likely to respond to mid-frequency noise. Sound measures are given a frequency weighting in order to account for this, and the most widely accepted is A-weighting for humans and birds. For repetitive or continuous sound, a Sound Pressure Level (SPL, measured in decibels dB) is expressed as an average, over a certain period of time, of the ratio of the actual sound pressure to a reference sound pressure of 20 μPascal.

Birds possess a highly evolved auditory system and sensitive hearing, and vocal communication plays an important role in many species. The best hearing in birds is in the range of 1 to 4 kHz and there is a steep increase in the threshold up to 10 kHz that is the normal upper limit. In specialized species of birds the upper threshold approaches 20 kHz. (Meyer 1986). Amplitudes of songs at average call frequencies range from - 15 to 50 dB SPL (where 0 dB = 20 μPascal), and at typical frequencies are 5 to 10 dB in most birds. Birds, such as owls, are unique with hearing sensitivity extending to about – 20 dB, and for example, in the pigeon hearing extends into the infrasound range down to 0.1 Hz.

Similar to humans and other mammals, birds discriminate frequency differences and sound intensities. Because of the small head of most birds, sound attenuation between ears is small, and this is important for sound localization (Dooling 1982, 2000; Necker 2000). Sounds separated by a gap are recognized as separate if the gap exceeds 2 to 10 msec (Wilkerson and Howse 1975). Most birds are able to localize sound in the azimuth (horizontal plane) but not in elevation, an exception being owls that are able to localize sound both in the azimuth and in elevation with minimal localization error (Knudson 1980).

Noise varies with disturbance type, and typically there is a threshold beyond which response increases markedly (Pater 2001). For example, adverse outcomes in Harlequin Ducks increased with corresponding increases in the level of exposure to aircraft noise beyond a threshold of about 85 decibels (A-weighted) (dBA) (Goudie and Jones 2004). Responses by birds to noise vary among species (Ryals et al. 1999).

Presence of Artificial Structures

Large numbers of birds breed in northern biomes with extended daylight, where it is relatively free of man-made structures, and migrate annually through highly-industrialized areas with buildings heavily serviced by power utilities, and with substantial darkness. Birds generally fly at different altitudes and in differing patterns at night than during the day (Gauthreaux 1972). Light conditions depend on latitude and season, and species breeding at high latitudes (especially juveniles such as shorebirds) might suffer higher mortality during migration because of the short daylight periods, because they have never experienced nighttime and structures before undertaking the southward movements (Bevanger 1994).

Some species exploit open habitats (e.g. Short-eared Owls, Northern Harrier), and/or are nocturnal (petrels) which puts them at high risk of collision with structures. Utility structures may be the highest structures in the landscape, and often attract considerable nesting and roosting of raptors, e.g. Osprey (*Pandion haliaetus*) in Labrador, and Bald Eagles (*Halieetus leucocephalus*) (Bohm 1988). Utility structures can be selectively used by raptors, owls and corvids for nesting, perching and/or roosting. Use of utility structures for perches in an otherwise flat landscape has led to mass electrocutions of vulnerable bird species (Erickson et al. 2005; Manville 2005). Birds of prey, corvids and other bird species may be attracted to power lines and utility structures for perching, roosting and/or nesting. These behaviours increase the risk of collisions. Notably, raptors make dramatic stoops when attacking prey e.g. Gyrfalcon (*Falco rusticolis*) (Clausen and Gudmundsson 1981), and at such times their singular focus will not detect an intervening power line.

Bird migration is greatly influenced by weather conditions and atmospheric structure. Weather conditions influence migrant as well as resident species, and it is important to distinguish between the two. Dull overcast weather, fog, drizzle and other forms of precipitation reduce the visibility of structures and power lines, as well as generally resulting in birds flying at lower altitudes (Elkins 1988). Some of the most tragic mortalities against man-made structures have occurred under inclement weather conditions (Erickson et al. 2005; Manville 2005). Strong wind and inclement weather reduces the maneuverability of birds, and/or force birds to fly closer to the ground, and this can increase the risk of collision with structures and power lines. Birds flying into head winds generally fly lower than those on tail winds, and tail winds reduce the ability of some bird species to maneuver and avoid collision with power lines (Brown et al. 1987). In strong head winds, the wind speed is generally lower near the ground.

Different bird species fly at different heights, and species vary the altitude of flights depending on the activity. For example, during migration waterfowl and cranes reduce energy expenditure by flying higher to take advantage of tail winds (Tucker 1975) where the risk of collisions with structures and power lines is much reduced, whereas when feeding and roosting they may be particularly prone to colliding with structures and wires when they occur between roosting and feeding areas, because they undertake shorter flights at lower altitudes (Crevelli et al. 1998). Many passerines migrate at night and fly at relatively high altitudes (e.g. 241-1127 m) but may move to within a few metres of the ground in inclement weather (Gauthreaux 1972), and there can be mass mortality due to impacts with anthropogenic structures, e.g. > 100,000 per event (Manville 2005).

<u>Artificial Structures</u>

Large numbers of birds breed in northern biomes with extended daylight, where it is relatively free of artificial lighting, and migrate annually through highly industrialized areas with substantial artificial lights. Species breeding at high latitudes (especially juveniles such as shorebirds) might suffer higher mortality during migration because of short daylight periods because they have never experienced nighttime and artificial light before undertaking the southward movements (Bevanger 1994).

The Leach's Storm Petrel (*Oceanodroma leucorhoa*) is the most abundant breeding seabird in Newfoundland (Lock et al. 1994) and, similar to other shearwaters and petrels, is active at night, and may be particularly vulnerable (Imber 1975, Bourne 1976). On occasion in severe marine storms and foggy weather, large numbers can be blown inland and over coastal headlands. Ainley et al. (2001) reported that in some cases more than 10per cent of fledging Newell's Shearwaters (*Puffinus auricularis newelli*) were blinded by artificial lighting and collided with utility poles, power lines and other man-made structures. Sometimes a combination of circumstances can precipitate a mortality event, such as strong head winds, a cold front, or artificial lighting that force migrating songbirds or shorebirds to fly closer to the ground. Wires and structures that are otherwise avoided may be particularly deadly when in the presence of artificial lighting. For example, lighting may cause migrating flocks of shorebirds to fly at lower altitudes resulting in collisions with wires (Manville 2005). Birds often collide with power lines during inclement weather, e.g. hundreds of grebes during a snowstorm (Cottam 1929).

Birds when confronted with artificial light can lose their reference to the horizon line (Herbert 1970), or become attracted to lighted areas and become disorientated (Weir 1976). Different types of lighting may affect birds differently, and can create synergistic effects that increase potential for collisions with wires (Erickson et al. 2005, Manville 2005). For example, nocturnal migrants displayed more hovering and curving and circling flight behaviour at towers with red lights than those with white strobe lights, and there was more such aberrant behaviour at lit towers than unlit control sites (Gauthreaux 1988). Tall towers with non-blinking lights may be most detrimental to birds (Gehring 2005).

Air Emissions and Contaminants

Atmospheric Emissions – Construction Phase

Various emissions will be associated with construction activities, which includes dust from site development, excavation, vehicular traffic and road construction, mobile equipment and vessels loading and offloading, etc.; also emissions from temporary power generators, heaters, storage tanks, mobile equipment, etc. Construction methods and environmental control and mitigation measures considered for each activity have been described in detail in Volume 2.

No unusually high concentrations of toxic emissions are anticipated nor are there potential for cumulative effects. Therefore no negative impacts are predicted for emissions during construction, and effects are not further considered.

Prior to the construction phase, the Proponent will prepare a general program to control atmospheric emissions of major heavy equipment. This program will be incorporated into the contractors' specifications to make sure it is strictly enforced.

The program will include among other items:

- A dust control program;
- Heavy equipment specifications to have recent equipment in good condition (to minimize air contaminants emissions);
- Heavy equipment maintenance program;
- Fuel oil specifications.

An environmental monitoring station will be installed at the property limit to verify the compliance to ambient air quality criteria. Air emissions from the proposed new refinery are assessed Section 4.6.2, Project Effects During Operations.

EFFECTS ASSESSMENT: Residual Effects

Impact of Habitat Destruction and Alteration

Habitat Loss

There will be direct loss of terrestrial and wetland habitat associated with the road right-of-ways, and especially the footprint of the development (~4 km^2) (Figure 4.22). The geographic context is low (1 to 10 km^2) in a regional context relative to the expanses of natural coastal habitat in this area of Newfoundland. Loss of terrestrial and wetland habitat is equated to lessening of carrying capacity (see Bell and Owen 1990 for waterfowl), that is, some animals are being prevented from exploiting areas they would otherwise selectively use. Species such as waterfowl are thought to saturate the wetlands of a given landscape. Loss of habitat is directly linked to loss of carrying capacity hence ‘no net loss’ of wetlands is premised on the negative effects of habitat loss on waterbird populations. The belief that animals can simply “go somewhere else” may not be a valid concept and has been the cause of large scale habitat loss, for example, wetlands such as prairie potholes critical for waterfowl breeding (North American Waterfowl Management Plan 1986).

No national, regional or locally significant populations of birds or bird habitats were identified in the Southern Head area of Placentia Bay, Newfoundland. The loss of birds associated with bird habitat altered and removed for site construction and access roads is not significant because the effects are deemed to not cause a change in this VEC that will alter its status or integrity (Table 4.21). It is anticipated that the development will introduce a number of invasive anthropogenic plant species that will compete with the currently relatively pristine native flora. Direct habitat loss from construction is anticipated to be of low magnitude over a geographic area of 1 to 10 km^2, continuous, and the effects are irreversible as the habitat is destroyed. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium (Table 4.22).

Wetlands

In considering loss of wetlands, focus is on wetlands having potential to support waterbirds and shorebirds. The overall classification of vegetation in the 311 ha footprint area and 72.2 ha classified road right-of way yielded coverage of 126 ha (40.7per cent) and 26.9 ha (37.4per cent) of wetlands, respectively, when all peatlands were included (Table 4.20, Figure 4.23). Hence, these wetlands generally contain some proportion of open water. Thirty-four wetlands supporting open water suitable for waterbirds and 36.3 ha will be directly lost due to excavation and construction of the new refinery at Southern Head. An additional nine wetlands totaling 9.8 ha will be lost along proposed road right-of-ways. During construction 53 wetlands totaling 55.1 ha will be affected through noise and projected related disturbances, and during project operations this will be reduced to 51 wetlands and 41.3 ha (Table 4.19). Some of these effects are reversible because 4 wetlands totalling 13.8 ha will not be affected following construction. About 20 per cent of impacts on bird use of wetlands due to disturbance will be reversible. Hence, about two-thirds of wetlands in the Project Area were considered of value to waterbirds and predicted to be impacted negatively.

Loss of wetlands from construction are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2, continuous, and the effects are irreversible as the habitat is destroyed. This non-significant impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium (Table 4.22).

