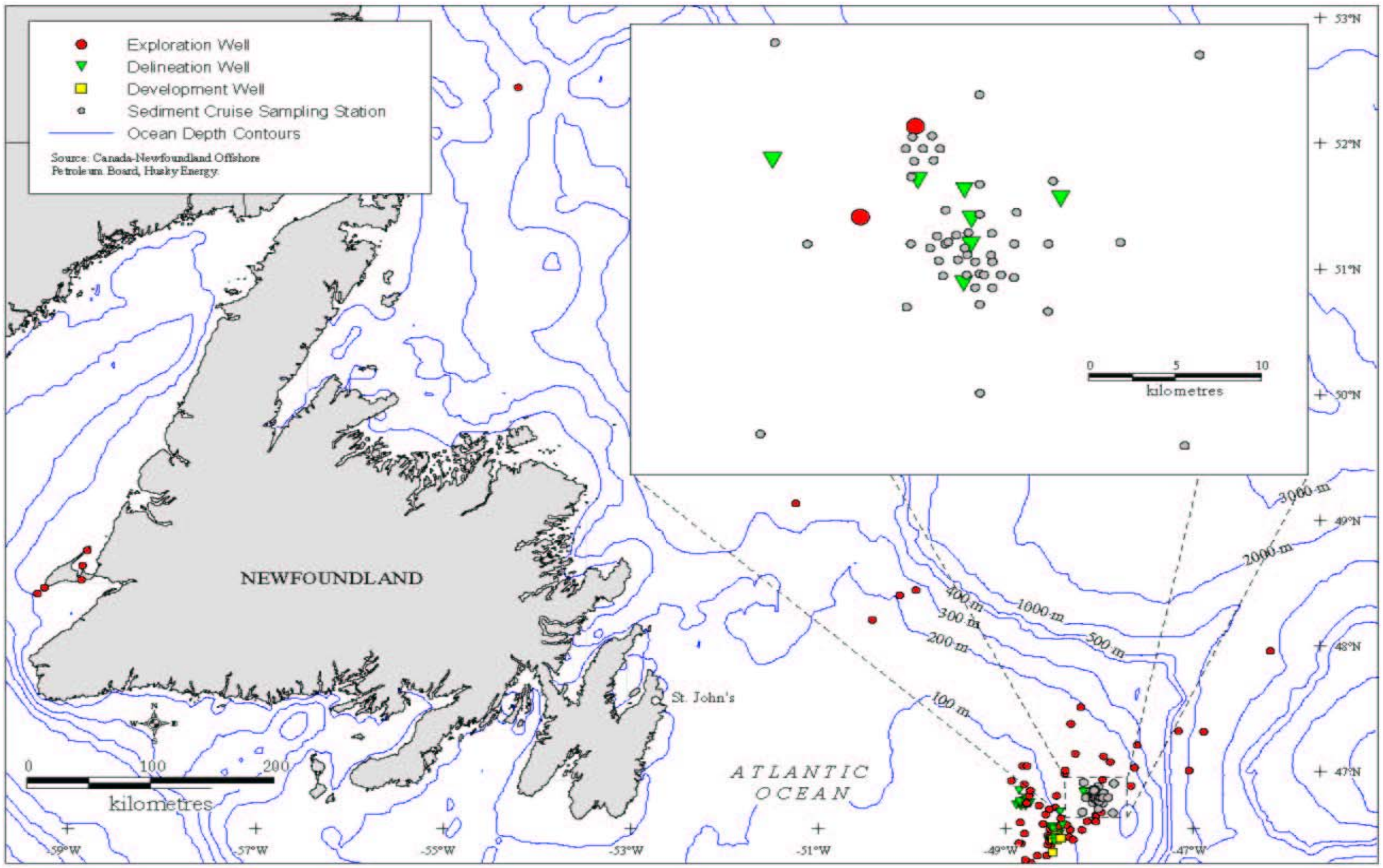


Figure 3.4. Locations of White Rose Wells and Baseline Sampling Stations.

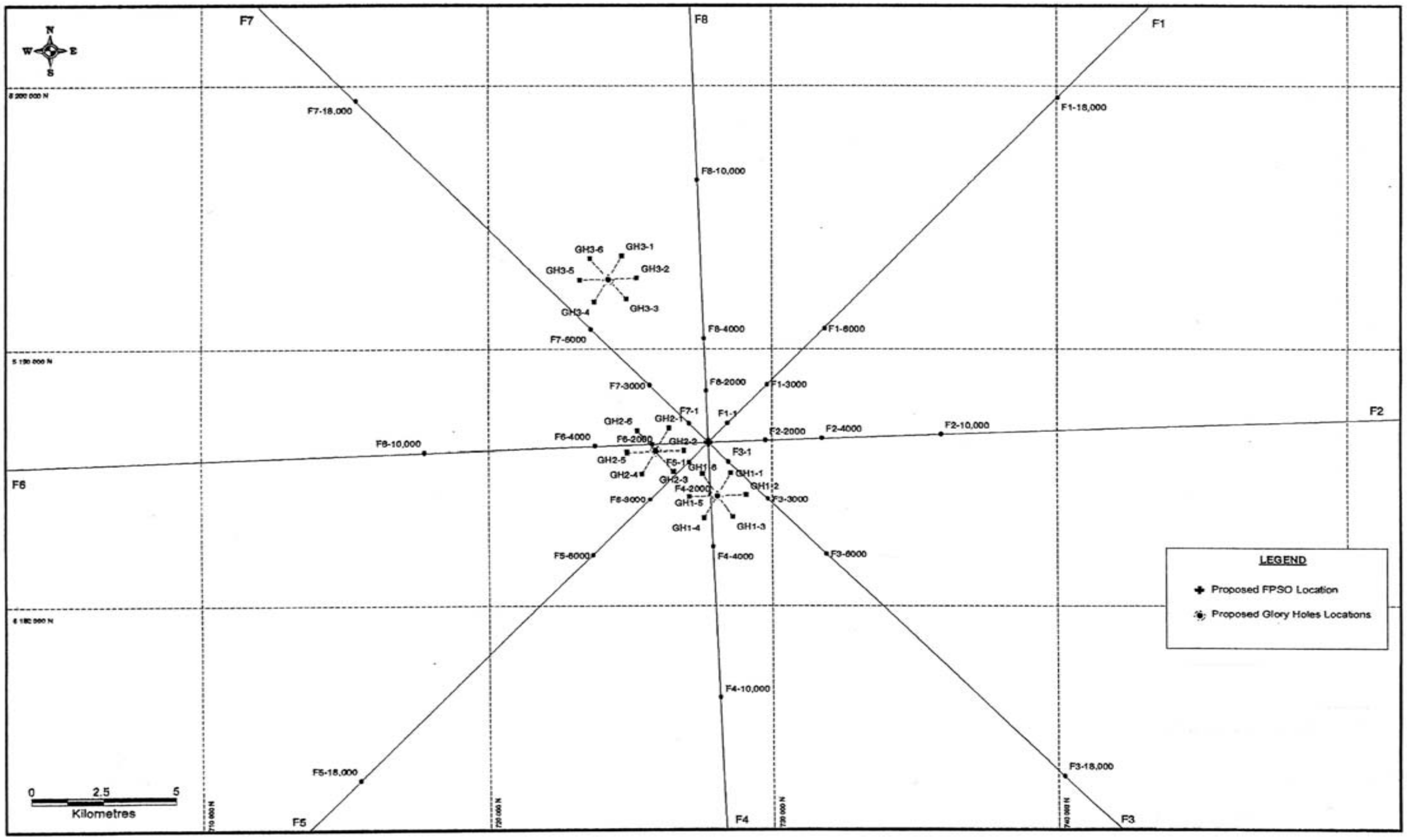


Figure 3.5. White Rose Sampling Pattern.

Source: Husky (2001b).

Variables included:

<u>Sediments</u>
Particle size
Chemistry (metals including barium, PAH, TPH, and oil and grease; TIC, TOC, TC)
Toxicity (amphipod survival-lethal, bacterial luminescence-sublethal)
Benthic infauna (determined species present, abundance, total biomass; subsequently analysed for number of organisms per station, wet weigh of invertebrates per station, number of taxa per station, species diversity, and community composition)

<u>Water Quality (at 25 of 50 stations)</u>
Temperature
Salinity
Oxygen
pH
TSS
Metals
TPH
Oil and grease
PAH
Chlorophyll

<u>Fish Health (American plaice and snow crab)</u>
Body burden
Tainting (plaice only)
Histopathology and MFO (plaice only)

3.3.3.2. White Rose Results

3.3.3.2.1. Sediment Quality

Sediments were primarily sand with some gravel; silt and clay generally accounted for less than 1% of the sediment and TOC was low in both the study and reference areas (Husky 2001b). PAHs were not detected above the LOQ in any sediment sample. The only hydrocarbon above the LOQ (ELQ) was naphthalene. Metals above the ELQs included aluminum, arsenic, barium, chromium, cobalt (not in NW reference area), iron, lead, manganese, nickel (not in NW reference area), strontium, thallium, uranium, vanadium, and zinc. Not surprisingly, concentrations of most metals, including barium, were higher in the finer sediments with higher organic content. Water depth and distance appeared to be more important than direction although depths and direction were confounded to some degree, particularly in an E-W direction. In spatial regressions, only water depth effects were significant for % fines, which increased with depth. There was high variability with the other physical and chemical characteristics around the glory hole locations even though depths were similar. TOC was not affected by any of the spatial variables.

Barium concentrations significantly increased with increasing depth and from south to north, and decreased with distance from the FPSO location and from west to east. Concentrations are shown in Figure 3.6.

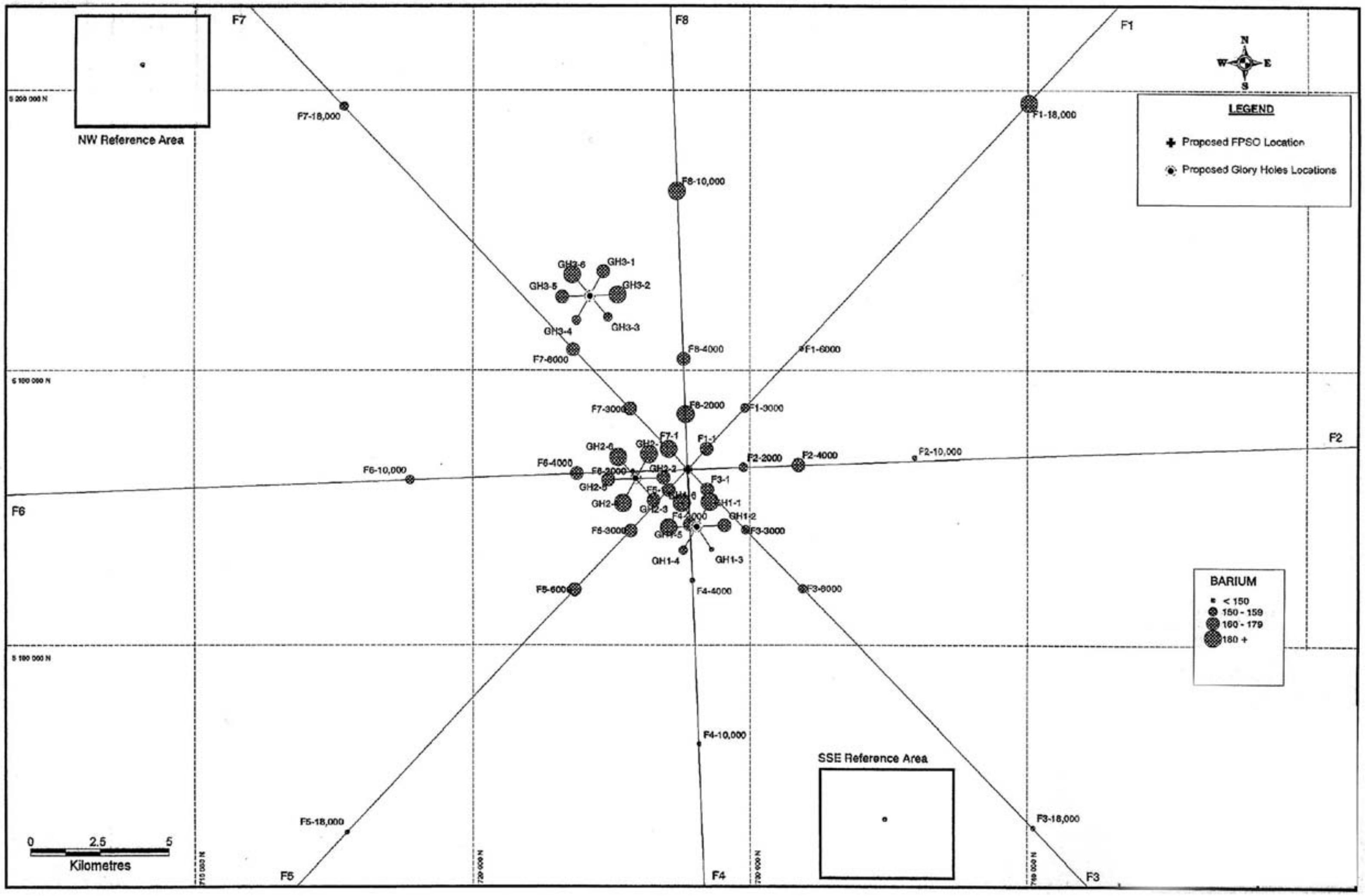


Figure 3.6. Barium Levels in Sediment for White Rose Baseline Characterization Program 2000.

Source: Husky (2001b).

Based on the amphipod toxicity test (acute lethal test) and the Microtox™ test (sublethal test), none of the sediments tested could be considered toxic. Lowest survival rates in the amphipod test tended to occur around the glory hole locations.

3.3.3.2.2. Water Quality

Water quality results were variable and no noteworthy trends were apparent. There were no differences between the reference and study areas in structure of the water column.

3.3.3.2.3. Infaunal Communities

Infauna was diverse (63 families) but dominated by polychaetes which accounted for about 80% of the organisms collected (excluding oligochaetes, nematodes and nemerteans). Communities at the reference areas were different than those in the study area. In general, there was a high degree of variability among all benthic infauna variables except standing crop. The effects of distance and direction from the future FPSO site on benthic infauna variables were stronger, and water depth effects weaker, than for sediment physical and chemical characteristics (Husky 2001b).

3.3.3.2.4. Body Burdens

Body burden analyses were based upon relatively few composited samples (only 3-5) with varying numbers of animals per composite. With the exception of manganese, arsenic, cadmium, copper, iron, manganese, mercury, selenium, and zinc were present in all samples of plaice livers. Arsenic mercury and zinc were found in all plaice fillets, and, metal concentrations, with the exception of mercury, were generally higher in livers than fillets.

Arsenic, boron, copper, mercury, selenium, strontium, and zinc were found in all snow crab leg samples. Cadmium and silver were detected in two samples in 2000.

In general, results were similar between the study area and the reference areas although strontium was very high (relative to other samples) in a snow crab sample from the Northwest Reference Area.

3.3.3.2.5. Tainting

Tainting as tested by taste panelists was not detected in any samples from the study area or the reference areas.

3.3.3.2.6. Fish Health

In general, the fish health component of the study documented background levels for external lesions, histopathology, and hepatic MFO. Several fish were noted to have lesions potentially indicative of contaminant stress (Husky 2001b).

3.3.3.2.7. Important Conclusions

Conclusions included:

- NW reference area sediments were found to be quite different from the study area and were excluded from much of the analyses. This station should be dropped.
- For the most part natural variability can be accounted for in subsequent samplings.
- Many sediment characteristics varied widely even at the closest (1-km) stations. Particle size and TOC had least amount of variability.
- Number of stations (46-50) appeared to be adequate.
- Sufficient numbers of organisms and taxa were collected per core to conduct statistical analyses. Replicate cores are not required for benthic analyses if stations are considered as replicates. Increases in power decrease rapidly for sample sizes greater than 20, and particularly after 50.
- Numbers of body burden samples may have been too small; need at least five samples per area. Fish health work should be conducted on the same specimens, if possible.
- The SQT approach looks good, as there were no 'false positives.'
- Water quality sampling was of limited utility.

4.0 East Coast Issues

4.1. Issue Scoping

Informal interviews and meetings were held in Newfoundland and Nova Scotia with a variety of interested parties, including representatives from the regulatory sector, offshore oil and gas industry, fisheries associations, NGOs, and scientists. Interviews focused on three main issues:

- Is EEM required for drilling a single exploratory well off the East Coast? If so, under what conditions? If not, under what rationale for exclusion?
- What are the key variables/issues?
- Any study design suggestions?

Detailed results and analysis are presented in Appendix III. The results of the interviews were quite different for Newfoundland versus Nova Scotia; this section reviews the main themes that arose, and the commonalities and differences between the regions.

4.1.1. Newfoundland

Discussions in the Newfoundland region focused on 29 issues, some of which overlapped. Issues raised by participants fell into several general categories:

- Overall monitoring program design issues;
- Site-specificity of monitoring design;
- Logistics and efficiency, and
- Public policy concerns.

Most issues, discussions and suggestions in regard to a study design for exploratory EEM were general, as opposed to specific scientific recommendations.

There was an overall sense that the present EEM programs were well designed and were providing useful information on the effects of the producing developments at Hibernia and Terra Nova. Respondents thought that production EEM program designs were good starting points for exploratory drilling EEM, if it were to be conducted at all.

There was agreement that local environmental conditions, particularly water depth, currents, and the presence of corals, must be considered in any offshore EEM program. Any critical habitats should be identified during the EA process and avoided. If they cannot be avoided, then the EEM program should be enhanced as appropriate.

Similarly, site-specific drilling scenarios need to be considered in the design. For example, while different rig types have generally similar discharges their depth of discharge may vary. Also, ‘jack-up’ and semi-submersible rigs emit less noise than drill ships. The type of drill mud (water-based vs. synthetic) used may affect the distribution of potential contaminants and hence should influence the sampling design.

Most participants felt that monitoring program design should be flexible to account for unforeseen events. Flexibility may be a more important issue for exploratory EEM rather than production, because of the much shorter lead times.

Opportunistic bird and mammal surveys presently being conducted from supply boats at Hibernia and Terra Nova were viewed favourably, although most agreed that they are not, strictly speaking, EEM but rather general survey data. It was, however, pointed out that such data are of limited use unless they are publicly available and analyzed and interpreted into useful reports. Virtually every non-industry person stated that the EEM data should be available to the academic community, industry researchers, EA practitioners, and the general public much sooner than the now regulated under the *Atlantic Accord* five-year confidentiality period.

The suggestion that cumulative effects be considered under the auspices of exploratory EEM is also one that warrants discussion; one well may have little or no effect but a large number of them might, depending upon timing, local conditions, and other factors.

4.1.2. Nova Scotia

Most interviewees agreed that EEM programs should be a routine part of offshore drilling, whether for exploration or production. However, there were sharp difference among them regarding the reasons for monitoring, conceptual design, funding, and program implementation and interpretation. These differences were not merely between sectors, but also between individuals and organizations within the different sectors.

Most, but not all, agreed that environmental concerns are lower for exploration drilling than for production platforms. They saw the wells as having little or no effect, especially in the long term and when located in habitats with few or no sensitive features. Those who held this view agreed that conceptually, EEM should focus on looking for real consequences. The EEM projects need to be species and site-specific, ideally monitoring different trophic levels.

However, some interviewees feared that exploration wells could have serious environmental effects, particularly when considering cumulative impacts. Many of these respondents felt that EEM requirements should be the same for exploration wells as for development platforms.

Some respondents urged a decision tree approach to designing monitoring programs, keeping options flexible to reflect local conditions. Several felt strongly that efforts had to be geared toward the scale of activities, with less detail expected for exploration wells than for development platforms.

The C-NSOPB would like to see a class screening approach to exploration drilling, rather than a comprehensive study required for every well, and good EEM data are required to satisfy *CEAA* that this would be an acceptable approach. As well, a number of government, industry, and academic respondents thought there was considerable merit in the idea of implementing full EEM programs at several sites on the Scotian Shelf and Slope that represented common habitat types; other wells in similar habitats would then rely primarily on the representative site results. However, others from the same sectors felt strongly that monitoring had to be entirely site-specific, and full programs were needed for each project.

Most respondents agreed that a major function of EEM was to test predictions made in an EA; many of these also stressed the need to verify modeling predictions. A few, however, thought it should go beyond, and comprehensively survey outputs and effects, even if these were permissible under the *OWTG* or had not been judged to be of concern in the EA.

There was a basic disagreement between those focused on identifying and monitoring discharges, and those who were concerned primarily with the biological effects of discharges. Some NGO, fishing, and scientific respondents wanted everything that a rig discharged monitored for fate and ecological effects; others thought this unnecessary. Industry, in general, was of the opinion that monitoring had to go toward verifying EA predictions, and document once and for all the levels and severity of impact of exploration drilling.

One DFO scientist strongly argued that identifying impacts on organisms, and then figuring out what is causing the impact, should be the primary focus of EEM. A number of other respondents concurred that the existing focus for EEM has been, and is, on measuring contaminant levels rather than biological effects; there is a need to develop effective technologies to assess the latter.

Numerous respondents insisted that any environmental data collected from industry monitoring programs should be shared and released to the public. Some industry representatives raised concerns about confidentiality and expense, as well as how to manage data distribution.

The existing offshore EEM programs for oil and gas projects have been designed to examine the VECs identified during the EA process, while also taking into account those concerns expressed by the community. Monitoring programs that were most successful, with accepted results, were those that had baseline data to measure against.

A number of respondents raised concerns about cumulative impacts, and how to identify interactions between projects. It was stressed that the offshore oil and gas industry should not be taken in isolation, but cumulative and regional impact analyses needed to include shipping, fishing, and research as well.

Benthic effects were generally seen as most important, although other issues commonly raised were impacts on marine mammal, bird mortality/attraction, impacts on finfish, and air quality. Most agreed that concerns about toxicity of drilling wastes were at a lower level now than in the past, although there remain questions about the effects of synthetic muds.

Most respondents agreed that there were differences between monitoring in deep water versus shallow water sites. Some potential monitoring elements for deep-water sites include amounts and distribution of cutting piles, and biological effects from drilling. Instrumentation development is a real issue for deep-water sites, as are good models for sediment transport. At shallow water sites, wastes accumulate or reach shorelines more easily, depending on oceanographic conditions.

Sediment sampling and chemical analyses, while expensive, are probably the easiest monitoring methods to establish changes to the seabed. However, is it the most effective at establishing actual resulting impacts? It was strongly suggested by several respondents that the use of bivalves in cages on the seabed, with an appropriate local indicator species, was the preferable way to identify biological effects. Cages should go down before drilling starts and come up when done; "EEM should be kept that simple unless effects are seen," urged one scientist.

Even those who strongly believed impacts on fish should be monitored had difficulty suggesting concrete methods that would be successful in establishing effects. Some felt that reviewing water quality around an exploration rig would help identify any impacts on fish. Some suggestions for monitoring sub-lethal fish impacts were: tissue chemistry studies, histological analysis, the use of tracers in drilling fluids, assessment of condition before and after, analysis of population age at the site, and fecundity and age size.

Testing of the assumption that birds and marine mammals are attracted to rigs could use a simple program taking advantage of the helicopter supply runs, one respondent suggested. Each run could be varied by direction to the rig; time of day and sea bird/mammal counts could establish if the rigs act as attractants.

One academic scientist strongly urged carrying out comprehensive ROV surveys and other baseline work for every well, following protocols of Kostylev et al. (2001).

Respondents concurred that statistical validity is absolutely crucial to EEM. It was suggested that revisiting sites after a year (and, if effects were detectable, after two) would be useful to accurately determine if there were long-lasting effects.

An offshore oil and gas industry respondent suggested that fishing activity and catch rates could be monitored by keeping in touch with area fishermen by radio while drilling proceeded.

One NGO respondent strongly believed that the essence of environmental concerns on the offshore centered around the license-issuing process, and the quality – or lack thereof – of the Strategic Environmental Assessments. NGO respondents raised the Gully as a particular concern, suggesting that permanent monitoring sites should be established in it to pick up sediment transport, if any.

5.0 Comparisons: Newfoundland and Labrador vs. Nova Scotia

It is difficult to directly compare the issues as they are perceived in Nova Scotia versus those in Newfoundland and Labrador for a number of reasons. The interviews and meetings were intentionally informal and unstructured, which is good for soliciting input but also means that care must be taken in weighting one issue over another. Furthermore, in the interest of cost efficiencies and local knowledge, different people conducted the interviews in the two provinces.

There are also obvious differences in demographics between the two regions and important differences in environmental conditions and development scenarios. Nova Scotia to date has developed gas mostly in shallow water using 'jack-up' rigs whereas Newfoundland has developed oil at moderate depths using the Hibernia GBS, semi-submersible drill rigs, and FPSO's. However, development scenarios may be moving into deepwater in both locations. Nonetheless, it is worthwhile to reflect somewhat on the differences and similarities between the two regions.

5.1. Some Differences in Perceived Issues

There were, of course, differences between respondents in their perceptions of the issues and of the best species to monitor. These differences appeared to be much more pronounced in Nova Scotia than in Newfoundland and Labrador. Without putting too fine a point on the differences between the different regions, there appear to be the following differences in regard to exploratory drilling EEM.

- **Emphasis on benthos.** Both regions agreed that benthic environments are key in monitoring the effects of offshore oil and gas because of likely contaminant pathways, relative sedentary nature of benthos, and relative ease of sampling. Fate and extent of cuttings piles, barite residues, and hydrocarbon levels were mentioned by many. However, there appeared to be much more emphasis on benthic monitoring for exploration wells in Nova Scotia. This was evident in concern for effects of barite, the benthic boundary layer, deep sea corals, and so forth (see below).

- **Emphasis on fish.** In general, the Newfoundland Region appeared to place more emphasis on fish and related issues than Nova Scotia. In Nova Scotia, there is, and has been, more emphasis on shellfish. There has been considerable study on scallops and monitoring programs have used scallops extensively; at least one project used caged mussels extensively.

- **Degree of monitoring.** While there was a wide range of opinions in both areas, there was a wider range in Nova Scotia and two clearly defined groups: (1) the 'monitor everything' group, and (2) the 'monitor select variables' one. In Newfoundland, individuals and groups appeared more focused and no one advocated monitoring everything.

The generally higher interest in benthic issues in Nova Scotia is at least partly attributable to differences in substrate, water depth, and water current regimes. In addition, the shellfish industry (excluding crab) is significantly more important off Nova Scotia than off Newfoundland. Demographics and research interests of individual scientists also undoubtedly played a role.

5.2. Some Similarities in Perceived Issues

Some important common points of view found in both areas are listed below.

- **Level of concern with exploration drilling**. Although there were some exceptions, most people had a much lower level of concern for the environmental effects of a single exploratory well than for a production development.

- **Assurance monitoring.** While some argued strongly for extensive statistical work, there still was a common thread that most people wanted some level of reassurance that a specific site was not being unduly affected. A number of people suggested some camera drops and some grab samples might be enough to accomplish the goal of providing a suitable level of comfort.

- **Testing EA.** A number of participants suggested that one of the key functions of a monitoring program is to test predictions, and in some cases modeling, that were conducted during the EA process. A potential corollary of this attitude is the suggestion by some that one or several wells should be selected as 'test cases' and monitored possibly in aid of a Class or Generic EA approach. This would provide rationale for including or excluding monitoring variables for future individual wells.

- **Biological effects**. With some exceptions, most felt that any monitoring programs should focus on biological effects as opposed to simply 'shopping' for increases (however slight) of potential contaminants.

- **Birds and mammals**. Many agreed that there were potentially important issues in regard to marine birds and mammals. However, it was also pointed out by a number of people that routine surveys conducted from the rig or supply boats do not necessarily constitute any monitoring of effects *per se*.

- **Site specifics.** Local and site specific issues must be considered in the design and conduct of any EEM. This was a virtually universal comment. There is awareness in both locations of some potential for different issues in deep versus shallow drilling scenarios. To date, however, the depth differences have been most apparent off Nova Scotia where most wells have been drilled in shallow water or increasingly in deepwater.

- **Data availability.** Almost everyone stated that availability of EEM data is an important issue. At present, the *Atlantic Accord* allows a development to hold the EEM data confidential for five years. In fact, availability of data was an issue with the conduct of this study.

- **Cumulative effects.** While many were not particularly concerned with the effects of one exploratory well, they suggested that a large number of single wells could be an issue, particularly if they were within a relatively small geographic and/or time frame. On the other hand, no one had any ready solutions to this problem.

6.0 Application of Production EEM Experience to Exploratory Drilling EEM

The offshore production EEM experience developed on the East Coast over the last 10 years or so is applicable to EEM for exploratory drilling as representing a 'worst case' scenario. The production EEM programs were developed for large multi-well, multi-year projects that have more potential to affect the marine environment than a single exploratory well, which is small scale and often dry. Big developments such as Hibernia or SOEI entail the drilling of multiple wells, underwater excavation and infrastructure, loading and unloading of hydrocarbon products over a long period of time, the discharge of produced water, and so forth. As a result, the discharges, effects, and measureable 'footprint' will be different by orders of magnitude. One scientist likened it to a 'footprint' versus a 'fingerprint.' Nonetheless, based on the review of information and consultation with numerous interested and knowledgeable parties, the following conclusions can be drawn.

- Aside from a large oil blowout (a very unlikely event according to previous EAs) and a few other special cases, any effects from an exploratory situation are of much less concern than a production scenario.

- In general, the production EEM programs completed to date are viewed as adequate for confirming EA predictions and in providing a level of assurance that the East Coast marine ecosystems have not been significantly affected to date. They have also served as testing of techniques for use in EEM off the East Coast.

- Baseline studies conducted by Hibernia, Terra Nova, and White Rose can provide valuable insights into the effects of drilling because these studies were done at varying periods of time after drilling of a number of wells. White Rose data (reviewed herein) may be the most relevant in this regard because they are the most recent.

- To date, the conclusions that the Study Team has seen drawn from the production EEM studies, are that there have been no significant effects on the variables that have been measured. Thus, it seems reasonable to conclude that a properly run exploration drilling program will produce effects that will be on the low end of the scale and difficult to measure; it will certainly not create any significant effects on the marine environment.

- If drilling EEM was required, perhaps because of drilling with a new technology or in a potentially sensitive area, then one or a combination of the production EEM design(s) would provide a good starting point.

7.0 Discussion

7.1. Decision Process

A ‘decision tree’ approach to EEM was suggested by several stakeholders in both Nova Scotia and Newfoundland and Labrador. A potential ‘decision tree’ for exploratory drilling EEM is shown in Figure 7.1. This approach is a type of hybrid between the zoning approach used in the Gulf of Mexico, the generic EA advocated by some for Nova Scotia, and the highly targeted approach used in the US and Canadian Arctic.

7.2. Scenarios

After the drilling application and EA are submitted a decision should be made based on three scenarios appropriate to the East Coast (at least as far as experience to date dictates):

Scenario 1—Exploratory drilling of a single well in an area where data are sufficient to determine there are no issues requiring EEM. An example of this could include an exploratory well within (or immediately adjacent to) an area previously assessed in a detailed manner (e.g., the Terra Nova Development). Compliance monitoring would be conducted but no specific EEM is required. Opportunistic bird and mammal surveys (not, strictly speaking EEM) would be at the option of the Operator.

Scenario 2—There are two alternatives in this scenario:

(a) Shallow water (≤200-m) situation with no known sensitive issues but the area has not undergone an extensive EA in the recent past. [Note this ‘shallow’ designation would encompass the areas containing all East Coast production developments done to date.]. ‘Before and after’ surveys would be ‘piggy-backed’ onto existing geophysical site surveys routinely conducted as part of the site permitting and clearance process. Video surveys/interpretation, opportunistic grabs with Van Veen or Shipek grabs, and bird and mammal shipboard surveys can be conducted with little additional cost to the Operator. This would not only provide EEM data but also assist the Operator in addressing any potential liability issues. A final report accessible to the public would be prepared.

(b) Deep water (>200-m) situation with no known sensitive issues but the area has not undergone extensive EA in the recent past. Deep water may require more detailed work-ups than shallow areas if the level of knowledge is much lower for the deep water areas. ‘Before and after’ surveys would be ‘piggy-backed’ onto existing geophysical site surveys routinely conducted as part of the site clearance process. Side scan sonar (or equivalent) surveys and interpretation, video surveys/interpretation, grab sampling with Van Veens or box corers, and bird and mammal shipboard surveys can be conducted with little additional cost to the Operator. A final report accessible to the public would be prepared.

Scenario 3—Sensitive areas (shallow or deep). Surveys and sampling would be conducted as per Scenario 2 (above) plus custom-designed surveys or monitoring program. It is anticipated that this scenario would primarily be associated with marine mammal areas (e.g., The Gully). The custom monitoring could include additional or more detailed or systematic surveys and such specialty components as noise measurements. A final report accessible to the public would be prepared.

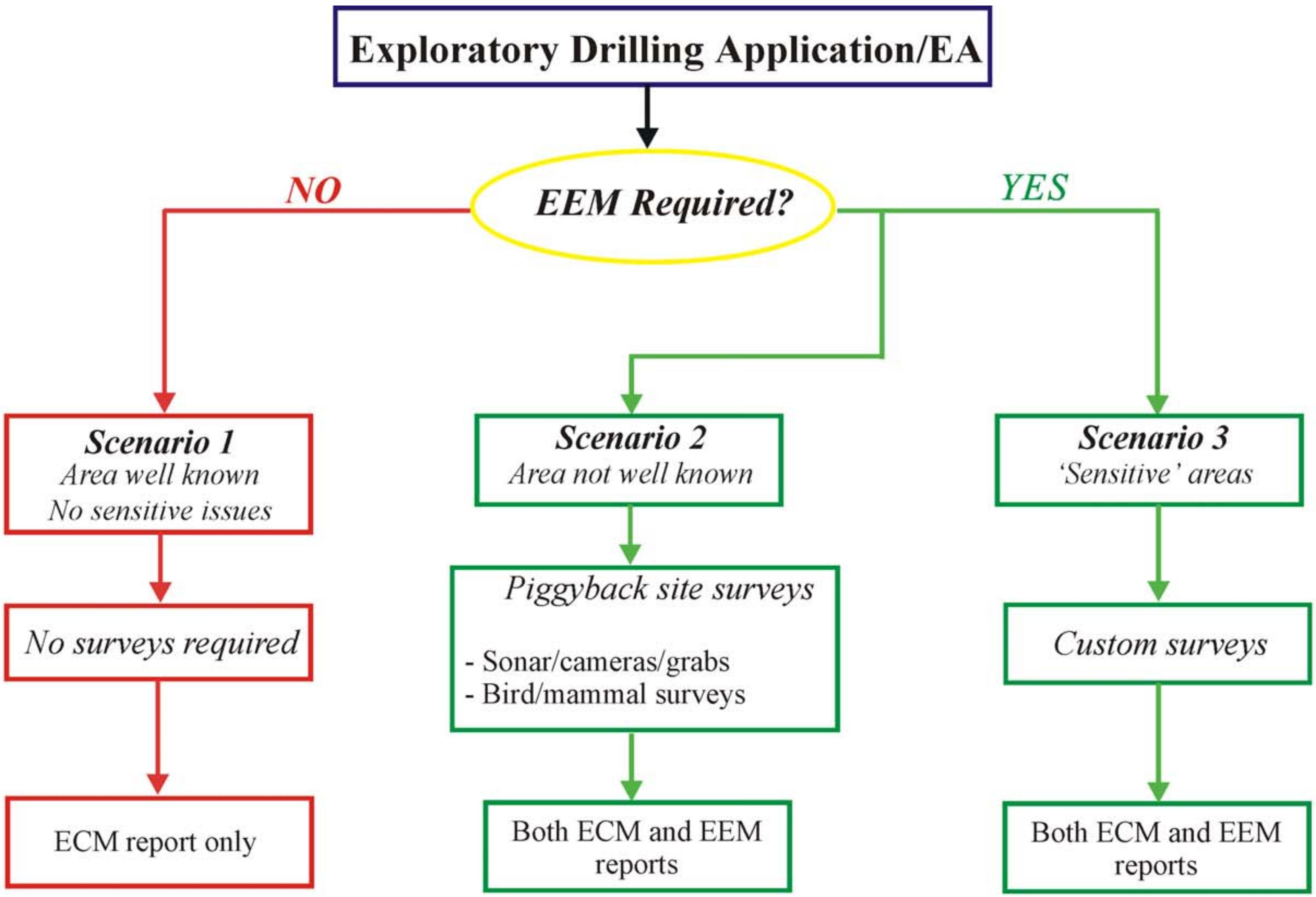


Figure 7.1. Proposed Decision Tree for Exploratory Drilling EEM.

Note that sampling on-site for Scenario 2 would be ‘opportunistic’ in the sense that logistics would depend upon operational site survey logistics. Typically (but not always, if there are good 3-D seismic data available prior to drilling) the well site surveys would consist of sonar, ROV, and grab work prior to drilling and at least ROV surveys post-drilling.

More detail on approaches for the different scenarios is contained in the following sections.

7.3. Shallow vs. Deep Wells

For the purposes of this report we have arbitrarily defined ‘shallow’ as 200-m or less, which covers the continental shelf of the East Coast and includes all presently producing wells. Based on the review and consultations, and well depths to present, we conclude that while environmental conditions and species composition may differ somewhat, there are no overwhelming differences between shallow and deep as far as EEM study design for the East Coast is concerned (other than those few exceptions noted here). Any effects will be similar although perhaps somewhat different in magnitude or distribution. For example, WBM released at the surface at a deep location may disperse more widely than a shallow location although currents would play a large role as well in either location. Sound propagation from the drill rig may also be somewhat different depending upon depth to the bottom, but again other environmental factors such as temperature and salinity would also be important.

In terms of East Coast issues, the main one strictly related to depth would be the presence or absence of any special benthic communities such as deep water corals. [This is analogous to the situation in the Gulf of Mexico where there is concern for special benthic communities such as coral outcrops and chemosynthetic communities.]

In general, we conclude that location is much more important than water depth in designing EEM programs. In other words, proximity to special areas such as The Gully or concentrations of deep water corals is much more important than whether a well is shallow or deep.

7.4. Potential EEM Designs

The recommended study designs to address the three scenarios are provided below. They have intentionally been left general in order to avoid being too prescriptive and to allow for specific circumstances.

7.4.1. Scenario 1—No EEM

In this scenario, data are sufficient and thus no EEM data are required. However, compliance monitoring (ECM) must be conducted according to *OWTG*. At least a summary of the compliance monitoring data should be made available to the public after a reasonable period of time for QA/QC.

The cost for EEM under this scenario is nil but there would be some cost involved in summarizing the ECM data in a suitable format, understandable by a knowledgeable layperson.

7.4.2. Scenario 2—No Known Sensitive Issues but Few Data

7.4.2.1. Shallow Water or On-shelf Wells

This scenario assumes a relatively low level of environmental concern, albeit more than for an area that has been intensively studied. Studies would be 'piggy-backed' onto routine well site surveys and sampling would be opportunistic. The primary goal will be to provide some level of 'assurance' that the bottom environment has not been unduly impacted by the drilling activity.

7.4.2.1.1. Objectives

Objectives would be to gain as much information as possible before and after drilling on the following top priority variables

- Sediment grain size (useful for both EA and interpretation of EEM data)
- Redox potential (an indicator of environmental quality)
- Barium (a drilling 'fingerprint' metal)
- Benthic macro-fauna (video survey)

Sediment samples could be archived or analyzed for other potential contaminants such as TOC/TIC, metal and petroleum hydrocarbons at the Operator's discretion. Infauna could be identified if it was deemed to be of use.

Bird and mammal surveys from the rig and/or supply boats would be opportunistic and at the Operators' discretion.

7.4.2.1.2. Sampling Design

It is recommended that sampling be conducted along the axes of dominant bottom currents if they are known. Because it is highly likely in most cases that there will not be enough bottom current data, it is suggested that a radial transect approach such as commonly used now is probably the best design.

Numbers of samples can be opportunistic and somewhat at the Operators' discretion but it is suggested that on the order of 15 sediment samples be collected.

Video surveys should be collected along the radials and interpreted for substrate and benthic macro-fauna (and flora if present).

7.4.2.1.3. Equipment and Methodology

Sediment samples would be collected by standard methods using a grab or corer. Van Veen and/or Shipek grabs are typically used for the routine well site surveys so the use of this equipment would not incur extra costs.

Video surveys would be conducted by the equipment and technician normally aboard for the well site surveys and thus would not incur significant extra costs.

Sampling, surveys, data collection, interpretation and reporting should be under the direction of an experienced marine biologist.

Some preliminary draft survey protocols for bird and mammal surveys are contained in Appendix IV. The reader is also referred to a previous ESRF report on seabird monitoring (Montevecchi et al. 1999). Note that LGL Limited is presently completing protocols under the ESRF.

7.4.2.1.4. Costs

There may be large variations in the costs of EEM for Scenario 2 with the largest variable being the logistic costs. Also, cruise length and marine bird and mammal surveys could be quite variable which would affect personnel time. As this scenario is considered 'opportunistic' certain logistic costs such as major sampling equipment, ship time, video equipment and technician may not be included. A list of potential cost items is provided below

Benthos, Sediment Sampling

<u>Field Mobilization, Implementation, Demobilization</u>

Personnel
Grabs
Video
Disbursements

<u>Laboratory Analyses</u>

20 (+/-) samples (particle size, TOC/TIC, metals, redox)

<u>Data Analyses and Report</u>

Personnel
Disbursements

<u>Bird and Mammal Surveys</u>

Personnel (1 observer – 30 (+/-) days)
Disbursements

<u>Data Analyses and Report</u>

Personnel
Disbursements

Total costs for this scenario are intermediate between Scenario 1 and Scenario 3.

7.4.2.2. Deep Water Wells

This part of the scenario assumes a potentially higher level of environmental concern than for shallow water, primarily because of the general lack of knowledge on deep water areas. Studies would be 'piggy-backed' onto routine well site surveys but sampling would be less opportunistic and more pre-planned than for shallow water. The primary goal will be to provide a higher level of assurance (than shallow water where more general knowledge is available) that the bottom environment has not been unduly impacted by the drilling activity.

7.4.2.2.1. Objectives

Objectives would be to gain as much information as possible before and after drilling on the following top priority variables

- Sediment grain size (useful for both EA and interpretation of EEM data)
- Redox potential (an indicator of environmental quality)
- Barium (a drilling 'fingerprint' metal)
- TOC/TIC
- Benthic macro-fauna (video survey)

Plus

- Side scan sonar surveys (or equivalent), including interpretation, to gain information on habitat (bottom topography, substrate, etc.)
- Grab or core samples collected in a more systematic manner

Sediment samples would be archived for possible analyzing for other potential contaminants such as metal and petroleum hydrocarbons at the Regulator's discretion. Infauna samples could be identified to various taxonomic levels if it was deemed to be of use.

Bird and marine mammal surveys would be conducted from the rig and/or the supply boats.

7.4.2.2.2. Sampling Design

It is recommended that sampling be conducted along the axes of dominant bottom currents if they are known. Because it is highly likely in most cases that there will not be enough bottom current data, it is recommended that a radial transect approach such as commonly used now be adopted.

A minimum of 30 sediment samples would be collected.

Video surveys should be collected along the radials and interpreted for substrate and benthic macro-fauna.

7.4.2.2.3. Equipment and Methods

Sediment samples would be collected by standard methods using a grab or corer. Van Veen and/or Shipek grabs are typically used for the routine well site surveys so the use of this equipment would not incur extra costs.

Video surveys would be conducted by the equipment and technician normally aboard for the well site surveys and thus would not incur significant extra costs. The ‘drop camera’ would be a deep sea camera capable of taking high resolution photos of the sea bottom (e.g., Benthos Deep Sea Camera or equivalent).

Sampling, surveys, data collection, interpretation and reporting would be under the direction of an experienced marine biologist.

Some preliminary draft survey protocols for bird and mammal surveys are contained in Appendix IV. See also Montevecchi et al. (1999). LGL Limited is presently developing protocols for the ESRF.

7.4.2.2.4. Costs

There may be large variations in the costs of EEM for deep water with the largest variable being the logistic costs. Also, cruise length and marine bird and mammal surveys could be quite variable which would affect personnel time. Because this is a ‘piggy-back’ survey, logistic costs such as major sampling equipment, ship time, video equipment and technician may not be included. However, because of a more systematic sampling approach and the dedicated ‘drop camera’ work, it is likely that an extra day or two ship time will be required. A list of potential cost items is provided below.

Benthos, Sediment Sampling

<u>Field Mobilization, Implementation, Demobilization</u>

Personnel
Grabs
Video
Drop camera rental
Disbursements

<u>Laboratory Analyses</u>

30 (+/-) samples (particle size, TOC/TIC, metals, redox)

<u>Data Analyses and Report</u>

Personnel
Disbursements

Bird and Mammal Surveys

Personnel (1 observers – 40 (+/-) days)
Disbursements

Data Analyses and Report

Personnel
Disbursements

The costs for deep water work would be approximately twice those of shallow water EEM.

7.4.3. Scenario 3—Sensitive Areas

This scenario involves all of Scenario 2 plus custom-designed surveys (see above for objectives, designs, equipment, methods, and costing). We cannot 'pre-judge' what might be designed for specific areas of interest but these often involve marine mammal and noise issues. Some suggested methods for marine mammal and acoustic monitoring are contained in Moulton et al. (2003).

7.4.3.1. Costs

Costs for definitive studies on marine mammal and noise issues are substantial and may be on the order of $250,000 to $500,000 range or more. Costs for other potential studies on, for example, deep sea corals could also easily reach those levels.

7.4.4. Regional EEM

It is beyond the scope of a document dealing with single exploratory well scenarios to consider regional environmental assessment or regional EEM. Nonetheless, as the oil industry expands off the East Coast, regional issues will likely move to the forefront. As part of regional studies, it has been suggested by some of the stakeholders that permanent reference stations or transects be established. It may be advantageous to 'piggy-back' these reference stations on existing long term ones such as Station 27 or the 'Bonavista Transect' off Newfoundland or the 'Halifax Line' or 'Gully Station' off Nova Scotia. Such stations would serve as useful long term reference or 'control' points for any studies examining the effects of exploratory wells.

7.5. Potential EEM Support Studies

The decision framework and approach to study designs under different situations has been provided in previous sections. More specific study suggestions are presented in this section. Special studies in support of EA or EEM to deal with emerging issues may be advisable. It became obvious to us during the course of this study, that there are still some 'issues on the table' that could be addressed by 'stand-alone' studies. For example, what is the actual (not theoretical or modeled) area smothered by the disposal of drill cuttings and mud on the sea floor, or what do the noise 'envelopes' around the different types of rigs or supply boats look like. Such studies would provide useful support to both EA and EEM, and help in setting priorities and designing programs. We have termed this an 'emerging issues scenario' because past experience has shown us that as some concerns diminish either through accumulation of data or by mitigation, other new ones tend to appear. Such special or supporting studies are not strictly EEM but they may start as EEM studies and then evolve into special studies or they may be specifically designed to aid EEM.

Nova Scotia and Newfoundland suggested studies are presented separately below because the issues and level of concern as expressed during the consultations were somewhat different.

7.5.1. Nova Scotia Studies

A study or series of studies could be conducted to monitor a suite of benthic variables at a minimum of four different locations representing four distinct habitats.

7.5.1.1. Rationale

As reviewed and discussed in previous sections (see Sections 2.0 to 4.0), it is clear that even though there has been considerable monitoring of multi-well situations, the issue of the extent and degree of benthic habitat alteration or contamination from a single well still appears to be outstanding. On the one hand it seems reasonable to assume that if large multi-well developments do not produce important or significant effects then single wells also will not produce them. On the other hand, there have been suggestions that the magnitude of surface enrichments from drilling discharges among sites within similar depositional environments (i.e., judged by water depth) was similar regardless of the number of wells drilled (CSA *in* Kennicutt et al. 1996a). Large scale reviews of the environmental effects of offshore oil and gas development have identified the effects of discharges of produced water and accumulations of drill mud and cuttings as the key research priorities (see Peterson et al. 1996). There continues to be a relatively high level of concern related to offshore drilling in Nova Scotia waters compared to Newfoundland waters. One of the primary concerns is with effects on benthos, particularly shellfish. In addition, there is potential for drilling in a variety of habitats containing a range of substrates and physical oceanographic regimes. To date, there are four potential exploration drilling scenarios for Nova Scotia waters: (1) on a bank (i.e., shallow water, generally sandy-bottom environments), (2) on the slope (≥200m), (3) in a gully (i.e., deep valley within the shelf area), and (4) deep water off the slope. The two North Triumph wells have been suggested as likely candidate locations for a shallow water site and it may be useful to re-examine any existing data for this area.

It is suggested that the following EEM support studies be conducted until variables reach background levels or the issue is settled. The results will be of use to both future impact assessments as well as monitoring programs.

7.5.1.2. Objectives

The objectives of the Nova Scotia studies would be:

- To test the null hypothesis that environmental effects (as measured by sediment chemistry, benthic communities, and toxicity) from exploratory drilling do not extend beyond 500-m from a single exploratory well,

- To further test and validate the **bblt** model,

- To determine the physical area (s) of effects, and

- To determine the longevity of any effects.

7.5.1.3. Methodology

It is suggested that the Chapman's sediment quality triad (SQT) approach as advocated by Green and Montagna (1996) is the most effective methodology. This approach uses data from sediment chemistry, benthic infauna, and toxicology that have been collected at the same time to assess environmental quality. Sampling should be conducted with stainless steel box corer or bottom grab. The following variables are suggested as the top priority ones; others could be added (e.g., shellfish body burdens, enzyme activity, if appropriate).

<u>Sediment chemistry</u>

- Total PAH
- Total alkanes
- Particle size
- Total inorganic carbon (TIC)
- Total organic carbon (TOC)
- Redox potential
- Metals (particularly Ba*)

*Note that care should be taken with the selection of extraction method because results can differ by orders of magnitude (Hartley 1996 *in* Holdway 2002).

<u>Benthic infauna</u>

- Identify at least to major taxa
- Determine abundance and biomass

<u>Toxicology</u>

- Microtox™ (bacterial bioluminescence)

<u>Optional Components</u>

- Amphipod survival test (if Microtox™ tests positive)
- Body burdens of petroleum hydrocarbons and/or metals in indigenous shellfish

The above variables are commonly collected during East Coast EEM studies (e.g., Husky 2001a,b).

7.5.1.4. Sampling Design

The suggested sampling design is one that uses radial transects with sampling conducted at appropriate intervals such as 50, 100, 200, 500, 3,000-m (or something similar) as was used during the major Gulf of Mexico platform study (GOOMEX) (see Carr et al. 1996b; Ellis et al. 1996; Green and Montagna 1996; Kennicutt et al. 1996a,b; McDonald et al. 1996; Montagna and Harper 1996; Husky 2001a,b, and others).

The radials should be set along cardinal points unless data are available on prevailing bottom currents where it would be advisable to orient at least one transect along the axis of the predominant current.

7.5.1.5. Numbers of Samples

The decision on the numbers of samples to be collected is a crucial one because, if too few, then validity is questionable; if too many, then costs become too high relative to the value of the data. If the intention is to describe in detail the situation at one individual site, then one would take large numbers of samples at few sites (see Green and Montagna 1996). However, we believe that our situation calls for generalizations about drilling in particular areas so that once the study is complete, results can be applied to future exploration without the need for additional sampling. If this is the case, then it would be better to take potentially fewer samples at one site but sample more sites, potentially as many as 12 sites per area (Green and Montagna 1996). One of the key findings of Ellis (1996) during the GOOMEX study was the highly platform-specific nature of environmental variables and associated macro-epifaunal communities. It is recognized that this may be considered a large number of sites but the data can be assembled over time; not all 12 sites have to be done immediately. Also, there also may be economies to be obtained by reducing the numbers of sampling sites along each transect, for example, by analyzing near field vs. far-field effects (Green and Montagna 1996).

The actual number of samples to be collected will have to be determined after a more detailed examination of environmental conditions at each site, once the likely sites are known. This determination should made using statistical techniques such as those outlined in Green (1979, 1984) and in consultation with the C-NSOPB. In order to gain some appreciation of the order of magnitude--Husky (2001b) concluded that three replicate samples (subsequently combined into one) collected at about 50 stations was sufficient for their EEM purposes at White Rose.

7.5.1.6. Data Analyses

A priori power analysis should be used to aid in determining the numbers of samples required (e.g., Zar 1998). Multivariate analysis is the preferred methodology for analyzing SQT data (R. Green, pers. comm.).

7.5.2. Newfoundland and Labrador Studies

It is suggested that existing data from Terra Nova and White Rose be assembled and re-analyzed for the purposes of assessing the effects from single exploratory wells. There is now a considerable amount of data (both baseline and EEM) that can be related to well locations, timing, volumes and types of drilling mud used, water depths, substrate types, currents, and so forth (e.g., Petro-Canada 1999; Husky 2001b, 2003a,b, and others). Consideration should also be given to re-analyzing the Hibernia EEM data, or at least the baseline data although the Hibernia situation can now be considered atypical for the East Coast. In the case of Terra Nova, there may be some confounding of factors if data after production started is used.

Rationale, objectives, previous methodology, and data analysis procedures are all virtually identical to the above (Nova Scotia studies above).

7.6. Ongoing ESRF Studies

It should be noted that the ESRF has a number of ongoing studies that should be of direct relevance to addressing some of the issues discussed in previous sections (see ESRF 2003). For example, the following studies are ongoing:

- *Field Verification of Benthic Boundary Layer Modelling Effects.* This DFO study is using existing SOEI data to test the benthic boundary layer models. [Report has been submitted, Hannah et al. 2003.]

- *Deep Water Benthic Community Study.* This study by DFO is using video and photography techniques to obtain information on deep water corals. The final report was due in April 2004.

- *Mesocosm and Laboratory Study of Effects of Drill Cuttings.* This study, also by DFO, concerned biological effects, recovery rates, physical vs. chemical effects, and possible interactions of several rig sites. Final report was due in March 2003.

- *Seabird Attraction to Production Installations: Instrument-Based Approaches.* An RFP will be issued in 2003.

8.0 Conclusions

The primary conclusions of this study were:

2. There are notable differences between the different regions in the East Coast concerning the need for, and the amount required of, EEM. However, most stakeholders agreed that the concern was much less for the single exploratory well than for a production development.

   Some important common points of view found in both areas are listed below.

   - **Level of concern with exploration drilling**. Although there were some exceptions, most people had a much lower level of concern for the environmental effects of a single exploratory well than for a production development.

   - **Assurance monitoring.** While some argued strongly for extensive statistical work, there still was a common thread that most people wanted some level of reassurance that a specific site was not being unduly affected. A number of people suggested some camera drops and some grab samples might be enough to accomplish the goal of providing a suitable level of comfort.

   - **Testing EA.** A number of participants suggested that one of the key functions of a monitoring program is to test predictions, and in some cases modeling, that were conducted during the EA process. A potential corollary of this attitude is the suggestion by some that one or several wells should be selected as 'test cases' and monitored possibly in aid of a Class or Generic EA approach. This would provide rationale for including or excluding monitoring variables for future individual wells.

   - **Biological effects**. With some exceptions, most felt that any monitoring programs should focus on biological effects as opposed to simply 'shopping' for increases (however slight) of potential contaminants.

   - **Birds and mammals**. Many agreed that there were potentially important issues in regard to marine birds and mammals. However, it was also pointed out by a number of people that routine surveys conducted from the rig or supply boats do not necessarily constitute any monitoring of effects *per se*.

   - **Site specifics.** Local and site specific issues must be considered in the design and conduct of any EEM. This was a virtually universal comment. There is awareness in both locations of some potential for different issues in deep versus shallow drilling scenarios. To date, however, the depth differences have been most apparent off Nova Scotia where most wells have been drilled in shallow water or increasingly in deepwater.

- **Data availability.** Almost everyone we talked to stated that availability of EEM data is an important issue. At present, the *Atlantic Accord* allows a development to hold the EEM data confidential for five years. In fact, availability of data was an issue with the conduct of this study.

- **Cumulative effects.** While many were not particularly concerned with the effects of one exploratory well, they suggested that a large number of single wells could be an issue, particularly if they were within a relatively small geographic and/or time frame. On the other hand, no one had any solutions to this problem.

3. Existing offshore production EEM programs appear to be working reasonably well and results are at least partially relevant to the design and conduct of EEM for exploratory wells.

   - Aside from a large oil blowout (a very unlikely event according to previous EAs) and a few other special cases, any effects from an exploratory situation are of much less concern than a production scenario.

   - In general, the production EEM programs completed to date are viewed as adequate for confirming EA predictions and in providing a level of assurance that the East Coast marine ecosystems have not been significantly affected to date. They have also served as testing of techniques for use in EEM off the East Coast.

   - Baseline studies conducted by Hibernia, Terra Nova, and White Rose can provide valuable insights into the effects of drilling because these studies were done at varying periods of time after drilling of a number of wells. White Rose data (reviewed herein) may be the most relevant in this regard because they are the most recent. These data should be re-examined with this different objective of teasing out effects of exploration, if any.

   - To date, the conclusions that the Study Team has seen drawn from the production EEM studies, are that there have been no significant effects on the variables that have been measured. Thus, it seems reasonable to conclude that a properly run exploration drilling program will produce effects that will be on the low end of the scale and difficult to measure; it will certainly not create any significant effects on the marine environment.

   - If drilling EEM was required, perhaps because of drilling with a new technology or in a potentially sensitive area, then one or a combination of the production EEM design(s) would provide a good starting point.

4. EEM is not warranted for the single exploratory well in all situations; for example, in non-sensitive areas that are well known. Compliance monitoring would still be conducted and reported.

5. A potential ‘decision tree’ has been suggested for different levels of EEM based on three different scenarios:

(a) Scenario 1—well known area with no sensitive issues. Compliance monitoring but no EEM would be conducted.

(b) Scenario 2—shallow or deep areas with no known sensitive issues. Opportunistic EEM surveys of sediments, benthos, seabirds and marine mammals would be ‘piggy-backed’ on existing logistics.

(c) Scenario 3—sensitive areas. Custom EEM surveys would be required.

6. Most EEM for an exploratory well can be ‘piggy-backed’ onto existing programs such as well site surveys in order to minimize costs.

7. ‘Special’ EEM support studies of selected existing data and new data could be collected to further refine, and potentially reduce EEM in the future.

9.0 Literature Cited

Borgmann, U., W.P. Norwood, T.B. Reynoldson and F. Rosa. 2001. Identifying cause in sediment assessments: bioavailability and the sediment quality Triad. Can. J. Fish. Aquat. Sci. 58: 950-960.

Breeze, H., D.S. Davis, M. Butler and V. Kostylev. 1997. Distribution and status of deep sea corals off Nova Scotia. Marine Issues Committee Special Publication No. 1, Ecology Action Centre. 58 p.

Cantelmo, F.R., M.E. Tagatz and K.R. Rao. 1979. Effect of barite on meiofauna in a flow-through experimental system. *Mar. Environ. Res.*, 2: 301-309.

CAPP. 1999. Estimation of direct human resource requirements offshore exploration and production Newfoundland and Nova Scotia 2000-2010. Report by the Canadian Association of Petroleum Producers.

CAPP. 2001a. Safety zones. Canadian Association of Petroleum Producers. 7 p. + App.

CAPP. 2001b. Offshore drilling waste management review. Canadian Association of Petroleum Producers Technical Report 2001-0007. 194 p. + App.

Carr, R.S., D.C. Chapman, C.L. Howard and J.M. Biedenbach. 1996a. Sediment quality triad assessment survey of the Galveston Bay, Texas system. Ecotoxicology 5, pp. 341-364.

Carr, R.S., D.C. Chapman, B.J. Presley, J.M. Biedenbach, L. Robertson, P. Boothe, R. Kilada, T. Wade, and P. Montagna. 1996b. Sediment porewater toxicity assessment studies in the vicinity of offshore oil and gas production platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci. 53: 2618-2628.

Chapman, P.M., R.N. Dexter, H.A. Anderson and E.A. Power. 1991. Evaluation of effects associated with an oil platform, using the Sediment Quality Triad. Toxicol. Chem. 10: 407-424.

C-NOPB. 2002. Offshore waste treatment guidelines. Prepared by National Energy Board, Canada – Newfoundland Offshore Petroleum Board and the Canada – Nova Scotia Offshore Petroleum Board. 11 p + App.

Conklin, P.J., D.G. Doughtie and K.R. Rao. 1980. Effects of barite and used drilling muds on crustaceans, with particular reference to the grass shrimp, Palaemonetes pugio. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Cranford, P.J. and D.C. Gordon Jr. 1992. The influence of dilute clay suspensions on sea scallop (*Placopecten magellicanus*) feeding activity and tissue growth. Neth. J. Sea Res. 30:107-120.

Cranford, P.J., D.C. Gordon, K. Lee, S.L. Armsworthy and G.H. Tremblay. 1999. Chronic toxicity and physical disturbance effects of water- and oil-based drilling fluids and some major constituents on adult sea scallops (*Placopecten magellanicus*). *Mar. Environ. Res.*, 48: 225-256.

Cranford, P.J., K. Lee, J.W. Loder, T.G. Milligan, D.K. Muschenheim and J.F. Payne. 2001. Scientific considerations and results relevant to the review of the 1996 offshore waste treatment guidelines. *Can. Tech. Rep. Fish. Aquat. Sci.*, 2364.

d'Entremont, A. 2003. Environmental effects monitoring results of offshore wells. CAPP Powerpoint Presentation to RAC Sub-committee.

Davies, J.M., J.M. Addy, R.A. Blackman, J.R. Blanchards, J.E. Ferbrache, D.C. Moore, H.J. Sommerville, A. Whitehead and T. Wilkinson. 1984. Environmental effects of the use of oil-based drilling muds in the North Sea. *Mar. Poll. Bull.*, 15: 363-370.

Ellis, M.S., E.A. Wilson-Ormand, and E.N. Powell. 1996. Effects of gas-producing platforms on continental shelf macroepifauna in the northwestern Gulf of Mexico: abundance and size structure. Can. J. Fish. Aquat. Sci. 53: 2589-2605.

Environmental Protection Agency (EPA). 2000. Environmental assessment of final effluent limitations guidelines and standards for synthetic-based drilling fluids and other non-aqueous drilling fluids in the oil and gas extraction point source category. EPA-821-B-00-014, December 2000.

ESRF. 2003. Environmental studies research funds annual report 2002. National Energy Board, Calgary. 23 p.

Fechhelm, R.G., B.J. Gallaway, G.F. Hubbard, S. MacLean and L.R. Martin. 2001. Opportunistic sampling at a deep-water synthetic drilling fluid discharge site in the Gulf of Mexico. Gulf of Mexico Science. 2: 97-106.

Gallaway, B.J., L.R. Martin, R.L. Howard, G.S. Boland and G.D. Dennis. 1981. Effects on artificial reef and demersal fish and macrocrustacean communities. In: Environmental Effects of Offshore Oil Production: the Buccanear Gas and Oilfield Study. Middleditch, BS, 1981.

GESAMP (IMO/FAO/UNESCO/WHO/IAEA/UN/UNEP Group of Experts on the Scientific Aspects of Marine Pollution). 1993. Impact of oil and related chemicals and wastes on the marine environment. *Rep. Stud. GESAMP*, 50, 180 p.

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. Wiley, New York.

Green, R.H. 1984. Statistical and nonstatistical considerations for environmental monitoring studies. Environ. Monit. Assess. 4: 293-301.

Green, R.H. and P. Montagna. 1996. Implications for monitoring: study designs and interpretation of results. Can. J. Fish. Aquat. Sci .53: 2629-2636.

Grizzle, J.M. 1986. Lesions in fishes captured near drilling platforms in the Gulf of Mexico. *Mar. Environ. Res.*, 18: 267-276.

Hannah, C.G., A. Drozdowski, D.K. Muschenheim, J.W. Loder, S. Belford, and M. MacNeil. 2003. Evaluation of drilling mud dispersion models at SOEI Tier I Sites: Part 1 North Triumph, Fall 1999. Can. Tech. Rep. Hydrography and Ocean Sciences 232: 1-51.

HMDC 1995. Hibernia baseline environmental effects monitoring data report October, 1995. Report by Hibernia Management Development Company, St. John's, NL. 122 p. + List of Errata + November 23, 1995 Addenda + App.

Holdway, D.A. 2002. The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. Mar. Poll. Bull. 44: 185-203.

Husky. 2000. White Rose Oilfield Comprehensive Study. Submitted by Husky Oil Operations Limited, St. John's, NL.

Husky. 2001a. White Rose Oilfield Comprehensive Study Supplemental Report. Submitted by Husky Oil Operations Limited, St. John's, NL. 265 p. + App.

Husky. 2001b. White Rose baseline characterization data report June 2001. Prepared by Jacques Whitford Environment Limited for Husky Oil Operations Limited, St. John's, NL. 109 p. + App.

Husky. 2002. Husky Jeanne d'Arc Basin Exploration Drilling Program Project Description and Environmental Assessment. Prepared by LGL Limited, Oceans Limited, Provincial Airlines Limited, and S.R. Ross Environmental Research Ltd. for Husky Oil Operations Limited, St. John's, NL. 179 p.

Husky. 2003a. Husky Lewis Hill Prospect Exploration Drilling Program Environmental Assessment. Prepared by LGL Limited, Oceans Limited, Provincial Airlines Limited, and S.R. Ross Environmental Research Ltd. for Husky Oil Operations Limited, St. John's, NL. 324 p.

Husky. 2003b. White Rose baseline addendum draft report January 2003. Prepared by Jacques Whitford Environment Limited for Husky Oil Operations Limited, St. John's, NL. 14 p. + App.

ICES (International Council of the Exploration of the Sea) Workshop. 2002. Biological Effects in Pelagic Ecosystems (BECPELAG), Copenhagen.

JWE Ltd. (Jacques Whitford Environmental Limited). 1998. Terra Nova baseline characterisation data report, prepared for Petro-Canada, 1998.

JWE Ltd. (Jacques Whitford Environmental Limited). 2000. White Rose baseline characterisation data report, prepared for Husky, 2000.

Kennicutt II, M.C., P.N. Boothe, T.L. Wade, S.T. Sweet, R. Rezak, F.J. Kelly, J.M. Brooks, B.J. Presley, and D.A. Wiesenberg. 1996a. Geochemical patterns in sediments near offshore production platforms. Can. J. Fish. Aquat. Sci. 53: 2554-2566.

Kennicutt II, M.C., R.H. Green, P. Montagna, and P.F. Roscigno. 1996b. Gulf of Mexico Offshore Operations Monitoring Experiment (GOOMEX), Phase I: Sublethal responses to contaminant exposure—introduction and overview. Can. J. Fish. Aquat. Sci. 53: 2540-2553.

Kingston, P.F. 1992. Impact of offshore oil production installations on the benthos of the North Sea. ICES J. Mar. Sci. 49: 45-52.

Kostylev, V., B.J. Todd, G.B.J. Fader, R.C. Courtney, G.D.M. Cameron, and R.A. Pickrill. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and seafloor photographs. Mar. Ecol. Prog. Ser. 219: 121-137.

LGL Ltd. 2003. Orphan Basin Strategic Environmental Assessment. Report by LGL Limited, St. John's, NL, to Canada-Newfoundland Offshore Petroleum Board. 229 p.

Mathieu, A. 2002. Potential impacts of exploratory drilling on the health and productivity of finfish and shellfish: A review. Report by Oceans Ltd. prepared for LGL Limited. 25 p.

McDonald, S.J., K.L. Willett, J. Thomsen, K.B. Beatty, K. Connor, T.R. Narasimhan, C.M. Erickson, and S.H. Safe. 1996. Sublethal detoxification responses to contaminant exposure associated with offshore production platforms. Can. J. Fish. Aquat. Sci. 53: 2606-2617.

MMS. 2000. Environmental impacts of synthetic based drilling fluids. U.S. Dept. Interior Minerals Management Service Gulf of Mexico OCS region. OCS Study MMS 2000-064. 121 p.

Montagna, P.A. and D.E. Harper, Jr. 1996. Benthic infaunal long-term response to offshore production platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci. 53: 2567-2588.

Montagna, P.A., S.C. Jarvis, and M.C. Kennicutt, II. 2002. Distinguishing between contaminant and reef effects on meiofauna near offshore hydrocarbon platforms in the Gulf of Mexico. Can. J. Fish. Aquat. Sci. 59: 1584-1592.

Montevecchi, W.A., F.K. Wiese, G. Davoren, A.W. Diamond, F. Huettmann, and J. Linke. 1999. Seabird attraction to offshore platforms and seabird monitoring from offshore support vessels and other ships: literature review and monitoring designs. Prepared for Canadian Association of Petroleum Producers.

Moulton, V.D., R.A. Davis, J.A. Cook, M. Austin, M.L. Reece, S.A. Martin, A. MacGillivray, D. Hannay, and M.W. Fitzgerald. 2003. Environmental assessment of Marathon Canada Limited's 3-D seismic program on the Scotian Slope, 2003. LGL Rep. SA744-1. Rep. by LGL Limited, St. John's, Newfoundland, and Greeneridge Sciences Inc., Santa Barbara, CA, for Marathon Canada Ltd., Halifax, Nova Scotia. 173 p. + Appendices.

Muschenheim, D.K. and T.G. Milligan. 1996. Flocculation and accumulation of fine drilling waste particulates on the Scotian shelf (Canada). *Mar. Poll. Bull.*, 32, 10: 740-745.

National Academy of Science (NAS). 1983. Drilling discharges in the marine environment. Panel on Assessment of Fates and Effects of Drilling Fluids and Cuttings in the Marine Environment, Marine Board, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, D.C., 1983.

NEB, C-NOPB and C-NSOPB. 2002. Offshore waste treatment guidelines. National Energy Board, Canada-Newfoundland Offshore Petroleum Board, and Canada-Nova Scotia Offshore Petroleum Board. 21 p.

NEB, C-NOPB and C-NSOPB. 1999. Guidelines respecting the selection of chemicals intended to be used in conjunction with offshore drilling and production activities on frontier lands. Prepared by National Energy Board, Canada – Newfoundland Offshore Petroleum Board and the, Canada – Nova Scotia Offshore Petroleum Board. 16 p.

Neff, J.M., M. Bothner, N. Maciolek and J. Grassle. 1989. Impacts of Exploratory drilling for oil and gas on the benthic environment of Georges Bank. *Mar. Environ. Res.*, 27, 2: 77-114.

Neff, J.M., S. McKelvie and R.C. Ayers. 2000. Environmental impacts of synthetic based drilling fluids. OCS Study, MMS 200-064, published by U.S. Dept of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, August 2000.

NORDCO. 1983. Study of residual toxicity and debris on Hibernia P-15, B-08 and K-18 wellsites. Rep. for Department of the Environment, Environmental Protection Service.

Olsgard, F. and J.S. Gray. 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Mar. Ecol. Prog. Ser.*, 122: 277-306.

Payne, J.F., C. Andrews, S. Whiteway and K. Lee. 2001a. Definition of sediment toxicity zones around oil development sites: Dose response relationships for the monitoring surrogates Microtox[r] and amphipods, exposed to Hibernia source cuttings containing a synthetic base oil. *Can. Manuscr. Rep. Fish. Aquat. Sci.*, No 2577, vi + 10 p.

Payne, J.F., L Fancey, C. Andrews, J.D. Meade, F.M. Power, K. Lee, G. Veinott and A. Cook. 2001b. Laboratory exposures of invertebrate and vertebrate species to concentrations of IA-35 (Petro Canada) drill mud fluid, production water, and Hibernia drill mud cuttings. *Can. Manuscr. Rep. Fish. Aquat. Sci.*, No 2560, iv + 27 p.

Payne, J.F., L. Fancey, J. Hellou, M.J. King and G.L. Fletcher. 1995. Aliphatic hydrocarbons in sediments: a chronic toxicity study with winter flounder (*Pleuronectes americanus*) exposed to oil well drill cuttings. *Can. J. Fish. Aquat. Sci.*, 52: 2724-2735.

Peterson, C.H., M.C. Kennicutt II, R.H. Green, P. Montagna, D.E. Harper Jr., E.N. Powell, and P.F. Roscigno. 1996. Ecological consequences of environmental perturbations associated with offshore hydocarbon production: a perspective on long-term exposures in the Gulf of Mexico. *Can. J. Fish. Aquat. Sci.* 53: 2637-2654.

Petro-Canada 1999. Terra Nova Environmental Monitoring Program.

Stagg, R.M. 1998. The development of an international program for monitoring the biological effects of contaminants in the OSPAR convention area. *Mar. Environ. Res.*, 46, 1-5: 307-313.

Stagg, R.M., A. McIntosh and P. Mackie. 1995. Elevation of hepatic monooxygenase activity in the dab (*Limanda limanda L.*) in relation to environmental contamination with petroleum hydrocarbons in the northern North Sea. *Aquat. Toxicol.*, 33: 245-264.

Terrens, G.W., D. Gwyther, M.J. Keough and R.D. Tait. 1998. Environmental assessment of synthetic based drilling mud discharges to Bass Strait, Australia. SPE 46622, 1-14. *In:* 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production ; Caracas, Venezuela, 7-10 June 1998. Society of Petroleum Engineers, Inc. Richardson, TX.

Thomson, D.H., R.A. Davis, R. Bellore, E. Gonzalez, J. Christian, V. Moulton and R. Harris. 2000. Environmental assessment of exploration drilling off Nova Scotia. Report by LGL Limited for Canada-Nova Scotia Offshore Petroleum Board, Mobil Oil Canada Properties Ltd., Shell Canada Ltd., Imperial Oil Resources Ltd., Gulf Canada Resources Ltd., Chevron Canada Resources, PanCanadian Petroleum, Murphy Oil Ltd., and Norsk Hydro. 278 p.

Veale, L.O., A.S. Hill, S.J. Hawkins and A.R. Brand. 2000. Effects of long-term disturbance by commercial scallop fishing on subtidal epifaunal assemblages and habitats. *Mar. Biol.*, 137: 325-337.

Wassenberg, T.J., G. Dews and S.D. Cook. 2002. The impacts of fish trawls on megabenthos (sponges) on the Northwest shelf of Australia. *Fish. Res.*, 58: 141-151.

Watling, L., R.H. Findlay, L.M. Mayer and D.F. Schick. 2001. Impact on scallop drag on the sediment chemistry, microbiota and faunal assemblages of a shallow subtidal marine benthic community. *J. Sea Res.*, 46: 309-324.

Wilson-Ormond, E.A., M.S. Ellis and E.N. Powel. 1994. The effect of proximity to gas producing platforms on size, stage of reproductive development and health in shrimp and crabs. National Shellfisheries Association, Charleston, South Carolina, *Abstracts*, 1994 Annual Meeting, April 24-28: 306.

Zar, J. H. 1998. Biostatistical Analysis. 4th Edition. Prentice Hall, NJ. 663 p. + App.