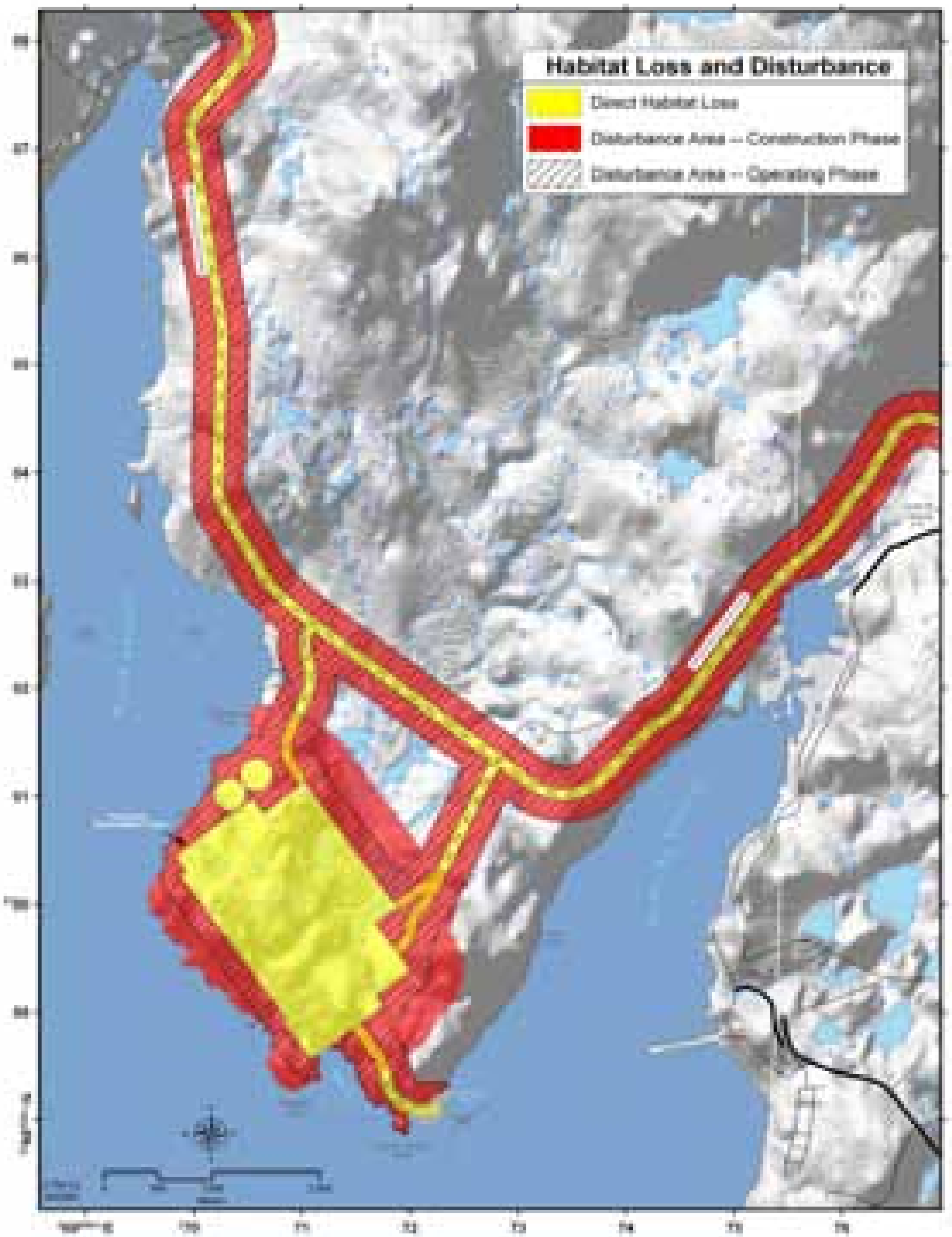

Figure 4.22 Estimated area of direct habitat loss due to project footprint, and area encompassing terrestrial and wetland habitats affected by disturbance due to project construction and operation at Southern Head, Placentia Bay.

Table 4.19 Wetland classes and area affected in the area proposed for the development of a new oil refinery at Southern Head, Placentia Bay.

Wetland Class[1]	FOOTPRINT		DIRECT LOSS[2]		CONSTRUCTION PHASE[3]		OPERATING PHASE[4]	
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)
Alluvial Meadow	0	0.0	1	0.9	8	1.9	8	1.9
Basin Bog	17	12.7	18	12.8	11	3.7	11	3.7
Basin Marsh	5	15.4	5	15.5	12	12.7	11	10.7
Basin Water	10	7.8	13	8.3	8	3.4	8	3.2
Blanket Bog	0	0.0	2	6.8	4	16.6	4	16.6
Domed Bog	2	0.4	2	0.4	1	2.7	1	2.7
Fen	0	0.0	2	1.3	5	1.3	5	1.3
Flat Bog	0	0.0	0	0.0	1	0.9	1	0.9
Intertidal Flat	0	0.0	0	0.0	1	0.0	1	0.0
Lentic Marsh	0	0.0	0	0.0	1	11.5	0	0.0
Riparian Delta Marsh	0	0.0	0	0.0	1	0.3	1	0.3
TOTAL	34	36.3	43	46.1	53	55.1	51	41.3

1Wetland types presented here are those suitable for use by waterbirds and shorebirds.

2Direct loss includes the footprint area and road right-of ways.

3Construction phase predicted to last four years, and have an affected area of disturbance out 500 m from the main footprint.

4Operating phase predicted to have an affected area of disturbance out 200 m from the main footprint.

Table 4.20 General wetland vegetation and area affected (ha) in the area proposed for the development of a new oil refinery at Southern Head, Placentia Bay.

Vegetation Class	Footprint ha (% of total area)	Road Right-Of-Ways ha (% of total area)
Bog	93.2 (29.9%)	26.5 (36.7%)
Fen	12.9 (4.1%)	0.3 (0.5%)
Water	20.8 (6.7%)	0.1 (0.2%)

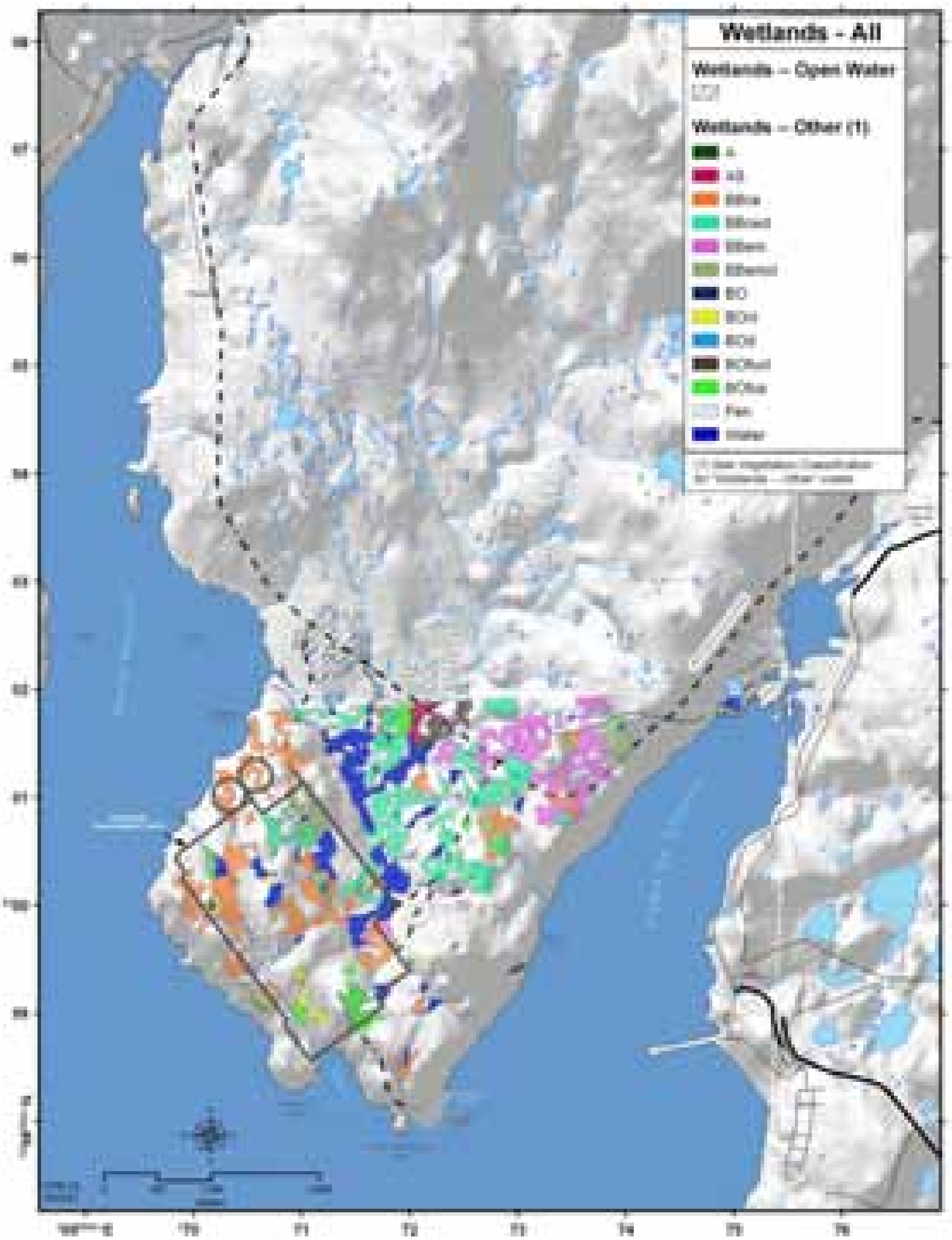

Figure 4.23 All wetlands delineated in the classified area of Southern Head, Placentia Bay.

Loss of Rare Habitats

Enriched habitats were identified as fens that comprised 29.3 ha or 2.4 per cent of the 1207 ha area classified in and near the footprint of the refinery, and herb-rich balsam fir forests comprised 80.8 ha or 6.7per cent of this classified area. The relatively rich vegetation in herb-rich balsam fir forests in the upper slopes of Southern Head, and in fens in the transition of these forests into the nutrient poor blanket bogs were identified along the upper slopes of the surveyed area, and of the 80.8 ha (6.7 per cent) of herb-rich forests classified in the 1207 ha classified area 0.5 ha (0.2 per cent) were delineated in the footprint of the greenfield site (311.7 ha) for the proposed oil refinery, and 2.7 ha (3.7 per cent) were located within the part of the proposed access road (72.2 ha) that falls within the survey area. There is greater diversity of herbaceous plants among these coastal balsam fir forests, and those present appear more prolific and dense than interior forests with a number of uncommon plants. In particular, these forests supported the uncommon round-leaf orchid (*Platanthera orbiculata*) and the dwarf plumboy (*Rubus arcticus* ssp. *acaulis*) extending the known range of these species in the province (see Goudie and Munier 2007). It is likely that these enriched habitats receive relatively high use by terrestrial birds reflecting the increased biodiversity expected in associated fauna such as insects that are important food for birds. The sites identified with the above-named plants will be lost to the proposed refinery footprint.

The impacts of the loss of bird habitats is estimated to be insignificant because of the small areas involved, the larger home range of birds, and the likely presence of similar habitats throughout the geographic area (Table 4.21). Direct effects from construction are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2, continuous, and the effects are irreversible as the habitat is destroyed. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium (Table 4.22.) The implications to the rare plant species is highly uncertain as there are very few inventories of plants in this geographic area that would allow more certainty of the uniqueness of the current findings. None of the uncommon vascular plants found in the Project Area are currently listed under species at risk legislation.

Impact of Noise

Noise can interfere with, i.e., masking, the communication pattern between songbirds, and birds may abandon 'low quality' impacted habitat due to noise (Foppen and Reijnen 1994) or human disturbance (Madsen 1994). Loud noises associated with project construction would be expected to reduce use of habitats adjacent to the project footprint. A negative effect would be anticipated due to the effect of construction and project noise on densities of birds adjacent to the footprint area, and disturbance would diminish use of wetlands by waterbirds.

The negative impact of the development of a new oil refinery at Southern Head would be expected to extend beyond the immediate structural footprint (Figure 4.24) because high levels of noise are anticipated especially over the 48-month construction window. Such disturbance would be expected to impact species differentially, and certain types of disturbance impact terrestrial bird communities. The relative sensitivity of songbirds occurring in the Southern Head area to noise disturbance is unknown but would be expected to vary by species. For example, Reijnen et al. (1995) determined that twenty-six of forty-three species of songbirds showed reduced densities in forested habitats adjacent to noisy highways in the Netherlands. Those effects were especially pronounced within a 200 m zone adjacent to highways, and the effects of vehicular traffic on breeding bird densities were largely explained by noise load.