Personal Communication

Boland, G.	U.S. Minerals Management Service, New Orleans, LA
Dunphy, R.	Hibernia Management and Development Company Ltd., St. John's, NL
Green, R.	Biostatistics Expert Consultant
Payne, J.	Fisheries and Oceans, St. John's, NL
Robson, W.	Nexen Inc., Calgary, AB
Turpin, W.	Canadian Wildlife Service, Environment Canada, St. John's, NL
Wilson, B.	LGL Limited, Anchorage, Alaska

Appendix I

Review of Toxicity Effects

POTENTIAL IMPACTS OF EXPLORATORY DRILLING ON THE HEALTH AND PRODUCTIVITY OF FINFISH AND SHELLFISH: A REVIEW

Prepared for:

LGL Limited
Environmental Research Associates
P.O. Box 13248, Stn. A
388 Kenmount Road,
St. John's, Newfoundland
A1B 4A5

December 2002

POTENTIAL IMPACTS OF EXPLORATORY DRILLING ON THE HEALTH AND PRODUCTIVITY OF FINFISH AND SHELLFISH: A REVIEW

Prepared for:

LGL Limited
Environmental Research Associates
P.O. Box 13248, Stn. A
388 Kenmount Road,
St. John's, Newfoundland
A1B 4A5

by:

Oceans LTD.
31 Temperance Street
St. John's, Newfoundland
A1C1 3J3

Anne Mathieu, Ph.D
amathieu@oceans.nf.net

Telephone: 709-753-5788
Facsimile: 709-753-3301

December 2002

Doc.Ref.No.11302

TABLE OF CONTENTS

1
Overview on Laboratory Studies on the Toxicity Potential of Discharges of Drilling Fluids and Cuttings

An overview on the toxicity potential of discharges of drilling fluids and cuttings is provided in order to assist with projections about the scale of biological impacts around exploratory wells. Both water-based and oil-based fluids have been extensively used for drilling in the marine environment. Oil-based fluids which originally contained diesel oil have superior engineering properties but fell into disfavour through observations of more extensive impacts on sediment communities around platforms where they were being used (e.g. Daan et al., 1994; Olsgard and Gray, 1995). However, the newer synthetic-based fluids (SBF) provide similar engineering properties as the older oil-based fluids, and may pose lesser risk to more environmental components than water-based fluids. This is due in part to the potential for greater and more widespread contamination associated with use of water-base drilling fluids.

The major ingredients in most water-based drilling fluids are minerals such as barite and bentonite, and while hundreds of additives are available for formulating drilling fluids, the total number of ingredients in most fluids is often a dozen or less. These include ingredients such as dispersants, viscosifiers, fluid control agents, and corrosion inhibitors. Drilling fluids and drilling fluid components in general have a very low acute toxicity potential. Leuterman et al. (1989) reviewed the extensive data base on the acute toxicity of drilling fluid additives for mysid shrimp which are considered among the most sensitive animals to a wide variety of contaminants. The majority of additives were indicated to be practically non toxic (at concentrations > 10,000 ppm with the majority being in the 100,000 ppm range or higher). Also, according to 96 hours acute toxicity tests recommended by the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) (1993), most drilling wastes are only slightly toxic (1,000-10,000 ppm) or practically non toxic (> 10,000 ppm).

Synthetic base fluids are replacing the diesel based fluids used in earlier days. Such fluids usually fall into the categories of synthetic alkanes, ethers, esters or olefins. A variety of SBF's have been shown to pass the U.S. acceptance criterion for toxicity of suspended particulates to mysid shrimp (LC50 > 30,000 mg/l) (adapted from Neff et al., 2000). Synthetic-based fluids have also been shown in sediment bioassays to be considerably less toxic than oil-based fluids (adapted from Neff et al., 2000). The synthetic isoalkane (IA-35) used in the Newfoundland offshore has also been reported to have a very low to negligible toxicity potential as assessed by exposure of various species to both contaminated water and sediment (Payne et al., 2001a; b). However, since some synthetic base fluids such as esters may degrade quite rapidly in the environment, they pose greater potential for creating anaerobic conditions which may have an impact on benthic communities in the near vicinity of rig sites (EPA, 2000).

Ground barite is a major component of drilling fluids and upon discharge the fine particles will settle to the ocean bottom at varying distances from platform sites, dependent upon water depth and current conditions. Studies in Canada have specifically drawn attention to the potential for relatively high concentrations of barite (or bentonite) to remain suspended in the water column near the bottom in the so called benthic boundary layer (e.g. Muschenheim and

Milligan, 1996). Use of water-base drilling fluids may generally result in more extensive contamination of the marine environment with barite (as well as with other ingredients) than use of synthetic fluids since the latter are discharged in lesser quantities. Use of synthetic fluids can also result in greater agglomeration of fine particulates reducing their geographical spread throughout the water column. This may be particularly important for some species.

Although ionic barium is quite toxic, the barium associated with barite is in the form of highly insoluble barium sulfate, reducing its "chemical" toxicity potential. Other than its deposition on the ocean bottom and potential for affecting benthic communities through physical alteration of sediments (e.g. Cantelmo et al., 1979), barite has generally been considered to be of negligible environmental significance. However, scallops which are an important commercial species on the East coast have a very low tolerance to suspended barite particulates (Cranford et al., 1999). Pathological effects have also been produced in other bivalves exposed to relatively high concentrations of barite for short periods (e.g. Barlow and Kingston, 2001). Earlier observations on the potential for barite to produce pathological effects in shrimp (Conklin et al., 1980) exposed to concentrations in the 100-500 ppm range for 30 days are of some interest given the importance of the shrimp fisheries off the East coast. Pathological and biochemical effects have also recently been observed in flounder exposed to relatively high concentrations of barite (J.F. Payne, Department of Fisheries and Oceans, unpublished). It is not presently known whether the effects associated with barite are wholly physical in nature or whether a chemical toxicity component may also be involved.

Briefly, laboratory derived acute toxicity studies indicate that water-based or synthetic drilling fluids pose little environmental risk. Any small risk posed by these fluids would be diminished even further by the relatively small quantities of fluids and cuttings discharged through drilling of single exploratory wells. Interestingly, although water-based fluids have generally been promoted as the best environmental option, it is currently realised that this may not be the case "in theory", due in part to the relatively higher quantities of contaminants released through use of water-based fluids. The potential for barite (and bentonite) from water-based fluids to disperse over wide areas of the water column and potentially impact biota to a small degree, provides an example in this regard. This type of impact could also be of greater importance for environmental and fisheries interests than any small impacts on sediment communities which have been intensively studied by comparison.

Overall, acute toxicity studies indicate that impacts on either sediment communities or on water column organisms such as fish and shellfish resulting from the drilling of single exploratory wells should be quite low or negligible. However, any monitoring programs required to confirm hypotheses about potential biological impacts of exploratory wells should also place emphasis on aspects other than the slight and relatively well known potential for impacts on sediment communities. Which organisms (fish, shellfish etc) might be of importance for assessment would depend on the exploratory site and stakeholder questions.

2
Overview on Field Surveys for Biological Effects Around Single Wells Or Sites Involving a Limited Number of Wells

Supplementary to the overview on the assessment of toxicity potential of drilling fluids as derived from laboratory studies, a similar overview is provided on relevant field studies at sites involving single or a limited number of wells.

Field studies can provide further assistance in estimating the scale of potential biological impacts around exploratory wells and representative studies from the North Sea, the Gulf of Mexico, and Australia have been included. Emphasis was placed on collating and reviewing studies carried out around single wells and sites involving a limited number of exploratory or development wells but a few production wells are also included. Also included are some regional studies such as in offshore Newfoundland and Nova Scotia where sites have received discharges from several wells. It would have been useful to have relevant oceanographic information such as water depth and current velocity for individual sites as well as information on discharge volumes, but this was not available in many instances. Field studies by nature have limitations, but they can offer important insight into the general scale of potential impacts when taken together.

Most surveys have emphasised studies on sediment communities and impacts in general appear to be quite localised within a radius of a few to less than 500 or more commonly 200 meters from rig sites (Tables 1-3). Impacts may also be substantially reduced at varying periods post discharge. However, impacts from water-based fluids may extend greater distances than impacts from synthetic fluids.

The US EPA has specifically noted the value of selected synthetic fluids for deep water drilling (EPA, 2000). The EPA also favours the use of synthetic fluids which degrade (at least in part) more rapidly. However, fluids which degrade more rapidly such as esters may also have a greater potential for producing anaerobiosis resulting in more deleterious effects on sediment habitat around rig sites. Interestingly, according to the regulatory regime in Canada such habitat effects could potentially warrant more attention and determined to be in contravention of the habitat provisions of the Fisheries Act.

Table 1: Representative Studies Around Wells Using Water Based Fluids (primary emphasis has been placed on collating biological impacts)

Location **Reference**	**Depth (m)**	**Cuttings/ Fluid Discharged**	**Variables Studied**	**Impacts**
Gulf of Mexico (Zingula, 1975)	33.5		• principally macro and megabenthos	• studied 8.5 months pd* • fauna comparable at discharge and reference sites
Gulf of Mexico (US DOI, 1977)	36 E *		• principally megabenthos	• animal abundance decreased within 100 m radius • some effects out to 1000 m radius
Offshore California (Meek and Ray, 1980)	63 E *	2,854 bbl*	• dispersion of cuttings	• indication that most cuttings fell to the bottom within 50 m radius • 70 – 80 % of settled solids redistributed
Alaska (Houghton et al., 1980)	62 E *		• dispersion of cuttings (currents >50 cm/sec)	• cuttings entrained to a depth of 12 cm into the sea floor after approx. 3 months • maximum cuttings found at 100 m (north) • 1.34 mm cuttings found 400 m north • no cuttings pile
Alaska (Lees and Houghton, 1980)	62 E *		• sediment communities	• number of organisms decreased at 100 and 200 m compared to controls
Mid Atlantic Continental Shelf (Mariani et al., 1980)	120 E *		• chemical and physical alteration in the benthic environment	• increased percentage of clay size particles out to 800 m • Ba increased 21-fold at 1.6 km • Pb increased 3.6-fold at 200 m • Ba in mollusks, brittlestars and polychaetes collected at 1.6 km increased 4, 18, 20-fold respectively (not known if major proportion in gut contents only)
Mid Atlantic Continental Shelf	120 E *		• benthic community	• study conducted 2 weeks after drilling • sessile mega and macrobenthos buried within approx. 75 m radius

Location Reference	Depth (m)	Cuttings/ Fluid Discharged	Variables Studied	Impacts
(Menzie et al., 1980)				• species diversity within range for the region • low values in the immediate vicinity of the well site (75 m)
Mid Atlantic Continental Shelf (EG & G Environmental Consultants, 1982)	120 E *		• sediment chemistry • mega and macrobenthos • metals in benthos	• study conducted one year pd • percent clay levels decreased to pre-drill type levels within 800m • patches of clay out to 800 m • 3-fold increase in Ba at 400 m (direction of predominant current) • even distribution of megabenthos from discharge point • dominant macrobenthos, depressed below pre-drill densities, but increase from previous studies conducted 2 weeks pd • species richness change out to 1.2 km (but not correlated with Ba) • Cr increased in polychaetes out to 1.2 km (not known if in gut contents only)
Beaufort Sea (Northern Technical Services, 1981)	8 E *		• cutting deposition • megabenthos	• sampled same plots for differences 4 months pd • 5 – 6 cm thick accumulation at discharge point, 1-2 cm at 6 m • number of organisms reduced in immediate area of discharge in comparison with 500 m distance • metals in sediment at discharge site similar to variations at control site
Georges Bank (Bothner et al., 1985)	E * 8 wells		• sediment chemistry	• 25 % of barite discharged at block 312 was present in sediments within 6 km of the rig, 4 weeks pd • maximum post-drilling

Location **Reference**	**Depth (m)**	**Cuttings/ Fluid Discharged**	**Variables Studied**	**Impacts**
				concentration of Ba (172 ppm) is similar to that found naturally in fine sediments • elevated concentrations of Ba in fine-grain sediments 65 km west of Block 312 • elevated concentrations of Ba 35 km east of one drilling site, against the dominant current
Georges Bank (Neff et al., 1989)	E *		• benthic community	• studies around 2 platforms • changes in benthic communities near the platforms attributed to natural changes
Florida (Continental Shelf Associates (CSA), 1988)	21 E *		• sea grass	• sea grass impacted within 300 m of discharge • surveys one year and two years pd indicated sea grass recovery • burial related impacts on bottom community within immediate area of discharge (25m)
Gulf of Mexico (Boothe and Presley, 1989)	79 P * 25 wells		• metals in sediment	• production site involving 25 wells • Zn gradient, elevation 5 – 10 times control • elevated Hg in sediment within 125 m of site
Gulf of Mexico (Boothe and Presley, 1989)	76 D * 8 wells		• metals in sediment	• elevated Hg in sediments within 125 m • Pb gradient, 3.8-fold higher within 500 m • Zn gradient, elevation 5 – 10 times control • elevation of HC (4–5-fold) within 250m
Gulf of Mexico (Continental Shelf Associates (CSA) and Barry A. Vittor and	40 – 60	7,285 m^3 drilling fluid; 726 m^3 cuttings	• sediment chemistry • macroinfaunal assemblages	• concentration of several metals were within or near ranges reported in offshore waters in the area • infaunal assemblages related to grain size and not

Location **Reference**	**Depth (m)**	**Cuttings/ Fluid Discharged**	**Variables Studied**	**Impacts**
Associates, 1989)				proximity to the discharge site • groupings determined primarily by season • individual abundance correlated with sediment texture and varied with season and not related to distance from the discharge site
Gulf of Mexico (CSA and Barry A. Vittor Associates, 1989)	40–60	7,285 m^3 drilling fluid; 726 m^3 cuttings	• sediment chemistry • metals in oysters	• significant increases in Ba concentrations were detected to 500 m • no increase in a number of metals in oyster tissue • Arsenic displayed a temporary increase (may not be linked to drilling)
Gulf of Mexico (CSA Associates, 1989)	60 1 well		• sediment chemistry • major visual changes in epibiotic community as assessed by photography and video	• indication that sediment Ba may have increased 4-fold at 2 km, Cr 8 – 10-fold at 500m • no “catastrophic” large scale changes in epibiotic community
California OCS, Platform Hidago (Steinhauer et al., 1990 as cited in EPA, 2000)	90-410 7 wells		• sediment chemistry • macrofauna and meiofauna	• significant temporal variation of macro and meiofauna, with inconsistent within-year variations • change in soft coral coverage seemed to be related to drilling, but not clear-cut

* pd = post discharge; bbl = baril; E = Exploratory well(s); D = Development well(s); P = Production well(s)

Table 2: Representative Studies Around Wells Using Synthetic Base Fluids (SBF) (primary emphasis has been placed on collating biological impacts)

Location (Reference)	Depth (m)	Amount Cuttings/ Fluids discharged (Fluid type)	Variables Studied	Impacts
North Sea (Smith and May, 1991)	67	749 mt containing 96.5 mt* (ester)	• SBF in sediments • benthic community	• 85,300 mg/kg at 50 m SW 46,400 mg/kg at 100 m SW 208 mg/kg at 200 m SW • dropped to less than 2 mg/kg (1 year pd*) • effects on benthic fauna at 100 m (8 months pd) • no effects (1 year pd)
Gulf of Mexico (Candler et al., 1995)	39	441 bbl cuttings 354 bbl* fluids <45 mt (poly alpha olefin)	• SBF in sediments • benthic community	• 134,428 mg/kg at 50 m (9 days pd) • 2,850 mg/kg at 50 m (8 months pd) • 3,620 mg/kg at 50 m (2 years pd) • 280 mg/kg at 200 m (2 years pd) • effects on benthic fauna at 50 m (2 years pd)
North Sea (Bakke et al., 1996)		55 mt (poly alpha olefin)	• SBF in sediments • benthic community	• SBF detected to 2 km from site • benthic fauna affected at 500 m (1 survey pd)
North Sea (Bakke et al., 1996)		115 mt (probably ester)	• SBF in sediments • benthic community	• low concentration of SBF to 2 km • benthic fauna normal (1 survey pd)
North Sea (Bakke et al., 1996)		46 m^3 (ester base)	• SBF in sediments • benthic community	• low concentration of SBF to 500 m • minor effects on benthic fauna to 500 m (1 survey pd)
North Sea (Bakke et al., 1996)		544 mt (ether)	• SBF in sediments • benthic community	• low concentration of SBF to 2 km • effects on benthic community to 1 km down current, 250 m in other directions (1 survey pd)
North Sea	30	361 m^3 synthetic based fluids	• SBF in sediments	• 393 mg/kg at 75 m (4 months pd)

Location (Reference)	Depth (m)	Amount Cuttings/ Fluids discharged (Fluid type)	Variables Studied	Impacts
(Daan et al., 1996)		180 mt (ester)	• benthic community	• 706 mg/kg at 75 m (8 months pd) • 54 mg/kg at 200 m (8 months pd) • effects on benthic fauna at 500 m (4 months pd) • effects on benthic fauna at 200 m (1 year pd)
Gulf of Mexico (Continental Shelf Associates, 1998) EPA benthic data	61	1,394 bbl cuttings with 1,315 bbl adhering fluids (internal olefin)	• SBF in sediments • benthic community	• 23,000 mg/kg (2 years pd) • benthic fauna affected at 50 m
Gulf of Mexico (Continental Shelf Associates, 1998) EPA benthic data	39	448 bbl cuttings with 850 bbl adhering fluids (linear alpha olefin and internal olefin)	• SBF in sediments • benthic community	• 6,700 mg/kg at 50 m (11 months pd) • 41 mg/kg at 100 m (11 months pd) • benthic fauna not impacted
Gulf of Mexico (LGL Ecological Research Associates, Inc., 1998)	565	6,263 bbl adhering fluids before 1997 survey 1,486 bbl additional before 1998 survey (90 % linear alpha olefin; 10 % ester)	• SBF in sediments • benthic community	• ~ 165,000 mg/kg at 75 m (1997 survey) ~ 198,000 mg/kg at 75 m (1998 survey) • density of some fauna greatly increased (3 months pd)
Australia (Terrens et al., 1998)	70	2,000 m^3 (ester)	• SBF in sediments • benthic community	• 12,000 mg/kg maximum after drilling • 200 mg/kg (6 months pd) • benthic fauna affected within 100 m of platform shortly after drilling • recovered in 4 months

Location (Reference)	Depth (m)	Amount Cuttings/ Fluids discharged (Fluid type)	Variables Studied	Impacts
North Sea (Det Norske Veritas, 1999)	5 separate wells	(synthetic and water-based)	• benthic community	• little or no effect on benthic community outside a radius of 250 m
Australia Wanaea – 6 (Oliver and Fisher, 1999)	80 1 well	48 mt (low toxicity oil based mud in lower section of well)	Studied 3 years pd • hydrocarbons in sediments • sediment communities	• sediment HC concentrations greater than 1mg/kg restricted to within 200 m • alteration of benthic community appeared to be limited to 100 m
Australia Lynx – 1a (Oliver and Fisher, 1999)	77 1 well	175 mt (low toxicity oil based mud)	• hydrocarbons in sediments	• Sediment HC 2,980 mg/kg at 100 m (shortly after pd) to 0.11 mg/kg approximately 1 year later
North Sea (Neff et al., 2000)	150	3,304 mt cuttings; 304 mt (ester)	• SBF in sediments • benthic community	• ~ 8,000 mg/kg at 25 m • ~ 1,260 mg/kg at 50 m • benthic fauna affected within 100 m of platform shortly after drilling • recovery in 4 months
North Sea (UK OOA, as cited in Neff et al., 2000)		57.5 mt (linear paraffin)	• SBF in sediments • benthic community	• 28,000 mg/kg maximum at 210 m • benthic fauna affected at heavily contaminated sites
North Sea (UK OOA, as cited in Neff et al., 2000)	150	304 mt (ester)	• SBF in sediments • benthic community	• 8,400 mg/kg maximum at 25 m (after drilling) • 1,800 mg/kg at 25 m (1 year pd*) • benthic fauna affected at stations with high concentrations of ester

* mt = metric tons or tonne; pd = post-discharge; bbl = baril

Table 3: Representative Studies around Wells off the East Coast of Canada

Location Site (Reference)	Depth (m) Number of wells	Amount Cuttings/ Fluids discharged (Fluid type)	Variables Studied	Impacts
Grand Banks Hibernia (JWE Ltd. (Jacques Whitford Environmental Ltd.), 2001a)	~ 90 18 wells	~ 9000 mt* cuttings ~ 1350 mt fluid (iso alkane)	• sediment chemistry • sediment bioassays • fish quality	• fuel range hydrocarbons (~ C10-C12 range) similar to those in base fluid at a maximum concentration of ~ 1100 mg/kg 50-100 m from the rig site • sediment from 250 m produced a toxic amphipod response which may be rig related • polychaete growth responses variable and not causally linked to rig • no apparent tainting or contamination of plaice
Grand Banks Terra Nova (JWE Ltd. (Jacques Whitford Environmental Ltd.), 2001b)	90 4 wells	634 mt (iso alkane)	• sediment quality • water quality • fish quality • fish health	• fuel range hydrocarbons (~ C10-C12 range) similar to those in base fluid generally quite low (~ 6 mg/kg or less) around periphery of exclusion zone • no apparent effects on benthic fauna • water quality (chemistry, chlorophyll) similar at development and reference sites • fuel range HC detectable in some scallops (may be from particulate in gut) • trace of HC found in flounder rig related • no apparent tainting of scallop or flounder

Location Site (Reference)	Depth (m) Number of wells	Amount Cuttings/ Fluids discharged (Fluid type)	Variables Studied	Impacts
				• fish health indicators (histopathology, MFO enzymes, haematology) comparable between rig and reference sites
Sable Island Bank Cohasset Panuke (MacNeill and Full, 2000; also personal communication)	40 17 wells 6 wells 7 wells	2,344 m^3 (low toxicity mineral oil) - (water-based) 937 m^3 (low toxicity mineral oil)	• hydrocarbons in sediments • sediment community • tainting of caged mussels	• HC in sediments not detected beyond 1000 m • no apparent impact on benthic community • tainting of mussels mostly within 500 m and while drilling underway • HC returned to background when discharges stopped
Venture Thebaud North Triumph (Hurley, 2000)	20 - 20 - 80 -	- (water base and internal olefin)	• hydrocarbons in sediments and water • sediment toxicity • sediment communities • mega fauna • shellfish taint	• elevated levels of HC in sediments, confined to 250-500 m • some amphipod toxicity at 250 m at Thebaud and North Triumph • no obvious effects on sediment communities outside cuttings piles or on epifauna • some evidence of low level contaminant of mussels with HC at the Venture site • some evidence of low level contamination of scallops with HC (source unknown) • no evidence of taint in scallops

* mt = metric tons or tonne

3
Benthic Impacts Produced by Petroleum Development Versus Other Impacts

In Canada the Fisheries Act can prohibit or seek compensation for an undertaking leading to the “alteration, disruption or destruction of fish habitat”. Dumping of cuttings can disturb benthic habitat, much in the same way as storms, dredging, fishing activities (or for instance natural discharges of large volumes of suspended sediments by rivers) (e.g. National Academy of Science (NAS), 1983). Thus it is of interest in the context of either environmental risk or the Fisheries Act to compare the size of zones of impacts stemming from petroleum activities with other marine activities. It is outside the remit of this exercise to carry out a risk analysis of different impacts, but the comparative impacts posed by the fishing industry is briefly discussed. The alteration and disruption of benthic habitat by fishing trawls and dredges is well recognised (e.g. Veale et al., 2000 and references therein; Watling et al., 2001; Wassenberg et al., 2002) and it has been reported that while the combined major biological effects of petroleum development in the UK sector of the North Sea (in 1989) was 106 km^2 (Table 4), the Irish Sea which is 2-3 thousand km^2 in area by comparison is trawled over 2.5 times per year (GESAMP, 1993). Also, it is important to note that some hundreds of wells contributed to the petroleum related impacts in the North Sea. Furthermore, toxic diesel based muds which can greatly enhance benthic impacts were commonly used in drilling during this period. Scallop dredging is known to be especially disruptive to benthic habitat resulting in changes in abundance of epifauna as well as infaunal species and depending on geographical region, could conceivably alter or disrupt benthic habitat over several hundreds to thousands of km^2 (e.g. Veale et al., 2000). Also with respect to clam dredging, the National Academy of Science (1983) noted in their review of drilling discharges, that while the drilling of a single well may lead to the deposit of 442 m^3 of cuttings altering benthic habitat, dredging for surf clams covers average swathes 1.5 m wide and 46 cm deep, which might impact 4,300 m^3 of sediment per vessel per day. It is not known how such an extensive impact on benthic habitat would compare with for instance the hydraulic dredging of clams on the Grand Banks or scallop dragging off the East coast.

Table 4: Area of Seabed Around North Sea Drilling Sites Affected by Oil-Based Drilling Muds (Davies et al., 1989; adapted from GESAMP, 1993)

Location/impacts	Number of wells	Average size/shape of zone
United Kingdom		
Major biological effects*	380 single	250 m radius
Subtle biological changes	380 single	1,000 x 500 m ellipse
OBM hydrocarbons present	380 single	1,000 x 2,000 m ellipse
Norway		
Major biological effects*	Single	500 m radius
Minor	Single	1,000 radius
Hydrocarbons present	single	2,000 x 4,000 to 6,000 m ellipse

* Toxic diesel based muds were commonly used during this development period exaggerating impacts on sediment habitat

4
Biological Monitoring Programs around Rig Sites in Relation to Generally Recommended Procedures for the Marine Environment

Environmental quality is ultimately biological in nature and over the past number of years there has been increasing emphasis on the use of biological techniques in monitoring programs in order to supplement more traditional chemical approaches, which were commonly used alone. There are a number of reasons for this shift in emphasis towards biological monitoring. For instance, reliance on chemical analysis alone presupposes that the contaminants of concern are known and dose-response relationships have been established for effects on various ecosystem components. This is rarely the case for any chemical or any species. Furthermore only representative contaminants can be measured and chemical analyses cannot take into consideration factors of biological significance such as the combined effects of contaminants, their degradation products and their interaction with environmental factors. The International Commission for the Exploration of the Sea (ICES) has recommended biological monitoring techniques for the marine environment under the framework of the Olso and Paris Commissions (Table 5). The list of techniques is not unlike those which are being used already in many "informal" as well as more formal monitoring and assessment programs (e.g. studies by the National Oceanic and Atmospheric Administration in the United States).

Analysis of benthic community structure or benthic community structure in combination with sedimentary microtoxicity tests, is recognised, including by ICES, as a valuable approach for assessing impacts on sediment habitat. Analysis of benthic community structure has also been one of the most widely used technique for assessing sediment habitat impact around petroleum exploration and development sites. This is the case for developments in the North Sea and the Gulf of Mexico (Tables 1-2) and more recently in Canada (Table 3) and Australia (Table 2). Studies indicate that any potential for significant impacts on sediment habitat around single exploratory or development wells through use of synthetic, or water base muds should generally be confined to within a few to 200 m of rig sites, if at all, (with impact zones being possibly somewhat shifted away from the immediate area of rig sites in deeper waters with fast currents). Noted in this regard is the observation that impacts associated with multi wells can also fall within the < 200 m range. Also, benthic impacts associated with petroleum development are indicated to be quite small in comparison with other impacts such as those produced by fishing activities (see section Benthic Impacts Produced by Petroleum Development Versus Other Impacts).

Considerable emphasis has been placed on studies of sediment communities around relevant well sites and the scale of impacts are fairly well known to be quite limited or negligible. However, there is a general lack of data on effects on fish and shellfish or other component which may be at some risk. Since population level effects in species such as fish would be both highly expensive to investigate and difficult to detect in the absence of major impacts, there is increasing emphasis on use of biochemical and histopathological indicators of chemical stress to obtain an appreciation of the degree and severity of any potentially impending problems in the marine environment. These indicators are commonly referred to as early warning or health effect bioindicators. Relevant indicators for monitoring effects in fish and shellfish such as induction of mixed-function oxidase (MFO) enzymes and histopathology are noted in the list of techniques recommended by the Oslo and Paris Commissions (Table 5).

Assessment of any potential impacts on fish and fisheries can be of considerable socioeconomic importance for regulators and the oil and fishery industries and bioindicators can provide a powerful tool for assessing if effects are occurring and if so, whether they might be of such a nature as to be of regulatory or socio-economic importance. For instance, perceptions/concerns about population level effects would have little scientific credibility in the absence of continuing evidence for individual level effects some distance from rig sites.

Laboratory studies indicate a potential for localised effects on fish and shellfish around petroleum development sites (e.g. Cranford et al., 2001 and references therein). Studies in the UK sector of the North Sea have demonstrated induction of MFO enzymes in fish around some platforms (Davies et al., 1984; Stagg et al., 1995). Histopathological lesions have also been found in finfish (Gallaway et al., 1981; Grizzle, 1986) and shrimp (Wilson-Ormond et al., 1994) around some production platforms in the Gulf of Mexico. Recognising that most of the biological monitoring programs carried out to date in association with oil development have primarily emphasised investigations on impacts on sediment habitat, and given the potential for effects on fish and other pelagic organisms around rig sites, studies have recently been carried out under the auspices of ICES around a development site in the North Sea. These studies have confirmed a potential for effects on fish and shellfish around platforms (ICES Workshop, 2002).

It is noted that the bioindicator studies carried out to date with fish and shellfish have been in association with development sites and the effects observed may primarily be linked to production waters. However, chronic effects associated with other potential contaminants including these found in drilling fluids cannot be discounted. As for impacts on benthic communities, any potential for impacts on fish around exploratory sites and especially these involving single wells some distance apart would seem to be quite low. It is of interest in this regard that Terra Nova has carried out fish health studies on a commercially importance flatfish (American plaice) around their site in advance of development (JWE Ltd., 1998). No differences were noted in the bioindicators studied between their predevelopment site, where a number of wells have been drilled, and the reference site. Similar observations on bioindicators of fish health have also been made with respect to the predevelopment site at White Rose where a number of wells have been drilled (JWE Ltd., 2000). These field results are consistent with observations by Payne et al. (1995) who found little evidence for health effects in flounder chronically exposed to levels of drilling fluids (aliphatic hydrocarbon based) similar to those commonly found beyond 200 m or so from rig sites. The laboratory studies of Cranford et al. (1999) with scallops and Conklin et al. (1980) with shrimp also indicate that any significant potential for localised effects should be more or less in association with deposits from multiple, not single wells. However, in the absence of evidence and with due regard for unknown chronic toxicity potentials, effects on fish, shellfish or other ecosystem components could be greater than those on sediment communities. It is also recognised that it is often important to provide assurance that effects are not occurring in some species. This could apply for instance to commercially important fish, “species at risk” or other high profile species.

Table 5: Biological Effects Techniques for Monitoring as Recommended by the Oslo and Paris Commissions (Stagg, 1998)

Type of monitoring	Purpose	Monitoring methods
General biological effects monitoring	• Monitor general quality status	• *Early warning indicators:* Cytochrome P-450 1A, lysosomal stability, liver histopathology (e.g. preneoplastic changes), reproduction in viviparous blenny • *Indicators of long-term change:* External fish diseases, benthos community structure studies, the occurrence of liver nodules
	• Identify known or suspected areas of impact	• *Bioassays:* Sediment, Pore water and water column • *Biomarkers:* Cytochrome P-450 1A (EROD), lysosomal stability, liver pathology/nodules in caged or sedentary organisms • *Population/community responses:* External fish diseases, reproduction in viviparous blenny, benthos community structure studies, liver histopathology
Contaminant-specific effects monitoring	• Effects of PAHs	• PAHs in sediment, PAH metabolites in bile, EROD in liver, DNA adducts in liver, liver pathology
	• Effects of Hg, Cd, Pb	• Metals in sediment and liver, metallothionein in liver, ALA-D in blood, antioxidant defenses in liver
	• Effects of TBT	• TBT in flesh, imposex/intersex in gastropods or shell thickening in *Crassostrea*

5
General Approach to Biological Effects Monitoring Around Exploratory Wells

Overall, exploratory drilling of single wells will likely result in minor or negligible impacts on fish habitat or on the health of fish, shellfish or other ecosystem components. However, any monitoring programs required to confirm hypotheses about potential biological impacts of exploratory wells in different types of environment should also place emphasis on studies of ecosystem components other than (or as well as) impacts on sediment communities which range from slight to negligible and are relatively well known. Which organisms (fish, shellfish etc) might be of importance for assessment would depend on the exploratory site. Candidate indices for monitoring effects in the marine environment have been recommended by the Oslo and Paris Commissions (Table 5). These include well known indices such as benthic community structure, sediment bioassays, mixed function oxygenase (MFO) enzymes, and histopathology. With respect to determination of health effects in individual organisms, concepts such as growth and histopathology can be applied to a large variety of animals in addition to fish. However, the nature of environmental effects monitoring, precludes being too prescriptive since new techniques are always evolving or novel environmental observations may be made requiring a change in approach. For instance, specific cytochemical changes in bivalves (peroxisomal proliferation) is evolving as a novel technique for assessing pathological effects produced by hydrocarbons and other organic chemicals in bivalves. Similarly, depending on purpose, caged or resident organisms could be studied. For instance, concerns about potential for effects on general environmental quality could be addressed in part by caging selected animals near discharge sites. However, such an approach could greatly exaggerate exposure conditions and produce highly misleading results should the question be related to whether resident organisms such as commercial fish species are being affected to any degree around rig sites. Any monitoring for impacts on bottom habitat or the health of fish or other organisms in association with exploratory drilling (or similar) should seemingly give priority to monitoring in shallow continental waters having relatively weak current regimes instead of at deep water sites, where any impacts of drilling fluids and cutting deposits would be greatly reduced by water depth and currents (e.g. areas such as the Flemish Pass). Also it is of interest to note that since environmental "fingerprints" or "zones of influence" are only important in relation to actual biological effects, ICES Working Groups on Biological Effects commonly recommend that first priority be given to assessing biological effects when carrying out monitoring programs. Under this approach, extensive chemical monitoring is only justified when biological effects have been observed. For instance, would chemical monitoring be justified at deep water sites where traces of drilling fluids of no biological significance might be deposited in sediments at tens of kilometers from source (similar to for instance deposition from myriad sources of sewage and other effluents entering the marine environment).

A general approach to biological effects monitoring is described but it is important to draw upon various stakeholder groups, regulators and scientific experts for final design and implementation once the purpose(s) has been clearly defined. It is also important to note that the emphasis here has been on biological effects, which is often the most difficult to deal with from a variety of perspectives. It is also understood in this regard that there may be need for a level of chemical monitoring at representative sites with respect to providing assurance for the quality of fish and shellfish or for instance assessing the degree of sediment contamination in the near vicinity of rig sites over time.

6
References

Bakke, T., Gray, J.S., Lichtentaler, R.G. and K.H. Palmork. 1996. Environmental surveys in the vicinity of petroleum installations on the Norwegian shelf. Report for 1994, Rapport 96 : 15, Statens Forurensningstilsyn (SFT), Oslo, Norway.

Barlow, M.J. and P.F. Kingston. 2001. Observations on the effects of barite on the gill tissues of the suspension feeder *Cerastoderma edule* and the deposit feeder *Macoma balthica*. *Mar. Poll. Bull.*, 42, 1: 71-76.

Boothe, P.N. and B.J. Presley. 1989. Trends in sediment trace concentrations around six petroleum drilling platforms in the Northwest Gulf of Mexico ; In: F.R. Englehardt, J.P. Ray and A.H. Gillan (Eds), Drilling Wastes, Elsevier Applied Science, London, 3-22.

Bothner, M.H., Rendings, R.R., Campbell, E.Y., Doughton, M.W., Parmenter, C.M., O'Dell, C.H., Dilisio, G.P., Johnson, R.G., Gillison, J.R. and N. Rait. 1985. The Georges Bank monitoring program 1985: Analysis of trace metals in bottom sediments during the third year of monitoring. Final report submitted to the US MMS US DOI, USGS, Woods Hole, MA, 99 p.

Candler, J. E., Hoskin, S., Churan, M., Lai, C.W. and M. Freeman. 1995. Seafloor monitoring for synthetic-based mud discharged in the Western Gulf of Mexico. SPE 29694, 51-69. *In:* SPE/EPA Exploration & Production Environment Conference, Houston, TX, 27-29 March 1995. Society of Petroleum Engineers, Inc. Richardson, TX .

Cantelmo, F.R., Tagatz, M.E. and K.R. Rao. 1979. Effect of barite on meiofauna in a flow-through experimental system. *Mar. Environ. Res.*, 2: 301-309.

Conklin, P.J., Doughtie, D.G. and K.R. Rao. 1980. Effects of barite and used drilling muds on crustaceans, with particular reference to the grass shrimp, Palaemonetes pugio. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Continental Shelf Associates, Inc. 1988. Monitoring of drillsite A in the Gainesville area block 707, prepared for Sohio Petroleum Company, Houston, TX, April 26, 1988, 124 p.

Continental Shelf Associates, Inc. 1989. Pre-drilling and post-drilling surveys for Pensacola Area Block 996. Prepared for Texaco Producing Inc., 38 p. + appendices.

Continental Shelf Associates, Inc. 1998. Joint EPA/Industry sceening survey to assess the deposition of drill cuttings and associated synthetic based mud on the seabed of the Louisiana Continental Shelf, Gulf of Mexico. Prepared for API Health 1 Environmental Sciences Dept., Washington, DC. Data Report, Continental Shelf Associates, Inc., Jupiter, FL, 58 p plus appendices.

Continental Shelf Associates, Inc. and Barry A. Vittor and Associates, Inc. 1989. Environmental monitoring to assess the fate of drilling fluids discharged into Alabama State waters of the Gulf of Mexico, prepared for Offshore Operators Committee, 46 p. plus appendices.

Cranford, P.J., Gordon, D.C., Lee, K., Armsworthy, S.L. and G.H. Tremblay. 1999. Chronic toxicity and physical disturbance effects of water- and oil-based drilling fluids and some major constituents on adult sea scallops (*Placopecten magellanicus*). *Mar. Environ. Res.*, 48: 225-256.

Cranford, P.J., Lee, K., Loder, J.W., Milligan, T.G., Muschenheim, D.K. and J.F. Payne. 2001. Scientific considerations and results relevant to the review of the 1996 offshore waste treatment guidelines. *Can. Tech. Rep. Fish. Aquat. Sci.*, 2364.

Daan, R., Mulder, M. and P. Leeuwen. 1994. Differential sensitivity of macrozoobenthic species to discharges of oil-contaminated drill cuttings in the North Sea. *Netherland J. Sea Res.*, 33, 1: 113-127.

Daan, R., Booij, K., Mulder, M. and E.M. van Weerlee. 1996. Environmental effects of a discharge of drill cuttings contaminated with ester-based drilling muds in the North Sea. *Environ. Toxicol. Chemistry*, 15: 1709-1722.

Davies, J.M., Addy, J.M., Blackman, R.A., Blanchards, J.R., Ferbrache, J.E., Moore, D.C., Sommerville, H.J., Whitehead, A. and T. Wilkinson. 1984. Environmental effects of the use of oil-based drilling muds in the North Sea. *Mar. Poll. Bull.*, 15: 363-370.

Davies, J.M., Bedborough, D.R., Blackman, R.A., Addy, J.M., Appelbee, J.F., Grognan, W.C., Parker, J.G. and A. Whitehead. 1989. The environmental effect of oil-based mud drilling in the North Sea. In: Drilling Wastes, F.R. Engelhart, J.P. Ray and A.H. Gillam (eds.). Elsevier Applied Science, New York, pp. 59-89.

Det Norske Veritas. 1999. Dispersion and effects of synthetic drilling fluids on the environment: Biological survey, long-term effect of oil and produced water, chemicals and oil spill contingency. Prepared by Jensen, T., Palerud, R., Olsgard, F., Bakke, S.M. for the Ministry of Oil and Energy, Report no. 99-3507, 49 p.

EG & G Environmental Consultants. 1982. A study of environmental effects of exploratory drilling on the mid-Atlantic outer continental shelf. Final Report of the block 684 monitoring program, prepared for Offshore Operators Committee. October 1982.

EPA (Environmental Protection Agency). 2000. Environmental assessment of final effluent limitations guidelines and standards for synthetic-based drilling fluids and other non-aqueous drilling fluids in the oil and gas extraction point source category. EPA-821-B-00-014, December 2000.

Gallaway, B.J., Martin L.R., Howard, R.L., Boland, G.S. and G.D. Dennis. 1981. Effects on artificial reef and demersal fish and macrocrustacean communities. In: Environmental Effects of Offshore Oil Production: the Buccanear Gas and Oilfield Study. Middleditch, BS, 1981.

GESAMP (IMO/FAO/UNESCO/WHO/IAEA/UN/UNEP Group of Experts on the Scientific Aspects of Marine Pollution). 1993. Impact of oil and related chemicals and wastes on the marine environment. *Rep. Stud. GESAMP*, 50, 180 p.

Grizzle, J.M. 1986. Lesions in fishes captured near drilling platforms in the Gulf of Mexico. *Mar. Environ. Res.*, 18: 267-276.

Houghton, J.P., Britch, R.P., Miller, R.C., Runchal, A.K. and C.P. Falls. 1980. Drilling fluid dispersion studies at the Lower Cook Inlet, Alaska, COST Well. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Hurley, G.V. 2000. Nearshore and offshore environmental effects monitoring at the Sable offshore energy project. *Can. Tech. Rep. Fish. Aquat. Sci*., 2311: 39-42.

ICES (International Council of the Exploration of the Sea) Workshop. 2002. Biological Effects in Pelagic Ecosystems (BECPELAG), Copenhagen.

JWE Ltd. (Jacques Whitford Environmental Limited). 1998. Terra Nova baseline characterisation data report, prepared for Petro-Canada, 1998.

JWE Ltd. (Jacques Whitford Environmental Limited). 2000. White Rose baseline characterisation data report, prepared for Husky, 2000.

JWE Ltd. (Jacques Whitford Environmental Limited). 2001a. Hibernia production phase environmental effects monitoring program, Year 3, prepared for Hibernia Management Development Corporation, 2001.

JWE Ltd. (Jacques Whitford Environmental Limited). 2001b. Terra Nova production phase environmental effects monitoring program report, Year 2, prepared for Petro-Canada, 2001.

Lees, D.C. and J.P. Houghton. 1980. Effects of drilling fluids on benthic communities at the Lower Cook Inlet, Alaska, COST Well. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

LGL Ecological Research Associates, Inc. 1998. Opportunistic sampling at a synthetic drilling fluid discharge site on the continental slope of the northern Gulf of Mexico: The Pompano Development, 10-11 July 1997 and 13-14 March 1998. Report prepared by Gallaway, B.J., Fechhelm, R.G., Hubbard, G.F. and S.A. MacLean for BP Exploration, Inc.

Leutermann, A.J., Jones, F.V., Bettge, G.W. and C.L. Stark. 1989. New drilling fluid additive toxicity data developed. *Offshore*, 49.

MacNeill, M. and S. Full. 2000. Environmental effects monitoring for the Cohasset Project. *Can. Tech. Rep. Fish. Aquat. Sci.*, 2311: 36-37.

Mariani, G., Sick, L. and C. Johnson. 1980. An environmental monitoring study to assess the impact of drilling discharges in the Mid-Atlantic, III, chemical and physical alterations in the benthic environment. Alaska, COST Well. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Meek, R.P. and J.P. Ray. 1980. Induced sedimentation, accumulation and transport resulting from exploratory drilling discharges of drilling fluids and cuttings on the Southern California outer continental shelf. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Menzie, C., Maurer, D. and W. Leathem. 1980. An environmental monitoring study to assess the impact of drilling discharges in the mid-Atlantic, IV, the effects of drilling discharges on the benthic community. *In*: Symposium, Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Florida, January 21-24, 1980. API, Washington, D.C.

Muschenheim, D.K. and T.G. Milligan. 1996. Flocculation and accumulation of fine drilling waste particulates on the Scotian shelf (Canada). *Mar. Poll. Bull.*, 32, 10: 740-745.

National Academy of Science (NAS). 1983. Drilling discharges in the marine environment. Panel on Assessment of Fates and Effects of Drilling Fluids and Cuttings in the Marine Environment, Marine Board, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, D.C., 1983.

Neff, J.M., Bothner, M., Maciolek, N. and J. Grassle. 1989. Impacts of Exploratory drilling for oil and gas on the benthic environment of Georges Bank. *Mar. Environ. Res.*, 27, 2: 77-114 .

Neff, J.M., McKelvie, S. and R.C. Ayers. 2000. Environmental impacts of synthetic based drilling fluids. OCS Study, MMS 200-064, published by U.S. Dept of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, August 2000.

Northern Technical Services. 1981. Beaufort sea drilling effluent disposal study, prepared for the Reinder Island Stratigraphyc Test Well Participants, under the direction of Sohio Alaska Petroleum Company, 329 p.

Oliver, G.A. and S.J. Fisher. 1999. The persistence and effects of non-water-based drilling fluids on Australia's Northwest shelf: progress findings from three seabed surveys. *APPEA J. 1999*: 647-662.

Olsgard, F. and J.S. Gray. 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Mar. Ecol. Prog. Ser.*, 122: 277-306.

Payne, J. F., Fancey, L., Hellou, J., King, M.J. and G.L. Fletcher. 1995. Aliphatic hydrocarbons in sediments: a chronic toxicity study with winter flounder (*Pleuronectes americanus*) exposed to oil well drill cuttings. *Can. J. Fish. Aquat. Sci.*, 52: 2724-2735.

Payne, J. F., Andrews, C, Whiteway, S. and K. Lee. 2001a. Definition of sediment toxicity zones around oil development sites: Dose response relationships for the monitoring surrogates Microtox[r] and amphipods, exposed to Hibernia source cuttings containing a synthetic base oil. *Can. Manuscr. Rep.Fish. Aquat. Sci.*, No 2577, vi + 10 p.

Payne, J. F., Fancey, L., Andrews, C, Meade, J.D., Power, F.M., Lee K., Veinott, G. and A. Cook. 2001b. Laboratory exposures of invertebrate and vertebrate species to concentrations of IA-35 (Petro Canada) drill mud fluid, production water, and Hibernia drill mud cuttings. *Can. Manuscr. Rep.Fish. Aquat. Sci.*, No 2560, iv + 27 p.

Smith, J. and S.J. May. 1991. Ula wellsite 7/12-9 environmental survey 1991. Report FSC/RC/13/91. Field Studies Council Research Centre, UK.

Stagg, R.M., McIntosh, A. and P. Mackie. 1995. Elevation of hepatic monooxygenase activity in the dab (*Limanda limanda L.*) in relation to environmental contamination with petroleum hydrocarbons in the northern North Sea. *Aquat. Toxicol.*, 33: 245-264.

Stagg, R.M. 1998. The development of an international program for monitoring the biological effects of contaminants in the OSPAR convention area. *Mar. Environ. Res.*, 46, 1-5: 307-313.

Steinhauer, M. et al. 1990 (as cited in EPA, 2000). California OCS phase II monitoring program, Year 3, annual report, chapter 13, Program Synthesis and Recommendations.

Terrens, G.W., Gwyther, D., Keough, M.J. and R.D. Tait. 1998. Environmental assessment of synthetic based drilling mud discharges to Bass Strait, Australia. SPE 46622, 1-14. *In:* 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production ; Caracas, Venezuela, 7-10 June 1998. Society of Petroleum Engineers, Inc. Richardson, TX.

U.S. Department of Interior (US DOI). 1977. Baseline monitoring studies, Mississipi, Alabama, Florida, Outer Continental Shelf, 1975-1976, volume VI, Rig monitoring, (assessment of the environmental impact of exploratory oil drilling), prepared by the State University System of Florida, Institute of Oceanography. Contract 08550-CT5-30, Bureau of Land Management, Washington, D.C.

Veale, L.O., Hill, A.S., Hawkins, S.J. and A.R. Brand. 2000. Effects of long-term disturbance by commercial scallop fishing on subtidal epifaunal assemblages and habitats. *Mar. Biol.*, 137: 325-337.

Watling, L., Findlay, R.H., Mayer, L.M. and D.F. Schick. 2001. Impact on scallop drag on the sediment chemistry, microbiota and faunal assemblages of a shallow subtidal marine benthic community. *J. Sea Res.*, 46: 309-324.

Wassenberg, T.J., Dews, G. and S.D. Cook. 2002. The impacts of fish trawls on megabenthos (sponges) on the Northwest shelf of Australia. *Fish. Res.*, 58: 141-151.

Wilson-Osmond, E ;A., Ellis, M.S. and E.N. Powel. 1994. The effect of proximityto gas producing platforms on size, stage of reproductive development and health in shrimp and crabs. National Shellfisheries Association, Charleston, South Carolina, *Abstracts*, 1994 Annual Meeting, April 24-28: 306.

Zingula, R.P. 1975. Effects of drilling operations on the marine environment. In: Conference Proceedings on Environmental Aspects of Chemical use in Well-Drilling Operations, Houston, Texas, May 21-23, 1975.

Appendix II

Review of Nova Scotia EEM Results

Table 1. Water Quality: TSS AND TPH, Sediment Chemistry: Barium, Extent of Cuttings Pile and Hydrocarbons (HC) in Sediments, BBL

EEM Report Date (SEEMAG minutes)	Water Quality: TSS AND TPH	Sediment Chemistry: Barium	Extent of Cuttings Pile and Hydrocarbons (HC) in Sediments	BBL
Baseline (June/July 98) VENTURE	TPH: BDL	250-m – 140-170-mg/kg; 15-km, 330-mg/kg	HC detected in 250-500-m range.	12 sites established, 250-m to 15-km. 10 sites, barium 0.2-1.5-µg/l, 2 sites 1.5-5.6-µg /l
SOUTH VENTURE	TPH: BDL	86 – 340-mg/kg, at the 15-km site		12 sites, 250-m to 15-km. .2-.9-µ/l
THEBAUD	TPH: BDL	85–300-mg/kg, peak at 9–12-km.		13 sites, 250-m – 20-km concentrations from 1.8 to 12-µ/l.
GULLY	TPH: BDL	78 – 159-mg/kg		None found in any of five sites
Fall 98 (Nov. 99) VENTURE	TSS: Elevated to 13.2-mg/L at 250-m and 500-m TPH: Did not exceed 75.2-ppm, i.e. not detected at modeled levels of 1,000-ppm or 10,000-ppm at 250-m. Elevated concentrations at 1 250-m site, but at levels predicted for 600-700-m. sites.		HC seen in prevailing current direction	No significant variation from baseline measurements for either SPM or barium.
SOUTH VENTURE				
THEBAUD	TSS: Fine particulates settle out within 500-m of platform. No plume visible			
GULLY				
April–June 99 (Nov. 99) VENTURE	TSS: No peak seen TPH: Did not exceed 75.2-ppm, i.e. not detected at levels of 1,000-ppm or 10,000-ppm at 250-m. Elevated concentrations at 2 250-m sites, but at levels predicted for 600-700-m sites.	No difference	Rig survey after storms: max height of pile approx. 3-m, with side slopes declining at 45° down NE and SE faces. Western boundary to 22-m; southern to 25-m; east to 70-m; north not provided. Venture model had predicted max height of 3.5-m, with spread out to 1.0-mm at 400-500-m radius. Smaller concentrations of HC in sediments within 250-m	No significant variation from baseline measurements for either SPM or barium.

EEM Report Date (SEEMAG minutes)	Water Quality: TSS AND TPH	Sediment Chemistry: Barium	Extent of Cuttings Pile and Hydrocarbons (HC) in Sediments	BBL
THEBAUD	TSS: No plume visible from discharge point. No change up to several km from platform TPH: 1510-ppm and 560-m found at 2 250-m sites these levels were predicted for 400 and 600-m; model predicted 10,000-m. Samples in direction of prevailing current had odour detectable in lab; small oil sample found.	Barium increased at 250-m on Axes 3 and 7. Not much change in Ca, Pb, Cu, Z	Elevated HC concentrations seen in prevailing current direction (east)	SPM and barium well below levels predicted by **bblt** model.
Summary Venture/Thebaud			No evidence of drilling muds 250-m from platforms at Venture or Thebaud. Sediments clean and grain size consistent at 250 and 500-m. sites. Thebaud model had predicted max height of 1-m, with spread to 1-mm at 500-600-m.	Model predicted SPM 7-mg/L at 250–1000-m – not found at either Venture or Thebaud. Model predicted drilling mud fines .1-mg/L; not found – values variable, but lower, did not change significantly with distance from discharge point
1998-1999 Program Conclusion (May 00)	TPH: TPH and barium found to be only reliable indicators of drilling wastes. All elevated TPH concentrations found along prevailing currents.	TPH and barium found to be only reliable indicators of drilling wastes. All elevated barium concentrations found along prevailing currents.	Drill waste piles considerably smaller than modeled. Appearance and disappearance of detectable drill waste within 250 and 500-m at Venture and Thebaud demonstrates dynamic nature of seabed in shallow water on Sable Island Bank.	
Fall 99 (Oct. 00) Venture			Drill cutting pile at end of drilling extended out to 70-m. Drill wastes diminishing, projected to be gone in a year	
North Triumph			In deeper water than other wells; wider spread of plume, as predicted. Plume extends to 3-km. Thin veneer of cuttings at 250- m.	
Thebaud		Back to baseline.	Drill wastes diminishing, projected to be gone in a year.	

EEM Report Date (SEEMAG minutes)	Water Quality: TSS AND TPH	Sediment Chemistry: Barium	Extent of Cuttings Pile and Hydrocarbons (HC) in Sediments	BBL
June 00 (Oct. 00) Venture		Correlates well with HC concentrations.	HC at background though some evidence at 250-m to NE.	
Thebaud		Concentrations up again to 1900-mg/L. Note: barium can be problematic to analyze. Hard to dissolve, concen-trations can be underestimated.	Some remnant drill cuttings persisting in prevailing current direction.	
North Triumph			Plume reduced but persisting to 250-500-m. Up to 40-mg/kg HC in grab from top 5-cm that included fine sediments. Drill wastes appear much more stable, projected to take up to 3 years to disperse.	
Summary Tier 1 Results (Apr. 01)			Overall much less drill waste impact than modeled. Much of drill waste appears cohesive and clumps. Tends to stay in narrow pile within 70–100-m of source. Cutting piles under rigs lasting longer than predicted as SBM sticky and holding cuttings in place. Hydrocarbon levels consistently very low; detectable concentrations (close to background levels) found at 250-m and 500-m in direction of prevailing currents at Thebaud and North Triumph	Bentonite-sized particles not detected in SPM extracted from BBL water samples. Maximum concentration of barium 2 orders of magnitude less than sub-lethal effects on scallop.
Review of 2001 (Nov. 01)			Carried out storm scour surveys and collected samples of drill cutting piles for bacterial analysis. ROV surveys of cuttings piles.	Annual rather than semi-annual program. No evidence of drill waste muds found over past three years.
Venture		Barium at background/	Reduction in total HC (THC) contamination over time at 250-m and 500-m. Samples now at background.	

EEM Report Date (SEEMAG minutes)	Water Quality: TSS AND TPH	Sediment Chemistry: Barium	Extent of Cuttings Pile and Hydrocarbons (HC) in Sediments	BBL
Thebaud		Barium elevated.	Some residual THC contamination. Cuttings pile has plasticine texture. Cuttings do not move easily and pile has distinct edge. Crabs live on it and are seemingly healthy. This quality of cutting may not have been modeled – seems almost like artificial reef.	
North Triumph		Barium back to background.	THC back to background. Cuttings much more friable than at Thebaud.	
July 02 (Nov. 02)				
Venture	At background.	At background.	Cuttings pile still very prominent, although it should have disappeared quickly. Has a plastic consistency. Protected by mattresses. Sulphide-reducing bacteria blanketing sediment close to the jacket—cause unclear. Algal growth and crabs on cuttings, fish nearby.	
Thebaud	Elevated at 250-m (recent drilling activity)	Elevated at 250-m (recent drilling activity)		
North Triumph		Elevated at 250-m		

Source: CEF (2003).

Table 2. Sediment Toxicity, Mussel Body Burden and Taint, Other substances/issues.

EEM Report Date and Locations (SEEMAG minutes)	Sediment Toxicity	Mussel Body Burden and Taint	Other substances/issues
Baseline (June/July 98) VENTURE	Echinoid fertilization – looking for failure due to natural processes. Failures at 20-km reference site. No sulphides, ammonia .5-mg/L.		
SOUTH VENTURE	Failures at 2 stations, 250-m and 3-km. Microtox™ reduction at 250-m.		
THEBAUD	Failures at 2 stations, 250-m (ammonia .06-mg/L) and 20-km (ammonia .11-mg/L). Microtox™ reduction at 250-m.		
GULLY	Failures at 2 stations northeast of Venture.		
Fall 98 (Nov. 99) VENTURE	No Microtox™ effects. No amphipod toxicity. Toxic effect on echinoid fertilization at one 500-m site.	Only 3 of 7 complete sets retrieved from 500-m, 4-km, and 30-km. – gear loss due to shipping and seismic. Taste and smell showed sig. diff. in odour at 4-km, body burden with C23 and on long hydrocarbons. Different phytoplankton at that site. Comparison with store-bought showed no sig. diff. in sensory evaluation. Baseline bulge at 500-m in OBM region (C17-C20; mussels healthy and feeding. Hydrocarbon concentrations in mussel tissues not solely due to discharges.	
SOUTH VENTURE			
THEBAUD	No Microtox™ effects. No amphipod toxicity. No echinoid fertilization toxicity.		

EEM Report Date and Locations (SEEMAG minutes)	Sediment Toxicity	Mussel Body Burden and Taint	Other substances/issues
GULLY			
April - June 99 (Nov. 99) VENTURE	No Microtox™ effects. No echinoid fertilization toxicity. Amphipod toxicity at 2 250-m sites, also at 500, matched to SBM.	Seven partial sets retrieved at 500-m, 1-km, 2-km, 4-km, 10-km, 13-km, 30-km. Small amounts in source, control and 13 samples. Highest concentration overall and from OBM (3.04-mg/L) from top of 500-m site. Samples from 1 and 2-km (top), 4-km (top and bottom and 10-km (top) showed moderate amounts of hydrocarbons, with small base mud oil envelop 1.98-2.12-mg/L – greater than tainting levels predicted for scallop (2-mg/L) and mussels (1-mg/L). No differences in flavour and odour from control samples, and concentrations not toxic to animals, which were feeding and healthy.	
THEBAUD	No Microtox™ effects. No amphipod toxicity. No echinoid fertilization toxicity.		
Summary Venture/Thebaud (Nov. 99)	Model predicted pronounced toxicity within 150–300-m, but not apparent from 250-m. Venture or Thebaud data. Need to verify persistence and cause of toxicity at V500-3.	Hydrocarbons predicted to extend 10-15-km. Found at all sites, including control. Highest concentrations of base mud oil at 500-m (3.04-mg/L), 4-km (1.98-mg/L), 10-km (1.34-mg/L). High peaks of pristance indicated mussels healthy and feeding.	
1998-1999 Program Conclusion (May 00)	All amphipod mortality toxicity effects found along prevailing currents as established in the sampling design.	Hydrocarbons detected in tissues out to 10-km, but appear not to be causing taint.	Sound spectra do not appear to influence marine mammals' presence or behaviour. Likely no large scale bird fatalities in vicinity of platforms. None of oiled seabirds found on Sable had hydrocarbons traceable to SOEP. Oct.-Nov. 99 no effects on air quality on Sable Island during one-month monitoring period EIS models considerably overestimated impacts from drilling waste discharges. Effects observed validate conclusions that SOEP unlikely to cause sig. adverse env. effects. Impacts far less than anticipated.

EEM Report Date and Locations (SEEMAG minutes)	Sediment Toxicity	Mussel Body Burden and Taint	Other substances/issues
Fall 99 (Oct. 00) Venture	No hits with either Microtox™ or amphipods.	Detected at 500-m. Nov. 99 – Feb. 00. Change in flavour, apparently not biogenic; occurred during discharge of SBM and produced water.	
North Triumph		Detected at up to 1000-m. Appeared to be biogenic source as sweet taste.	
Thebaud	Toxicity at 250 m.	Detected at up to 1000-m. Appeared to be biogenic source as sweet taste.	
June 00 (Oct. 00) Venture			
Thebaud			
North Triumph			
Summary Tier 1 Results (Apr. 01)	No toxicity found in survey array close to platforms (40 – 150 m).	No tainting found in survey array close to platforms (40 – 150 m). Positive odour and taste results found to have been caused by biogenic HC from phytoplankton.	No effect on epifauna and infauna communities at any survey stations. Lots of juvenile groundfish, mussels and crab around platforms. Large epibenthics colonizing exposed portions of pipeline (anemones, urchins, etc.) Snow crabs on and along sides of pipeline and in high densities around North Triumph. Thebaud protective mattresses had many sea cucumbers. No effects seen on marine mammals within acoustic range. No large-scale bird fatalities from flares, no oiled seabirds on Sable with HC attributable to Tier 1.
Review of 2001 (Nov. 01)	Moved to annual toxicity analysis. Echinoid not successful. Now using amphipods only—better indicators of solid phase contamination.	Mussel moorings taken out as being run over by vessels. Only one reinstalled, at 1000-m from Venture.	Crab traps set a North Triumph. Established radial survey array for Venture, Thebaud, North Triumph and a remote reference site.
Venture	No amphipod mortality observed.		Limited benthic diversity.
Thebaud	Some amphipod mortality along prevailing current direction.	Previous odours/tastes in mussels determined to be due to phytoplankton. Some HC detected in flesh but no sensory taint detected. No HC contamination in crabs, nor taint. Data consistently show taste differentiation at 2250-m, but not much at 500-m and none at 1000-m. Taste and odour do not seem to relate to body burden.	Some variability in benthic diversity.

EEM Report Date and Locations (SEEMAG minutes)	Sediment Toxicity	Mussel Body Burden and Taint	Other substances/issues
North Triumph			Some variability in benthic diversity. (Note on both: difficult to measure benthic diversity, thus hard to evaluate spatial and temporal changes. Annual sampling does not allow definition of spatial change.)
July 02 (Nov. 02)	Now limited to amphipod toxicity with ammonia and sulphide used to establish cause and effect.	Program reduced to scraping mussels off platform legs and sampling at 1000-m mussel mooring off Venture. None at Thebaud.	No significant effects on benthos at Venture, Thebaud or North Triumph beyond cuttings piles. Sentinel species being introduced, e.g., snow crab; Jonah crab around Venture and Thebaud also possibility.
Venture		April: HC presence in mussels similar to October 01; strong biogenic HC signature. July: mussels had high levels of interfering material. Hepatopancreas showed traces of Nova Plus Drill Mud. Aliphatic hydrocarbon detected, but no tainting.	Leg mussels of crab showed Nova Plus Drill Mud profiles.
Thebaud	Amphipod mortality found at 250 and 500-m.	Mussels showed lower level peaks in C12 and C17 ranges of same material as Venture. Aliphatic hydrocarbon detected, but no tainting.	

Source: CEF (2003).

Appendix III

Results of Consultations

Appendix III - Results of Consultations

East Coast Issues

Issue Scoping

A series of informal interviews and meetings were held in Newfoundland and Nova Scotia with a variety of regulators and other interested parties. Formal questionnaires were not used and participants were advised that their responses would not be directly attributable to them in the final report. The Study Team decided that this informal approach was the one most likely to gain timely and candid input from the interviewees.

The meetings and interviews served as a type of issue scoping that provided information on the following main questions.

- Is EEM required for drilling a single exploratory well off the East Coast? If so, under what conditions? If not, under what rationale for exclusion?
- What are the key variables/issues?
- Any study design suggestions?

The results of the interviews were quite different for Newfoundland versus Nova Scotia and thus the results are presented separately below.

Results of Newfoundland Consultations

Meetings or interviews were conducted with representatives of the Canada-Newfoundland Offshore Petroleum Board, Fisheries and Oceans (DFO) (both Science and Management Branches), Environment Canada (Environmental Protection Branch, Canadian Wildlife Service), the Natural History Society, Food, Fish and Allied Workers (FFAW), Fishery Products International, Fisheries Association of Newfoundland and Labrador (FANL), One Oceans, Oil and Gas Industry (Husky, Petro-Canada, Hibernia).

The discussions can be condensed into about 29 issues, albeit with some degree of overlap. Issues were provided a numerical 'score' (score simply means the number of times they were discussed in the various conversations and the general importance that respondents appeared to place on them). The list of issues more or less in order of perceived importance includes the following.

1. Production EEM designs (e.g., SQT, FHI, etc.) considered good
2. Consider local conditions (depth, currents, etc.)
3. Continue opportunistic bird, mammal and turtle surveys from supply boats
4. Maintain a flexible approach
5. Allow public access to EEM data within a reasonable period of time
6. Consider critical habitats
7. Consider drilling scenario (e.g., rig, mud types, etc.)

8. ‘Piggyback’ EEM on existing required efforts such as pre- and post-drilling well site surveys (e.g., geophysical, geochemical, ROV surveys, etc.)
9. Relevance of water quality monitoring
10. Size of cuttings pile/disturbed area
11. Test model predictions of mud/cuttings dispersion
12. Consider degree of risk of effects in EEM design
13. Conduct research studies to address recurring perceptions/issues
14. Practicality/cost considerations (e.g., time constraints, baseline, etc.)
15. Benthic communities
16. Monitor barite signature
17. Monitor redox potential
18. Monitor for ‘comfort’ if nothing else
19. Scale down production EEM for exploratory
20. Baseline data required
21. Liability issues of not monitoring
22. Incorporate any special public concerns
23. Deepwater corals
24. Birds on structures
25. Qualifications of observers/monitors
26. Consider effects of other industrial activities (e.g., fishing, transportation, etc.)
27. Cumulative effects of many exploratory wells
28. Monitor habitat compensation projects as well
29. More policy discussion of exploratory EEM

The above order of issues should not be taken totally at face value because some issues at the bottom of the list (e.g., Issue 23 *corals*) may be related to those near the top (e.g., Issue 6 *critical habitats*). Nonetheless, it is clear that the following issues were important discussion points at every meeting, namely:

- For the most part, everyone appeared satisfied that the present EEM programs were well designed and were providing useful information on the effects of the producing developments at Hibernia and Terra Nova. Many people felt that if EEM were going to be conducted for exploratory drilling then the production EEM program designs were good starting points.

- Local environmental conditions, particularly water depth and currents, must be considered in any offshore EEM program. Note also that corals may be an issue in certain deepwater areas but not shallow areas.

- The opportunistic bird and mammal surveys presently being conducted from supply boats at Hibernia and Terra Nova were viewed favourably by most interviewees although it was agreed that they are not, strictly speaking, EEM but rather general survey data. It was, however, pointed out that the data are of limited use unless they are publicly available and analyzed and interpreted into useful reports. Birds on structures has been a recurring issue in public meetings in Newfoundland but it appears that the ESRF and others may be addressing these questions and thus they have been de-emphasized.

- Most people suggested that the design be flexible to account for unforeseen events. Flexibility may be a very important issue in the case of exploratory programs which have much less lead-time than production programs.

- Virtually every non-industry person stated that the EEM data should be available to the academic community, industry researchers, EA practitioners, and the general public much sooner than the now regulated under the Atlantic Accord five-year confidentiality period.

- Any critical habitats should be identified during the EA process and avoided. If they cannot be avoided, then the EEM program should be enhanced as appropriate.

- Various drilling scenarios need to be considered in the design. For example, while different rig types have generally similar discharges their depth of discharge may vary. Also, 'jack-up' and semi-submersible rigs emit less noise than drill ships. The type of drill mud (water-based vs. synthetic) used may affect the distribution of potential contaminants and hence should influence the sampling design.

Several excellent points were made during the meetings such as the suggestion to 'piggyback' EEM on existing well site programs (Issue 8 above which also ties in not only with Issue 14 *cost and practicality* but also Issue 4 *flexible approach*, 10 *size of disturbed area*, 11 *test modeling*, and 21 *liability*). The suggestion to monitor the effects of habitat compensation programs is also an interesting one, albeit mostly related to developments where DFO determines a situation of habitat alteration, disruption or destruction (HADD) and then requires a habitat compensation program, which in itself may create environmental impacts. To date, DFO has not required compensation for exploratory wells.

The suggestion that cumulative effects be considered under the auspices of exploratory EEM is also one that warrants discussion as one well may have little or no effect but a large number of them might, depending upon timing, local conditions, and other factors.

Most issues, discussions and suggestions in regard to a study design for exploratory EEM were general in nature as opposed to specific scientific recommendations. An exception was one DFO scientist who suggested that the most useful variables to measure would be barite and perhaps redox potential. Barite was suggested not because of its potential to cause effects but rather because it provides a specific signature for drilling activity.

The FFAW (Reg Anstey, pers. comm.) made the point that it is difficult for them to properly provide input to the scientific design of EEM. Their main areas of concern center around potential contamination and loss of fishing grounds but the FFAW feels that they cannot be more specific because they do not have the necessary resources. [Note that this concern was also expressed during the White Rose Commission Hearings.]

Results of Nova Scotia Consultations

Interviews were conducted with representatives from five sectors concerned with offshore oil and gas activities: regulatory, science (both university and government), fishing industry, NGOs, and the offshore oil and gas (OOG) industry. The potential list of interviewees was reviewed and approved by the Scientific Authority for the study; their names are appended. Interviewees were assured of confidentiality to encourage frank discussion. This report synthesizes their responses.

Should EEM be Part of Exploration Drilling?

Most interviewees agreed that EEM programs should be a routine part of offshore drilling, whether for exploration or production. However, there were sharp difference among them regarding the reasons for monitoring, conceptual design, funding, and program implementation and interpretation. These differences were not merely between sectors, but also between individuals and organizations within the different sectors. Some interviewees feared that exploration wells could have serious environmental effects, particularly when considering cumulative impacts. Others thought that the wells had little or no effect, especially in the long term, especially when located in habitats with few or no sensitive features. The C-NSOPB would like to see a class screening approach to exploration drilling, rather than a comprehensive study required for every well, and good EEM data are required to satisfy CEAA that this would be an acceptable approach.

On the one extreme, some respondents felt that EEM requirements should be the same for exploration wells as for development platforms. Others urged that EEM for exploration projects should be limited to satisfying minimum CEAA requirements; some felt representative sites should be used to predict effects, rather than monitoring programs at each well. Others felt there was no right answer, and that each well had to be considered on a case-by-case, site-specific basis, using a risk-based approach that took into account the surrounding environment. Others felt that an individual well likely had no impacts in and of itself, but that the cumulative effects of development on the Shelf as a whole needed to be established.

One scientist summed up his view as: “You need to do it until you’ve proven that it doesn’t need to be done." This opinion was somewhat mirrored by the offshore industry representative who said "We need to do more so that we can **document** these don't have any effects!" Another noted that if EEM could establish that exploration wells had few if any effects, that it might be possible to persuade CEAA to remove exploratory drilling from the comprehensive studies list.

Focus of EEM

Most, but not all, agreed that environmental concerns are lower for exploration drilling than for production platforms. Those who held this view agreed that conceptually, EEM has to focus on looking for **real** consequences. Projects need to be species and site-specific, ideally monitoring a different trophic levels.

Most respondents agreed that a major function of EEM was to test predictions made in an EA; many of these also stressed the need to verify modeling predictions. A few, however, thought it should go beyond, and comprehensively survey outputs and effects, even if these were permissible under the OWTG or had not been judged to be of concern in the EA.

Some respondents urged a decision tree approach to designing monitoring programs, keeping options flexible to reflect local conditions. Several felt strongly that efforts had to be geared toward the scale of activities, with less detail expected for exploration wells than for development platforms.

One regulator noted that a key question is "What's acceptable? How do you define acceptable limits?" He went on to say that DFO and the OOG industry should be cooperating on any offshore research programs, with industry doing routine work, and DFO responsible for high-tech bioassays.

Currently, there is no formal C-NSOPB requirement for EEM, and no absolute commitment from industry that it will be carried out.

Reference Sites Versus Every Well

A number of government, industry, and academic respondents thought there was considerable merit in the idea of implementing full EEM programs at several sites on the Scotian Shelf and Slope that represented common habitat types; other wells in similar habitats would then rely primarily on the representative site results. ESRF might be approached to assist with funding for these, to lessen the burden on the companies that had the more rigourous programs. Clearly, such a study would be entirely opportunistic, relying on the coincidence of wells being sited in representative habitat areas. Ideally, wells would be using different drilling fluids.

Related to this was the strong suggestion that at least one well site **away** from the CoPan and SOE projects be chosen and thoroughly studied; there are too many confounding variables near the existing production sites. Those suggesting this approach felt that this could avoid a full representative program for other sites up on the Shelf, if it could be documented that the well was essentially benign.

However, others from the same sectors felt strongly that monitoring had to be entirely site-specific, and full programs were needed for each project. Others were willing to consider the concept, possibly with regard to classes of effects or habitats; e.g., designing varying levels of EEM based on the use of different drilling fluids or the proximity of sensitive biota.

What are the Primary Environmental Issues? What Should be Monitored?

The OOG industry respondents, and some scientists, generally agreed that any one exploration well was unlikely to have major effects, and the chance of long-term effects was negligible. Most believed the transitory nature of exploration activities makes it very difficult to identify pathways and effects. One noted "Maybe we need a study that clearly demonstrates the difference between the effects of exploration and production!" Several respondents noted that their primary concern is the chance of a blow-out, and making sure that adequate response plans and equipment are in place to deal with this eventuality.

There was also a general sense among industry, and some scientific respondents, that EEM monitoring for exploratory wells had to focus on documenting the suspected lack of impacts. Most had a standard list of potential VECs/causes that they felt needed investigation, though details varied, reflecting professional interests. These are discussed below in more detail.

Benthic effects were generally seen as most important, although other issues commonly raised were impacts on marine mammal, bird mortality/attraction, impacts on finfish, and air quality. Occasionally mentioned concerns were methyl mercury accumulation, other metals, and endocrine disruptors (apparently there have been concerns in the North Sea about phenols in produced water).

Most agreed that concerns about toxicity of drilling wastes were at a lower level now than in the past, although there remain questions about the effects of synthetic muds. There is also still concern about the bentonite and barite in WBM; toxicity is limited but there are definite growth effects from non-toxic materials. Another issue is that of the effect of SBM/hydrocarbon residues on cuttings, which is allowed to reach 6.9%, although SOEI was limited to 1% (and thus shipped most cuttings to shore).

Environmental Components Versus Emissions

Opinions about the monitoring of discharges, especially those permitted under the OWTG, varied widely. Some NGO, fishing, and scientific respondents wanted everything that a rig discharged monitored for fate and ecological effects; others thought this unnecessary. Industry, in general, was of the opinion that monitoring had to go toward verifying EIA predictions, and document once and for all the levels and severity of impact of exploration drilling.

One DFO scientist strongly argued that identifying impacts on organisms, and then figuring out what is causing the impact, should be the primary focus of EEM. However, he acknowledged, documenting cause and effect can be difficult, and sometimes impossible; sometimes all that can be done is to investigate if there is a correlation between contaminant levels and biological impacts.

Conceptually, he said, you should start by asking (1) is there a biological effect? Is it lethal, sub-lethal, or a question of tainting? (2), contaminant analysis should **follow** from this: “If you don’t see an effect don’t go searching for a cause!”

A number of other respondents concurred that the existing focus for EEM has been, and is, on measuring contaminant levels rather than biological effects; there is a need to develop effective technologies to assess the latter.

Others were strongly of the opinion that "end-of-pipe" monitoring of all discharges was crucial.

Benthos and Corals

Almost all respondents identified benthic impacts as an important issue, for three main reasons: muds and cuttings ultimately reach the benthos, there are physical disturbances from the drilling itself, and benthic organisms are exposed directly to contaminants, whether by ingestion or surface adherence. Issues identified were smothering, tainting, and non-lethal effects like slowed growth.

EAs should routinely include the same sort of calculations that were done for SOEP, showing the percentage of scallop beds that lay in range of effects from the project, suggested one DFO respondent. This would help determine the need for, and extent of, local monitoring.

Overall, respondents concurred that benthic monitoring around platforms should include, at a minimum:

- fate and extent of cuttings piles;
- the detection of barite residues and other sediment chemistry, and
- hydrocarbon levels.

There is currently no information on coral sensitivities, and this is a data gap that needs to be filled as soon as possible. In situ coral samples could be taken before and after drilling; element composition in coral skeletons can be analysed to see if they have picked up trace metals.