The construction of this mega-project will generate high amplitude noise, and a prudent estimated affected zone around the refinery footprint of 500 m was selected for the 48-month construction window (Figure 4.22).

Because the densities of terrestrial birds in this area are relatively low and there are no apparent high quality terrestrial habitats, these impacts are assessed as not significant (Table 4.21). Noise effects from construction are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2. The effects are reversible. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is high (Table 4.22).

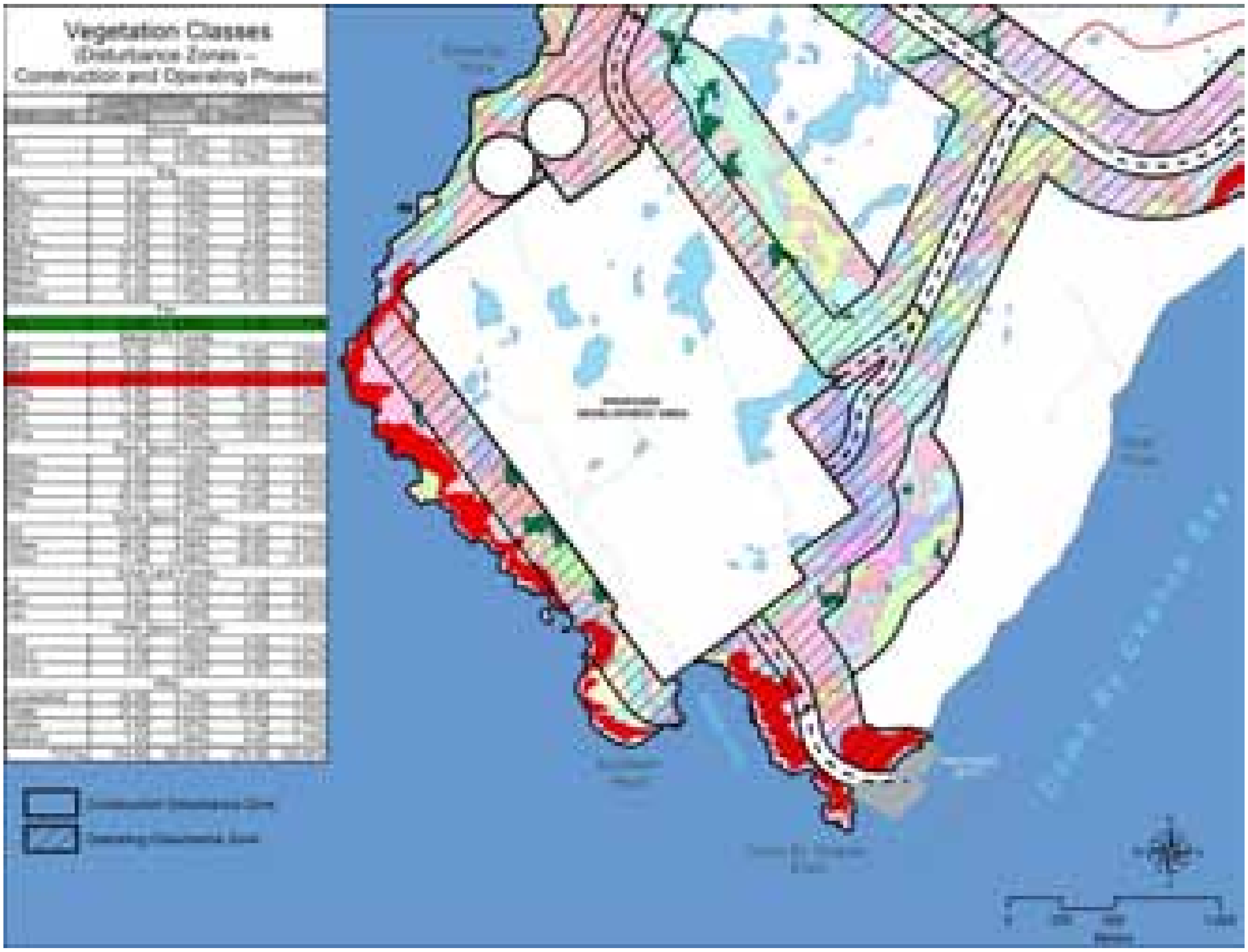

Figure 4.24 Terrestrial habitats within the predicted 200 m and 500 m disturbance zones adjacent to the project footprint of the proposed oil refinery at Southern Head, Placentia Bay.

<u>Impact of Structures and Artificial Lighting</u>

Artificial Structures and Lighting

The site of the proposed new refinery at Southern Head in Placentia Bay is on a coastal headland. Certain species, such as storm petrels, may frequently be at risk of collisions and/or disorientation due to artificial lights in spring, summer and fall when birds are breeding and fledging from colonies in and around Placentia Bay area. Such events are more probable in association with heavy onshore winds and fog. Shorebirds and passerines migrate and stage through coastal areas along the inner Placentia Bay. On occasion these species might be at risk of collisions and/or disorientation due to artificial lights, and this would be most probably in late summer-early fall when the major southward migration of passerines and shorebirds occurs. In years of heavy Arctic pack ice, large aggregations of sea ducks (mainly Common Eiders) have been documented in spring in St. Mary's Bay and Placentia Bay in southeastern Newfoundland. During these times flocks have been observed migrating overland to move toward the Arctic nesting grounds. Eiders have been documented to collide with structures, particularly utility wires and guy wires, during spring migration.

The scientific certainty that such collisions could occur related to manmade structures and artificial lighting at Southern Head, Placentia Bay is low because of the paucity of scientific information. Monitoring for such anthropogenic-related mortalities would be prudent and provide for an adaptive management approach should mitigation become advisable. Nevertheless, the predicted impact is classed as insignificant but uncertain. Effects from construction are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2, and the effects may be partly reversible as mitigation measures exist to minimize potential for collisions. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium (Table 4.22).

Run Off and Siltation

Run-off and siltation are anticipated to be controlled on site, therefore no further assessment was undertaken. Native vegetation may be unable to re-vegetate areas significant altered by siltation. Effects from construction are anticipated to be of low magnitude over a geographic area of <1 km^2 and the potential effects will be mitigated through environmental protection measures that minimize potential for run-off. This impact will occur in a relatively pristine area or area not adversely affected by human activity.

Table 4.21 Effects assessment of construction activities on Migratory Bird VEC (terrestrial bird and bird habitat).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation :								
Noise	Disturbance (A)		1	2	6	4	R	1
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Loss of Habitat	Effects on health (A)		1	2	6	4	I	1
Site Access Road, Transmission Lines, Pipelines, Quarry Development								
Noise	Disturbance (A)		1	2	6	4	R	1

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Refinery Complex								
Noise	Disturbance (A)		1	2	6	4	R	1
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Presence of new structures	Collision (A)	Minimize lighting; monitor	1	2	6	4	I	1
Marine Terminal								
Noise	Disturbance (A)		1	1	6	4	R	1
Lights	Disturbance (A)		1	1	5	4	R	1
Vehicular traffic	Disturbance (A)		1	1	6	4	R	1
Presence of new structures	Collision (A)	Minimize lighting; monitor	1	1	6	4	I	1
Intakes/ Outfalls								
Lights	Disturbance (A)		1	1	6	4	R	1

Table 4.22 Summary of residual impact predictions of construction activities on Migratory Bird VEC (terrestrial bird and bird habitat).

Valued Environmental Component: Bird and Bird Habitat				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Loss of Habitat	NS	2	-	-
Site Access Road, Transmission Lines, Pipelines, Quarry Development				

Valued Environmental Component: Bird and Bird Habitat				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Refinery Complex				
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Presence of new structures	NS	2	-	-
Marine Terminal				
Noise	NS	2	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Presence of new structures	NS	2	-	-
Intakes/ Outfalls				
Noise	NS	2	-	-
Lights	NS	2	-	-

Marine

Seabirds

Most construction activities associated with the oil refinery, the access roads and the marine terminal are not expected to interact with pelagic birds or seabirds. The primary concern for pelagic birds is the accidental release of hydrocarbons. This is assessed in Section 7.0. Construction activities will occur in a limited area at the head of Placentia Bay where pelagic species do not normally occur. It is possible that lights at the marine terminal construction site and especially on vessels (tugs, barges) will attract pelagic birds at night. The stranding of seabirds on (sea-going) vessels is a regular event. The Leach's Storm-Petrel is prone to stranding on vessels in Newfoundland waters. Strandings often happen on foggy nights when storm-petrels are attracted to lights. Bright lights on a ship attract Leach's Storm-Petrels, which fly into ship infrastructure and fall to the deck. With weak legs they have difficulty regaining flight. The birds are then stranded and may remain in this position until they become weak and eventually die. However, if found within a few hours of stranding, birds can usually be rescued and released in good health.

Strandings are unlikely at the construction site. Although nearly 200,000 pairs of Leach's Storm-petrels breed on three islands on the western side of Placentia Bay, this species is expected to be rare in the area of construction. The species feeds far out at sea. Only one individual was recorded on all seabird surveys conducted by LGL Limited in the period from August 2006 to May 2007 (see Section 3.7.3). This bird was observed in the outer reaches of central Placentia Bay in October 2006. Leach's Storm-Petrels typically move between breeding islands and the offshore feeding areas under the cover of darkness for protection from predators, especially gulls. Minimizing lighting unnecessary for safe operations of vessels and construction sites would help reduce the incidences of Leach's Storm-Petrels stranding. If birds do strand, the protocol for dealing with any stranded birds will be followed (Williams and Chardine, n.d.). During construction, which is estimated to take 48 months, the effects of lighting (with appropriate mitigation measures in place) on pelagic birds would be negligible over a geographic extent of <1 km^2 to 1-10 km^2 (Table 4.23) It is predicted that there will be no significant negative effect on pelagic birds from lighting (Table 4.24). The "level of confidence" associated with this assessment is high..

Table 4.23 Effects assessment of construction activities on Migratory Birds (pelagic species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Lights	Stranding (A)	Minimize lighting; release protocols	0	1	5	4	R	1
Site Access Road, Transmission Lines, Pipelines, Quarry Development								
Lights	Stranding (A)	Minimize lighting; release protocols	0	1	5	4	R	1
Refinery Complex								
Vessel traffic (lighting)	Stranding (A)	Minimize lighting; release protocols	0	1	5	4	R	1
Marine Terminal								
Lights	Stranding (A)	Minimize lighting; release protocols	0	1	5	4	R	1
Vessel traffic (lighting)	Stranding (A)	Minimize lighting; release protocols	0	2	5	4	R	1
Intakes/ Outfalls								
Accidents or Malfunctions [a]								

a Considered in Operation assessment.

Table 4.24 Summary of residual impact predictions of construction activities on Migratory Birds (pelagic species).

Valued Environmental Component: Migratory Birds – Pelagic Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Lights	NS	3	-	-
Site Access Road, Transmission Lines, Pipelines, Quarry Development				
Lights	NS	3	-	-
Refinery Complex				
Vessel traffic (lights)	NS	3	-	-
Marine Terminal				
Lights	NS	3	-	-
Vessel traffic (lights)	NS	3	-	-
Intakes/ Outfalls				
Accidents or Malfunctions[a]				

Note:

a Considered in Operation assessment.

Coastal Birds

Coastal birds of the Study Area include waterfowl, loons, grebes, cormorants, shorebirds, and birds of prey (including Bald Eagle and Osprey) that feed in nearshore waters or in the intertidal zone. These birds were discussed in detail in Section 3.7.3, Marine-associated Birds. Construction activities which have the potential to interact with coastal birds include: noise, lights, run-off/siltation, vehicular traffic, and the presence of new structures.