Birds

A few respondents expressed concern about oil emissions and flares, which could affect birds, and strongly urged monitoring of both. Several OOG industry representative felt that the issue of whether birds and marine mammals are actually attracted to rigs should be investigated. Continuing and expanding the Oil and Gas Observer Program (OGOP) might be a mechanism to achieve this, one suggested.

Fish

Fish may formerly have shown effects from toxic chemicals that were once used in drilling muds. Most respondents concurred that impacts on fish were no longer a concern given the current use of low toxicity muds. However, some DFO scientists still flagged this as an issue. Flounders have shown some histopathological impacts with regard to gill damage; it is possible that this is a physical, as opposed to a toxic, effect. American plaice showed impacts around the Hibernia wells, and DFO Newfoundland is trawl sampling to better define the area and time; there may also have been flounder effects documented at Terra Nova.

Several respondents from all sectors brought up the issue of supposed methyl mercury contamination and bioaccumulation in fish around rigs in the Gulf of Mexico, and wanted this element monitored[1].

Some noted that animals will be attracted to the rig while it is in place — the attraction of fish to offshore structures is well-known — but it was felt that the short time frame negates any long term effects.

Eggs and larvae are unlikely to be affected; some minimal impacts have been shown with haddock, but at levels that are not a concern.

Marine Mammals and Noise

Noise was identified as a major issue by one scientist, primarily in relation to marine mammal issues. He strongly urged monitoring of noise levels from both the rig and supply vessels, using hydrophones dispersed around the rig at intervals until the sound diffuse to 100 dB. He noted that in deep water, hydrophones could be spread over a variety of depths, and at least on either side of the thermocline. Recording times could be matched to levels of activity on the rig. Others noted the need to establish both sound levels and frequencies at different distances from the rig.

An OOG industry respondent felt that acoustic background levels should be measured if near sensitive habitats, and then regular measurements taken during drilling. Others felt that rig-based visual observations were adequate.

[1] It should be noted that this issue was publicized by an investigative journalist for the Mobile (Alabama) Register in January, 2002. The US Minerals Management Service has stated that no evidence exists of general elevated mercury levels around Gulf of Mexico rigs. Follow-up research is being carried out to better document this.

Air Emissions

One regulator identified this as a particularly important issue, noting that an air quality station will shortly be in place at Sable Island, allowing for localized testing of air quality. Other stations could be set up on the satellite platforms around Sable, or on buoys. It was also suggested that detailed modeling studies could also be done to evaluate potential emissions, and that the Offshore Boards should require that companies use the latest available technology to achieve efficient burns.

Several industry representatives also brought up air quality and flaring efficiency, suggesting that air quality could be modelled based on knowledge of what was going into the flares. They concurred that when the new air quality station was set up it would be much easier to track air quality, and correlate spikes in emissions at platforms and rigs with observed differences. Some suggested that air evaluation could be tied into other ESRF studies, particularly with regard to cumulative effects.

Sharing the Results of EEM Programs

Numerous respondents insisted that any environmental data collected from industry monitoring programs should be shared and released to the public. Many were distressed at what one characterized as “the Sable mess”. It was generally felt that results had to be public in order for a program to have legitimacy, credibility, and be scientifically useful.

Some industry representatives raised concerns about confidentiality and expense, as well as how to manage data distribution. The question was raised about non-contributing operators piggybacking on studies funded by other companies. Most OOG respondents, however, felt that at least some level of detail had to be made public to ensure credibility and improve overall knowledge.

Cumulative Impacts

A number of respondents raised concerns about cumulative impacts, and how to identify interactions between projects. It was stressed that the OOG industry should not be taken in isolation, but cumulative and regional impact analyses needed to include shipping, fishing, and research as well. It was pointed out that shipping, in particular, was responsible for much oil contamination at sea, from discharge of oily wastes and bilge waters.

One OOG representative strongly urged that the only area on the Shelf where cumulative impacts could be identified is the Sable sub-basin, arguing that activity on other blocks was too sparse to derive any meaningful results. He felt that the map of granted lease blocks was misleading in terms of the actual likely level of effort, pointing out that some lease blocks are currently held by speculators and are unlikely to be drilled before the leases run out, and others have been eliminated by disappointing seismic results. He projected a maximum of five or six wells a year outside the Sable sub-basin area, spaced far apart along the Shelf Edge and Slope.

Research Issues and Study Design

There was a basic disagreement between those focused on identifying and monitoring discharges, and those who were concerned primarily with the biological effects of discharges. Said one scientist, “No one has proven that end-of-pipe "measure everything" methods work – or are even needed. You need to start by identifying the most sensitive part of the ecosystem – the benthos – and then measure the most sensitive indicator species – around here, the scallop." Another noted, "Sediment chemistry doesn't mean much unless you have biological effects." The essential principle for designing any program must be K.I.S.S., said one scientist, and several others echoed this view. However, other government and academic scientists, as well as some fishing representatives, felt strongly that all substances or physical effects produced by a rig should be measured and documented.

There are two basic questions, one scientist urged: (1) is there **any** effect?, and if the answer is yes: (2) what does this mean in real life? Population level? Ecosystem level?

Shallow versus Deep Water Sites

Most respondents agreed that there were differences between monitoring in deep water versus shallow water sites. Distinguishing elements in deeper water include:

- The greater dilution rate in deep water; much less material arrives on the bottom near the well after the first few weeks;

- Organisms are much different, and overall biomass and diversity appear much lower at deep water sites;

- There are more unknowns in deep water; e.g., there is little firm knowledge of the effects of drill wastes on many of the organisms, like corals, and

- Because of the lower biodiversity, one can avoid having to monitor certain elements, which would be of routine concern in shallower water.

- Some potential monitoring elements for deep-water sites include amounts and distribution of cutting piles, and biological effects from drilling. Techniques could include:

  - Drop cameras: stills and video, to record pre-drilling benthos and changes over time. Photo interpretation can show obvious biology activity;

  - Grab samples for barium analysis will tell something about where the discharged material is going.

Instrumentation development is a real issue for deep-water sites, as are good models for sediment transport. Essentially, persistence and fate are unknown in the deep-water areas, as is the fate of gas escaping at that temperature and pressure.

At shallow water sites, wastes accumulate or reach shorelines more easily, depending on oceanographic conditions. Bottom smothering can be a more critical issue (as long as there's something on the bottom to smother, noted several respondents, pointing out how relatively barren many of the mud-bottom habitats on the Shelf are). As well, there are more people involved, more human interests, more competition for marine resources.

EEM can shift into “comfort monitoring,” carried out to ensure that those with an interest in the other area resources are assured that no impacts are happening.

Equipment and Methods

Soil sampling and chemical analysis, while not cheap, are probably the easiest monitoring methods to establish changes to the seabed. However, is it the most effective at establishing actual resulting impacts? It was strongly suggested by several respondents that the use of bivalves in cages on the seabed, with an appropriate **local** indicator species, was the preferable way to identify biological effects. No other approach has been shown to be both effective and sensitive. Cages should go down before drilling starts and come up when done; "EEM should be kept that simple unless effects are seen,” urged one scientist.

A good, cost-effective method to test BBLT has not yet been developed; physical sampling has to be frequent enough to be meaningful. One respondent argued strongly that identification and assessment of biological effects was critical instead—is there a biological effect to confirm the model predictions? This was the basis of the Hibernia scallop project— to assess BBLT, based on saying “Here’s the effect … and here’s how much contamination had to be there to produce it.”

Some industry representatives liked using mussels as indicator species, but other scientists disagreed. One noted that "Mussels are **too** robust; they will absorb and survive anything!". He argued that since scallops will show effects at very low levels, and are resident species almost everywhere (sea, Icelandic, bay, etc.), that scallop is a more appropriate species to choose. Another urged "Only use mussels if there's **nothing** else there!" One government scientist suggested that before, during and after benthic grab samples to identify community effects were preferable to the use of caged bivalves not resident in the area.

Possibly because of their feeding mechanisms, scallops are extremely sensitive to ingestion of drilling muds; filtering slows down or stops at about 0.1 mg/L, whereas other organisms must get over 50 mg/L before showing effects. DFO found initial problems in using scallop, as they tended to try to move in bags and would injure themselves and each other; however, packaging them in individual mesh bags solved this issue. Bedford Institute developed a remote release mechanism for the bottom-moored; they now float up to the surface where they can be collected. At Hibernia, the EEM program has managed 100% cage recovery and low mortality. However, other scientists at DFO disagreed with the emphasis on a single species.

Some fishing industry representatives urged that crabs be included in sampling as well. Other respondents strongly urged the use of ROV and drop camera photography to evaluate before and after benthic conditions. Several suggested going back a year later to see if a cuttings pile had persisted.

Another government scientist's primary concern was with degradation and natural recovery rates at the lower trophic levels; he stressed that microbial activity was a key issues. He felt that chemical kinetics was important to understand, and that studying bacteria and other micro-organisms would yield useful information on fate and persistence of contaminants, urging analysis of rates of metabolic processes. Much of the physical and chemical analyses could be based on laboratory work, he noted, and technologies existed to monitor chemical levels, e.g., semi-permeable membranes capable of accumulating organics.

Again, the split between the "track everything" and the "look for actual effects" opinions was evident. Some felt that toxicity testing – e.g., the TRIAD approach – would not yield useful information about exploratory wells. Others were adamant that it was necessary to know what contaminants were entering the eco-system of the area, even if there were no obvious, immediate impacts.

Most agree that, at least to some degree, monitoring design has to depend on site-specific conditions and the EIA findings. “If you’re near a coral reef, you’re going to have one set of issues. But if you’re on a mud bottom with nothing there, and an impact zone of maybe 200 m—you’re going to have to show there’s a real concern before you demand that large amounts of money and time go into EEM!”

Several respondents pointed out that synthetic-based muds (SBM) have different properties from water-based muds (WBM), which may affect EEM methods. Grain size analysis is sometimes the only way to detect WBM residues, depending on underlying sediment chemistry; barium tracers could be useful. WBMs disperse quickly, but cuttings with SBMs on them tend to clump, flocculating into an almost plasticine-like substance. Even those who strongly believed impacts on fish should be monitored had difficulty suggesting concrete methods that would be successful in establishing effects. One respondent suggested using sand lance; another, mummichog, and several pointed to the use of flounder and plaice at Terra Nova and Hibernia. These may be useful for benthic dwellers, but do not really address impacts on those living higher in the water column. Some felt that reviewing water quality around an exploration rig would help identify any impacts on fish. Some suggestions for monitoring sub-lethal fish impacts were: tissue chemistry studies, histological analysis, the use of tracers in drilling fluids, assessment of condition before and after, analysis of population age at the site, fecundity and age size. It was noted that no adequate baseline on metal contamination in Scotian Shelf sediments exists, and there are neither good signatures nor ratios.

Several participants, both scientific and regulatory, raised concerns about the validity and reliability of OGOP data. Another noted that OGOP did not provide very useful marine mammal data beyond distribution information, as the presence or absence of marine mammals does not necessarily correlate with impacts from rig activities.

An OOG representative felt that not enough information was being used from the spill patrol overflights flown by Transport Canada. Currently, these only look for oil spills; why not use them to take photographs of the mud plume extending from the rig? This could help in documenting WBM dispersion. Or, supply helicopter flights could be diverted slightly to take similar pictures.

Testing of the assumption that birds and marine mammals are attracted to rigs could use a simple program taking advantage of the helicopter supply runs, one respondent suggested. Each run could be varied by direction to the rig; time of day and sea bird/ mammal counts could establish if the rigs act as attractants.

One academic scientist strongly urged carrying out comprehensive ROV surveys and other baseline work for every well, following protocols published by BIO's Kostylev in the Prog. Mar. Eco. Series, before any exploratory drilling could take place. Such a study would look at which species were present, the relative abundances, age distribution, sex ratio, sex phase, size and where possible health conditions. The video surveys would highlight abundance, distribution and community associations.

Statistical Design, Sampling Patterns and the Gradient Approach

Respondents concurred that statistical validity is absolutely crucial to EEM: said one OOG industry representative "I **hate** work that not's valid! Coming up with ex post facto hypotheses – ugh!". Statistical design has to be one of the most important elements of an EEM program.

Several stressed the need for a good baseline, and a before/during/after sampling methodology. It was suggested that revisiting sites after a year (and, if effects were detectable, after two) would be useful to accurately determine if there were long-lasting effects.

Some scientists criticized the bulls-eye/gradient approach as too restrictive, and one noted that the Terra Nova project has moved away from it. Another felt that bulls-eye methods were comfort monitoring, not hard science.

One stressed replicability, saying "Do three or four or five different analyses and then decide there's no effect, not just one stats test." For example, multi-variate analysis can show completely different results from regression analysis. The use of ANOVA and graphical presentations of structures along the gradient was suggested, as were ABC curves to measure common changes.

Trends in Environmental Effect Monitoring Projects

Environmental effects monitoring for oil and gas projects have been designed to examine the VECs identified during the EIS process, while also taking into account those concerns expressed by the community. Monitoring programs that were most successful, with accepted results, were those that had baseline data to measure against.

Pitfalls in Designing an EEM Project

In his keynote address at the BIO workshop "Understanding the Environmental Effects of Offshore Hydrocarbon Development", Dr J.P. Ray raised a series of points to consider when developing an EEM program:

- Designing the monitoring program is often the critical step in the process. The design must be very clear about what is being tested and must be able to deliver appropriate statistics to answer the questions.

- Modeling and lab work can be considered in a monitoring program but these should be field verified in the end. It is often best to test the local species in situ, as they are adapted to that specific environment. When using imported species, it is often hard to distinguish between an affect due to industrial development and one due to change in environmental location.

- For an EEM program to be successful, it should be endorsed by a number of stakeholders. The data must also be publicized in a timely manner, preferable in peer-reviewed journals.

Dr. Ray summed up his comment by saying

> "You can conduct the best monitoring programs, but unless they are conducted in an open manner, and bought into by all interested parties, the results will **not** be accepted and used."

Regulatory Issues: C-NSOPB and DFO

Regulators concurred that they needed scientifically defendable, statistically valid results. There may eventually be a role for EEM with regard to stop orders or modifications of activities (e.g., zero discharge of oiled cuttings) in specific situations. One regulator strongly suggested reviewing discharge limitations in other jurisdictions and for other sectors, e.g., pulp and paper and mining, to see what is permissible for comparable quantities and elements in industrial discharges into oceans. An industry representative suggested that a regional EEM mechanism was needed, calling it a "SEEMAG for the whole industry, with everyone contributing." Environment Canada noted that its regulatory "hands were tied," and it was restricted to a review and advisory role.

The Oceans Act and DFO's Mandate

The Oceans Act assigns DFO the lead role in the integrated planning and management of all ocean activities. To carry out this responsibility with regard to oil and gas development on the Scotian Shelf, staff from Oceans and Environment Branch, Science Branch, Habitat Management Division, and Invertebrate Fisheries Division work as a team to review assessments and liaise with other agencies.

The team emphasized that EEM has to meet DFO regulatory needs, both in substantive conclusions that allow validation of EA predictions and models, and in data supply/information exchange. The Oceans Act looks to a multi-stakeholder, shared resource model; following this, the OOG industry must be prepared to share environmental data. EEM programs must be collaborative, not secretive.

DFO is looking forward to the EEM workshop in May, with the hopes that new, useful material will be developed from it.

Requiring an Ecosystem Approach

Conceptual trends in the identification of environmental effects are moving toward analysis of biodiversity and an ecosystem approach. Baseline data collection and monitoring programs should not only be directed to commercially-fished species, but look at the broader eco-system as well. Several DFO scientists felt that we need to know more about the cumulative effects on the Shelf. What are the interactions between production platforms and exploration wells? What is the overall stress on the Shelf ecosystems? There is concern within DFO about the Sable Island gyre, and whether organisms are getting repeatedly exposed to the outputs of all the different activities.

Fishing Industry Issues

Those fishing industry representatives who agreed to an interview concurred that important concerns included:

- discharges from the rigs, both accidental and those allowed under the Waste Treatment Guidelines;
- physical impact of the rigs on the benthos, and
- interference with fishing activities.

Industry representatives suggested continuing and expanding OGOP, placing an observer on each rig. The suggestion was made that observers could be trained to carry out more detailed studies, e.g., whether a rig attracts birds at night.

What are the Socio-economic Effects? How Can Impacts of the Safety Zones on the Industry be Identified?

One respondent discussed the difficulty of identifying which boats took catch from what areas, and how to define an economic loss. If a fishing boat can simply move to a different area and take the same catch, is this an impact? An OOG industry respondent suggested that fishing activity and catch rates could be monitored by keeping in touch with area fishermen by radio while drilling proceeded.

An OOG industry representative noted that safety zones act as de facto much larger exclusion zones for longliners, given their length of gear, its tendency to drift and shift position with the tides, and the potential for snagging and entanglement. Longliners have to stay much further away than 500 m.

Offshore Oil and Gas Industry Issues

Technical and Financial Feasibility

OOG industry representatives were cautious about commenting on the feasibility of a detailed EEM program for exploratory drilling. One said bluntly, however "If we're required to do it under the regulations, we'll do it .. but anything we do adds to the costs of the well, and could put the work at risk .. especially if measures aren't required in other areas". It was noted that the marginal cost of monitoring while the rig was in place and operating was relatively low, but before and after studies added considerably more cost to the program.

Experiences During Exploration Drilling

Industry representatives had found no particular environmental problems during exploration drilling.

Oiled birds have occasionally washed up on Sable Island, with residues traceable to CoPan (especially after the Uniacke blowout) and SOEI. Industry representatives who were familiar with offshore work noted that occasionally birds do land on the rigs, or are seen following supply vessels: "Maybe they think they're fishing boats, and are expecting a meal." Industry representatives with offshore experience have seen whales very close to operating rigs, but acknowledged that one would not observe those who were avoiding them.

NGO Issues

Focus on Broader Concerns

One NGO respondent strongly believed that the essence of environmental concerns on the offshore centered around the license-issuing process, and the quality – or lack thereof – of the Strategic Environmental Assessments. He suggested that if there are concerns at areas potential well sites, that these should be identified early on, whether based on ecological or public policy issues — he pointed to the issuance of licenses close to the shores of Cape Breton as an example. Leases should not be let in sensitive areas. He stressed that public concern, however, should not determine whether EEM was required at a drill site. Rather, effective EEM should merely be an accepted part of a good management process.

NGO respondents raised the Gully as a particular concern, suggesting that permanent monitoring sites should be established in it to pick up sediment transport, if any. Sound monitors should also be installed and checked on a regular basis, to establish what, if any, OOG-generated sound was reaching the prime whale habitat areas.

One stressed: "We need a whole planning process for the oceans, and not just a process where industry meets standards based upon their footprint. The process has to start with a plan of where it is appropriate to have oil and gas industrial activity."

Comparisons: Newfoundland and Labrador vs. Nova Scotia

It is difficult to directly compare the issues as they are perceived in Nova Scotia versus those in Newfoundland and Labrador for a number of reasons. The interviews and meetings were intentionally informal and unstructured, which is good for soliciting input but also means that care must be taken in weighting one issue over another. Furthermore, in the interest of cost efficiencies and local knowledge, different people conducted the interviews in the two provinces. There are also obvious differences in demographics between the two regions and important differences in environmental conditions and development scenarios. [Nova Scotia to date has developed gas mostly in shallow water using 'jack-up' rigs whereas Newfoundland has developed oil at moderate depths using the Hibernia GBS, semi-submersible drill rigs, and FPSO's. However, development scenarios may be moving into deepwater in both locations.] Nonetheless, it is worthwhile to reflect somewhat on the differences and similarities between the two regions.

Some Differences in Perceived Issues

There were, of course, differences between respondents in their perceptions of the issues and of the best species to monitor. These differences appeared to be much more pronounced in Nova Scotia than in Newfoundland and Labrador. Without putting too fine a point on the differences between the different regions, there appear to be the following differences in regard to exploratory drilling EEM.

- **Emphasis on benthos.** Both regions agreed that benthic environments are key in monitoring the effects of offshore oil and gas because of likely contaminant pathways, relative sedentary nature of benthos, and relative ease of sampling. Fate and extent of cuttings piles, barite residues, and hydrocarbon levels were mentioned by many. However, there appeared to be much more emphasis on benthic monitoring for exploration wells in Nova Scotia. This was evident in concern for effects of barite, the benthic boundary layer, deep sea corals, and so forth (see below).

- **Emphasis on fish.** In general, the Newfoundland Region appeared to place more emphasis on fish and related issues than Nova Scotia. In Nova Scotia, there is, and has been, more emphasis on shellfish. There has been considerable study on scallops and monitoring programs have used scallops extensively; at least one project used caged mussels extensively.

- **Degree of monitoring.** While there was a wide range of opinions in both areas, there was a wider range in Nova Scotia and two clearly defined groups: (1) the 'monitor everything' group, and (2) the 'monitor select variables' one. In Newfoundland, individuals and groups appeared more focused and no one advocated monitoring everything.

The generally higher interest in benthic issues in Nova Scotia is at least partly attributable to differences in substrate, water depth, and water current regimes. In addition, the shellfish industry (excluding crab) is significantly more important off Nova Scotia than off Newfoundland. Demographics and research interests of individual scientists also undoubtedly played a role.

Some Similarities in Perceived Issues

Some important common points of view found in both areas are listed below.

- **Level of concern with exploration drilling**. Although there were some exceptions, most people had a much lower level of concern for the environmental effects of a single exploratory well than for a production development.

- **Comfort monitoring.** While some argued strongly for extensive statistical work, there still was a common thread that most people wanted some level of reassurance that a specific site was not being unduly affected. A number of people suggested some camera drops and some grab samples might be enough to accomplish the goal of providing a suitable level of comfort.

- **Testing EA.** A number of participants suggested that one of the key functions of a monitoring program is to test predictions, and in some cases modeling, that were conducted during the EA process. A potential corollary of this attitude is the suggestion by some that one or several wells should be selected as 'test cases' and monitored possibly in aid of a Class or Generic EA approach. This would provide rationale for including or excluding monitoring variables for future individual wells.

- **Biological effects**. With some exceptions, most felt that any monitoring programs should focus on biological effects as opposed to simply 'shopping' for increases (however slight) of potential contaminants.

- **Birds and mammals**. Many agreed that there were potentially important issues in regard to marine birds and mammals. However, it was also pointed out by a number of people that routine surveys conducted from the rig or supply boats do not necessarily constitute any monitoring of effects *per se*.

- **Site specifics.** Local and site specific issues must be considered in the design and conduct of any EEM. This was a virtually universal comment. There is awareness in both locations of some potential for different issues in deep versus shallow drilling scenarios. To date, however, the depth differences have been most apparent off Nova Scotia where most wells have been drilled in shallow water or increasingly in deepwater.

- **Data availability.** Almost everyone we talked to stated that availability of EEM data is an important issue. At present, the Atlantic Accord allows a development to hold the EEM data confidential for seven (?) years. In fact, availability of data became an issue with the conduct of this study.

- **Cumulative effects.** While many were not particularly concerned with the effects of one exploratory well, they suggested that a large number of single wells could be an issue, particularly if they were within a relatively small geographic and/or time frame. On the other hand, no one had any ready solutions to this problem.

Application of Production EEM Experience to Exploratory Drilling EEM

The offshore production EEM experience developed on the East Coast over the last 10 years or so is not directly applicable to EEM for exploratory drilling. The production EEM programs were developed for large multi-year projects that have more potential to affect the marine environment than a single exploratory well, which is small scale and often dry. Big developments such as Hibernia or SOEI entail the drilling of multiple wells, underwater excavation and infrastructure, loading and unloading of hydrocarbon products over a long period of time, the discharge of produced water, and so forth. As a result, the discharges, effects, and measureable 'footprint' will be different by orders of magnitude. One scientist likened it to a 'footprint' versus a 'fingerprint.' Nonetheless, based on the review of information and consultation with numerous interested and knowledgeable parties, the following conclusions can be drawn.

- Aside from a large oil blowout (a very unlikely event according to previous EAs) and a few other special cases, any effects from an exploratory situation are of much less concern than a production scenario.

- In general, the production EEM programs completed to date are viewed as adequate for confirming EA predictions and in providing a level of comfort that the East Coast marine ecosystems have not been significantly affected to date.

- Baseline studies conducted by Hibernia, Terra Nova, and White Rose can provide valuable insights into the effects of drilling because these studies were done at varying periods of time after drilling of a number of wells. White Rose data (reviewed herein) may be the most relevant in this regard because they are the most recent. Unfortunately, the baseline studies appear to have been designed without recognition of the potential value of these data. [As a result, it may still be necessary to conduct additional studies on new wells to adequately address some of the issues still associated with exploratory drilling.]

- To date, the conclusions that the Study Team has seen drawn from the production EEM studies, are that there have been no significant effects on the variables that have been measured. Thus, it seems reasonable to conclude that a properly run exploration drilling program will produce effects that will be on the low end of the scale and difficult to measure; it will certainly not create any significant effects on the marine environment.

- If drilling EEM was required, perhaps because of drilling with a new technology or in a potentially sensitive area, then one or a combination of the production EEM design (s) would provide a good starting point.

Appendix IV

Preliminary Survey Protocols for Bird and Mammal Surveys

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0101	Regular Pay - CFT	Rémunération de base - EPTP	01	01	0101
0102	Emergency Salary Advance	Avance de salaire urgente	01	01	0101
0103	Ships Officers and Crew - Regular Pay	Officiers et équipage de navires - Rémunération de base	01	01	0101
0104	Regular Pay - Other	Traitement de base - Autres	01	01	0102
0105	Term Ships Officers and Crew - Regular Pay	Temporaire - Officiers et équipage de marine - Rémunération de base	01	01	0102
0106	Students	Étudiants	01	01	0102
0107	Students/term Employed IRB Program	Étudiants/temporaires employés en vertu du programme ESC	01	01	0102
0108	Bilingual Bonus	Prime au bilinguisme	01	01	0106
0109	Severance Pay	Indemnité de départ	01	01	0107
0110	Training & Education Allowance (EDI)	Allocation de formation et d'étude (PDA)	01	01	0107
0112	Lump Sum Payment - Salaries	Paiements fortaitaires - Salaires	01	01	0101
0113	Retiring Allowance	Allocation de retraite	01	01	0107
0121	Retroactive pay - Previous years	Salaire rétroactif - Années antérieures	01	01	0110
0122	Retroactive Pay CFT - Current Year	Salaire rétroactif EPTP - Année courante	01	01	0111
0123	Retroactive Pay Other - Current Year	Salaire rétroactif Autres - Année courante	01	01	0111
0126	Performance Pay	Prime de rendement/performance	01	01	0101
0127	Miscellaneous Pay	Salaires divers	01	01	0101
0128	Arrears Pay	Arrérages de salaire	01	01	0101
0130	All premiums - Evg, night, wkds, holidays,shift change, etc.	Toutes primes-soir,fin de semaine,jour férié, changement d'horaire, etc.	01	01	0103
0131	Holiday & Vacation Pay - Non Recovery	Congés annuels et fériés - non recouv.	01	01	0104
0132	Leave Pay - Active Employees (Ent. Code 033 only)	Congés annuels et fériés, employés actifs (code paie 033)	01	01	0104
0133	**LIMIT-Exec.Interchange Prog & other exchange prog.($paid/rec'd)**	**LIMITE-Echange personnel direction & autres prog. d'échange ($payé/reçu)**	**01**	01	**0181**
0134	Leave Pay-SOS (Ent. Code 029 only)	Congés annuels et fériés, employés inactif (code paie 029)	01	01	0104
0140	Pay for Lay Day	Indemnité de jour de relâche	01	02	0105
0141	Overtime	Temps supplémentaire	01	02	0105
0146	Allowances (stand-by, call back, security duty)	Indemnités (disponibilité, rappel au travail, sécurité)	01	02	0105
0147	Commanding Officers and Chief Engineers-Extra Duty Allowance	Commandant et ingénieurs chef-Indemnité pour travail hors fonction	01	02	0105
0155	Retroactive Overtime - Previous Year	Temps supplémentaire rétroactif - Année antérieure	01	02	0110
0156	Retroactive Overtime - Current Year	Temps supplémentaire rétroactif - Année courante	01	02	0111
0159	Civilian Pay Equity	Civils, équité salariale	01	01	0112
0160	Civilian Pay Equity Allowances	Civils, indemnités pour équité salariale	01	03	0122
0172	Meteorological Allowance, Sea Duty, Diving & Dirty Work Allowance etc…	Prime pour observations météo, services en mer, plongée, et travail malpropre etc…	01	03	0121

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0174	Allowance for certain types of expenses that are incurred as part of regular employment (room&board, transfer, parking for disabled, commuting assistance, telephone allowance, etc.)	Allocation pour certaines dépenses qui sont entraînées par un emploi régulier (allocations de pension, transfert, stationnement pour les handicapés, transport quotidien, téléphone, etc.)	01	03	0120
0176	Isolated Posts Allowance	Indemnité de postes isolés	01	03	0125
0177	Maternity Allowance	Indemnité de maternité	01	03	0126
0178	Education leave allowance	Indemnité de congé d'étude	01	03	0126
0179	Armed boarding allowance	Indemnité: abordage armé	01	03	0126
0180	Equalization Adjustment Allowance	Rajustements de péréquation	01	03	0126
0181	Other Allowances and Benefits	Autres Indemnités et avantages	01	03	0126
0187	Cont. To Emp.Benef.Plan (CEBP)-Superannuation	Cont.au plan prest,de l'employé (CPPE)-Fonds de pension	01	04	0160
0188	Cont. To Emp.Benef.Plan (CEBP)-PS Death Benefit	Cont.au plan prest,de l'employé (CPPE)-Prestations de décès	01	04	0162
0189	Cont. To Emp.Benef.Plan (CEBP)-Employment Insurance	Cont.au plan prest,de l'employé(CPPE)-Assurance emploi	01	04	0169
0190	Cont. to Employee Benef. Plan (CEBP)-Canada & Quebec Pension	Contr. au plan prest. de l'employé (CPPE)-Pension Canada & Québec	01	04	0172
0191	Awards	Primes	01	01	0186
0192	**LIMIT-Taxable Benefits & Other payments (eg. housing, parking, etc.)**	**LIMITE-Avantages imposables & autres versements (ex. logement, stationnement, etc.)**	**01**	**04**	**0186**
0195	Reimbursement of claims to Provincial Workers' Compensation Boards	Remboursement d'indemnités aux Commissions provinciales des accidents du travail	01	04	0184
G103	Payment-OGD Employee Secondment & Transfers to	Remboursement Détach.& Transferts AMG au MPO	01	01	0192
G106	Other Payments to OGD for Personnel Services	Autres paiements à AMG pour les services personnels	01	04	0199
G123	Recovery from OGDs - DFO Employee Secondment & Transfers	Recouv. De AMG - Detach. et transferts Employés du MPO	01	01	0193

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0201	Travel - Local Headquarters Area including taxis	Voyage - Région locale du bureau	02	05	0201
0202	Travel in Canada	Voyage au Canada	02	05	0201
0204	Travel - Training	Voyage - Formation	02	05	0201
0205	USA Travel	Voyage aux États-Unis	02	05	0201
0208	Foreign Travel (Other than USA)	Voyage à l'étranger (sauf Etats-Unis)	02	05	0201
0211	Travel: Vacation (Isolated Post)	Voyage: Vacances (postes isolés)	02	05	0201
0212	Aircraft Charters - Duty Travel Only	Vol nolisé: Voyages-serv. commandés seulement	02	05	0201
0214	Travel - Non-Public Servants	Voyage - Autres que des fonctionnaires	02	05	0202
0215	Travel Advances - Cheque issue (Receiver general)	Avances de voyage - chèques émis (Receveur général)	50	05	0201
0216	Travellers Cheques Suspense	Chèques de voyage compte d'attente	50	05	7099
0217	Travel Advances - Travellers Cheques	Avances de voyage - chèques de voyage	50	05	0201
0218	Travel Training paid to CCG College	Voyages des employées - Formation Collège GCC	12	05	3425
0219	Travel: Medical (Isolated Post)	Voyage: Maladies (postes isolés)	02	05	0201
0220	Weekend Travel Pilot: Employee/Spouse/Dependent-CAN&US	Projet pilote, voyage fin de semaine-employé/conjoint/personne à charge-CAN&E.U.	02	05	0201
0230	Employee Relocation (Including Central Removal Services-CRS)	Réinstallation des employés (Incluant Serv.Central dém.-SCD)	02	06	0207
0232	Employee Taxable Benefits-Relocation	Avantages imposables employé(s)-Réinstallation	02	06	0207
0235	Relocation Advances	Avances de réinstallation	50	06	5030
0245	Postage and Parcel Post	Affranchissement et colis postal	02	07	0212
0246	Courier Services	Agences de messageries	02	07	0213
0247	Surface - Freight and Cargo Services	Surface - Fret & Cargo	02	07	0210
0249	Air - Freight & Cargo Services	Air - Fret & Cargo	02	07	0210
0250	Arctic Resupply - Freight, Express and Cartage	Ravitaillement de l'Arctique - Fret, messagerie et	02	07	0210
0260	Telephone Services except Long Distance	Services téléphoniques (sauf interurbains)	02	08	0220
0261	Teleconferences - Common Carriers(including GTIS & OGD)	Conférences téléphoniques - Télécommunications publiques (Incluant SGTI & AMG)	02	08	0220
0262	Long Distance Services	Services interurbains	02	08	0220
0267	Local & Intercity Voice Circuit - Common Carriers	Circuits vocaux/locaux & interurbains - Télécom, Publiques	02	08	0220
0269	Communication Services - Pager, Bellboy Pagette, Cellular Telephone, etc.	Services de communications - Récepteur de poche Bellboy Pagette, téléphone cellulaire, etc.	02	08	0220
0270	Other Voice Communication Services - Common Carriers - Including GTIS & OGD	Autres services de communication vocale - Télécommunications publiques - Incluant SGTI & AMG	02	08	0220
0273	Data Communication Services (incl. Non-Voice)	Serv. transmission de données (incl. non vocal)	02	08	0226
0275	Data Circuits and Data Interchange - Common Carriers (incl. Local)	Circuits de données et échange des données - Télécommunications publiques (incl. Locale)	02	08	0221
0279	Telegraph Cable and Radio Messages (Telex Pulse Toll Charges)	Câbles télégraphiques et dépêches radio (frais d'impulsions télex ou droits)	02	08	0221
0281	Other Communication Circuits & Services - Common Carriers - Including GTIS (incl. Enhanced Telecommunication Services)	Autres circuits et services de communication - Télécommunications publiques-Incluant SGTI (incl.Services améliorés)	02	08	0222
0283	Digital Channel Communications Services	Services communications voie numérique	02	08	0223
0284	Data Communication Service (Non Voice)	Serv. transmission de données (non-vocal.)	02	08	0226
0286	Other Telecommunications Services	Autres services de télécommunications	02	08	0227
G201 Cancelled /Annulé	Travel Expenses - OGD	Frais de voyage - AMG			
G210 Cancelled/ Annulé	Relocation CRS (PWGSC)	Réinstallation - SCD (TPSGC)			
G211 Cancelled/ Annulé	Reloc. in Can.-Exp. Paid to OGD (excl. PWGSC)	Frais de réinstall.au Can. payés-AMG (sauf TPSGC)			

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
G213 Cancelled/ Annulé	CFS(PWGSC)-Overseas Traffic, and Fleet Mgmnt	SCD(TPSGC)-transp. outre-mer et parc de véhicules			
G220 Cancelled/ Annulé	Freight, Express, and Cartage Services - Non-Overseas	Transport de Marchandises, messagerie et camionnage - non-Outre-Mer			
G230 Cancelled/ Annulé	GTIS-Reg. Service(L30,L31,L32,L33,L34,L35,P85)	SGTI-Services régul.(L30,L31,L32,L33,L34,L35,P85)			
G231 Cancelled/ Annulé	GTIS-Long Distance (S01,S02,S10,C01,C21)	SGTI-Services interurbains(S01,S02,S10,C01,C21)			
G233 Cancelled/ Annulé	Teleconferences - GTIS	Conférences téléphoniques - SGTI			
G234 Cancelled/ Annulé	Shared and Customized Message/Text and Data Services - GTIS	Services de transmission de données, de messages et de textes partagés et personnalisés - SGTI			
G235 Cancelled/ Annulé	Other OGD Communication Services (excl. GTIS)	Autres serv. communic. - AMG (sauf SGTI)			

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0301	Communication Research Services	Services de recherche en communication	03	09	0341
0302	Public Relations Services	Services de relations publiques	03	09	0352
0303	Communications Services (speech,media,tech.writing etc..)	Serv.Communications (discours, média, rédaction tech, revision texte etc..)	03	09	0351
0331	Advertising Services	Services de réclame	03	10	0301
0332	Exposition Services	Services d'exposition	03	10	0331
0361	Printing Services	Frais de services pour la reproduction et l'impression	03	11	0321
0362	Audio Visual Services	Services audio-visuel	03	11	0332
0363	Publishing Services (Departmental reports, publications and manuals)	Services de publications (Rapports, publications et manuels ministériels)	03	11	0311
G301 Cancelled/ Annulé	Communication Research Services - OGD	Services de recherche en communication - AMG			
G302 Cancelled/ Annulé	Communications professional Services - OGD excl. PWGSC	Services prof. communications - AMG			
G311 Cancelled/ Annulé	Advertising Services - OGD	Services de réclame - AMG			
G313 Cancelled/ Annulé	Publishing (excl printing) - OGD	Édition (sauf imprimerie) - AMG			
G321 Cancelled/ Annulé	Printing Services - OGD	Frais de service d'administration pour la reproduction et l'impression - AMG			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
4001	Accounting and Audit Services	Services de comptabilité et de vérification	04	12	0401
4002	Legal Services	Services juridiques	04	12	0410
4003	Collection Agency Fees and Charges	Frais de service d'agence de recouvrement	04	12	0815
4004	Inspection Analyses Fees related to Equipment, Vessels and Machinery	Frais d'inspection/analyses reliés à l'équipement, aux navires et à la machinerie	04	12	0420
4005	Architectural Services - Vessels & Buildings (Design, plans, construction supervision)	Services d'architecture - Navires et bâtiments (Designs, plans, et supervision construction)	04	12	0421
4006	MARINE-Engineering Consultants	MARINE-Conseillers techniques	04	12	0423
4008	CONSTRUCTION-Engineering Consultants (civil, mechanical, electrical, structural, design, drafting)	CONSTRUCTION-Conseillers techniques (génie civil, mécanique, structure, électrique, dessins)	04	12	0422
4009	INFRASTRUCTURE-Engineering Consultants	INFRASTRUCTURES-Conseillers techniques	04	12	0423
4010	MARINE-Engineering Services excluding Consultants	MARINE-Services techniques excluant les experts-conseils	04	12	0420
4011	Medical Expenses - Physicians and Surgeons	Frais médicaux - Médecins et chirurgiens	04	12	0453
4012	Medical Expenses - Para-medical Personnel (Nurses, etc.)	Frais médicaux - Personnel para-médical (infirmiéres,etc.)	04	12	0454
4013	Medical Expenses - Other (X-Rays, Optical, Counselling , etc)	Frais médicaux - Autres (rayons-X, matériel optique, counselling, etc)	04	12	0451
4015	Environmental Consultants	Service de consultants en environnement	04	12	0499
4016	INFRASTRUCTURE-Engineering Services excluding Consultants	INFRASTRUCTURES-Services techniques excluant les experts-conseils	04	12	0420
4017	Science,Habitat,Environmental-Engineering Serv.(excl.Consultants)	Science,Habitat,Environnement-Services techniques (excl.experts-conseils)	04	12	0420
4018	Science,Habitat,Environmental-Engineering Consultants	Science,Habitat,Environnement-Conseillers techniques	04	12	0423
4101	Laboratory and Sampling Services	Services laboratoire & analyses des échantillons	04	13	0430
4103	Oceanography, Aquaculture and Fisheries Research-Scientific Services (excl.consultants)	Océanographie, aquaculture et recherches sur les pêches-Services scientifiques (excl. experts-conseils)	04	13	0430
4104	Environmental Science, Ocean Programs and Habitat Mgmt-Scientific Services (excl. consultants)	Science de l'environnement, programmes des océans et gestion de l'habitat-Services scientifiques (excl. experts-conseils)	04	13	0430
4105	Scientific Consultants-Environmental Science, Ocean Programs and Habitat Mgmt	Experts-conseils scientifiques-Sciences de l'environnement, programmes des Océans et gestion de l'habitat	04	13	0431
4106	Trade Marks, Patents & Copyright	Marques déposées, brevets et droit d'auteur	04	13	0499
4107	Scientific Consultants-Oceanography, Aquaculture and Fisheries Research	Experts-conseils scientifiques-Océanographie, aquaculture et recherches sur la pêche	04	13	0431
4111	Hydrography -Scientific Services (excl.consultants)	Hydrographie-Services scientifiques (excl. experts-conseils)	04	13	0430
4112	Scientific Consultants-Hydrography	Experts-conseils scientifiques-Hydrographie	04	13	0431
4201	Reimbursement of Tuition Fees to Employees on their own time - Personal Development, i.e. CMA, CGA, CA etc.	Remboursement des frais scolaires aux fonctionnaires dans leur temps libre - Croissance personnel, c.-à-d. CMA, CGA, C.A. etc.	04	14	0445
4202	Advances for Tuition Fees and Books	Avances pour frais scolaires et livres	04	14	0445
4203	Post-Secondary Tuition Fees and Books (working hours)	Frais de scolarité et livres, études post-sceondaire (heures de travail)	04	14	0447
4204	Language Training	Formation linguistique	04	14	0447
4205	Training Courses - Seminars and Conferences	Cours de formation - Séminaires et conférences	04	14	0447
4206	Purchase of Training Packages and Courses	Achats de programme de formation et de cours	04	14	0448
4207	Teachers and Instructors on Contract	Professeurs et instructeurs à contrat	04	14	0444
4208	Training - Non Public Servants	Enseignement - non fonctionnaires	04	14	0440
4302	Work performed by Carpenter and/or Mechanic Service Shops (CCG)	Travail accompli par atelier menuiserie et/ou mécanique (CCG)	04	15	0859
4402	Protection Services (Guardians, Corps of Commissionaires,security guards etc…)	Services de sécurité (gardiens, Corps des Commissionnaires, gardes de sécurité, etc.)	04	16	0460
4403	Management Consulting Services	Services de conseillers en gestion	04	16	0491
4404	**LIMIT-Research Contracts excluding scientific and engineering**	**LIMITE-Contrats de recherche excluant scientifique et génie**	**04**	16	**0492**

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
4405	Honorariums: Advisory Boards & Commissions	Honoraires: Offices & commissions consultatifs	04	16	0499
4406	Economic Consultant or Advisory Services	Services de consultation en économie	04	16	0499
4407	Design and Drafting Services	Services de design et de dessin technique	04	16	0499
4408	Brokerage Fees	Frais de courtage	04	16	0499
4409	Translation	Traduction	04	16	0494
4410	Interpretation Services	Services d'interprétation	04	16	0493
4411	Writing Services & Library Services	Services de Rédaction & services reliés aux bibliothéques	04	16	0859
4412	Custom Import Duties	Droits de douane à l'importation	12	16	3441
4418	Motor Vehicle Registration and Inspection	Enregistrement pour véhicule à moteur et inspection	04	16	0854
4419	Banking Services	Services bancaires	04	16	0851
4420	Building Cleaning Services	Service d'entretien des immeubles	04	16	0811
4421	Temporary Help Services	Services temporaires	04	16	0813
4422	Non-professional personal service contracts	Contrats de services personnels non professionnels	04	16	0819
4423	Hospitality	Frais de réception	04	16	0822
4424	Conference Fees	Cotisations de conférences	04	16	0823
4425	Membership Fees	Cotisations d'adhésion	04	16	0821
4446	Building/Land Services (Electrical, Plumbing, Landscaping, Fit-up etc.)	Services aux édifices/terrains (incl. Électricité, plombereie, aménagement paysager, améliorations etc.)	04	16	0859
4447	Contracted Bldg. for Hatchery Oper. (Labour)	Entretien édifice - act. piscicoles(main-d'oeuvre)	04	16	0859
4449	Environmental - Toxic Cleaning-up	Nettoyage toxique, environnemental	04	16	0859
4450	Laundry, Dry Cleaning and Related Services	Blanchissage, nettoyage à sec et services connexes	04	16	0859
4451	Snow Removal, Light Servicing & Sanitation Services	Enlévement de la neige, entretien des feux et services sanitaires	04	16	0859
4461	Dockage, Towage, Wharfage and Moving Fees	Frais de bassin, remorquage, quayage des navires	04	16	0859
4463	Diving Services	Services de plongée sous-marine	04	16	0859
4464	Buoy Servicing by Private-Sector Contract (CCG)	Entretien des bouées, contrat par le secteur privé	04	16	0859
4471	Harbour Authorities Management Services	Gestion des Hâvres de pêche par les autorités	04	16	0859
4472	Harbour Manager's Commissions	Commissions des responsables de ports	04	16	0859
4473	Observers of Canadian and Foreign Fishers	Surveillants des pêcheurs canadiens et étrangers	04	16	0859
4474	Community Dev.: Public Participation Programs	Dévelop. communautaire: prog. particip. du public	04	16	0859
4476	Photography Service	Services de photographie	04	16	0859
4477	Assessors and Appraisers Services - Private Sector	Services d'expertises et estimations - Secteur privé	04	16	0859
4478	Rewards-Fish Tag & Bounties-Harbour Seals	Récompenses étiqu.poisson et primes phoque commun	04	16	0859
4479	Storage & Warehousing (excl. Space Rental Contracts)	Frais d'entreposage (sauf locat. d'espace-contrat)	04	16	0859
4480	Marine-Related Services not elsewhere specified (CCG)	Services relatifs à la marine - non précisés ailleurs	04	16	0859
4483	Ice Reconnaissance - Environment Canada	Reconnaissance des glaces - Environnement Canada	04	15	0859
4484	Helicopter Operation and Maintenance provided by Transport Canada	Services de F et E- Hélicoptère fournis par Transports Canada	04	15	0859
4485	Real Estate and Legal Fees - PWGSC Revolving Fund	Frais de courtage immobilier et juridique - TPSGC	04	16	0852
4486	Management Fees - PWGSC	Frais de gestion - TPSGC	04	16	0852
4487	Acquisition Fee - PWGSC	Frais d'acquisition - TPSGC	04	16	0855
4801	Informatics Services - Telecommun. Consultants	Serv d'informatique Exp.conseils-télécommunication	04	17	0471
4802	Consultant Services - Computer Management, Development and Programming	Conseillers techniques - Gestion systéms informatiques, développement et programmation	04	17	0472
4806	Electronic/Automated Office Systems Consultants	Conseillers en bureautique	04	17	0472
4807	EDP and Computer Services	Accés à la banque d'information d'ordinateur	04	17	0812
G401 Cancelled/ Annulé	Accounting & Audit Services - OGD	Serv. comptabilité & vérification - AMG			
G402 Cancelled/ Annulé	Legal Services - Department of Justice	Services juridiques du Ministère de la Justice			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
G403 Cancelled/ Annulé	Architectural and Engineering Services - PWGSC Revolving Fund	Services architecturaux et d'ingénierie - Fonds renouvelables de TPSGC			
G405 Cancelled/ Annulé	Engineering Consultants - OGD	Ingénieurs Conseils - Paiements - AMG			
G406 Cancelled/ Annulé	Medical and Employee Assistance - Health Canada	Frais médicaux et aides aux employés - Santé Canada			
G407 Cancelled/ Annulé	**Other Professional Services Not Elsewhere Specified - OGD**	**Autres Services professionnels non précises ailleurs - AMG**			
G411 Cancelled/ Annulé	Post-Doctorate Fellowships - OGD	Bourses post-doctorales - AMG			
G412 Cancelled/ Annulé	Scientific Services and Research - OGD	Services scientifiques et de recherche - AMG			
G422 Cancelled/ Annulé	Training Packages & courses - PSC	Progr. de formation & cours-CFP non linguistique			
G423 Cancelled/ Annulé	Training (excl. PSC) & Conference Registration Fees - OGD	Formation (excl. CFP) et frais de conférence AMG			
G434 Cancelled/ Annulé	Ice Reconnaissance - Environment Canada	Reconnaissance des glaces - Environnement Canada			
G435 Cancelled/ Annulé	Helicopter Operation and Maintenance provided by Transport Canada	Services de F et E- Hélicoptère fournis par Transports Canada			
G441 Cancelled/ Annulé	Real Estate and Legal Fees - PWGSC Revolving Fund	Frais de courtage immobilier et juridique - TPSGC			
G442 Cancelled/ Annulé	Protection Services - OGD	Services de sécurité - AMG			
G443 Cancelled/ Annulé	Management Consulting Services provided by Other Goverment Departments	Service de consultation pour les gestionnaires provenant d'autres ministères			
G444 Cancelled/ Annulé	Management Fees - PWGSC	Frais de gestion - TPSGC			
G447 Cancelled/ Annulé	PWGSC - Architectural & Engineering Services	TPSGC - Services d'architecture et de genié			
G449 Cancelled/ Annulé	Translation and Interpretation Services OGD	Traduction et interprétation - AMG			
G451 Cancelled/ Annulé	Building Service - PWGSC	Service de bâtiment - TPSGC			
G452 Cancelled/ Annulé	Acquisition Fee - PWGSC	Frais d'acquisition - TPSGC			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
G454 Cancelled/ Annulé	Marine-Related Services - OGD	Services relatifs à la marine - AMG			
G455 Cancelled/ Annulé	Ship Inspection - OGD	Inspection des navires - AMG			
G461 Cancelled/ Annulé	**Other Services OGD**	**Autres services - AMG**			
G462 Cancelled/ Annulé	Professional and Technical Services - PWGSC Revolving Fund	Services professionnels et techniques - TPSGC			
G481 Cancelled/ Annulé	**Computer Consultants - OGD**	**Experts-conseils en traitement des données-AMG**			
G482 Cancelled/ Annulé	**Computer Services - OGD**	**Services d'informatiques - AMG**			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0501	Rental of Vacant, Unimproved Land	Location de terrains vacants	05	18	0501
0502	Rental of Residential Buildings - Including PWGSC	Location de maisons - Incluant TPSGC	05	18	0510
0503	Rental of Office Buildings	Location de bâtiments à bureaux	05	18	0511
0504	Rental of Industrial and Commercial Buildings	Location des bâtiments industriels et commerciaux	05	18	0512
0505	Rentals of Other Buildings	Location de bâtiments - autres	05	18	0514
0520	Ship Charters	Nolisement de navires	05	19	0566
0525	Automobile Rental	Location de véhicules automobiles	05	19	0540
0526	Aircraft Rental (including charter for Aerial Ice Surveys but not charter for supply)	Affrètement d'aéronefs (y compris l'affrètement pour des relevés aériens des glaces mais non l'affrètement pour le ravitaillement)	05	19	0561
0550	Rental of Telephone Equipment & Systems	Location de matériel & systèmes téléphoniques	05	20	0520
0551	Rental of Data Communications Equipment and Digital Communication Equipment)	Location matériel transmisson de données et de communications numériques	05	20	0521
0552	Rental of Image/Video Communication Equipment	Location de matériel de transmission d'images et de communications vidéo	05	20	0522
0554	Rental of Computer Software	Location de logiciels	05	20	0524
0555	Rental of Computer Equipment	Location de matériel informatique	05	20	0525
0556	Rental of Photocopiers	Location des photocopieuses	05	20	0533
0557	Rental of Other Office Equipment	Location d'autre matériel-bureau	05	20	0533
0558	Rental of Office Furn./Fixtures, Audio-Visual, Video, Photographic Equip., etc	Loc.machinerie, mobilier, installations de bureau, équip. audio-visuel, photographique, etc	05	20	0533
0559	Machinery and Heavy Equipment Rental	Location de machines et d'équipements lourds	05	20	0533
0566	Rental of Engineering Works Including Wharfage	Loc. installat. ingénierie incluant loc. de quai	05	20	0570
0568	**LIMIT-Rental - Not Elsewhere Specified (excluding Buildings)**	**LIMITE-Autres locations non spécifiés ailleurs (excl. bâtiment)**	**05**	20	**0570**
0569	Rental of Space other than Buildings (Parking Space, Ship Storage, Docks, Rooms for Meetings, etc.)	Location d'espace autre que des édifices (espaces de stationnement, entreposage pour navire, quai, salle de conférences, etc.)	05	20	0570
0570	Lease with Option to Purchase-Other(not Bldgs)	Locat. avec option d'achat-autres(sauf immeubles)	05	20	0570
G501 Cancelled/ Annulé	Land Rentals - OGD	Location des terrains - AMG			
G502 Cancelled/ Annulé	Rental of Buildings from PWGSC	Location d'édifices de TPSGC			
G524 Cancelled/ Annulé	**Other Rentals Not Elsewhere Specified - OGD**	**Autres locations non spécifiés ailleurs - OGD**			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0601	Repair and betterment of Ships & Small Craft Drydocking: Hull & Structure	Réparations et améliorations aux navires et petits bateaux en cale sèche: Coques et structures	06	21	0675
0602	Repair and betterment of Ships & Small Craft: Propulsion Systems & Equipment	Réparations et améliorations aux navires & petits bateaux : Sys.et équipement de propulsion	06	21	0675
0603	Repair and betterment of Ships & Small Craft: Electrical Generation & Distribution	Réparations et améliorations aux Navires & petits bateaux : Distribution et production électriques	06	21	0675
0604	Repair and betterment of Ships & Small Craft: Auxiliary Systems	Réparations et améliorations aux navires & petits bateaux : Systèmes auxiliaires	06	21	0675
0605	Repair and betterment of Ships & Small Craft: Domestic Systems	Réparations et améliorations aux navires & petits bateaux : Systèmes domestiques	06	21	0675
0606	Repair and betterment of Ships & Small Craft: Ventilation, Heating & Refrigeration	Réparations et améliorations aux navires & petits bateaux : Ventilation, chauffage et réfrigération	06	21	0675
0607	Repair and betterment of Ships & Small Craft: Deck Machinery	Réparations et améliorations aux navires & petits bateaux : Machinerie au pont	06	21	0675
0608	Repair and betterment of Ships & Small Craft: Alarm & Controls	Réparations et améliorations aux navires & petits bateaux : Alarme et contrôle	06	21	0675
0609	Repair and betterment of Ships & Small Craft: Safety Equipment	Réparations et améliorations aux navires & petits bateaux : Équipements de sécurité	06	21	0675
0610	Ships & Small Craft Repairs and betterment- self maintenance	Ent.& Rép.et améliorations aux navires et petits bateaux	06	21	0675
0611	Repair and betterment of ACV	Réparations et améliorations des VCA	06	21	0675
0630	Repair , maintenance and betterment of Marine Installations, e.g. Docks, Piers and Breakwaters and other marine structures	Réparation, entretien et améliorations des installations maritimes (Bassins, quais, jetées, brise-lames et autres structures marines)	06	21	0601
0631	Repair and betterment of Roads, Highways & Streets	Réparations et améliorations des chemins, routes et rues	06	22	0607
0632	Repair and betterment of Water Mains, Hydrants, Services and sewage systems	Réparations et améliorations des canalisations, aqueducs, bouches d'incendie et systèmes d'épuration	06	22	0611
0633	Repair and betterment of Power Transmission & Distribution Lines	Réparations et améliorations des lignes de transport & d'énergie	06	22	0619
0634	Repairand betterment of Installations	Réparations et améliorations des installations	06	22	0628
0641	**LIMIT-Repair and betterment of other Engineering Works**	**LIMITE- Réparations et améliorations aux autres travaux de génie**	**06**	22	**0628**
0642	Repair and betterment of Office Buildings	Réparations et améliorations aux édifices à bureaux	06	22	0630
0645	Repair and betterment of Radio Stations/Towers and Repair of Buildings or installations for Telecommunications Computers/or Electronic/Automated Office Systems	Réparations et améliorations aux postes ou tours de radio et aux bâtiments ou installations abritant matériel de télécommunications de TED ou bureautique	06	22	0640
0647	Repair and betterment of Maintenance and Service Buildings (incl. Elevators and escalators)	Réparations et améliorations aux bâtiments d'entretien et service (incl. Ascenseurs et monte-charge)	06	22	0645
0649	**LIMIT-Other Repairs and betterment to Buildings, Structures and Facilities**	**LIMITE-Autres réparations et améliorations aux édifices, structures et installations**	**06**	22	**0645**
0650	Repair and betterment of Residential Buildings	Réparations et améliorations de bâtiments résidentiels	06	22	0646
0665	Repair and betterment of Processing Machinery (Boilers, Engines, etc.)	Réparations et améliorations de machinerie de traitement (chaudières, moteurs,etc)	06	23	0655
0666	Repair and betterment of Heating, Air Conditioning & Refrigerat. Equip.	Réparations et améliorations d'appareils de chauffage,climatisation & réfrigérat.	06	23	0656
0667	Repair and betterment of Electric Lighting, Distrib. & Control Equip.	Réparations et améliorations aux éclairages électr., distribut. & contrôles d'électricité	06	23	0658
0668	Repair and betterment of Measuring, Controlling Laboratory, Medical and Optical Instruments, Apparatus,and accessories	Réparationset améliorations de matériel de météorologie, de génie, de science et de médecine	06	23	0660
0669	Repair and betterment of Furniture, Fixtures, Safety & Sanitation Equipment, Alarm & Signal Systems and all Other Small Equipments	Réparations et améliorations aux mobiliers et installations fixes, matériel de sécurité et d'hygiène, systèmes d'alarme et autres petits équipments	06	23	0665
0674	Repair and betterment of Engines	Réparations et améliorations aux machines	06	23	0665

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0675	Repair and betterment of Photographic Equipment, Electric Equipment & Appliances	Entretien et/ou réparations et améliorations d'équipments formation pour la marine, équipements audio-visuel, vidéo et photographique, et appareils électriques	06	23	0665
0679	Repair and betterment of Telecommunications Equipment	Réparations et améliorations d'équipements de télécommunications	06	23	0669
0680	Repair and betterment of Computer Equipment Hardware and Software	Réparations et améliorations d'équipements d'informatique - appareils et logiciels	06	23	0670
0681	Repair and betterment of Other Office Equipment	Réparations et améliorations autre matériel de bureau	06	23	0671
0682	Repair, maintenance and betterment of Road Motor Vehicles	Entretien, réparations et améliorations de véhicules à moteur	06	23	0682
0683	Repair and betterment of Miscellaneous Vehicles & Mobile Heavy Duty Equipment	Réparations et améliorations de véhicules divers et matériel roulant lourd	06	23	0683
G610 Cancelled/ Annulé	Repair of Buildings, Structures and Works - PWGSC	Réparations aux édifices, structures et installations - TPSGC			
G612 Cancelled/ Annulé	Dredging - PWGSC	Dragage - TPSGC			
G620 Cancelled/ Annulé	**Mainten. & Repair Services - OGD**	**Services entretien & rép.-AMG**			

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
7001	Electricity	Électricité	07	25	0701
7002	Natural Gas (utility)	Gaz naturel (utilité)	07	25	0702
7003	Water and Sewage	Égouts et aqueduc	07	25	0703
7006	**LIMIT-Other Public Utility Services**	**LIMITE-Autres services d'utilité publique**	**07**	25	**0709**
7008	Dangerous Waste Disposal	Elimination de matières dangereuses	7	25	0705
7101	Fuel for Aircraft/Hovercraft	Carburant pour aéronef/aéroglisseur	07	26	1123
7121	Diesel Fuel	Carburant diésel	07	26	1124
7140	Light Fuel Oil (incl. Furnace or Heating Oil)	Mazout léger (incl. Combustible de chauffage)	07	26	1125
7160	**LIMIT-Other Mineral Fuels, Oils & Products**	**LIMITE-Autres combustibles minéraux, huiles minérales et produits minéraux**	**07**	26	**1128**
7162	Liquified Petroleum Gas (excl. for Road Motor Vehicles), Propane, Natural Gas, Refined & Manufactured Gas	Gaz pétrole liquéfié (excl. véhicles routiers), propane, gaz naturel, gaz de raffinerie ou fabriqué	07	26	1128
7182	Gasoline for Boats and Small Craft	Essence pour petits bateaux et autres embarcations	07	26	1122
7184	Gasoline (excl. Boats and Small Craft)	Essence (excl. pour petits bateaux et autres embarcations)	07	26	1122
7204	Cable Wires	Câbles	07	27	1139
7205	Cutlery	Coutellerie	07	27	1163
7310	Lubricating Oil and Grease	Huile de graissage et graisses	07	28	1127
7313	Wood Fabricated Materials	Matériaux fabriqués de bois	07	28	1141
7314	Inorganic & Organic Chemicals, incl. Plastics, Rubber & Products (excl. Tires and Tubes)	Produits chimiques inorganiiques et organiques, incl. Matières plastiques, caoutchouc et leurs produits, sauf les pneus et chambres à air	07	28	1130
7317	Ferrous Metals, Hardware Items, etc./Metal Basic Products (Nuts, bolts)	Métaux ferreux (Articles de quicaillerie, etc.)	07	28	1160
7318	Non-ferrous Metals	Métaux non-ferreux	07	28	1161
7333	Fabricated Materials - Glass	Matériaux fabriqués de vitre	07	28	1139
7334	**LIMIT-Miscellaneous Chemical Products Not Elsewhere Specified**	**LIMITE-Autres produits chimiques non spécifiés ailleurs**	**07**	28	**1139**
7335	Uniforms	Uniformes	07	28	1151
7336	Protective & Other Clothing	Vêtements protecteurs et autres	07	28	1152
7337	Footwear	Chaussures	07	28	1153
7338	House Furnishings - Floor Covering, Curtains, Towels, etc. (excl. Furniture)	Accessoires de maison excl. mobilier (couvre-plancher, rideaux serviettes, etc.)	07	28	1173
7339	Hunting, Fishing, Recreational and Sporting Equipment and Supplies	Accessoires et matériel de chasse, pêche, de loisir et de sport	07	28	1159
7340	Textile Fabricated Material - Fishing Nets & Gear, etc.	Produits textiles - Filets et engins de pêches, etc.	07	28	1159
7341	**LIMIT-Miscellaneous Textiles - Headgear, Umbrellas etc.**	**LIMITE-Matiéres textiles diverses, coiffures, parapluie, etc.**	**07**	28	**1159**
7342	Printed Matter (including subscriptions)	Produits imprimés (incluant abonnements)	07	28	1143
7343	Containers and Closures	Récipients et couvercles	07	28	1179
7344	Office & Stationary Supplies	Papeterie et fournitures de bureau	07	28	1172
7345	Photographic Goods (eg. film)	Fournitures de photographie (ex. film)	07	28	1134
7347	Medical and Hospital Supplies	Matériel médical et hospitalier	07	28	1171
7348	Library Acquisitions	Achats pour la bibliothèque	07	28	1143
7350	Fish Tags	Étiquettes pour poisson	07	28	1179
7352	Awards - Gifts (excl. Money)	Primes - Cadeaux (excl. primes en argent)	07	28	1179
7353 Cancelled/ Annulé	Corporate Services Only (payment credit cards)	Serv.ministériels seulement (paiement cartes crédit)	07	28	1179
7354	Scientific Supplies Miscellaneous	Matériel scientifique divers	07	28	1179
7357	Hydrographic and/or Cartographic Supplies	Matériel divers cartographie et hydrographie	07	28	1179
7360	**LIMIT-Other Miscellaneous Products and Goods**	**LIMITE-Autres Prduits et biens divers**	**07**	28	**1179**
7361	Cleaning Supplies for vessels and laboratories	Produits de nettoyage pour navires et laboratoires	07	28	1130
7505	**Provisions - Groceries - Other Food not specified**	**Provisions - Autres aliments non précisés**	**07**	**30**	**1115**

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
7507	Fish Food and Feed, Fish Bait, Fish Fry, Fish Eggs	Nourriture de poisson et autres pour animaux, fretin, oeufs de poisson et appâts	07	30	1115
G712 Cancelled/ Annulé	Fuel, Gas - OGD	Gaz, Mazout - AMG			
G734 Cancelled/ Annulé	**Materials, Supplies & Public Utilities - OGD**	**Fournitures, approvisionnements et utilités publiques - OGD**			
G736 Cancelled/ Annulé	**Stocked Items - PWGSC**	**Articles stockés - TPSGC**			

Line Object
Articles d'exécution

Line Obj Art. exéc.	**Description - E**	**Description - F**	**Std Obj Art Cour**	**Obj.Grp Gr.art.**	**Econ.Obj. (TB) Obj. Écon. (CT)**
0801	Acquisition of Land	Acquisition de terrains	08	31	1301
0810	Marine Installation: Docks, Wharves...	Génie maritime: Docks, quais...	08	32	1310
0811	Roads, Highways, Parking Lots, Sidewalks, Paths	Chemins, routes, stationnement, trottoirs et sentiers	08	32	1316
0812	Bridges,Trestles,Culverts,Overpasses,Viaducts	Ponts, chevalets, ponceaux, voies sup., viaducs	08	32	1335
0818	Fences, Snowsheds, Signs, Guardrails, Gates, Towers & Masts, Waterworks, Sewage Systems, Landscaping & Related Works	Clôtures, pare avalanches, écriteaux, garde fous, barrières, tours et mâts, canalisation, systèms d'égouts, paysagement	08	32	1339
0819	New Hatcheries	Nouvelles piscicultures	08	32	1339
0824	**Other Construction or Acquisition of Works**	**Autres constructions ou acquisitions de travaux**	**08**	32	**1339**
0850	Acquisition of Office Buildings	Acquisition d'édifices à bureaux	08	33	1340
0852	Acquisition of buildings or installations for telecommunications, EDP and/or electronic/automated office systems	Acquisition de bâtiments ou installations devant abriter du matériel de télécommunications, traitement des données ou de bureautique ou des deux	08	33	1360
0854	Acquisition of Residential Buildings/Fishery Officers'Cabins	Acquisition d'immeubles résidentiels & cabines-agents des pêches	08	33	1370
G810 Cancelled/ Annulé	Capital Projects - PWGSC	Projets d'immobilisation - TPSGC			
G830 Cancelled/ Annulé	**Other Land, Building & Works (OGD) excluding PWGSC, Revolving Fund**	**Autres terrains, bâtiments & ouvrages (AMG) sauf TPSGC, fonds renouvelable**			

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0901	Special Shop & Industrial Equipment (Manufacturing Equipment etc.)	Equipement d'atelier et industriel spécial (Equipement d'usine etc.)	09	35	1211
0902	General Purpose Industrial and conveying, elevating & material handling equipment	Equipement général, industriel, d'élévation, de manutention	09	35	1219
0904	Measuring, Controlling, Laboratory, Medical and Optional Instruments, Apparatus and Accessories	Instruments, appareils et accessoires de mesure de contrôle, de laboratoire, de médecine et d'optique	09	35	1243
0906	Radar Equipment (incl. Electronic Navigation Equipment and Lightstations, etc.	Equipment de radar (incl. Équipement d'aides électroniques pour la navigation) et phares	09	35	1244
0909	Safety & Sanitation Equipment	Equipement de sécurité et d'hygiène	09	35	1245
0910	Office Furniture & Furnishings	Mobilier et ameublement de bureau	09	35	1231
0911	Heating/AirConditioning/Refrigeration/Lighting/Cooling System Parts	Chauffage, climatisation, réfrigération, éclairage électrique, systèm de refroidissement	09	35	1249
0913	Hydraulic Equipment	Matériel hydraulique	09	35	1249
0917	Mobile Equipment - Parts	Matériel roulant-pièces	09	35	1249
0919	Electric Lighting, Distribution and Control Equipment	Matériel d'éclairage, de contrôle et de distribution électrique	09	35	1242
0920	**LIMIT-Other Equipment & Parts Not Elsewhere Specified (x-ray, recreational, food cooking, non-electric cleaning equipment, etc.)**	**LIMITE-Autres équipements et pièces non spécifiés ailleurs (radiographique, récréatif, appareils à cuisson, appareilsde nettoyage non électriques, etc.)**	**09**	35	**1249**
0921	Other Electrical Equipment and Appliances	Autre équipement et accessoires électriques	09	35	1249
0922	Other Furniture & Fixtures (incl. Parts)	Autres mobilier et installations fixes incl. Pièces	09	35	1246
0923	Voice Communications Equipment	Matériel de communications vocales	09	35	1221
0924	Telecommunications Systems Equipment	Equipement de systèmes de télécommunication	09	35	1225
0925	Data/Message/Text and Computer/Communications Equipment	Matériel de transmission de données (messages-textes, données informatisées)	09	35	1222
0927	Image/Video, Audio Visual & Photographic Equipment	Matériel transmission d'images & communications vidéo, audiovisuel et photographique	09	35	1223
0929	Computer Equipment - Large/Medium - Mainframe - Mini	Matériel d'ordinateur - Gros/médium, ordinateur principal et mini	09	35	1226
0930	Computer Equipment - Small - Desktop/Personal/Portable	Matériel d'ordinateur petit, dessus de bureau, personnel/portatif	09	35	1227
0931	Computer Software	Ensembles de logiciels	09	35	1228
0932	Computer Equipment - Parts	Equipement d'ordinateurs et pièces	09	35	1229
0934	Digital Communications Equipment	Matériel de communications numériques	09	35	1224
0935	Other Office Equipment & Parts	Autre matériel de bureau et pièces	09	35	1239
0936	Other Equipment - for use on land	Autre équipement - usage sur terre	09	35	1249
0937	Tools and Implements	Outils et outillages	09	35	1212
0938	Plumbing Equipment and fittings incl. Parts	Matériel et accessoires de plomberie, y compris les pièces	09	35	1241
0950	Ships and Boats	Navires et embarcations	09	36	1256
0956	Ships and Small Craft - Capital Improvements to Ships	Navires et petits bateaux - Amélior. importantes aux navires	09	36	1256
0957	Ships and Boats Equipment-Parts (incl. ACV)	Equipement et pièces de navires et bateaux (incl.VCA)	09	36	1257
0958	Buoy Equipment	Equipement bouées	09	35	1249
0980	Road Motor Vehicles (cars, trucks, tractor trailers)	Véhicules à moteurs routiers (autos, camions, tracteurs)	09	37	1261
0981	Other Vehicles	Autres véhicules	09	37	1264
0982	Road Motor Vehicles Parts	Pièces de véhicules automobiles de route	09	37	1263
0983	Miscellaneous vehicles parts (excl.road veh) incl.rubber tires and tubes	Pièces de véhicules diverses (excl.véh.routiers) incl. Pneus et chambres à air	09	37	1267
0984	Weapons incl. Parts	Armes incl. Pièces	09	35	1271
0985	Munitions and ammunition	Munitions	09	35	1273
G901 Cancelled/ Annulé	Office Furniture & Fixtures - PWGSC	Mobilier de bureau et installations fixes - TPSGC			
G902 Cancelled/ Annulé	**Machinery and Equipment Acquired from OGD**	**Machinerie et équipement achetés des AMG**			

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
1001	Payments to First Nations and Inuit people	Paiements de transfers aux Premières Nations et aux Inuit	10	38	2032
1002	Payments to univ. prof.& students - research	Paiem. aux prof. & étud. d'univ. - recherche	10	38	2041
1004	Income Support Payments to due to the collapse of the Atlantic Fishery	Paiements de soutien du revenu dus à la disparition des pèches de l'Atlantique	10	38	2042
1005	Aboriginal Transfer Program	Programme de transfert aux autochtones	10	38	2049
1006	Payments to Fishers or fishing vessel owners	Paiements aux pêcheurs ou prop.bateaux pêche	10	38	2049
1009	**LIMIT-Other Transfer Payments to Individuals**	**LIMITE-Autres paiements de transfert aux particuliers**	**10**	38	**2049**
1011	Non profit-National Organizations	Non lucratif-Organisations nationales	10	38	2431
1013	Non profit-Grants or Contrib.-Research & Dev.	Non lucratif-Subv.ou contrib.-recherche & dévelop.	10	38	2436
1014	Non profit-Improving the Environment	Non lucratif-Amélioration de l'environnement	10	38	2437
1015	Non profit-Fishery related Organizations	Non lucratif-Organisations reliées aux pêches	10	38	2449
1016	Reimbursement of Canadian Marine Rescue Auxiliary Costs for Operations	Remboursement des coûts des auxiliaires de sauvetage de la marine canadienne pour opérations, recherche et	10	38	2449
1017	Reimbursement of Canadian Marine Rescue Auxiliary Costs for Administration and Organization	Remboursement des coûts des auxiliaires de sauvetage de la marine canadienne pour administration et organisation	10	38	2449
1018	Reimbursement of Canadian Marine Rescue Auxiliary Costs for Training and Exercises	Remboursement des coûts des auxiliaires de sauvetage de la marine canadienne pour la formation et les manoeuvres	10	38	2449
1019	Reimbursement of Canadian Marine Rescue Auxiliary Costs for Prevention	Remboursement des coûts des auxiliaires de sauvetage de la marine canadienne pour les activités de prévention, recherche et sauvetage	10	38	2449
1020	First Nations and Inuit Associations	Associations des premières nations et des inuits	10	38	2423
1031	Payments for Research and Development-Industry	Paiements pour recherche et dévelop.-Industrie	10	39	2126
1032	Payments under loan guarantees (used with allot 430 only)	Paiements en vertu de garanties d'emprunt (utilisé avec affectation 430 seulement)	10	39	2127
1034	**LIMIT-Industry-Miscellaneous Subsidies**	**LIMITE-Industrie-Aide diverse à l'industrie**	**10**	**39**	**2139**
1036	Marine Operations for Emergency Dredging	Opérations maritimes pour dragage d'urgence	10	39	2139
1040	**LIMIT-Transfer Payments to Provinces/Territories**	**LIMITE-Paiements de transfert aux provinces/territoires**	**10**	**40**	**2259**
1051	**LIMIT-Grants or Contributions outside Canada**	**LIMITE-Contributions ou subventions hors du Canada**	**10**	**41**	**2329**
G001 Cancelled/ Annulé	**Payments of Grants & Contributions to OGD**	**Paiements de subventions & contributions aux AMG**			