Noise: Noise is not expected to have a major effect on coastal birds except any that may be present on or near the refinery footprint area. Noise from construction will primarily be restricted to the refinery and marine terminal footprint area and adjacent coastline. During the 48 month construction time period the effects of noise on coastal birds would be negligible to low magnitude over a geographic extent of 1-10 km^2 (Table 4.25). It is predicted that there will be no significant negative effect on coastal birds from noise (Table 4.26). The "level of confidence" associated with this assessment is high.

Lights: Lights are expected to have negligible effect on coastal birds (Table 4.25). In general coastal species are not adversely affected by lights. It is predicted that there will be no significant negative effect on coastal birds from light (Table 4.26). The "level of confidence" associated with this assessment is high.

Run-off/Siltation: It is possible that run-off and siltation may impact coastal birds by reducing the availability of some prey; the likelihood of such an impact is low, as run-off and siltation will be controlled during construction. Silt curtains will be used to contain suspended materials. During construction, the effects of run-off and siltation from the refinery complex, marine terminal, intakes and outfall locations (with appropriate mitigation measures in place) on coastal birds is predicted to be negligible over a geographic extent of <1 km^2 to 1-10 km^2. Any effect of exposure to run-off or siltation or decreased prey availability would be reversible (Table 4.25). It is predicted that there will be no significant negative effect on coastal birds from run-off or siltation during construction of the refinery complex, marine terminal and intake and outfall pipes (Table 4.26). The "level of confidence" associated with this assessment is high.

Vehicular Traffic: The effects of vehicular traffic are predicted to be negligible on coastal birds outside the immediate area of construction at the refinery site, access roads and marine terminal. Birds occurring near vehicular traffic may avoid the immediate area of traffic. During construction, the effects of vehicular traffic associated with the Project on coastal birds is predicted to be negligible over a geographic extent of 1-10 km^2. Any effect of vehicular traffic would be reversible (Table 4.25). It is predicted that there will be no significant negative effect on coastal birds from vehicular traffic (Table 4.26). The "level of confidence" associated with this assessment is high.

Presence of New Structures: Construction of the proposed refinery will have a negative and irreversible impact on the land on which the infrastructure and roadways will be built. This foot print area is however relatively small (<4 km^2). The habitat is similar to that found commonly elsewhere in eastern Newfoundland. The refinery footprint contains limited habitat that may be suitable for nesting coastal birds such as American Black Duck and Ring-necked Duck. Both species were observed in the refinery footprint on a 28 June 2007 survey. An active nest of Osprey and Bald Eagle were present near Goat Point on the east side of Come By Chance Point in June 2007. These two nests are located about one kilometer from the footprint of the refinery. Preventative measures will be taken to avoid destroying the nest trees. Mitigation measures will require the location of these raptor nests be known to the construction crew and a buffer of 300 m around each nest will be established where no trees are to be cut. With appropriate mitigation measures in place, the effects (habitat loss) of the physical presence of the proposed refinery, its access roads, and marine terminal are predicted to range from low to high magnitude over a geographic extent of 1-10 km^2 (Table 4.25). It is predicted that there will be no significant negative effect on coastal birds from the presence of new structures (Table 4.26). The "level of confidence" associated with this assessment is high.

Table 4.25 Effects assessment of construction activities on Migratory Birds (coastal species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, Siltation	Prey availability (A)	Silt curtains	0	1-2	2	2-3	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Site Access Road, Transmission Lines, Pipelines, Quarry Development								
Noise	Disturbance (A)		0-1	2	6	4	R	1
Lights	Disturbance (A)		0	2	6	4	R	1
Run-off, Siltation	Prey availability (A)	Silt curtains	0	1-2	2-3	4	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Presence of new structures	Loss of habitat (A)	Avoid Eagle/Osprey nests	1-3	1	6	4	I	1
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0	1-2	?	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Presence of Structures	Loss of habitat (A)		1-3	2	6	4	I	1
Marine Terminal								
Noise	Disturbance (A)		0-1	2	6	3	R	1
Lights	Disturbance (A)		0	2	6	3	R	1
Run-off, siltation	Prey availability (A)	Silt curtains	0	1-2	2-3	3	R	1
Vessel traffic	Disturbance (A).		0-1	2	6	3	R	1
Vehicular traffic	Disturbance (A)		0	2	6	3	R	1
Presence of new structures	Loss of habitat (A)		1	1	6	3	I	1
Intakes/ Outfalls								

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Noise	Disturbance (A)		0	1	6	4	R	1
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, siltation	Prey availability (A)	Silt Curtain	0	1-2	6	2-3	R	1
Presence of new structures	Prey availability (A)		0	1	6	4	R	1
Accidents or Malfunctions[a]								

Note:

a Considered in Operation assessment.

Table 4.26 Summary of residual impact predictions of construction activities on Migratory Birds (coastal species).

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Lights	NS	3		
Run-off, Siltation	NS	3		
Site Access Road, Transmission Lines, Pipelines, Quarry Development				
Noise	NS	3		
Lights	NS	3		
Run-off, Siltation	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Refinery Complex				

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Run-off, siltation	NS	3		
Vessel traffic	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Marine Terminal				
Noise	NS	3		
Lights	NS	3		
Run-off, siltation	NS	3		
Vessel traffic	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Intakes/ Outfalls				
Noise	NS	3		
Lights	NS	3		
Run-off, siltation	NS	3		
Presence of new structures	NS	3		
Accidents or Malfunctions[a]				

Note:

a Considered in Operation assessment.

4.6.2 Project Effects During Operations

During operation of the oil refinery and the marine terminal, there are six main types of activities that may impact terrestrial birds and bird habitats:

- Habitat loss or deterioration (see Section 4.6.1, Project Effects During Construction)
- Noise and Disturbance (including traffic) (see Section 4.6.1, Project Effects During Construction)
- Presence of structures and artificial light

- Run-off, siltation (see Section 4.6.1, Project Effects During Construction)
- Air emissions
- Effluents/Contaminants (see Section 4.6.1, Project Effects During Construction)

Of these, habitat deterioration and noise/disturbance have the greatest potential to impact birds and bird habitat. Noise is defined as a sound of human origin that might significantly disturb animals (Bowles et al. 1991), that is, it may have deleterious effects on wildlife. Noise is associated with almost every aspect of the Project and this VEC is known to be sensitive to noise. Data exist for response of some species of birds to noise.

Terrestrial

Structures and Artificial Lighting

Artificial Structures

Large numbers of birds breed in northern biomes with extended daylight where it is relatively free of man-made structures, and migrate annually through highly industrialized areas with buildings heavily serviced by power utilities, and with substantial darkness. Birds generally fly at different altitudes and in differing patterns at night than during the day (Gauthreaux 1972). Light conditions depend on latitude and season, and species breeding at high latitudes (especially juveniles such as shorebirds) might suffer higher mortality during migration because of short daylight periods because they have never experienced nighttime and structures before undertaking the southward movements (Bevanger 1994).

Some species exploit open habitats (e.g. Short-eared Owls, Northern Harrier), and/or are nocturnal (petrels) which puts them at high risk of collision with structures. Utility structures maybe the highest structures in the landscape, and often attract considerable nesting and roosting of raptors, e.g. Osprey in Labrador, and Bald Eagles (Bohm 1988). Utility structures can be selectively used by raptors, owls and corvids for nesting, perching and/or roosting. Use of utility structures for perches in an otherwise flat landscape has led to mass electrocutions of vulnerable bird species (Erickson et al. 2005, Manville 2005). Birds of prey, corvids and other bird species may be attracted to power lines and utility structures for perching, roosting and/or nesting. These behaviours increase the risk of collisions. Notably, raptors make dramatic stoops when attacking prey e.g. Gyrfalcon (Falco rusticolis) (Clausen and Gudmundsson 1981), and at such times their singular focus will not detect an intervening power line.

Bird migration is greatly influenced by weather conditions and atmospheric structure. Weather conditions influence migrant as well as resident species, and it is important to distinguish between the two. Dull overcast weather, fog, drizzle and other forms of precipitation reduce the visibility of structures and power lines as well as generally resulting in birds flying at lower altitudes (Elkins 1988). Some of the most tragic mortalities against man-made structures have occurred under inclement weather conditions (Erickson et al. 2005, Manville 2005). Strong wind and inclement weather reduces the maneuverability of birds, and/or force birds to fly closer to the ground, and this can increase the risk of collision with structures and power lines. Birds flying into head winds generally fly lower than those on tail winds, and tail winds reduce the ability of some bird species to maneuver and avoid collision with power lines (Brown et al. 1987). In strong head winds, the wind speed is generally lower near the ground.

Different bird species fly at different heights, and species vary the altitude of flights depending on the activity. For example, during migration waterfowl and cranes reduce energy expenditure by flying higher to take advantage of tail winds (Tucker 1975) where they are generally out of danger to collisions with structures and power lines, whereas when feeding and roosting they may be particularly prone to colliding with structures and wires when they occur between roosting and feeding areas because they undertake shorter flights at lower altitudes (Crevelli et al. 1998). Many passerines migrate at night and fly at relatively high altitudes (e.g. 241-1127 m) but may move to within a few metres of the ground in inclement weather (Gauthreaux 1972), and there can be mass mortality due to impacts with anthropogenic structures, e.g. > 100,000 per event (Manville 2005).

Artificial Lighting

Large numbers of birds breed in northern biomes with extended daylight where it is relatively free of artificial lighting, and migrate annually through highly industrialized areas with substantial artificial lights. Species breeding at high latitudes (especially juveniles such as shorebirds) might suffer higher mortality during migration because of short daylight periods because they have never experienced nighttime and artificial light before undertaking the southward movements (Bevanger 1994).

The Leach's Storm Petrel is the most abundant breeding seabird in Newfoundland (Lock et al. 1994) and similar to other shearwaters and petrels is active at night, and may be particularly vulnerable (Imber 1975, Bourne 1976). On occasion in severe marine storms and foggy weather, large numbers can be blown inland and over coastal headlands. Ainley et al. (2001) reported that in some cases more than 10per cent of fledging Newell's Shearwaters were blinded by artificial lighting and collided with utility poles, power lines and other man-made structures. Sometimes a combination of circumstances can precipitate a mortality event, such as strong head winds, a cold front, or artificial lighting that force migrating songbirds or shorebirds to fly closer to the ground. Wires and structures that are otherwise avoided may be particularly deadly when in the presence of artificial lighting. For example, lighting may cause migrating flocks of shorebirds to fly at lower altitudes resulting in collisions with wires (Manville 2005). Birds often collide with power lines during inclement weather, e.g. hundreds of grebes during a snowstorm (Cottam 1929).

Birds when confronted with artificial light can lose their reference to the horizon line (Herbert 1970), or become attracted to lighted areas and become disorientated (Weir 1976). Different types of lighting may affect birds differently, and can create synergistic effects that increase potential for collisions with wires (Erickson et al. 2005, Manville 2005). For example, nocturnal migrants displayed more hovering and curving and circling flight behaviour at towers with red lights than those with white strobe lights, and there was more such aberrant behaviour at lit towers than unlit control sites (Gauthreaux 1988). Tall towers with non-blinking lights may be most detrimental to birds (Gehring 2005).

Air Emissions

Processing and Compounds

In the refinery, crude oil is converted into a variety of products, such as hydrocarbon fuels and feedstocks for the petrochemical industry. Crude oil will be transported to the refinery by marine vessel. The refined petroleum products will be exported by marine vessels. Various chemicals and elements can be anticipated in relation to emissions from an operating oil refinery, these are: gaseous air pollutants (carbon monoxide, nitrogen oxides and sulphur dioxide), volatile organic compounds (VOCs), petroleum hydrocarbon (PHC), polycyclic aromatic hydrocarbons (PAHs), and particulate matter (Bounicore and Davis 1992). Some release of these may result during testing of equipment for operations.