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
1201	Loss of Money < $500	Radiation des pertes de 500 $ et moins	12	43	3211
1202	Losses of Money > $500	Pertes d'argent > à 500 $	12	43	3212
1203	**Write Offs of Loans, Investments, Advances**	**Radiations de prêts,dotations en capital, avances**	**12**	43	**3215**
1204	Loss on Foreign Currency Transactions	Pertes relatives aux devises étrangéres	12	43	3216
1205	**LIMIT-Forgiveness of Loans, Investments and Advances**	**LIMITE-Renonciation de prêts, dotations-capital & avances**	**12**	43	**3217**
1206	Write-off of Accounts Receivables (to be used with allotment code 1BA)	Radiation des comptes débiteurs (utilisé avec affectation 1BA seulement)	12	43	3212
1207	Corporate Services Only (payment credit cards)	Serv.intégrés seulement (paiement cartes crédit)	70	28	7099
1208	Allowance for doubtfull Accounts in Abacus (to be used with allotment code 1BB)	Allocation pour créances douteuses dans Abacus (utilisé avec affectation 1BB seulement)	70	56	7021
1209	Reject IS Expenditures (used only by Corporate and with allot. 120)	RI-Dépenses rejetées (utilisé seulement par Serv.Intégrés et avec affectation 120)	12	47	3259
1210	Discounts Earned-Early Payments to Suppliers	Escomptes gagnés-paiements prématurés-fournisseurs	12	44	3241
1221	Court awards to industry	Décisions de la Cour en faveur de l'industrie	12	45	3249
1222	Court awards to persons	Décisions de la Cour en faveur des particuliers	12	45	3250
1225	Claims against the Crown	Réclamations contre la couronne	12	45	3251
1226	Ex Gratia Payments	Versements à titre gracieux	12	45	3257
1227	Interest & charges on Overdue Accounts	Intérêt & frais - comptes en souffrance	12	45	3252
1229	International Commission Agreements	Accords de commissions internationales	12	45	3259
1230	Third Party Liability Insurance Premiums	Primes d'assurance - responsabilité des tiers	12	45	3259
1231	Administration Fees (ex: credit cards)	Frais d'administration (par ex. cartes de crédit)	12	45	3259
1232	Repayment of Prior Years' Revenue	Remboursement de revenu de l'année précédente	12	45	3259
1280	Amortization Expense (Fixed Assets)	Dépense d'amortissement	12	46	3451
1281	Gain/Loss on Assets Disposal	Gain/perte sur disposition d'actifs	70	46	7099
1282 Cancelled/ Annulé	Proceeds from Sales	Produit des ventes	12		
1283	Cost of Removal	Coût d'aliénation	70	46	7099
1286	Proceeds of Assets Sales clearing account (to be used with allotment code 6CC)	Profit sur la vente d'actifs-Compte provisoire (utilisé avec affectation 6CC seulement)	70	46	7099
1299	Previous Years-Coding Change WIP	Années ant.-Changement codage TEC	70	46	7099
G021	Repayment of Prior Years Revenue - OGD	Remboursement de revenu de l'année précédente - AMG	12	47	3429
G022	Payments under Shared Costs Projects-OGD (debit)	Paiements - projets à coûts partagés-AMG (débit)	12	47	3427
G023	Recoveries under Shared Costs Projects-OGD (credit)	Recouvrements - projets à coûts partagés-AMG (crédit)	12	47	3715
G024	Suspense Account (debit) - Advance to OGD for Projects to be performed by them on our behalf	Compte d'attente (débit) - Avance à AMG pour projets qu'ils ont fait pour nous	12	47	3422
G025	Suspense Account (credit) - OGD	Compte d'attente (crédit) - AMG	12	47	3718
G026 Cancelled/ Annulé	**Miscellaneous Expenditures-OGD (excl.prof.serv.)**	**Dépenses divers-AMG (excl.serv.prof.)**			
G028 Cancelled/ Annulé	Customs Import Duties	Droits de douane à l'importation	12		
G029	Payments in lieu of Taxes paid to PWGSC	Paiements tenant lieu d'impôts payées à TPSGC	12	47	3428
G030	Recovery helicopter expenditures from OGD (used with allot.126 only)	Recouvrement dépenses hélicoptères AMG (avec affect. 126 seulement)	12	47	3472
G031	Suspense Account (credit) G&C-OGD	Compte d'attente (crédit) - Subvention et Contribution - AMG	12	47	3718
G032	Incremental cost recoveries from OGD's (credit)	Recouvrement des coûts d'accroissement AMG (crédit)	12	47	3472

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
1301	Cost Recovery from Employees for Rent (Housing - DFO) by Payroll Deduction (to be used with allotment code 601)	Recouvrement des coûts provenant des employés pour frais de location (Logement-MPO) provenant des déductions sur la paye (à être utilisé avec le code d'affectation 601)	13	48	4530
1302	Cost Recovery for Work Performed by Prescott Shops (to be used with allotment code 601)	Recouvrements des coûts des travaux achevés par les ateliers de Prescott (à être utilisé avec le code d'affectation 601)	13	48	4545
1303	**LIMIT-Other Recoveries (to be used with allotment code 601)**	**LIMITE-Autres recouvrements (à être utilisé avec le code d'affectation 601)**	13	48	**4569**
1306	Recovery from Non Coast Guard Sectors for Telecommunication Services (to be used with allotment code 601)	Recouvrement pour services de télécommunications maritimes des secteurs autres que la GCC (à être utilisé avec le code d'affectation 601)	13	48	4899
1307	Recoveries by Canadian Coast Guard College for Food, Accommodation (to be used with allotment code 601)	Recouvrement par le Collège de la GCC pour l'hébergement et les repas (à être utilisé avec le code d'affectation 601)	13	48	4899
1309	Cost Recovery - Helicopter Services - Private Sector (to be used with allotment code 601)	Recouvrement de coûts - Services hélicoptères - Secteur privé (à être utilisé avec le code d'affectation 601)	13	48	4569
1311	Tuition recovered by CCG Coll.from Private Sect	Recouv.frais scolarité par Coll.GCC, secteur privé	13	53	4569
1320	Small Vessel Regulations - Boat Capacity Plates (to be used with allotment code 601)	Règlements sur les petits bateaux - Plaques de capacité pour les bateaux (à être utilisé avec le code d'affectation	13	50	4559
1325	Icebreaking Serv.Fee-Foreign Flag Ships (used with allot.601 only)	Droit serv.déglaçage-Navires pav.étranger (utilisé avec affectation 601 seulement)	13	51	4564
1326	Icebreaking Serv.Fee-Canadian Flag Ships (used with allot 601 only)	Droit serv.déglaçage-Navires pav.canadien (utilisé avec affectation 601 seulement)	13	51	4564
1327	Icebreaking Serv.Fee-Ice Class Discount, Canada Type D (used with allot 601 only)	Droit serv.déglaçage-Escompte cote glace Canada type D(aff. 601 seulement)	13	51	4564
1328	Icebreaking Serv.Fee-Ice Class Discount,Canada Type C (used with allot 601 only)	Droit serv.déglaçage-Esc.cote glace,Canada type C (utilisé avec aff. 601 seul)	13	51	4564
1329	Icebreaking Serv.Fee-Ice Class Discount, Arctic Class,Canada Type Aor B (used with allot 601)	Droit serv.déglaçage-Esc.cote glace, classe arctique, Canada type A ou B (utilisé avec aff.601 seul.)	13	51	4564
1330	Marine Services Fee - Foreign Flag Cargo Loaded (to be used with allotment code 601)	Services de navigation maritime - Marchandises chargées-pavillon étranger (à être utilisé avec le code d'affectation 601)	13	51	4564
1331	Marine Services Fees - Foreign Flag Cargo Unloaded (to be used with allotment code 601)	Services de navigation maritime - Marchandises déchargées pavillon étranger (à être utilisé avec le code d'affectation 601)	13	51	4564
1332	Marine Services Fees - Foreign Flag Cruise Ships (to be used with allotment code 601)	Services de navigation maritime - Navires de croisière à pavillon étranger (à être utilisé avec le code d'affectation	13	51	4564
1333	Marine Services Fees - Domestic Flag Eastern Canada(to be used with allotment code 601)	Services de navigation maritime - Pavillon domestique Est du Canada (à être utilisé avec le code d'affectation 601)	13	51	4564
1334	Marine Services Fees - Other Foreign Flag (to be used with allotment code 601)	Services de navigation maritime - Autre pavillon étranger (à être utilisé avec le code d'affectation 601)	13	51	4564
1335	Marine Services Fees - Foreign Flag Operating in Coasting Trade (to be used with allotment code 601)	Services de navigation maritime - Pavillon étranger - opérations de cabotage (à être utilisé avec le code d'affectation 601)	13	51	4564
1336	Marine Services Fees - Pacific Region - Foreign Flag (to be used with allotment code 601)	Services de navigation maritime - Région du pacifique - Pavillon étranger (à être utilisé avec le code d'affectation 601)	13	51	4564
1337	Marine Services Fees - Precision Navigation Systems Fee Reduction (to be used with allotment code 601)	Services de navigation maritime - Réduction de droit relatif au systèmes de navigation de précision (à être utilisé avec le code d'affectation 601)	13	51	4564
1338	Marine Services Fees - Domestic Flag Pacific Region (use with allot 601)	Services navigation maritime-Pavillon domestique Région du Pacifique (use with allot 601)	13	51	4564
1340	Maintenance Dredging Services Fee - Foreign Flag Ships	Droit de services de dragage d'entretien - Navires pavillon étranger	13	51	4564

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
1341	Maintenance Dredging Services Fee - Canadian Flag Ships	Droit de services de dragage d'entretien - Navires pavillon canadien	13	51	4564
1342	Maintenance Dredging Services Fee - Foreign Flag Ships (Coasting Trade)	Droit de services de dragage d'entretien - Navires pavillon étranger (Cabotage)	13	51	4564
1343	Maintenance Dredging Serv.Tonnage Fees-Corporations	Droits pour services de dragage d'entretien basé sur la jauge Sociétés	13	51	4564
1345	Cost Recovery Arctic Resupply Private Sector (to be used with allotment code 601)	Frais de ravitaillement de L'Arctique - Secteur Privé (à être utilisé avec le code d'affectation 601)	13	52	4569
1346	Cost Recovery - Arctic Resupply Administrative Cost - Private Sector (to be used with allotment code 601)	Recouvrement de coûts - Ravitaillement de l'Arctique -Les frais administratifs - Secteur privé (à être utilisé avec le code d'affectation 601)	13	52	4569
1356	Cost Recovery Radio Tolls (to be used with allotment code 601)	Recouvrement de coûts-Frais de messages radio (à être utilisé avec le code d'affectation 601)	13	53	4564
1357	Marine Services - Other (to be used with allotment code 601)	Autres services maritimes (à être utilisé avec le code d'affectation 601)	13	53	4564
1359	**LIMIT-Revenue from Other Optional Services (use with allotment code 601)**	**LIMITE-Revenus d'autres services facultatifs (utiliser affectation 601)**	13	53	**4569**
1360	Recovery of Pollution Incident Costs	Recouvrement de coûts reliés aux incidents de pollution	13	53	4569
1362	Recovery of NSF Administrative Charges (to be used with allotment code 601)	Recouvrement de coûts- frais administratifs pour chèques sans fonds (à être utilisé avec le code d'affectation 601)	13	53	4586
1363	Premium, Discount and Exchange (to be used with allotment code 601)	Prime, escompte et échange (à être utilisé avec le code d'affectation 601)	13	53	4899
1364 Cancelled/ Annulé	Interest on overdue A/R (to be used with allotment code 601)	Intérêts sur comptes dt en souffrance (à être utilisé avec le code d'affectation 601)	13		4832
1370	Rental Land - Industrial, Recreational	Location terrains - industriel, récréatif	13	54	4525
1372	Rental Land - Agricultural (to be used with allotment code 601)	Location - Terrains - Agriculture (à être utilisé avec le code d'affectation 601)	13	54	4525
1385	Rental - Space, Control Lines and Power (to be used with allotment code 601)	Location - Locaux, lignes de contrôle et énergie (à être utilisé avec le code d'affectation 601)	13	55	4527
1386	Rental of Office, Adminstrative and Other Buildings (to be used with allotment code 601)	Location - Bâtiments administratifset autres (utiliser affectation 601)	13	55	4531
1388	**LIMIT-Rental - Miscellaneous (to be used with allotment code 601)**	**LIMITE-Location - Divers (à être utilisé avec le code d'affectation 601)**	13	55	**4539**
G051	**LIMIT-Recoverable Administrative Services - OGD (to be used with allotment code 601**)	**LIMITE-Services administratifs recouvrables - AMG (à être utilisé avec le code d'affectation 601**)	13	49	**4612**
G053	Sundry Service and Service Fees - OGD (to be used with allotment code 601)	Services divers et droits de service - AMG (à être utilisé avec le code d'affectation 601)	13	49	4619
G055	Cost Recovery - Helicopter Services - OGD (to be used with allotment code 601)	Recouvrement de coûts - Services hélicoptères - AMG(à être utilisé avec le code d'affectation 601)	13	49	4619
G056	**LIMIT-Other Recoveries - OGD (use with allotment code 601)**	**LIMITE-Autres recouvrements - AMG (utilisé affectation 601)**	13	49	**4619**
G057	Food & Acco.recovered by CCG Coll.from OGD	Recouvre.par GCC-Coll.pr hébergement & repas , de AMG	13	49	4619
G058	Tuition recovered by CCG Coll. from OGD	Recouvre.par GCC-Coll.pour frais scolarités, de AMG	13	49	4619
G060	Cost Recovery Artic Resupply - Administration Services for OGD and Agencies (to be used with allotment code 601)	Recouvrement de coûts - Ravitaillement de l'Arctique - Les frais administratifs pour AMG et agences (à être utilisé avec le code d'affectation 601)	13	52	4612
G061	Cost Recovery Arctic Resupply OGD and Agencies (to be used with allotment code 601)	Recouvrement de Ravitaillement de L'Arctique - AMG et agences (à être utilisé avec le code d'affectation 601)	13	52	4619
G065	Cost Recovery-Radio Tolls - OGD (to be used with allotment code 601)	Recouvrement -Frais des messages radio - AMG (à être utilisé avec le code d'affectation 601)	13	52	4619

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
2002	Capelin - Competitive (to be used with allotment code 611)	Capelan - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2003	Clams - Competitive (to be used with allotment code 611)	Clams - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2004	Clams - IQ (to be used with allotment code 611)	Clams - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2005	Crab - Competitive (to be used with allotment code 611)	Crabe - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2006	Crab - IQ (to be used with allotment code 611)	Crabe -QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2007	Geoduck/Horse Clam - Competitive (to be used with allotment code 611)	Panope & Fausse-Mactre - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2008	Groundfish - Competitive (to be used with allotment code 611)	Poissons de fond - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2009	Groundfish - IQ (to be used with allotment code 611)	Poissons de fond - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2010	Halibut - IQ (to be used with allotment code 611)	Flétan - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2011	Herring - Competitive (to be used with allotment code 611)	Hareng - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2012	Herring - IQ (to be used with allotment code 611)	Hareng - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2013	Lobster - Competitive (to be used with allotment code 611)	Homard - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2014	Lobster - IQ (to be used with allotment code 611)	Homard - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2015	Mackerel - Competitive (to be used with allotment code 611)	Mackerel - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2016	Marine Plants - Competitive (to be used with allotment code 611)	Plantes marines - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2017	Rockfish - Competitive (to be used with allotment code 611)	Sébaste - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2018	Sablefish - IQ (to be used with allotment code 611)	Morue charbonnière - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2019	Salmon - Competitive (to be used with allotment code 611)	Saumon - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2020	Scallops - Competitive (to be used with allotment code 611)	Pétoncles - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2021	Scallops - IQ (to be used with allotment code 611)	Pétoncles - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2022	Sea Urchins, Cucumber - Competitive (to be used with allotment code 611)	Oursins, holothurie - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2023	Seals - Competitive (to be used with allotment code 611)	Phoques - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2024	Shark - Competitive (to be used with allotment code 611)	Requin - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2025	Shrimp/Prawn - Competitive (to be used with allotment code 611)	Crevettes - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2026	Shrimp/Prawn - IQ (to be used with allotment code 611)	Crevettes - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2027	Squid - Competitive (to be used with allotment code 611)	Calmar - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2028	Swordfish - Competitive (to be used with allotment code 611)	Espadon - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2029	Swordfish - IQ (to be used with allotment code 611)	Espadon - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2030	Tuna - Competitive (to be used with allotment code 611)	Thon - Concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510
2031	Tuna - IQ (to be used with allotment code 611)	Thon - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2032	Other Licenses - Competitive (to be used with allotment code 611)	Autres licenses - concurrentielles (à être utilisé avec le code d'affectation 611)	14	70	4510

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
2033	Other Licenses - IQ (to be used with allotment code 611)	Autres licenses permis - QI (à être utilisé avec le code d'affectation 611)	14	71	4510
2034	Oyster Leases (to be used with allotment code 611)	Baux huîtriers (à être utilisé avec le code d'affectation 611)	14	70	4510
2035	Bait Fish Licences (to be used with allotment code 611)	Permis de poissons pour appât (à être utilisé avec le code d'affectation 611)	14	70	4510
2045	Vessel Registration (to be used with allotment code 611)	Immatriculation des bateaux (à être utilisé avec le code d'affectation 611)	14	70	4519
2046	Fisher Registration (to be used with allotment code 611)	Immatriculation des pêcheurs (à être utilisé avec le code d'affectation 611)	14	70	4519
2065	Other Privileges and Permits (to be used with allotment code 611)	Autres privilèges et permis (à être utilisé avec le code d'affectation 611)	14	70	4510
2066	Recreational Fishing License Pilot (to be used with allot.611 only)	Permis "pilote" pêche récréative (à être utilisé avec affect. 611 seulement)	14	73	4510
2070	Tidal Water Sports Fishing Licence (to be used with allotment code 611)	Permis de pêche sportive en haute mer (à être utilisé avec le code d'affectation 611)	14	73	4510
2071	Conservation Stamps (to be used with allotment code 611)	Timbres de conservation (à être utilisé avec le code d'affectation 611)	14	73	4510
2101	License Amendment Fees T.M.Z.P. (to be used with allotment code 611)	Droits de modification de permis P.Z.D.M. (à être utilisé avec le code d'affectation 611)	14	72	4510
2102	Fishing Fees (T.M.Z.P.) (to be used with allotment code 611)	Droits de pêche (P.Z.D.M.) (à être utilisé avec le code d'affectation 611)	14	72	4510
2104	Access Fees (T.M.Z.P.) (to be used with allotment code 611)	Droits d'accès (P.Z.D.M.) (à être utilisé avec le code d'affectation 611)	14	72	4510
2301	Sales of Fish/Fish Products & Baits (to be used with allotment code 645)	Ventes de poisson, produits à base de poissons et appâts (utiliser affectation 645)	14	76	4549
2410	SCH Berthage Commercial	PPB Amarrage-commercial	14	78	4569
2411	SCH Berthage Fishing	PPB Amarrage-pêcheur	14	78	4569
2412	SCH Berthage Recreational	PPB Amarrage-plaisancier	14	78	4569
2413	SCH Licence Commercial	PPB Permis commercial	14	78	4569
2414	SCH Licence Fishing	PPB Permis aux pêcheurs	14	78	4569
2415	SCH Licence Recreational	PPB Permis plaisancier	14	78	4569
2416	SCH Lease Commercial	PPB Baux-commercial	14	78	4569
2417	SCH Lease Fishing	PPB Baux-pêcheur	14	78	4569
2418	SCH Lease Recreational	PPB Baux-plaisancier	14	78	4569
2419	SCH Lease (Harbour Authority)	PPB Baux- Autorité Hâvre	14	78	4569
2420	SCH Wharfage Commercial	PPB Frais débzrquement commercial	14	78	4569
2421	SCH Wharfage Fishing	PPB Frais débarquement pêcheur	14	78	4569
2422	SCH Wharfage Recreational	PPB Frais débarquement plaisancier	14	78	4569
2423	SCH Other Commercial	PPB Autre-Commercial	14	78	4569
2424	SCH Other Fishing	PPB Autre-pêcheur	14	78	4569
2425	SCH Other Recreational	PPB Autre-plaisancier	14	78	4569
2450	Sale-Navigation Charts/Tables/Sailing Direct. (to be used with allotment code 645)	Ventes de cartes/tables/instructions de navigation (à être utilisé avec le code d'affectation 645)	14	79	4544
2530	Licence Income - Technology (to be used with allotment code 651)	Revenus de licences - Technologie (à être utilisé avec le code d'affectation 651)	14	81	4519
2560	Rental of Vacant Land (to be used with allotment code 651)	Location de terrains vacants (à être utilisé avec le code d'affectation 651)	14	82	4525
2561	Rental-Machinery/Equipment(other than vehicles) (to be used with allotment code 651)	Location machinerie/matériel (autres que véhicule) (à être utilisé avec le code d'affectation 651)	14	82	4527
2562	Rental of Residential Buildings (to be used with allotment code 651)	Location d'immeubles résidentiels (à être utilisé avec le code d'affectation 651)	14	82	4530
2563	Rental of Non Residential Buildings	Location de bâtiments non résidentiels	14	82	4531
2602	REVENU-Parking Fees (to be used with allotment code 651)	REVENU-Frais de stationnement (à être utilisé avec le code d'affectation 651)	14	83	4529

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
2603	Services/Fees under Access to Information Act (to be used with allotment code 651)	Services selon la Loi sur l'accès à l'information (à être utilisé avec le code d'affectation 651)	14	83	4581
2605	Interest on Overdue Acc. Receivable (to be used with allotment code 602)	Intérêts sur comptes dt en souffrance (à être utilisé avec le code d'affectation 602)	14	84	4832
2606	NSF Administrative Charges (to be used with allotment code 602)	Frais administratifs pour chèques sans fonds (à être utilisé avec le code d'affectation 602)	14	84	4586
2607	FILA Loan Guarantee (to be used with allotment code 602)	Prime sur un prêt garanti par la LPAOP (à être utilisé avec le code d'affectation 602)	14	84	4598
2608	**LIMIT-Other Miscellaneous Revenue (to be used with allotment code 602)**	**LIMITE-Autres recettes diverses (à être utilisé avec le code d'affectation 602)**	**14**	84	**4593**
2630	Sales of Publications and Manuals (excl 2450) (to be used with allotment code 645)	Ventes de publications et manuels (sauf 2450) (à être utilisé avec le code d'affectation 645)	14	84	4544
2632	**LIMIT-Sales Miscellaneous (excluding Prescott Shops L.O. 1302) (to be used with both allotment codes 602 and 645)**	**LIMITE-Ventes diverses (excluant les ateliers de Prescott A.E.1302) (à être utilisé avec les codes d'affectation 602 et 645)**	**14**	84	**4549**
2633	Cost Recovery from SLSA re: Coast Guard Aids Maintenance (to be used with allotment code 645)	Recouvrement de coûts de VMSL: entretien des aides à la navigation (à être utilisé avec le code d'affectation 645)	14	84	4569
2634	Sale of Crown Assets (to be used with allotment code 647)	Vente des biens de la couronne (utilisé avec affectation 647 seulement)	14	84	4843
2635	Gain on re-valuation or foreign currency assets and liabilities (allot.602)	Bénéfices de la réévaluation des opérations de change pour actifs et passifs (aff.602)	14	84	4892
2636	Sales of residential real property (to be used with allotment code 647)	Vente de biens immobiliers résidentiels (utilisé avec affectation 647 seulement)	14	84	4844
2639	Sales of non-residential real property (to be used with allotment code 647)	Vente de biens immobiliers non-résidentiels (utilisé avec affectation 647 seulement)	14	84	4845
2701	Refunds Prev Yr Exp-Purchase of Oper Goods/Serv (to be used with allotment code 631)	Remb. An. Antér.-dépenses-achats biens/services (à être utilisé avec le code d'affectation 631)	12	85	4711
2702	Refunds Prev Yr Capital Purchases (to be used with allotment code 631)	Remb. An. Antér.-dépenses d'achats immobilisat. (à être utilisé avec le code d'affectation 631)	12	85	4712
2703	Refunds Prev Yr- Tsf Pmt Individuals (to be used with allotment code 631)	Remb. An. Antér.-paiem.transf.- particuliers (à être utilisé avec le code d'affectation 631)	10	85	4713
2704	Refunds Prev Yr- Tsf Pmt Subsid & Cap. Assist (to be used with allotment code 631)	Remb. An. Antér.-paiem.transf.-subv & aide-invest. (à être utilisé avec le code d'affectation 631)	10	85	4714
2706	Refunds of payments - Can Saltfish Corporation (to be used with allotment code 631)	Remb. de paiements - Office can. du poisson salé (à être utilisé avec le code d'affectation 631)	12	85	4719
2707	Refunds of Previous Year's Expenditures for Recoveries against Losses of Money from Prior Years (to be used with allotment code 631)	Remboursement de dépenses de l'année précédente imputées au recouvrement contre pertes d'argent des années antérieures (à être utilisé avec le code d'affectation 631)	12	85	4719
2708 Cancelled/ Annulé	Refunds Prev Yr SCH Loan Repayment Principal (to be used with allotment code 631)	PPB remb. An. Antér.-de prêt principal (à être utilisé avec le code d'affectation 631)	14		4732
2709	Refunds of Previous Years' Expenditures - Salary Expenditures (to be used with allotment code 631)	Remb. An. Antér.-Dépense de salaire (à être utilisé avec le code d'affectation 631)	14	85	4719
2710	Refunds of program expenses-current year	Remboursement dépenses des programmes-année courante	12	85	3259
2750	Fines (to be used with allotment code 602)	Amendes (à être utilisé avec le code d'affectation 602)	14	86	4851
2752	Revenue from Forfeited Fish and Other Things (to be used with allotment code 602)	Recettes de poissons et autres confiscations (à être utilisé avec le code d'affectation 602)	14	86	4858
2753	Penalties (to be used with allotment code 602)	Pénalités (à être utilisé avec le code d'affectation 602)	14	86	4857
2754	Proceeds from Court Awards (S/B used with allot.602)	Produits de "décisions de la cour"(utiliser avec aff.602)	14	84	4858
2790	Interest on Loans - Enterprises & Individuals (to be used with allotment code 684)	Intérêts sur prêts - Entrepr. privées et individus (à être utilisé avec le code d'affectation 684)	14	87	4804

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
2791	Demutualization-Life Insurance (use with allot. 684 only)	Décentralisation-Assurance Vie (utiliser avec affectation 684 seulement)	14	87	4819
2801	Adj. of Prior Years' P.A.Y.E. , not OGD -(incl. O&M, Capital and Other (to be used with allotment code 632)	Rajust. Années antérieures CAFÉ sauf AMG (incl. F & E, capital et autres. Utiliser affectation 632)	14	88	4594
2802	Adj. of Prior Years' P.A.Y.E. excl OGD- Capital (to be used with allotment code 632)	Rajust années antér C.A.F.E. sauf AMG Capital (à être utilisé avec le code d'affectation 632)	14	88	4594
2803	Adj. of Prior Years' P.A.Y.E. excl OGD - Other (to be used with allotment code 632)	Rajust années antér C.A.F.E. sauf AMG Autres (à être utilisé avec le code d'affectation 632)	14	88	4594
2850	Repayable Contribution Agreements (to be used with allotment code 602)	Remboursements-ententes de contribution recouv. (à être utilisé avec le code d'affectation 602)	10	89	2151
2999	GST Collected on Sales (to be used with allotment code 691)	TPS perçue sur les ventes (à être utilisé avec le code d'affectation 691)	42	95	4200
G076	**LIMIT-Revenue from Departments or Agencies for Various Goods and Services (allot 651**)	**LIMITE-Revenus de ministères ou agences gouv. pour biens ou services variés (aff.651**)	**14**	**91**	**4593**
G078	Proceeds from Sales of residential Real Property-sales through PWGSC (allot. 647)	Produits des ventes de biens immobiliers résidentiels à travers TPSGC (aff.647)	14	91	4844
G079	Proceeds from sales of non-residential Real Property-sales through PWGSC (allot. 647)	Produits des ventes de biens immobiliers non-résidentiels à travers TPSGC (aff.647)	14	91	4845
G080	Surplus Assets - Sales through PWGSC (to be used with allotment code 647)	Biens excédentaires vendus par TPSGC (à être utilisé avec le code d'affectation 647)	14	91	4843
G090 Cancelled/ Annulé	Refunds of Previous Years' Expenditures - OGD (to be used with allotment code 631)	Recouvrement des dépenses des années antér. - AMG (à être utilisé avec le code d'affectation 631)			
G098	Interdepartmental Receipts-IS Cross Years Accounts (allot.633)	Reçus interministériels-Compte de R.I. D'exercices réciproques de transition à la SIF (affect.633)	14	91	4659
G099	Adjustments of Prior Years' P.A.Y.E. - OGD (to be used with allotment code 632)	Rajustements des années antérieures C.A.F.E. - AMG (à être utilisé avec le code d'affectation 632)	14	91	4594

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
3103	Standing Travel Advances (Open Balance)	Avances de voyage permanentes (Solde d'ouverture)	50	56	5032
3104	Petty Cash Advances (Open Balance)	Avances de petite caisse (Solde d'ouverture)	50	56	5030
3105	Temporary Travel Advance at Year End	Avance de voyage temporaire en fin d'année	50	56	5032
3106	Advance for establishing a change fund (Open Balance)	Avance pour constituer un fonds d'appoint (Solde d'ouverture)	50	56	5030
3110	Accounts Receivable - Default Account	Comptes à recevoir - Compte par défaut	50	56	5399
3127	Advances to producers of frozen groundfish (Open Balance)	Avances consentis product. poissons fond congelés (Solde d'ouverture)	50	56	5010
3128	Working Capital Loans-ice affected fish plants (Open Balance)	Prêts fonds roulement-usines poisson (glace) (Solde d'ouverture)	50	56	5010
3129	Loans to Haddock Fishers (Open Balance)	Prêts consentis aux pêcheurs d'aiglefin (Solde d'ouverture)	50	56	5010
3131	SPA-Contractors' Security Deposits (cashed) (Open Balance)	CFD-Cautionnements des entrepreneurs (encaissés) (Solde d'ouverture)	60	57	6081
3139	SPA-Miscellaneous Accounts (Open Balance)	CFD-Comptes divers (Solde d'ouverture)	60	57	6099
3142	Contractors' Holdbacks (Open Balance)	Retenues de garantie des entrepreneurs (Solde d'ouverture)	62	58	6299
3143	Great Lakes Fishery Commission (Open Balance)	Commission des pêcheries des Grands Lacs (Solde d'ouverture)	62	58	6299
3144	Monies received on behalf of OGD (Open Balance)	Sommes reçues au nom des AMG (Solde d'ouverture)	62	58	6299
3145	Provincial Sales Tax Collected on Sales (Open Balance)	Taxes de vente provinciales perçues sur ventes (Solde d'ouverture)	62	58	6299
3152	Paylist/Other Deductions (Open Balance)	Retenues de paie/autres(Solde d'ouverture)	62	58	6299
3153	Paylist deductions - Garnishments- employees (Open Balance)	Retenues de paie - Saisie arrêt - employés (Solde d'ouverture)	62	58	6299
3154	Employee's Source Deductions - Income Tax, CPP, EI (Open Balance)	Retenues à la source - Impôt sur le rev., RPC, AE (Solde d'ouverture)	62	58	6299
3155	Accrued Salaries and Wages	Rémunérations dûes	62	58	6299
3159	General Suspense Accounts (Open Balance)	Comptes d'attente général (Solde d'ouverture)	62	58	6299
3170	PODD (Open Balance)	PADE (Solde d'ouverture)	62	58	6299
3171	PAYE - non OGD (Open Balance)	CAFE - non AMG (Solde d'ouverture)	62	58	6299
3172	Interdepartmental accounts Receivable-year end (Open Balance)	Débiteurs interministériels fin d'exercice (Solde d'ouverture)	62	58	6299
3173	PAYE - OGD (Open Balance)	CAFE - AMG (Solde d'ouverture)	62	58	6299
3175	Open Deposit Control Account	Ouverture compte contrôle dépôts	52	61	5299
3176	Open Account CHCT	Ouverture compte ECPT	52	61	5299
3177	Open Account MRMAOFY	Ouverture compte MRAMIEP	52	61	5299
3191	Proceeds - forfeited assets & fines (Open Balance)	Produits des actifs confisqués et des amendes (Solde d'ouverture)	81	59	8290
3192	Payment to outside parties - seized assets (Open	Paiements à des tiers - actifs saisis (Solde d'ouverture)	81	59	8290
3193	Seized assets - transf proceeds to non-tax revenue (Open Balance)	Actifs saisis-transf produits aux recet. non fisc. (Solde d'ouverture)	81	59	8290
3198	Earmarked Fees and Levies (Open Balance)	Frais & perceptions pour affectation spéciale (Solde d'ouverture)	82	60	8220
3203	Standing Travel Advances (cr)	Avances de voyage permanentes (ct)	50	56	5032
3204	Petty Cash Advances (cr)	Avances de petite caisse (ct)	50	56	5035
3206	Advance for establishing a change fund (cr)	Avance pour constituer un fonds d'appoint (ct)	50	56	5035
3227	Advances to producers of frozen groundfish (cr)	Avances consentis product. poissons fond congelés (ct)	50	56	5015
3228	Working Capital Loans-ice affected fish plants (cr)	Prêts fonds roulement-usines poisson (glace) (ct)	50	56	5015
3229	Loans to Haddock Fishers (cr)	Prêts consentis aux pêcheurs d'aiglefin (ct)	50	56	5015
3231	SPA-Contractors' Security Deposits (cashed) (cr)	CFD-Cautionnements des entrepreneurs (encaissés) (ct)	60	57	6081
3239	SPA-Miscellaneous Accounts (cr)	CFD-Comptes divers (ct)	60	57	6099
3242	Contractors' Holdbacks (cr)	Retenues de garantie des entrepreneurs (ct)	62	58	6299
3243	Great Lakes Fishery Commission (cr)	Commission des pêcheries des Grands Lacs (ct)	62	58	6299
3244	Monies received on behalf of OGD (cr)	Sommes reçues au nom des AMG (ct)	62	58	6299
3245	Provincial Sales Tax Collected on Sales (cr)	Taxes de vente provinciales perçues sur ventes (ct)	62	58	6299

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
3252	Paylist/Other Deductions - CR	Retenues de paie/autres - Crédit	62	58	6299
3253	Paylist deductions - Garnishments- employees (cr)	Retenues de paie - Saisie arrêt - employés (ct)	62	58	6299
3254	Employee's source Deductions - Income Tax, CPP, EI	Retenues à la source- Impôt sur le rev., RPC, AE (ct)	62	58	6299
3259	General Suspense Accounts (cr)	Comptes d'attente général (ct)	62	58	6299
3265 Cancelled/ Annulé	Interdepartmental Settlements (cr)	Règlements Interministériels (ct)			
3270	PODD (cr)	PADE (ct)	62	58	6299
3271	PAYE - non OGD (cr)	CAFE - non AMG (ct)	62	58	6299
3272	Interdepartmental accounts Receivable-year end (cr)	Débiteurs interministériels fin d'exercice (ct)	62	58	6299
3273	PAYE - OGD (cr)	CAFE - AMG (ct)	62	58	6299
3275 Cancelled/ Annulé	Deposit Control Account-CR	Compte contrôle dépôts-CT	52		5241
3276	CHCT - CR	ECPT - CT	52	61	5299
3277	MRMAOFY - CR	Compte de MRAMIEP - CT	52	61	5299
3290	GST Refundable Advance Account (including Harmonized Sale Taxes) (cr)	Compte d'avances remboursables de TPS (Incluant la taxe de vente harmonisée) (ct)	50	56	5030
3291	Proceeds - forfeited assets & fines (cr)	Produits des actifs confisqués et des amendes (ct)	81	59	8290
3292	Payment to outside parties - seized assets (cr)	Paiements à des tiers - actifs saisis (ct)	81	59	8290
3293	Seized assets - transf proceeds to non-tax revenue (cr)	Actifs saisis-transf produits aux recet. non fisc. (ct)	81	59	8290
3298	Earmarked Fees and Levies (cr)	Frais & perceptions pour affectation spéciale (ct)	82	60	8220
3303	Standing Travel Advances (dr)	Avances de voyage permanentes (dt)	50	56	5032
3304	Petty Cash Advances (dr)	Avances de petite caisse (dt)	50	56	5030
3306	Advance for establishing a change fund (dr)	Avance pour constituer un fonds d'appoint (dt)	50	56	5030
3327	Advances to producers of frozen groundfish (dr)	Avances consentis product. poissons fond congelés (dt)	50	56	5010
3328	Working Capital Loans-ice affected fish plants (dr)	Prêts fonds roulement-usines poisson (glace) (dt)	50	56	5010
3329	Loans to Haddock Fishers (dr)	Prêts consentis aux pêcheurs d'aiglefin (dt)	50	56	5010
3331	SPA-Contractors' Security Deposits (cashed) (dr)	CFD-Cautionnements des entrepreneurs (encaissés) (dt)	60	57	6085
3339	SPA-Miscellaneous Accounts (dr)	CFD-Comptes divers (dt)	60	57	6099
3342	Contractors' Holdbacks (dr)	Retenues de garantie des entrepreneurs (dt)	62	58	6299
3343	Great Lakes Fishery Commission (dr)	Commission des pêcheries des Grands Lacs (dt)	62	58	6299
3344	Monies received on behalf of OGD (dr)	Sommes reçues au nom des AMG (dt)	62	58	6299
3345	Provincial Sales Tax Collected on Sales (dr)	Taxes de vente provinciales perçues sur ventes (dt)	62	58	6299
3352	Paylist/Other Deductions - DR	Retenues de paie/autres - Débit	62	58	6299
3353	Paylist deductions - Garnishments- employees (dr)	Retenues de paie - Saisie arrêt - employés (dt)	62	58	6299
3354	Employee's source Deductions - Income Tax, CPP, EI (dr)	Retenues à la source- Impôt sur le rev., RPC, AE (dt)	62	58	6299
3355	Provincial Sales Tax-AACR	Taxes de vente provinciales_RACA		58	6299
3359	General Suspense Accounts (dr)	Comptes d'attente général (dt)	62	58	6299
3365 Cancelled/ Annulé	Interdepartmental Settlements (dr)	Règlements Interministériels (dt)			
3370	PODD (dr)	PADE (dt)	62	58	6299
3371	PAYE - non OGD (dr)	CAFE - non AMG (dt)	62	58	6299
3372	Interdepartmental accounts Receivable-year end (dr)	Débiteurs interministériels fin d'exercice (dt)	62	58	6299
3373	PAYE - OGD (dr)	CAFE - AMG (dt)	62	58	6299
3375 Cancelled/ Annulé	Deposit Control Account - DR	Compte contrôle dépôts - DT	52	61	5242
3376	CHCT - DR	ECPT - DT	52	61	5299
3377	MRMAOFY - DR	MRAMIEP - DT	52	61	5299
3390	GST Refundable Advance Account (including Harmonized Sale Taxes) (dr)	Compte d'avances remboursables de TPS (Incluant la taxe de vente harmonisée) (dt)	50	56	5030
3391	Proceeds - forfeited assets & fines (dr)	Produits des actifs confisqués et des amendes (dt)	81	59	8295
3392	Payment to outside parties - seized assets (dr)	Paiements à des tiers - actifs saisis (dt)	81	59	8295