Refining operations consist of separation processes, conversion processes, treating processes, feedstock and product handling, and associated auxiliary operations. The flow scheme of the NLRC refinery is determined by the composition of the crude oil and the chosen slate of products. In general, emission sources are either those resulting from the petroleum products (namely, VOC emissions) or those resulting from combustion sources at the refinery.

Volatile organic compound emissions from refinery operations can be characterized as two types: (1) process point-source emissions and (2) fugitive emissions. Process point-source emissions are those emissions directly associated with or generated by a process unit. Process vents are an example of a point-source emission. Fugitive emission sources are VOC emission sources not specifically generated by a particular process unit. Such emission sources are found throughout a refinery and may or may not be associated with a process unit. They include valves, flanges, pump and compressor seals, cooling towers, storage tanks, transfer operations, and wastewater treatment systems. Fugitive emissions also result from the evaporation of leaked or spilled hydrocarbon liquid and gases.

Toxicity and Dose-Response

Toxicity is the potential for a chemical to produce any type of damage, permanent or temporary, to the structure or functioning of any part of the body. The toxicity of a chemical depends on the amount of chemical taken into the body (referred to as the “dose”) and the duration of exposure (i.e., the length of time the person is exposed to the chemical). For every chemical, there is a specific dose and duration of exposure necessary to produce a toxic effect in a biological system (this is referred to as the "dose-response relationship" of a chemical). The dose-response principle is central to risk assessment and for some chemicals there are thresholds below which no adverse effects are expected.

EFFECTS ASSESSMENT: Residual Effects

Loss of Terrestrial Habitats

Terrestrial birds using vegetation types in the 200 m operational impact zones are predicted to avoid these habitats. Hence, the area of coverage of habitat types within these zones constitutes a potential area of impact of terrestrial habitats (Figure 4.24). Because the densities of terrestrial birds in this area are relatively low and there are no apparent high quality terrestrial habitats in these zones of influence, these impacts are assessed as not significant (Figure 4.28).

Noise effects from operation activities are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2. Noise will be continuous adjacent to the refinery and intermittent along the road right-of-way footprint. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is high (Table 4.29).

IMPACT OF NOISE

Noise can interfere with, i.e., masking, the communication pattern between songbirds, and birds may abandon 'low quality' impacted habitat due to noise (Foppen and Reijnen 1994) or human disturbance (Madsen 1994). Loud noises would be expected to reduce use of habitats adjacent to the project footprint. A negative effect is predicted due to the effect of project noise on densities of birds adjacent to the footprint area, and disturbance would diminish use of wetlands by waterbirds.

The negative effects of the development of a new oil refinery at Southern Head would be expected to extend beyond the immediate structural footprint, and effects are predicted to be intermittent during operations; for example, they may intensify during maintenance shut-downs and start-ups. Such disturbance would be expected to impact species differentially, and potentially affect terrestrial bird communities. The relative sensitivity of songbirds occurring in the Southern Head area to noise disturbance is unknown but would be expected to vary by species, and by amplitude and frequency of noise. This zone of effect is predicted to approximate 200 m (see Reijnen et al. 1995) during the subsequent operation of the refinery over the decadal life of the project (Figure 4.22). Because the densities of terrestrial birds in this area are relatively low and there are no apparent high quality terrestrial habitats, these impacts are assessed as not significant. Impacts of noise are predicted to be of low magnitude over a geographic area of 1 to 10 km^2 and the effects are reversible (Table 4.28). This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium to high (Table 4.29).

Impact of Structures and Artificial Lighting

Artificial Structures and Lighting

The site of the proposed new refinery at Southern Head in Placentia Bay is on a coastal headland. Certain species may frequently be at risk of collisions and/or disorientation due to artificial lights in spring, summer, fall when birds are breeding and fledging from colonies in and around Placentia Bay area. Such events are more probable in association with heavy onshore winds and fog. Shorebirds and passerines migrate and stage through coastal areas along the inner Placentia Bay. On occasion these species might be at risk of collisions and/or disorientation due to artificial lights, and this would be most probably in late summer-early fall when the major southward migration of passerines and shorebirds occurs.

The scientific certainty that such collisions could occur related to manmade structures and artificial lighting at Southern Head, Placentia Bay is low because of the paucity of scientific information. Monitoring for such anthropogenic-related mortalities would be prudent and provide for an adaptive management approach should mitigation become advisable. Nevertheless, the predicted impact is classed as not significant. Effects from operation are anticipated to be of low magnitude over a geographic area of 1 to 10 km^2, and the effects may be partly reversible as mitigation measures exist to minimize potential for collisions. This impact will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is medium (Table 4.21).

IMPACT OF EMISSIONS

Summary of NLRC Refinery Emissions

The refinery will be engineered to use the best available technologies from the petroleum industry in order to minimize atmospheric emissions at source (Table 4.27).

Table 4.27 Summary Table of Contaminants Predicted for the Operation of a New Refinery At Southern Head, Placentia Bay, NL (Refinery capacity 300,000 bbl/day).

Source	PM_{Total} t/year	PM_{10} t/year	$PM_{2.5}$ t/year	NO_X t/year	SO_2 t/year	CO t/year	CO_2 eq t/year	COV t/year	Benzene t/year
Tanks								251	0.71
Stacks	584	521	386	2979	5241	906	3581383	60	0.028
Fugitive emissions								104	1.8
Waste water treatment								55	0.94
Discharge									
Cooling tower								56	0.96
Ship loading								51	0.34
Ship manoeuvring	25	23	21	835	1393	138	107066	255	2.2
Flares	0.035	0.035	0.035	1.2	6.2	6.8		2.6	
Total	**609**	**544**	**407**	**3816**	**6641**	**1051**	**3688449**	**833**	**6.9**

Air quality in a region is determined by the concentration of various contaminants in the atmosphere as well as the size and topography of the air shed basin, and its meteorological conditions. The Placentia Bay region has high turbulent winds, which are not conducive to local high accumulation of air pollutants for extended periods, and there is the possibility for quick dispersal of air contaminants.

Terrestrial receptors considered in the study area for the proposed new refinery at Southern Head, Placentia Bay included terrestrial invertebrates and terrestrial vegetation (SENES 2007). Terrestrial birds and vegetation can come into contact with chemicals in their environment in a variety of ways, depending on their daily activities and habitat use patterns. Chemicals generally enter a biological system from an environmental route, namely: inhalation, ingestion/uptake, and absorption (i.e., uptake through the skin).

Effects of Emissions and Contaminants on Birds

Atmospheric deposition of emissions from the proposed facilities will occur, and estimates of possible deposition over near-field areas indicate that concentrations for some metals and compounds will increase in the Project Area, and the likelihood of adverse effects associated with the magnitude of these increases is moderate because of the presence of terrestrial birds in this area of small body size and high rates of respiration (BMR), and the sensitivity of bird respiratory systems (N. Burgess, CWS, pers. comm.). Twenty-four hour cumulative emissions of SO_2 are predicted to exceed WHO recommended standards for human health because levels of SO_2 already existing have a potential for health effects in humans, and that the emissions from the proposed NLRC refinery will add to this risk (SENES 2007). It is uncertain how terrestrial bird species in the Project Area will respond to elevated levels of SO_2. Short-term negative effects on birds are not anticipated; however, the longer-term implications remain uncertain. Effects from operational emissions on terrestrial bird health are predicted to be low magnitude over a geographic area of 101 to 1,000 km^2 with continuous exposure (Table 4.28). This effect will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is low and follow-up monitoring is recommended (Table 4.25).

Effects On Bird Habitat

There is potential for adverse effects of gaseous air contaminants (primarily NO_2 and especially SO_2) on vegetation. This effect will be most pronounced on lichens because of their reliance on airborne nutrients and water, as well as lack of protective structures such as cuticles found in vascular plants (see Section 4.10, Species at Risk Effects Assessment). Trees and other vascular plants are affected by pollution, but are generally slower to show impacts than lichens (McCune 2000). The major sources of air pollution affecting lichens include oil refining (Cameron et al. 2007).

Sulphur dioxide is known to have adverse effects on plants as it penetrates the stomata of plants. Exposure to sulphur dioxide over time can cause acute injury in the form of foliar necrosis (death of the foliage). Longer term effects are important because even at lower concentrations, they are cumulative in nature resulting in adverse effects such as reduced growth and yield that may manifest as discoloring and death (chlorosis and necrosis) (SENES 2007). Sulphur dioxide will concentrate in balsam fir over time and during insect infestations species such as Hemlock Looper would be receptors that are in turn consumed by songbirds. Similarly, moose browse extensively on balsam fir (often exclusively in winter). These concentrations may not be of toxicological concern but the build-up of SO_2 in vegetation would be predicted to increase necrosis (death), forage quality (chlorosis) and increase acidification that deteriorates habitat and forage quality and releases metals into the food chain (CWS 2004).

Dose-response on native vegetation is scarce or lacking (WHO 2005). The current WHO phytotoxic guidelines for SO_2 are 30 $\mu g/m^3$ as an annual average and 100 μg/m3 as a 24-hour average (WHO 2000). The combined values of SO_2 for the geographic area of Southern Head, Placentia Bay are predicted to exceed these levels in 24-hour periods (but not the annual levels); risk analyses concluded that even though an assessment of the direct comparison to ecological benchmarks could not be made for the plant and earthworm species, these effects are captured within the food chain effects for the terrestrial animals, such as the mouse and rabbit. Thus, ecological receptors in the vicinity of the proposed refinery will likely not experience adverse effects from emissions arising from its operation and a more detailed ecological risk assessment is not warranted (SENES 2007). Because species-specific information is lacking there is considerable scientific uncertainty.

Near-field wetlands may experience adverse effects associated with acidic deposition, and existing wetlands have no buffering capacity to counteract increased acidity. Some waterfowl species, such as Ring-necked Ducks exploit wetlands of low pH. Nevertheless there are lower thresholds below which the wetland cannot sustain biological productivity (CWS 2004).

Therefore, short-term negative effects on bird habitat are not anticipated; however, the longer-term implications remain uncertain. Effects from operation are predicted to be low magnitude over a geographic area of 101 to 1,000 km^2 with continuous exposure. This effect will occur in a relatively pristine area or area not adversely affected by human activity. The level of confidence with this assessment is low and follow-up monitoring is recommended (Table 4.29).

Nitrogen in air pollutants can affect vegetation indirectly, via chemical reactions in the atmosphere or directly by deposition on vegetation soil or water. NO and NO_2 are precursors to trophospheric ozone which is also known to be phytotoxic. Uptake of NO_x (NO and NO_2) in the leaves from water deposition is generally via the cuticle. As with SO_2, environmental conditions such as humidity and temperature affect the phytotoxicity of NO_x. In a majority of scientific studies, no significant effects were observed at NO_x concentrations below 100 $\mu g/m^3$. Thus, the WHO provides a CLE for NO_x of 30 $\mu g/m^3$ on an annual basis and 75 $\mu g/m^3$ for a 24-hour average (WHO 2000). These levels are used in the assessment, and similar to the projected particulate matter the anticipated emissions from the proposed new refinery at Southern Head, Placentia Bay are far below recommended guidelines (SENES 2007). Therefore, no negative impacts are predicted on birds or bird habitat from nitrogen and particulate matter in emissions.

Effluents

All effluents will be treated to meet the applicable regulations before being discharged to the environment (outflow pipe). Therefore, no impacts on terrestrial birds or bird habitat are expected.

Table 4.28 Effects assessment of operation activities on Migratory Bird VEC (terrestrial bird and bird habitat).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Air emissions	Effect on habitat, health (A)	Reduce emissions	1	4	6	5	I	1
Noise	Effect on habitat, disturbance (A)		1	2	6	5	R	1
Lights	Disturbance (A)	Minimize lighting	1	2	5	5	R	1
Vehicular traffic	Disturbance (A)		1	2	6	5	R	1
Run-off, siltation	Habitat change (A)	Control measures	0-1	1	1	2-3	R	1
Marine Terminal Operations								
Lights	Disturbance (A)	Minimize lighting	1	1	5	5	R	1
Marine Transportation								
Noise	Disturbance (A)		1	1	6	5	R	1
Lights	Disturbance (A)	Minimize lighting	1	1	5	5	R	1
Intakes/Outfalls								
Accidents or Malfunctions								

Table 4.29 Summary of residual impact predictions of operation activities on Migratory Bird VEC (terrestrial bird and bird habitat).

Valued Environmental Component: Bird and Bird Habitat				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Air emissions	NS	1	-	-
Noise	NS	2-3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Run-off, siltation	NS	3	-	-
Marine Terminal Operations				
Lights	NS	2	-	-
Marine Transportation				
Noise	NS	2-3	-	-
Lights	NS	2	-	-
Intakes/ Outfalls				
Solid and Hazardous Wastes				
Accidents or Malfunctions				

Marine

Seabirds

As in the construction phase of the Project, the main activities during operation of the proposed refinery and marine terminal that could potentially affect seabirds (i.e., pelagic birds) are related to sea going vessels. The primary concern for pelagic birds is the accidental release of hydrocarbons; this is assessed in Section 7.0. Operations of the refinery itself are expected to have negligible effect on seabirds. Vessels traveling through Placentia Bay enroute to and from the marine terminal have the potential to affect pelagic birds. Lights on vessels at night, particularly in foggy conditions, can attract seabirds, especially Leach's Storm-Petrels, resulting in stranding. Minimizing lighting unnecessary for safe operations of vessels would help reduce the incidences of Leach's Storm-Petrels stranding. If birds do strand, the protocol for dealing with any stranded birds will be followed (Williams and Chardine, n.d.).

Lights: Lights are associated with the refinery and marine terminal operations, including vessels (i.e., tugs) that are docked at the terminal. During operations lights from the illumination of roadways and structures at the refinery and marine terminal should have little effect on marine birds. Leach's Storm-Petrel, the most prone species among seabirds in the Study Area to the adverse affects of lights, is expected to be rare at the head of Placentia Bay. During nights of fog and strong south winds in late summer and fall, Leach's Storm-Petrels may on occasion stray to the head of Placentia Bay. With appropriate mitigation measures in place, the effects of lighting at the refinery site, marine terminal and its attendant vessels would be negligible over a geographic extent of 1-10 km^2 (Table 4.30) predicted that there will be no significant negative effect on pelagic birds from lighting at the refinery and marine terminal. The "level of confidence" associated with this assessment is high (Table 4.31).

Lights on vessels (tankers, bulk carriers) transiting to and from the marine terminal have the greatest potential to attract Leach's Storm-Petrels. Leach's Storm-Petrels typically move between breeding islands and the offshore feeding areas under the cover of darkness for protection from predators, especially gulls. Nearly 200,000 pairs of Leach's Storm-Petrels breed on three islands on the western side of Placentia Bay. Leach's Storm-Petrels entering Placentia Bay in darkness may be attracted to the lights of vessels entering or leaving the outer reaches of the bay at the same time. With appropriate mitigation measures in place, the effect of lighting from tankers and bulk carriers is predicted to have low magnitude effect over a geographic extent of 1-10 km^2 to 10-100 km^2 (Table 4.30). It is predicted that there will be no significant negative effect on pelagic birds from lighting on vessels. The "level of confidence" associated with this assessment is high (Table 4.31).

Effluent Characteristics: During operation of the oil refinery, effluent will be discharged though the outfall pipe located west of Southern Head point. The pipe extends 500 m from the shoreline. All effluent will meet the requirements outlined in the provincial "Environmental Control Water and Sewage Regulations". Although the types and actual concentrations of various substances in the treated effluent are not available at present, substances could include heavy metals, benzene, and PAH, but concentrations will be less than those outlined in the provincial regulations. There is some risk that pelagic birds may be exposed to these substances via consumption of prey. However, the area of effluent outfall is limited and seabirds occur in very low numbers at the head of Placentia Bay. With appropriate mitigation measures in place, any negative effect from effluent on the prey of seabirds would be negligible over a geographic extent of < 1 km^2 (Table 4.30). The "level of confidence" associated with this assessment is high (Table 4.31). It is important that effluent outflow be monitored during the operational phase of the refinery to ensure discharge composition and levels are met.

Table 4.30 Effects assessment of operation activities on Migratory Birds (pelagic species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Vessel traffic	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Marine Terminal Operations								
Lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Vessel traffic lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Marine Transportation								
Lights	Stranding (A)	Minimize lighting; release protocols	1	2-3	5	5	R	1
Intakes/Outfalls								
Effluent characteristics	Effects on Prey (A)	Treatment guidelines	0	1	6	5	R	1
Solid and Hazardous Wastes								

Table 4.31 Summary of residual impact predictions of operation activities on Migratory Birds (pelagic species).

Valued Environmental Component: Migratory Birds – Pelagic Species				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Lights	NS	3		
Marine Terminal Operations				
Lights	NS	3		
Marine Transportation				
Lights	NS	3		

Valued Environmental Component: Migratory Birds – Pelagic Species				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Intakes/Outfalls				
Effluent characteristics	NS	3		
Solid and Hazardous Wastes				

Coastal Birds

Operational activities that have the potential to interact with coastal birds include: noise, lights, run-off/siltation, vessel traffic, the location of the outfall pipe and effluent characteristics. The operation of the refinery should have negligible to low magnitude effects on coastal birds if guidelines and protocols for safe and clean operations are followed (Table 4.32). It is predicted that there will be no significant effects of operational activities on coastal birds with appropriate mitigation measures in place (Table 4.33).

Table 4.32 Effects assessment of operation activities on Migratory Birds (coastal species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, siltation	Prey availability (A)	Silt Curtain	0	1-2	?	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Marine Terminal Operations								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Marine Transportation								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Intakes/Outfalls								
Noise	Disturbance (A)		0	1	6	4	R	1
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Location of outfall pipes	Prey availability (A)		0	1	6	4	R	1
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	1
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1

Table 4.33 Summary of residual impact predictions of operation activities on Migratory Birds (coastal species).

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Lights	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Storage and disposal of wastes, debris	NS	3		
Marine Terminal Operations				
Air emissions	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Marine Transportation				
Lights	NS	3		

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Intakes/Outfalls				
Noise	NS	3		
Lights	NS	3		
Vessel Traffic	NS	3		
Maintenance	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Solid and Hazardous Wastes				
Noise	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Maintenance	NS	3		
Vessel Traffic	NS	3		

4.6.3 Mitigation

Mitigation measures and monitoring proposed to minimize impacts on migratory birds (and their habitat) are summarized in Table 4.34.

Table 4.34 Summary of proposed mitigation measures and monitoring for migratory birds.

Project Activity	Project Phase	Potential Effect	Mitigation/Monitoring
Air Emissions and contaminants	Construction	Effects on health	Dust control program; heavy equipment maintenance; fuel oil specifications
Air emissions	Operations	Effects on health, habitat	Best available technology, follow-up monitoring
Collision with structures	Construction, Operations	Effects on health, mortality	Monitor for mortalities; minimize lighting
Run-off, siltation	Construction, Operations	Effects on habitat, prey availability	Silt curtain, control measures
Lighting	Construction, Operations	Stranding, potential mortality	Minimize lighting (when safe), implement release protocols (Williams and Chardine, n.d.)
Presence of new structures	Construction	Loss of nesting trees	Avoid Bald Eagle and Osprey nest trees by 300 m
Effluent	Operations	Effects on health	Meet provincial regulations, monitor output
Accidents and malfunctions	Construction, Operations	Effects on health, mortality	Spill response; contingency plan; follow-up monitoring

4.6.4 Accidents and Malfunctions

This section assesses the potential impacts of a marine oil spill on marine-associated birds, including pelagic and coastal species. Seabirds are the marine biota most at risk from oil spills. Shorebirds, sea ducks, and other water birds (e.g., loons and grebes) are also at risk, as they use the marine environment to varying degrees. The Grand Banks region is a very important area for large numbers of seabirds, and the south coast of Newfoundland is no exception. Exposure of birds to oil causes thermal and buoyancy deficiencies and often death. Some could survive initially, but physiological changes eventually could result in death (Ainley et al. 1981; Williams 1985; Frink and White 1990; Fry 1990). Oil spills can affect the size and composition of seabird populations, as well as their reproductive success and habitat use (Wiens 1995). Reported effects vary with species, type of oil, weather conditions, time of year, and duration of the spill (Gorsline et al. 1981).

Immediate Effects

External exposure to oil occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks, and swimming birds swim into slicks. The external exposure results in matting of the feathers, which effectively destroys the thermal insulation and buoyancy provided by the air trapped by the feathers. Consequently, oiled birds may suffer from hypothermia and/or drown (Clark 1984; Hartung 1995). Birds living in coldwater environments, such as the Study Area, are most likely to succumb to hypothermia (Hartung 1995). Most mortalities occur during the initial phase of oil spills when large numbers of birds are exposed to floating oil (Hartung 1995).

Oil spills at sea have the potential to kill tens of thousands of birds (Clark 1984; Piatt et al. 1990). However, it is difficult to estimate how many marine birds are oiled during any particular oil-spill, because some birds may not reach shore (dead or alive), and beached carcasses may be scavenged or washed out to sea before being counted (Ford et al. 1987). There is also no clear correlation between the size of an oil spill and numbers of seabirds killed (Burger 1993). The density of birds in a spill area, wind velocity and direction, wave action, and distance to shore can have a greater bearing on mortality than the size of the spill (Burger 1993). Accordingly, even small spills can cause cumulative mass mortality of seabirds (Joensen 1972; Carter et al. 2003; Hampton et al. 2003). In contrast, relatively low mortalities have been recorded from some huge spills. For example, the Amoco Cadiz spilled 230,000 tonnes of crude oil along the French coast, causing the recorded deaths of 4572 birds (Clark 1984). A major spill that persists for several days near a nesting colony could kill a high proportion of pursuit-diving birds (e.g., murres) within the colony (Cairns and Elliot 1987).

Short-term Effects

Oiled birds that escape death from hypothermia and/or drowning often seek refuge ashore, where they engage in abnormally excessive preening in an attempt to remove the oil (Hunt 1957 in Hartung 1995). The preening leads to the ingestion of significant quantities of oil that, although apparently only partially absorbed (McEwan and Whitehead 1980), can cause lethal effects. Noted effects on Common Murres and Thick-billed Murres oiled off Newfoundland's south coast include emaciation, renal tubular degeneration, necrosis of the duodenum and liver, anemia, and electrolytic imbalance (Khan and Ryan 1991). Glaucous-winged Gulls experienced similar effects after they ingested bunker fuel oil during preening (Hughes et al. 1990).

Another commonly observed effect is adrenal hypertrophy. This condition tends to make birds more vulnerable to adrenocortical exhaustion (e.g., Mallards, Anas platyrhynchos [Hartung and Hunt 1966; Holmes et al. 1979], Black Guillemots [Peakall et al. 1980], and Herring Gulls [Peakall et al. 1982]). The adrenal gland maintains water and electrolyte balance that is essential for the survival of birds living in the marine environment. Hartung and Hunt (1966) found that ingested oils can cause lipid pneumonia, gastrointestinal irritation, and fatty livers in several species of ducks. Aromatic hydrocarbons have been detected in the brains of Mallards (Lawler et al. 1978) and are probably associated with observed symptoms (e.g., lack of coordination, ataxia, tremors and constricted pupils) of nervous disorders (Hartung and Hunt 1966). Polyaromatic hydrocarbons (PAH) can also be detected in plasma samples of oiled Common Guillemots (Troisi and Borjesson 2005). The availability of an immunoassay for the determination of PAH concentrations in plasma samples of oiled birds potentially can serve in the exposure assessment during oil spill response and rehabilitation (Troisi and Borjesson 2005).