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
3393	Seized assets - transf proceeds to non-tax revenue (dr)	Actifs saisis-transf produits aux recet. non fisc. (dt)	81	59	8295
3398	Earmarked Fees and Levies (dr)	Frais & perceptions pour affectation spéciale (dt)	82	60	8225

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
U001	Land (Not use on expenditures)	Terrains	70	62	7099
U002	Buildings & Support Facilities (Not use on expenditures)	Bâtiments et installations de soutien	70	63	7099
U003	Works and Infrastruture (Not use on expenditures)	Travaux et infrastructures	70	64	7099
U004	Weapons (Not use on expenditures)	Armes	70	68	7099
U005	Vessels (Not use on expenditures)	Navires	70	69	7099
U006	Vehicles (Not use on expenditures)	Véhicules	70	90	7099
U007	Communications Equipments (Not use on expenditures)	Matériel de communications	70	65	7099
U008	Navigational Aids & Approach Equipment (Not use on expenditures)	Aides à la navigation et équipement d'approche	70	65	7099
U009	Surveillance Equipment (Not use on expenditures)	Equipement de surveillance	70	65	7099
U010	Trades Support Equipment (Not use on expenditures)	Équipement de soutien de métiers	70	65	7099
U011	Aircraft (Not use on expenditures)	Aéronefs	70	74	7099
U013 Cancelled/ Annulé	Vehicle Operating Areas	Zones d'exploitation de véhicules	70		7099
U014	Informatics Hardware (Not use on expenditures)	Matériel informatique	70	66	7099
U015	Custodial Assets (<10K) (Not use on expenditures)	Biens en réserve (<10K)	70	93	7099
U016	Other Support Equipment (Not use on expenditures)	Autres équipements de soutien	70	65	7099
U017	Scientific & Laboratory Equipment (Not use on expenditures)	Équipements scientifiques et de laboratoire	70	65	7099
U018	Informatics Software (Not use on expenditures)	Logiciels informatiques	70	67	7099
U019	Trailers (Not use on expenditures)	Remorques	70	92	7099
U020	Furniture & Fixtures (Not use on expenditures)	Meubles & installations	70	68	7099
U053	Leasehold improvement buildings (Not use on expenditures)	Amélioration locative bâtiments	70	94	7099
U059	Leasehold improvement works & infrastructures (Not use on expenditures)	Amélioration locative travaux et infrastructures	70	94	7099
U090 Cancelled/ Annulé	Depreciation Reserve	Amortissement cumulé	70		7099
U099	Non-Specified Equipments (Not use on expenditures)	Équipements non-spécifiés ailleurs	70	65	7099

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
W001 Cancelled/ Annulé	Inventory Control Account	Compte de contrôle de stocks		99	
W002 Cancelled/ Annulé	Purchase Price Variance	Écart dans les prix d'achat		99	
W003 Cancelled/ Annulé	Invoice Price Variance	Écart dasn les prix sur les factures		99	
W004 Cancelled/ Annulé	Cost of Sales	Coût des marchandises vendues		99	
W005 Cancelled/ Annulé	Inter-Organization Purchase Price Variance	Achat interorganisations - Écart dans les prix		99	
W006 Cancelled/ Annulé	Inter-Organization Transfer Credit	Transfert de crédit interorganisations		99	
W007 Cancelled/ Annulé	Inter-Organization Materiel-in-Transit	Matériel interorganisations en transit		99	
W008 Cancelled/ Annulé	Inventory AP Accrual	Produits à recevoir (stocks)		99	
W009 Cancelled/ Annulé	Inter-Organization Payable	Compte créditeur interorganisations		99	
W010 Cancelled/ Annulé	Inter-Organization Receivable	Compte débiteur interorganisations		99	
W011 Cancelled/ Annulé	Inventory Adjustments	Ajustement de stocks		99	
W012 Cancelled/ Annulé	Average Cost Variance	Ajustement (coût moyen) de stocks		99	
W013 Cancelled/ Annulé	Expense - Inventory	Dépenses - Stocks		99	
W014 Cancelled/ Annulé	Receiving Account (Inventory)	Compte de réception (Inventaire)		99	

Line Object
Articles d'exécution

Line Obj Art. exéc.	Description - E	Description - F	Std Obj Art Cour	Obj.Grp Gr.art.	Econ.Obj. (TB) Obj. Écon. (CT)
0000	BCMS Control Account	Compte de contrôle SGBT		99	0000
9997	RPS Pay Control Account	Compte de contrôle paie SRP		99	0000
9998	IS Control Account	Compte de contrôle RI		99	0000
1BCM	BCMS Cash Clearing Account-NFLD	Compte provisoire SGBT Trésorerie-NFLD	52	99	5299
2BCM	BCMS Cash Clearing Account-Maritimes	Compte provisoire SGBT Trésorerie-MAR.	52	99	5299
3BCM	BCMS Cash Clearing Account-Laurentian	Compte provisoire SGBT Trésorerie-LAUR.	52	99	5299
4BCM	BCMS Cash Clearing Account-C & A	Compte provisoire SGBT Trésorerie-C & A	52	99	5299
5BCM	BCMS Cash Clearing Account-Pacific	Compte provisoire SGBT Trésorerie-PAC	52	99	5299
6BCM	BCMS Cash Clearing Account-NCR	Compte provisoire SGBT Trésorerie-RCN	52	99	5299
7BCM	BCMS Cash Clearing Account-Gulf	Compte provisoire SGBT Trésorerie-GOLFE	52	99	5299
9BCM	BCMS Cash Clearing Account-CCG College	Compte provisoire SGBT Trésorerie-Collège GCC	52	99	5299
BCM1	BCMS Undistributed Chargebacks Account	Compte débit compensatoire SGBT non-appliqué	52	99	5299
BCM3	BCMS RGGL Clearing Account	Compte provisoire SGBT GL-RG	52	99	5299
CE99	SPS Control Account	Compte de contrôle SNP		99	0000
ISU1	IS Suspense Account	Compte d'attente RI	52	99	5399
ISU2	IS Suspense Clearing Account	Compte d'attente provisoire RI	52	99	5399
			52	99	5299
PAY3	Payroll Accruals Offset	Compensation des salaires courus	52	99	5299
PAY4	RPS PS-GL Clearing Account	Compte provisoire SP SP-GL	52	99	5299
PAY5	RPS Correcting Account	Compte corrections SRP	52	99	5299
RGL1	SPS RGGL Clearing Account (CAD)	Compte provisoire SNP/GL-RG (CAN)	52	99	5299
RGL2	SPS RGGL Clearing Account (USD)	Compte provisoire SNP/GL-RG (US)	52	99	5299
RGL3	SPS RGGL Clearing Account (Other Foreign Currencies)	Compte provisoire SNP/GL-RG (autres devises étrangères)	52	99	5299
RGL5	IS RGGL Credit Cash Clearing Account	Trésorerie-Crédit, compte provisoire RI GL-RG	52	99	6299
RGL6	IS RGGL Debit Cash Clearing Account	Trésorerie-Débit, compte provisoire RI GL-RG	52	99	5399
SPS0	SPS Cash Clearing Account	Trésorerie, compte provisoire SNP	52	99	5299
SPS1	SPS Cash Clearing Account (CAD)	Trésorerie, compte provisoire SNP (CAN)	52	99	5299
SPS2	SPS Cash Clearing Account (USD)	Trésorerie, compte provisoire SNP (US)	52	99	5299
SPS3	SPS Cash Clearing Account (Other Foreign Currencies	Trésorerie, compte provisoire SNP (autres devises étrangères)	52	99	5299
SPS4	SPS/IS Cash Clearing Account (Accounts Payable)	Trésorerie, compte provisoire SNP/RI (comptes payables)	52	99	6299
SPS5	SPS/IS Credit Cash Clearing Account	Trésorerie, compte provisoire SNP/RI Crédit	52	99	6299
SPS6	SPS/IS Debit Cash Clearing Account	Trésorerie, compte provisoire SNP/RI Débit	52	99	5399
SPS7	IS Receipt Clearing Accounts (Accounts Receivable)	Compte provisoire recettes RI (comptes recevables)	52	99	5399
ZZZZ	Default Coding - Net Equity	Codage par défaut - Capitaux propres		99	0000

Beaufort Wind Scale

In 1806, **Admiral Sir Francis Beaufort** devised a scale that coastal observers used to report the state of the sea to the Admiralty. It was adopted officially in 1838.

Beaufort Number	Wind Speed			Wind Force	Sea Surface	Sea State	Wave Height (m)	Code
	Knots	MPH	KPH					
0	< 1	< 1	< 1	Calm	Calm	0	0	Calm
1	1-3	1-3	1-5	Light air	Ripples with the appearance of scales; no foam crests.	0	0	Calm
2	4-6	4-7	6-11	Light Breeze	Small wavelets; crests of glassy appearance, not breaking.	1	0 - 0.1	Calm, rippled
3	7-10	8-12	12-19	Gentle Breeze	Large wavelets; crests begin to break; scattered whitecaps.	2	0.1 - 0.5	Smooth
4	11-16	13-18	20-28	Moderate Breeze	Small waves, becoming longer; numerous whitecaps.	3	0.5 - 1.25	Slight
5	17-21	19-24	29-38	Fresh Breeze	Moderate waves, taking longer form; many whitecaps; some spray.	4	1.25 - 2.5	Moderate
6	22-27	25-31	39-49	Strong Breeze	Larger waves forming; whitecaps everywhere; more spray.	5	2.5 - 4	Rough
7	28-33	32-38	50-61	Near Gale	Sea heaps up; white foam from breaking waves begins to blow in streaks.	6	4 - 6	Very Rough
8	34-40	39-46	62-74	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown into well-marked streaks.	6	4 - 6	Very Rough
9	41-47	47-54	75-88	Strong Gale	High waves; seas begins to roll; dense streaks of foam; spray may reduce visibility.	6	4 - 6	Very Rough
10	48-55	55-63	89-102	Storm	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility is reduced.	7	6 - 9	High
11	56-63	64-72	103-117	Violent Storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	8	9 - 14	Very High
12	>64	>73	>118	Hurricane	Air filled with foam; sea completely white with driving spray; visibility still more reduced.	9	14	Phenomenal

Seabird & Marine Mammal Monitoring Protocol

—Seahorse 2002 Glory Hole Construction

Purpose

This protocol documents the approach to observing and documenting seabird and marine mammal occurrences in the vicinity of the dredge vessel Seahorse during the conduct of the 2002 glory hole construction program on behalf of Husky Energy.

Responsibilities

Aboard the "Seahorse" the vessel's dynamic positioning operators have the responsibility for conducting seabird and marine mammal observations in accordance with this protocol as part of their normal duties. These operators are also responsible for conducting nightly deck searches for Leach's Storm Petrels that may become stranded onboard the vessel. Any Storm Petrels found will be treated in accordance with the protocol entitled "Helping Leach's Storm Petrel".

Training

The observers are provided with a minimum of one-half day's training in observation techniques and seabird/marine mammal identification by qualified individuals. Refresher and/or additional training will be provided as necessary.

Equipment

Observers are supplied with binoculars and a spotting scope and seabird and marine mammal identification guides.

Monitoring Methods

Observations for seabirds/marine mammals will be conducted three times per day. Preferred times are as follows:

- early morning (in full light),
- noon, and;
- late afternoon/early evening (in full light).

Surveys are conducted, in accordance with the above-noted training and will take place from the vessel's wing bridges and all observations of seabirds/ marine mammals within a 180-degree field of view are recorded for a total of 20 minutes during the three periods noted above. All data is recorded on the Seabird/Marine Mammal Observation Data Sheets (a copy of the data sheet is provided on the reverse. An electronic (Microsoft Excel) version of this datasheet is available from Husky's Environmental Coordinator.

Storm Petrel Protection Measures

A walk-about for Storm Petrels is conducted each night, around midnight and early in the morning (as soon after dawn as possible), or as appropriate to ongoing operations. The walk-about consists of a thorough flashlight search of the deck, paying particular attention to areas under deck lights, windows and deck structures. What to do if any Storm Petrels are found is explained in the protocol entitled "Helping Leach's Storm Petrel".

Reporting

Copies of Seabird/Marine Mammal Observation and Storm Petrel Capture and Release Data Sheets are to be faxed or e-mailed to Husky's Environmental Coordinator as follows:

Email: Taylor.Stjohns@huskyenergy.ca
Fax: 724-3915

Seabird/Marine Mammal Observation Record Sheet for SEAHORSE

Date d/m/y	Time 00:00 hr	Observer	Species	Number of Birds	Visibility	Sea State (m)	Wind scale	Percipitation	Comments

Comment Codes for seabird observations:

Skimming water — 1
Sitting on water — 2
Swop and dive — 3
Circling Rig — 4
On deck — 5
Feeding — 6
Flying By — 7 (incl. direction i.e., NW, SW, NE etc.)

Instructions:

This form was designed to be photocopied as needed. When completed fax or send it to Husky's Environmental Coordinator — Fax: 724-3915 / Address: Suite 801, Scotia Centre, St. John's.

Any dead birds should be double-bagged in plastic bags and frozen. Call/fax Husky's Environmental Coordinator at 724-3967 / fax: 724-3915 for pick up at dockside or shore base.

CETACEAN OFFSHORE OBSERVER: DATA ENTRY INSTRUCTIONS

Type of Data	Heading	Data Format
Date	Date	dd/mm/yy
Time	Time	0000
Location of observation (place names -if given)	Location	Name in lower case
Reliability of location	Est1	00
Latitude of location	Lat	0000
Longitude of location	Long	0000
Vessel name	Vessel	Name in lower case
Country Name	Country	Name in lower case
Species observed	Spp	000
Reliability of identification	Est2	00
Number of animals	Number	000
Heading of whales	Heading	000
Wind speed/Direction	Wind	00 NN
Visibility	Visibility	0
Beaufort sea state	Seastate	00
Ice	Ice	Y/N
Time of watch start	Start	0000
Time of watch end	Stop	0000
Duration of watch	WatchDur	000
Remarks	Remarks	text

Date: dd/mm/yy (if day or month data are missing for an event, replace by "xx").

Time: Leave blank if absent.

Location: Name of location if specify, not Lat./Long. information (leave blank if absent).

Vessel: Enter vessel name, if present

Country: Enter country name, if present

Est1: Reliability of location

CODE	RELIABILITY OF LOCATION
01	High level of confidence
02	Little or no confidence in identification

"Little confidence", is used in cases where the observer is not certain of their location.

Lat: Latitude of location (first two digits are the degree values, the last two are the minute values; e.g. 60^{o} 56' = "6056").

Long: Longitude of location (first two digits are the degree values, the last two are the minute values; e.g. 60^{o} 47' = "6047").

Spp: Species observed (type in text name of animal)

Code	Species Name
00	UNIDENTIFIED WHALE SPECIES
01	LARGE WHALE (>30 FEET, > 9 METERS)
02	MEDIUM SIZED WHALE (18-30 FEET, 5-9 METERS)
03	SMALL WHALE (<18 FEET, <5 METERS)
04	HUMPBACK (Megaptera novaeangliae)
05	POTHEAD, pilot whale, blackfish (Globicephala melaena)
06	MINKE (Balaenoptera acutorostrata)
07	BLUE WHALE (Balaenoptera musculus)
08	FIN WHALE, rorqual commun, (Balaenoptera physalus)
09	PORPOISE spp (Unidentified Species)
10	DOLPHIN spp , Jumper, squidhound (Unidentified Species)
11	KILLER WHALE, epaulard (Orcinus Orca)
12	HARBOUR PORPOISE, puffin pig (phocoena phocoena)
13	SPERM WHALE, cachalot (Physeter catadon)
14	WHITE SIDED DOLPHIN, dophin a flanc blanc (Lagenorhynchus acutus)
15	WHITE BEAKED DOLPHIN (Lagenorhynchus albirostris)
16	COMMON DOLPHIN, saddleback (Delphinus delphis)
17	BELUGA, white whale (Delphinapterus leucas)
18	RIGHT WHALE(Eubalaena glacialis)
19	SEI WHALE (Balaenoptera borealis)
20	SEA TURTLE spp (Unidentified Species)
21	BASKING SHARK (Cetorhinus maximus)
22	HARBOUR SEAL (Phoca vitulina)
23	WALRUS (Odobenus rosmarus rosmarus)
24	SEAL spp (Unidentified Species)
25	POLAR BEAR (Ursus maratimus)
26	GRAY SEAL (Halichoerus gryptus)
27	SHARK (Unidentified Species)
28	LEATHERBACK TURTLE
29	HARP SEAL, whitecoat, bedlamer, ragged jacket (Phoca groelandica)
30	HOODED SEAL, blueback, hopper (Cystophora cristata)
31	BLUE SHARK
32	BOTTLENOSED WHALE (Hyperoodon ampullatus)
33	NARWHAL, narval (Monodon monoceros)
34	BOWHEAD WHALE (Balaena mysticetus)
35	BOTTLENOSED DOLPHIN (Tursiops truncatus)

Est2: Reliability of Identification

CODE	RELIABILITY OF IDENTIFICATION
01	High level of confidence
02	Little or no confidence in identification

"Little confidence", is used in cases where the observer is not certain of their identification. The designation of "High level of Confidence" is used in instances where there is no apparent difficulty identifying the animal.

Certain species codes are automatically given a designation of "little confidence", and should always be designated as such: 00, 01, 02, 03, 09, 10, 20, 24, and 27. These are to be labeled code 02 ("Little or no confidence in identification") in the “reliability of identification” column.

#: Number of animals (use a conservative number; e.g., if 20-30 animals sighted, record as 20).

Heading: Heading of whales (compass bearing), leave blank if absent.

Wind: Wind speed/direction. Enter wind speed in the first two digits, with the general direction if specified following a space; e.g. a 15 knot north west wind "15 NW". If part of the information is missing (speed or direction, replace by "xx"). Leave blank if absent.

Visibility: Distance (nautical miles) or description (e.g. good, poor, cloudy,…) of visibility; leave blank if absent.

Seastate: Beaufort sea state (or wave height in meters if sea state not defined, include unit of wave height in entry, e.g., "4m"); leave blank if absent.

Ice: Presence or absence of ice. "Y" for present, "N" for absence; leave blank if absent.

Start: Time of watch start, leave blank if absent.

Stop: Time of watch end, leave blank if absent.

WatchDur: Duration of watch in hours if included; leave blank if not specified; if range of hours given, type lowest value.

Remarks: Any remarks included by observer.

Photo: J.A. Spendelow

About Leach's Storm-Petrels

The Species

The Grand Banks is home to large numbers of many seabird species. These birds use the area year round, migrating here from the Arctic, south Atlantic and Antarctic Oceans and from local breeding colonies on the Newfoundland coast. Eastern Canada's most abundant breeding species, Leach's Storm-Petrel, is found in our area of operations often feeding on the continental shelf edge. Most of Atlantic Canada's 10 million breeding storm-petrels are found around Newfoundland. In fact, the world's largest breeding colony is on Baccalieu Island in the mouth of Trinity and Conception Bays. A major migration occurs in September, when young birds and the adults leave the breeding colonies to winter on the Atlantic Ocean.

Photo: J.A. Spendelow

The Bird

Leach's Storm-Petrel is the smallest breeding seabird (50 grams) in Eastern Canada. The bird has dark grey/ brown to black body plumage, a white rump, and a forked tail. Its dark, hooked bill has tubular nostril on top that are typical of this kind of open ocean seabird. They feed by skimming the sea surface, seizing their prey in flight, which consists of small fish and crustaceans.

The Issue

Flying at night as a defense against predators these birds are often attracted to the light from offshore platforms and vessels. Experience shows that they can be attracted to or confused by lights and flares from ships and platforms and "crash" into lighted areas such as windows, portholes and deck lighting. Fog, which diffuses the light, may enhance this problem. When the bird "crashes" it usually falls or flutters to the deck stunned or disoriented but not hurt or killed. They will then seek a dark area or get underneath something to avoid the light. Given their reluctance to fly in daylight they may have difficulty becoming airborne again without help. The instructions on this page will allow you to assist the birds that do "crash" on your vessel or platform and do not take flight on their own.

Helping Leach's Storm-Petrels Safely & Effectively

Should storm-petrels crash on board your vessel or platform the following steps should be taken to ensure that they are safely returned to their ocean habitat.

Collection, Recovery and Holding

- Collect the birds by hand and place them gently in cardboard boxes (approximately 50 x 25 cm). Do not overcrowd the birds. No more than 6 birds should be put in a box of the size noted above.
- Once the birds are in the box the cover should be replaced and they should be left to recover in a quiet, sheltered, warm, dark area for 15 minutes or until they are dry ("recovery period"). Sometimes common sense will indicate that they may have to be kept for a longer "holding period" to ensure full recovery, if weather conditions are too extreme for release, or to await nightfall (see below).
- Birds captured near dawn that have not fully recovered by daylight, or found during the day where they have hidden the night before, must be kept until nightfall for release. Release of birds in daylight will only result in the bird being killed by seagulls. Keep the birds in a cardboard box in a shaded, sheltered, quiet area with minimal disturbance and under no circumstances attempt to feed or water them.

Releasing the Birds

Following the "recovery" or "holding" period, take the box containing the birds to an area that has minimal (if any) lighting. Open the box carefully so not to startle the bird(s) and take each bird out individually by hand. At the edge of the vessel or platform hold the bird in both hands, facing into the wind if possible. If they do not fly off in a few minutes then **gently toss** the bird up and away into the air. In most cases the bird will drop vertically for a short distance and then take flight out and downward to the ocean surface.

Remember releases should only be done at night.

General Handling Instructions:

Leach's Storm-Petrels are small and delicate birds and must be handled with care at all times. They do have a strong, musky odour that will stay on the handler's hands but handling Leach's Storm-Petrels does not pose a health hazard. If you chose to wear gloves (thin cotton or surgical gloves are recommended) to handle the birds then ensure they are free of any oil or grease. If you do not use gloves then it is recommended that you ensure there is no oil or grease on your hands before handling the birds and wash your hands after.

Seabird Recovery and Release Record Sheet

Vessel/Rig name:________________________

Date	Time	Observer	Species	Number Found on Deck	Number Held for Recovery	Number Released	Number Oiled	Number Dead	Comments

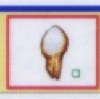
Instructions:

This form was designed to be photocopied as needed. When completed fax or send it to Husky's Environmental Coordinator at 724-3915 or Suite 801, Scotia Centre, St. John's. Any dead birds should be double-bagged with plastic bags and frozen for shipment to shorebase to the attention of Husky's Environmental Coordinator — phone 724-3967.

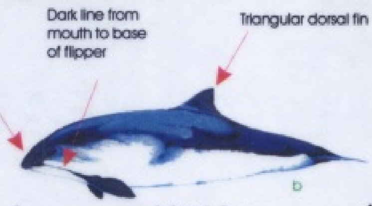
Field identification guide for cetacean and seals most commonly caught in fishing gear

Section I - Toothed whales

Length: < 3 meters

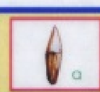


Spatula-shaped teeth and lack of beak.



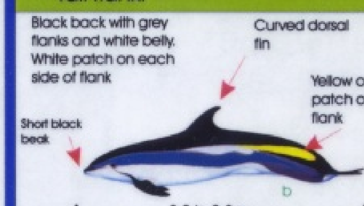
Harbour porpoise
Marsouin commun
Phocoena phocoena

Fig. 1



Cone-shaped teeth. Short and thick beak.

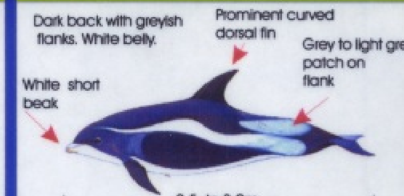
Yellow patch on each side of the tail flank.



White-sided dophin
Dauphin à flancs blancs
Lagenorhynchus acutus

Fig. 2

Grey patch on each side of the tail flank.

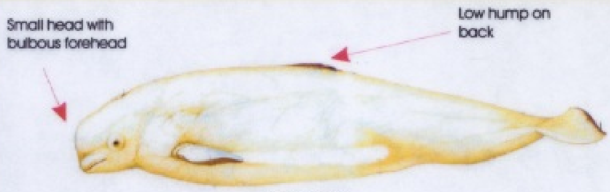


White-beaked dophin
Dauphin à nez blanc
Lagenorhynchus albirostris

Fig. 3

Length: > 3 meters to < 6 meters

Absence of dorsal fin. White, brown, grey or blue-grey animal.



Beluga whale
Béluga
Delphinapterus leucas

Fig. 4

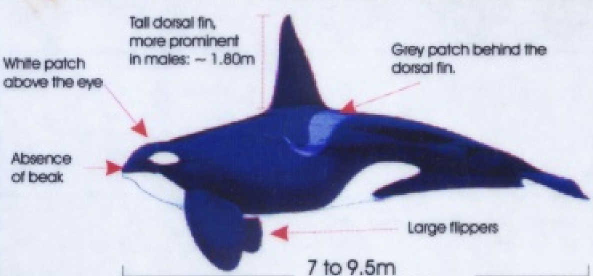
Long curved dorsal fin. Black animal.

Pilot whale
Globicéphale noir
Globicephala melas

Fig. 5

Length: > 6 meters to < 10 meters

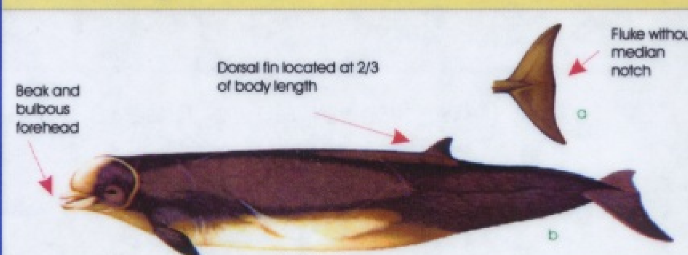
Absence of beak. Prominent dorsal fin. White patch above the eye.



Killer whale
Épaulard
Orcinus orca

Fig. 6

Beak with bulbous forehead. Dorsal fin beginning at 2/3 of body length.

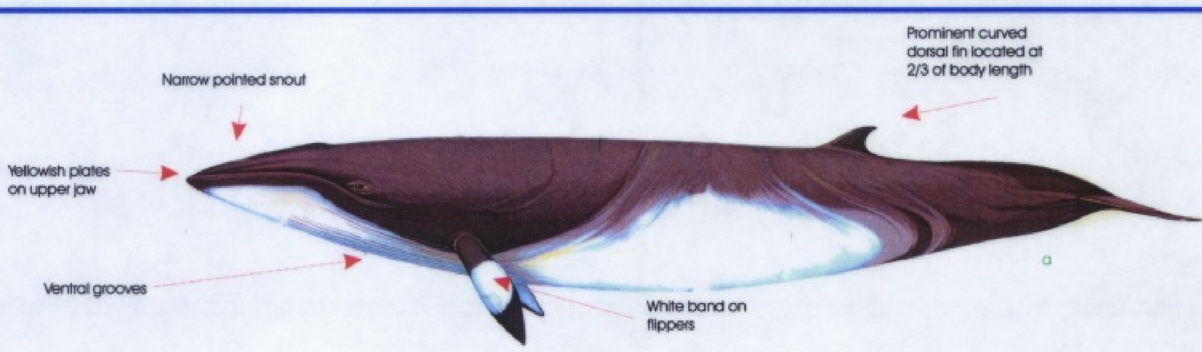


Northern Bottlenose whale
Baleine à bec commune
Hyperoodon ampullatus

Fig. 7

Section II - Baleen whale

Length: > 6 meters to < 10 meters



Minke whale
Petit rorqual
Balaenoptera acutorostrata

Fig. 8

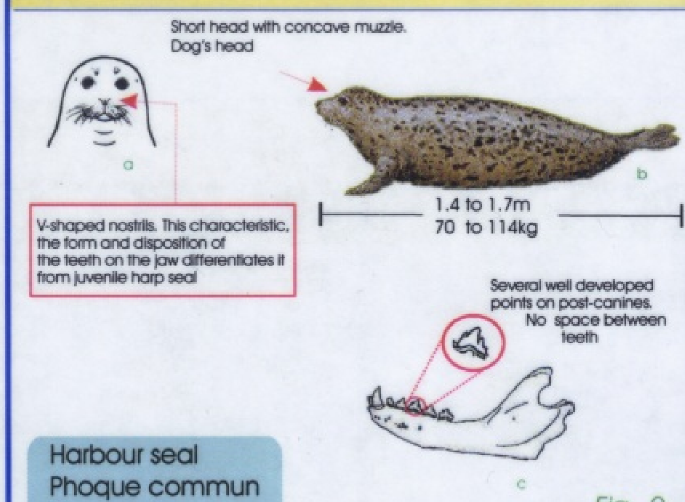
Note: *animals not to scale*

Section III: Seals

Distribution: These species can be found in the estuary and Gulf of St. Lawrence

Length: < 2 meters

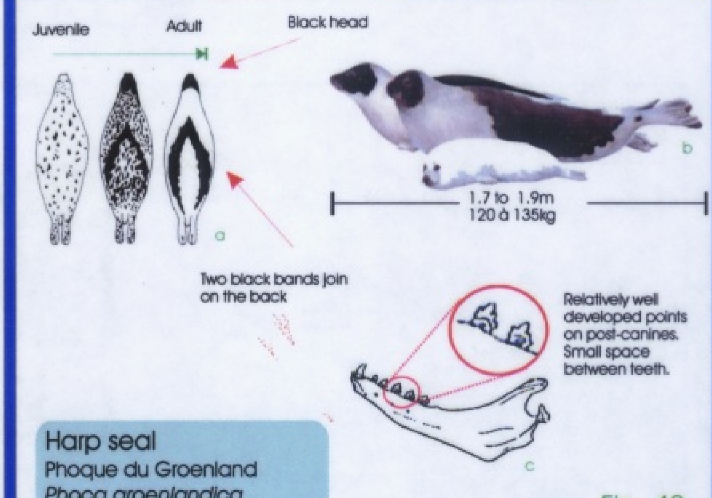
Bluish-grey coat covered with small dark spots. Short, concave, and dog-like head. V-shaped nostrils.



Harbour seal
Phoque commun
Phoca vitulina

Fig. 9

Grey to light grey coat. Adult have black head and two large bands that join on the back. The head is short and concave.

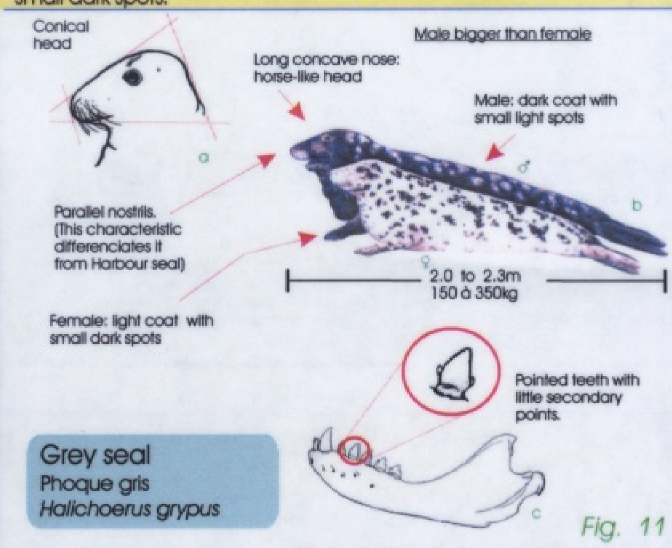


Harp seal
Phoque du Groenland
Phoca groenlandica

Fig. 10

Length: > 2 meters

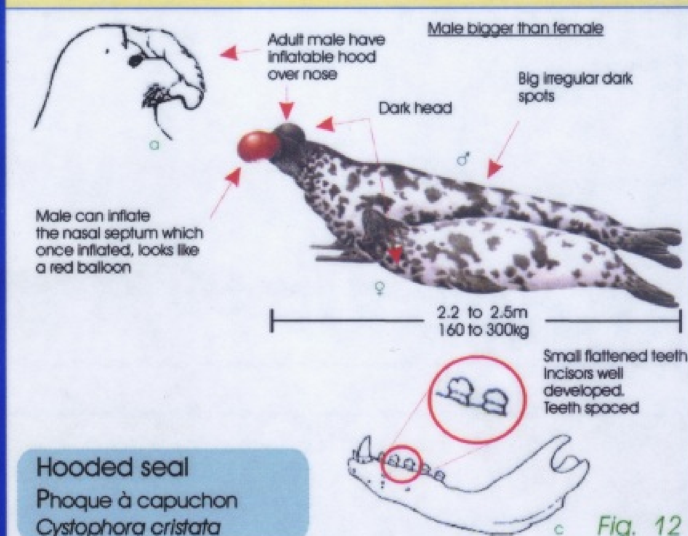
Big robust seal. Conical head with long and concave nose horse-like. Male: dark coat with small light spots. Female: light coat with small dark spots.



Grey seal
Phoque gris
Halichoerus grypus

Fig. 11

Blue-grey coat with big irregular dark spots. Dark head. Adult males have inflatable hood over nose.



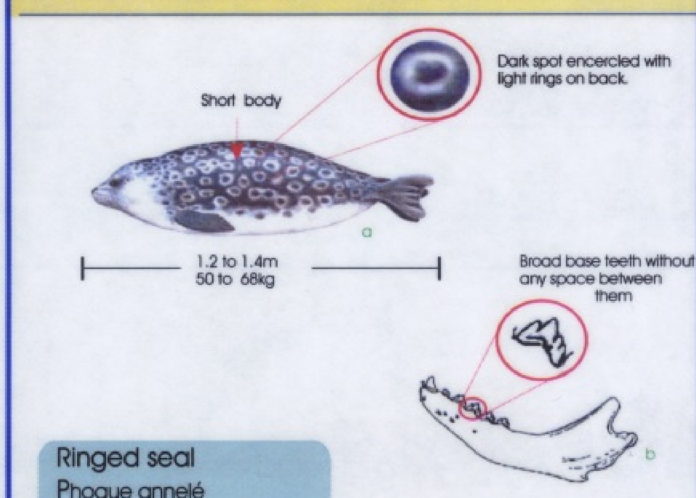
Hooded seal
Phoque à capuchon
Cystophora cristata

Fig. 12

Distribution: These two species can be found mainly in the northern Gulf of St. Lawrence (i.e. Strait of Belle Isle)

Length: < 2 meters

Short head and body. Usually dark grey with dark spots encircled with light rings. Light grey belly.

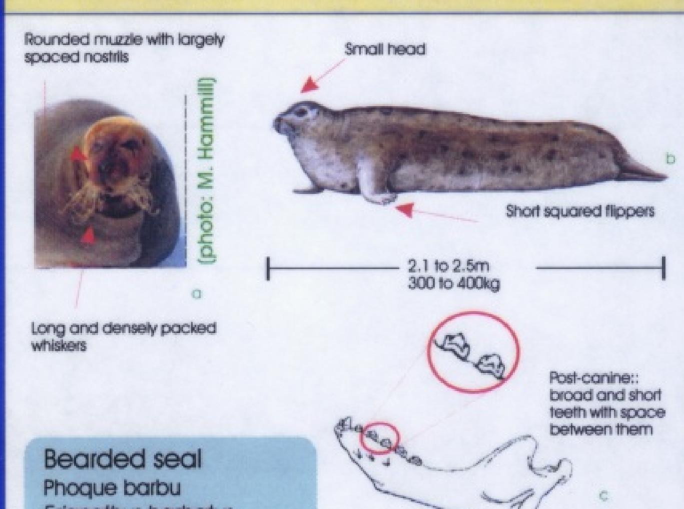


Ringed seal
Phoque annelé
Phoca hispida

Fig. 13

Length: > 2 meters

Large seal. Small head compared to body size. Many long and dense whiskers. Short and squared foreflippers.



Bearded seal
Phoque barbu
Erignathus barbatus

Fig. 14

References and Illustrations

* Prescott, J. and Richard, P. 1996. Guides Nature Quintin: Mammifères du Québec et de l'Est du Canada. Editions Michel Quintin. 399p.
* Sylvestre, J.-P. 1998. Guide des Mammifères Marins du Canada. Broquet. Québec. 330p.

Sections: I - Toothed whales and II- Baleen whale:

* Carwardine, M. 1995. Baleines Dauphins et Marsouins: Le guide visuel de tous les cétacés à travers le monde. Bordas, Paris. 255p. Illustrations: Fig. 1a - b; Fig. 2 a - b; Fig. 3; Fig. 4; Fig. 5; Fig. 6; Fig. 7 a - b et Fig. 8 a - b.
* Fontaine, P.-H. 1988. Biologie & écologie des Baleines de l'Atlantique Nord. Edited: Sylvio Thibeault. Québec. 185p.

Section III - Seals:

* Hannah, J. 1998. Field guide: Seals of Atlantic Canada and the Northeastern United States. International Marine Mammal Association Inc. Ontario. 33p. Illustrations: Fig. 10b; Fig. 11 b; Fib. 12 b; Fig. 13 a et Fig. 14 a - b.
* Katona, S. K., Rough, V. and Richardson, D. T. 1993. A field guide to whales, porpoises and seals from Cape Cod to Newfoundland. Smithsonian Institution Press. Washington. 316p. Illustrations: Fig. 9 a - c; Fig. 10 c; Fig. 11 a - c; Fig. 12 a - c; Fig. 13 c et Fig. 14 c.
* Lavigne, D. M., and Kovacs.K. M. 1988. Harps & Hoods: Ice-Breeding seals of the Northwest Atlantic. University of Waterloo Press. Waterloo. 174p. Illustration: Fig 10 a

Date: ________________________ **Vessel:** ______________________________________ **Coded?**

Month Day Year

Observer(s)		**Vessel Position**				**Time**				**Environmental Conditions**					**Marine Mammals**									
		Latitude		Longitude							Glare			Sightability								Initial Distance		
#1	#2	Deg	Min	Deg	Min	Hour	Min	Sec	**Ship Activity**	Sea State	Amount	From	To		Species	Pod Size	Sighting Cue	Reaction	Diving?	Swim Direction	Location Relative to Ship	# Reticles	# Meters	PI