Other toxicological effects, however, did not differ between samples taken from oiled and unoiled birds (Kammerer et al. 2004; Pérez-López et al. 2006). Levels of zinc, copper, arsenic, chromium, lead, and cadmium were all similar in the liver of three species (Common Guillemot, Atlantic Puffin, and Razorbill Murre) affected by the Prestige oil spill of September 2002 on the northwest Spanish Galician coast; only mercury showed increased levels in the liver of oiled birds (Pérez-López et al. 2006). Vanadium hepatic and renal concentrations did not prove to be appropriate biomarkers for recent exposure to oil spills following analyses of samples from Common Murres, Black Scoters, and Common Eiders exposed to the Erika wreck off coastal France (Kammerer et al. 2004).

Birds exposed to oil are also at risk of starvation (Hartung 1995). For example, oiled Common Eiders generally deplete all of their fat reserves and much of their muscle protein (Gorman and Milne 1970). In addition, energy demands are higher because the metabolic rate of oiled birds increases to compensate for the heat loss caused by the reduced insulating capacity of their plumage. This can expedite starvation (Hartung 1967; McEwan and Koelink 1973). For birds living under harsh environmental conditions (e.g., winters in colder climates), even a seemingly insignificant amount of oiling can have fatal consequences (Levy 1980).

Oiled birds that are cleaned and released might not have high survival rates. Pooling across the three species with the most ring recovery data between 1969 and 1994 (Western Grebe, Velvet Scoter, and Common Guillemot), the median days that cleaned birds survived were 4-11 days, or a mean of 4 days (Sharp 1996). Birds that survived longer were those that typically had a low degree of oiling and spent less time in captivity; initial or release weights did not seem to matter (Sharp 1996). Birds cleaned after 1990 using more modern methods did not have a higher survival rate than those cleaned before 1990 (Sharp 1996).

Long-term Effects

It appears that direct, long-term sublethal toxic effects on seabirds are unlikely (Hartung 1995). The extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species are capable of metabolizing them at rates that minimize bioaccumulation (Neff 1985 in Hartung 1995). Birds generally excrete much of the hydrocarbons within a short time period (McEwan and Whitehead 1980). However, nesting seabirds that have survived oil contamination generally exhibit decreased reproductive success.

Nesting seabirds transfer oil from their plumage and feet to their eggs (Albers and Szaro 1978). Very small quantities (1–20 µl) of oil on eggs have produced developmental defects and mortality in avian embryos of many species (Albers 1977; Albers and Szaro 1978; Hoffmann 1978, 1979a; Macko and King 1980; Parnell et al. 1984; Harfenist et al. 1990). The resultant hatching and fledging success of young appears to be related to the type of oil (Hoffman 1979b; Albers and Gay 1982; Stubblefield et al. 1995) and the timing of exposure during incubation. Embryos are most sensitive to oil during the first half of incubation (Albers 1978; Leighton et al. 1985). Breeding birds that ingest oil generally exhibit a decrease in fertilization (Holmes et al. 1978), egg laying and hatching (Hartung 1965; Ainley et al. 1981), chick growth (Szaro et al. 1978), and survival (Vangilder and Peterle 1980; Trivelpiece et al. 1984), as well as a reduction in mean eggshell thickness and strength (Stubblefield et al. 1995). Growth was retarded in Herring Gull chicks, Black Guillemot chicks, and Mallard ducklings after they ingested oil directly (Peakall et al. 1981; Szaro et al. 1981).

Oil spills can also cause indirect reproductive failure. Eppley and Rubega (1990) suggested that exposure to an Antarctic oil spill caused changes in the normal parental behaviour of South Polar Skuas, thus exposing young to increased predation and contributing to reproductive failure in that population. In another case, abandonment of nesting burrows by oiled adult Leach's Storm-Petrels may have contributed to reproductive failure in that population (Butler et al. 1988). Therefore, a spill that occurs during the reproductive period could cause mortality of young even if the adults survived the exposure to oil.

Some studies have suggested that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Clark 1984; Butler et al. 1988; Boersma et al. 1995; Erikson 1995; Stubblefield et al. 1995; White et al. 1995; Wiens 1995, 1996; Seiser et al. 2000) while others suggest the opposite (Piatt et al. 1990; Walton et al. 1997; Votier et al. 2005). Natural inter-annual variation in other factors that affect populations (e.g., prey availability and weather) reduces the ability of scientists to assess the full effect of oil spills on bird populations (Eppley 1992; White et al. 1995; Votier et al. 2005).

Studies conducted following the Exxon Valdez oil spill in 1989 have tried to ascertain whether seabird populations have recovered in the Prince William Sound area in Alaska. Esler et al. (2002) noted that as of 1998, the Harlequin Duck population that winters in Prince William Sound has not yet recovered, based on initial high mortalities, the decrease in population size only in oiled areas during 1995–1997, and the fact that fewer female adults survived winters in oiled areas possibly because of continued oil exposure through at least 1998 (likely still from the Exxon Valdez spill). For other populations, it is not as clear whether they have or have not yet recovered. Irons et al. (2000) conducted a study of seabird densities and found that as of 1998, five taxa (mostly those that dive for their food) were still negatively affected by the oil spill, including cormorants, goldeneyes (Bucephala sp.), mergansers, Pigeon Guillemot (Cepphus columba), and murres. Furthermore, as of July 2000, goldeneyes, mergansers, Pigeon Guillemots, and Black-legged Kittiwakes had decreased significantly in oiled areas, and only one species, the Black Oystercatcher, had shown signs of recovery (Irons et al. 2001). Wiens et al. (2001) disagreed with the study design and interpretation of data by Irons et al. (2000), maintaining that most populations are no longer affected by the oil spill. However, Esler et al. (2002) pointed out that the studies that have found rapid recovery of bird populations are either based on presence/absence data (Wiens et al. 1996), which do not give good information on the status of populations, on a short time period and inappropriate geographic scale for some species (Day et al. 1997), or on summer data (Murphy et al. 1997) when some populations mainly overwinter in Prince William Sound. All authors do agree, however, that bird populations responded differently to the Exxon Valdez oil spill. Some populations showed little signs of being affected, other populations recovered quickly, and some populations took as much as a decade to fully recover (e.g., Pigeon Guillemot; Golet et al. 2002 in Esler et al. 2002).

There are possible changes in habitat use by both oiled and unoiled birds. After a large oil spill off the coast of Washington by the Nestucca in December 1988, a study of oiled shorebirds suggested that within 10 days of the oil spill they could be found at beach roosting sites, but that after 10 days they tended to remain in the harbour rather than complete their usual return flight to beach roosting sites at high tide (Larsen and Richardson 1990). In June 1979, an oil spill occurred from the Ixtoc I off Texas, causing shorebirds there to avoid oil-affected foreshores and instead use poorer backshore feeding habitats and freshwater pools (Chapman 1981). Three months after the oil spill, storms cleaned the beaches, but shorebirds failed to return to the foreshore feeding habitats at their pre-spill levels (Chapman 1981).

Species Most at Risk

It is clear that truly aquatic and marine species of birds are most vulnerable and most often affected by exposure to marine oil spills. Diving species such as Black Guillemots, murres, Atlantic Puffins, Dovekies, eiders, Oldsquaws (Clangula hyemalis), scoters, Red-breasted Mergansers, and loons are considered to be the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000). Alcids, especially Common and Thick-billed Murres, often have the highest oiling rate of seabirds recovered from beaches along the south and east coasts of the Avalon Peninsula, Newfoundland (Wiese and Ryan 2003). Those were the only group of seabirds to show an annual increase over a 13-yr period (2.7per cent) in the proportion of oiled to stranded birds (Wiese and Ryan 1999). There also appears to be a strong seasonal effect, as significantly higher proportions of alcids (along with other seabird groups) are oiled in winter versus summer (Wiese and Ryan 1999). The impact of other anthropogenic impacts, such as the murre hunt in Newfoundland, are also important to modeling techniques and can provide additional insight on the impact of chronic marine oil pollution on local species (Wiese and Ryan 2003; Wiese et al. 2004).

Other species such as Northern Fulmars, shearwaters, storm-petrels, gulls, and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill cleanup (Lock et al. 1994).

The greatest decrease in use of contaminated habitats immediately following a spill occurs in species that feed on or close to shore and that either breed along the coast or are full-year residents (Wiens et al. 1996). Day et al. (1995) showed that species lacking clear evidence of recovery tended to be intertidal feeders and residents. However, they also found that other ecologically similar species did not show signs of initial impact or showed rapid recovery (Day et al. 1995). Shorebirds may be more affected by oil spills than has been suggested by carcass counts. A total of 7800 collected bird carcasses were identified after the Nestucca oil spill off Washington state in 1988, but only six shorebird carcasses were present out of 3574 oiled shorebirds observed by Larsen and Richardson (1990). The authors suggested that this reveals a historic difficulty in finding shorebird carcasses, which may be explained by the higher mobility of oiled shorebirds (Larsen and Richardson 1990).

Oil spills that affect prey availability of a species with low seasonal dietary variation could have a greater effect on that species through an indirect reduction in reproduction and poorer chick condition (Velando et al. 2005). Populations of bird species with little genetic differentiation among breeding colonies are, on the other hand, less likely to be affected severely by an oil spill because they have a greater potential for population recovery through dispersal (Riffaut et al. 2005). Birds are particularly vulnerable to oil spills during nesting, moulting, and the period of time before young seabirds gain the ability to fly. Because newly fledged murres and Northern

Gannets are unable to fly for the first two to three weeks at sea, they are less likely to be able to avoid contact with oil during that time (Lock et al. 1994). Before and during moult, the risks of hypothermia and drowning are increased (Erasmus and Wessels 1985), because feather wear and loss reduce the ability to repel water by about 50per cent (Stephenson 1997).

Past Oil Spills In and Near the Study Area

Several oil spills have occurred near the Study Area and "mystery" spills occur frequently. "Mystery" spills are most likely from ships that frequent the waters off Newfoundland as they traverse between Europe and North America. Some of these ships illegally dump waste oils, oil-tank wash-water, dirty ballast water, and bilge water, thereby exposing seabirds to chronic levels of oil pollution (Chardine and Pelly 1994; Wiese and Ryan 2003). These illegal discharges total more metric tons of oil on a world-wide basis than the total spillage from more well-known catastrophic spills, such as the Exxon Valdez and others (Brander-Smith et al. 1990 in Wiese and Ryan 2003). Between 1984 and 1999, the southeast coast of Newfoundland had the highest recorded rates in the world of oiled dead birds per kilometer of beach (0.77 versus 0.02–0.33 elsewhere; Wiese and Ryan 2003). Based on dated information, an estimated 18,000 seabirds have died in Placentia Bay, Newfoundland, because of illegally dumped waste (Anon 1990).

In February 1970, the Irving Whale spilled between 3000 and 7000 gallons of Bunker C oil near St. Pierre and Miquelon, which subsequently spread along Newfoundland's southeast coast. It was estimated that 7000 birds, primarily Common Eiders, were killed (Brown et al. 1973). During the same month, the Arrow ran aground in Chedabucto Bay, Nova Scotia. Approximately 2.5 million gallons of Bunker C fuel oil were spilled, and at least 2300 birds were killed in the bay itself (Brown et al. 1973). Primarily diving birds were affected, most notably Oldsquaws, Red-breasted Mergansers, murres, Dovekies, and grebes (Brown et al. 1973). The spill spread offshore to Sable Island where mostly murres, Dovekies, and Northern Fulmars were killed. The lowest estimate of seabird mortality from that part of the slick was 4800 birds (Brown et al. 1973). Terra Nova, a production development southeast of Newfoundland, had an oil spill (1000 barrels of crude) in November 2004 caused by faulty equipment. Relatively few oiled seabirds were observed or collected, but sea states were high and conditions poor for collecting reliable data on the number of birds affected. It was estimated that 10,000–16,000 murres and Dovekies may have been exposed to oil from the spill (Wilhelm et al. 2006).

On a broader geographical scale, it is estimated that 21,000 birds die annually from spills on the Atlantic coast of Canada, and that 72,000 birds die annually from all spills in Canada (Thomson et al. 1991). Clark (1984) estimated that 150,000–450,000 birds die annually in the North Sea and North Atlantic from oil pollution from all sources.

Effects Assessment

In the unlikely event of a major spill, seabirds are, by far, the VEC most at risk from the effects of oiling. The most common causes of mortality among oiled seabirds are hypothermia and starvation brought on by oiled plumage and ingestion of oil. Even a small area of oil on a seabird can lead to extreme declines of core body temperature leading to mortality. The Study Area supports some of the largest seabird colonies in Atlantic Canada and large numbers of Arctic breeding birds also occur there. The Study Area is also a moulting area for large numbers of non-breeding birds from the Southern Hemisphere, as well as being an important foraging area for migrant seabirds.

It is very difficult to make quantitative predictions of the effects of oil on numbers of seabirds. For example, seabirds are highly mobile and may travel large and variable distances to feed and the locations of their feeding are dynamic. Furthermore, detailed information on their behaviour, distribution and abundance are often lacking. In addition, the area affected by an oil spill is extremely variable depending upon the size of spill and type of oil and the physical environmental conditions existing at the time of spill. A small amount of crude oil could create a large surface slick that might persist for some time under calm conditions. Such a spill could affect a large number of birds if they happen to be congregated on the water at the time of spill. On the other hand, a spill of lighter oil under rough sea conditions might dissipate rapidly thus resulting in little or no mortality of marine birds in the case of few birds on the water at the time of spill. Effects of spill also can vary by species and those that spend large amounts of time on the water (e.g., murres) are usually considered most at risk.

A common practice in assessing impacts of oil spills is to apply a worst-case scenario approach. That is to assume that any bird that comes in contact with oil will experience mortality. For the purposes of this assessment, spills were assumed to occur at three locations: the proposed marine jetty, near Red Island, and in outer Placentia Bay, west of Cape St. Mary's. Probability contours of spilled oil at each of these sites suggest that oil may "travel" over an approximate 500 km2 area for a spill at the proposed marine jetty, a 3000 km^2 area for a spill near Red Island, and a 3900 km^2 area for a spill at the outer Placentia Bay site. These areas were derived from the 0 per cent probability contours shown in Section 7.2.

Pelagic Birds

Depending on the time of year and type of oil spill, the effects of an oil release on pelagic birds could be high magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km^2 are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the aerial extent of the 0 per cent probability contours depicted in Section 7.2. Oil spill countermeasures may reduce impacts but this is not certain. For all spill scenarios considered, the duration is predicted to be 1-12 months to 13-36 months and effects are considered irreversible at the individual level but likely reversible at the population level (Table 4.30). It is predicted that there will be a significant negative effect on pelagic birds from an accidental release of oil in the Study Area (Table 4.31). The level of confidence associated with this assessment is low. In the unlikely event that an oil spill occurs, follow-up monitoring will be undertaken to verify or refute the impact prediction.

Coastal Birds

Depending on the time of year and type of oil spill, the effects of an oil release on coastal birds could be high magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km^2 are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the aerial extent of the 0 per cent probability contours depicted in Section 7.2. Oil spill countermeasures may reduce impacts but this is not certain. For all spill scenarios considered, the duration is predicted to be 1-12 months to 13-36 months and effects are considered irreversible at the individual level but likely reversible at the population level (Table 4.32). It is predicted that there will be a significant negative effect on pelagic birds from an accidental release of oil in the Study Area (Table 4.38), however the level of confidence associated with this assessment is low. In the unlikely event that an oil spill occurs, follow-up monitoring will be undertaken to verify or refute the impact prediction.

Table 4.35 Effects Assessment of Operation Activities on Migratory Birds (pelagic species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Vessel traffic	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Marine Terminal Operations								
Lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Vessel traffic lights	Stranding (A)	Minimize lighting; release protocols	0	2	6	5	R	1
Marine Transportation								
Lights	Stranding (A)	Minimize lighting; release protocols	1	2-3	5	5	R	1

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Intakes/Outfalls								
Effluent characteristics	Effects on Prey (A)	Treatment guidelines	0	1	6	5	R	1
Solid and Hazardous Wastes								
Accidents or Malfunctions								
Oil spill at jetty	Effects on health, mortality (A)	Spill response; contingency plan	3	4	1	2-3	I[a]	2
Oil spill near Red Island	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2
Oil spill in outer Placentia Bay	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2

[a] May be reversible at the population level.

Table 4.36 Summary of residual impact predictions of operation activities on Migratory Birds (pelagic species).

Valued Environmental Component: Migratory Birds – Pelagic Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Lights	NS	3		
Marine Terminal Operations				
Lights	NS	3		
Marine Transportation				
Lights	NS	3		
Intakes/Outfalls				
Effluent characteristics	NS	3		
Solid and Hazardous Wastes				
Accidents or Malfunctions				
Oil spill	S	2		

Table 4.37 Effects assessment of operation activities on Migratory Birds (coastal species).

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects: Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, siltation	Prey availability (A)	Silt Curtain	0	1-2	?	4	R	1
Vessel traffic	Disturbance (A)		0-1	1-2	6	4	R	1
Marine Terminal Operations								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A)		0-1	1-2	6	4	R	1
Marine Transportation								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A)		0-1	1-2	6	4	R	1
Intakes/Outfalls								
Noise	Disturbance (A)		0	1	6	4	R	1
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A)		0-1	1-2	6	4	R	1
Location of outfall pipes	Prey availability (A)		0	1	6	4	R	1
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	1
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1
Accidents or Malfunctions								
Oil spill at jetty	Effects on health, mortality (A)	Spill response; contingency plan	3	4	1	2-3	I[a]	2
Oil spill near Red Island	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Oil spill in outer Placentia Bay	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2

a May be reversible at the population level.

Table 4.38 Summary of residual impact predictions of operation activities on Migratory Birds (coastal species).

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Lights	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Storage and disposal of wastes, debris	NS	3		
Marine Terminal Operations				
Air emissions	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Marine Transportation				
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Intakes/Outfalls				

Valued Environmental Component: Migratory Birds – Coastal Species				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Noise	NS	3		
Lights	NS	3		
Vessel Traffic	NS	3		
Maintenance	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Solid and Hazardous Wastes				
Noise	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Maintenance	NS	3		
Vessel Traffic	NS	3		
Accidents or Malfunctions				
Oil spill	S	1		

4.7 Freshwater Fish and Fish Habitat Effects Assessment

The potential effects identified are those interactions that have a reasonable probability of occurring. Each potential pathway is described below as well as a description of which activity outlined in the matrix table they may be associated with. In this way, similar pathways for numerous activities are identified and described without unneeded duplication.

The spatial boundaries associated with the potential interactions and assessment of fish and fish habitat are those water courses within the boundaries as described in Section 2.7.2 of the assessment methodology. In general, the Project boundaries with respect to freshwater fish and fish habitat are those watercourses within the direct footprint of the facility (including infrastructure) and those watercourses within any potential deposition or effluent zone of influence.

The temporal boundaries of the Project run from the start of construction through decommissioning as stated in detail in Section 2.7.1 of the assessment methodology.

The significance criteria associated with the potential interaction and assessment of freshwater fish and fish habitat are those as described in Section 2.8.4.

Potential Interactions

Interaction matrices have been used to identify potential interactions between the Project and Freshwater Fish and Fish Habitat (*see* Section 4.1.4). These matrices identify all reasonable Project activities that could interact with the VEC during construction and operation. The interactions identified are not defined in terms of their extent, only that an interaction may occur. The criteria as to whether an interaction could have a potential effect are outlined in Section 2.8.4 (Assessment Methodology).

4.7.1 Project Effects During Construction

Construction activities have the potential to interact with fish and fish habitat such as refinery footprint site preparation, marine wharf site preparation and access road construction.

The refinery site footprint will cover approximately 4 km^2 at the southern end of the Southern Head peninsula. Site preparation and access will include activities such as:

- Clearing and grubbing;
- Major earth works to level the site which may involve blasting;
- Surface drainage around the project area;
- Road construction; and
- Construction of the refinery and associated onshore infrastructure.

The refinery site will be cleared of all vegetation and overburden and the remaining bedrock will be levelled to an appropriate elevation. As such, the fish and fish habitat within the footprint will be lost. In addition, the outflows of many of the smaller streams within the footprint will also lose the majority of their drainage basin and hence will no longer be suitable fish habitat. Site levelling will also involve blasting to remove bedrock. While fish habitat within the footprint will be lost, it is important that blasting does not negatively affect fish in any nearby drainage basins, particularly Watson's Brook.

The marine terminal will have limited onshore construction, however clearing and levelling of the footprint will be required for laydown areas, service/administration buildings. While a portion of the wharf is onshore, no freshwater habitat exists in or near the footprint.

Road access is proposed for both the east side of the peninsula as well as the west side. Associated with these routes are typical road construction, bridge installations and culvert installations. In total, 38 potential stream crossings were identified which included North Harbour River, Come-by-Chance River and Watson's Brook; all scheduled salmon rivers. While many of the proposed crossing sites are intermittent, many will require culverts and/or bridges.

As shown above and described in Volume 2, construction interactions relate primarily to those potential pathways such as siltation, erosion, dust and blasting as well as those activities that will permanently affect existing fish and fish habitat as a result of the Project footprint. Spills are addressed separately in Accidents and Malfunctions (Section 7.0). For assessment purposes, the fish species of brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) will be used as they represent the two species found within the Project Area that would be considered to have a fishery potential. They would also be sensitive to habitat change.

Siltation, Erosion and Dust

Siltation and erosion of fish habitat due to site preparation, refinery and terminal complex construction, culvert/bridge installation and poor water management can occur throughout the construction phase of the Project. Increased erosion of stream bank soils or uncontrolled transportation of fine material from exposed areas can be deposited into freshwater fish habitat. Excess siltation can have a negative effect on the health of freshwater biota and can cause the loss or avoidance of critical/productive freshwater fish habitat. A potential pathway can also include airborne deposition (i.e. dust). Fine material can settle on substrates, particularly areas with lower water velocities, affecting physical processes, structural attributes and ecological conditions such as water clarity and overall habitat suitability. Suspended sediment also reduces water clarity and can cause damage to gills of fish (Gosse et al. 1998).

The control of siltation, erosion and runoff from construction sites is addressed in many standard practices and guidelines such as the Guidelines for Protection for Freshwater Fish Habitat (Gosse et al. 1998), Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993) and the Environmental Guidelines for General Construction Practices

(Water Resources Management Division 1997). All discharges of runoff from construction activities will also conform to the Environmental Control Water and Sewage Regulations, 2003 under the Water Resources Act (O.C. 2003-231).

Work Near Freshwater

Special consideration is needed when working in or near freshwater fish habitat. Construction activities that will encroach on freshwater habitat include: refinery footprint clearing/construction, installation of culverts and bridges. DFO provides numerous guideline publications. These include:

- The National Policy for the Management of Fish Habitat;
- Land Development Guidelines for the Protection of Aquatic Habitat;
- The Fisheries Act - Habitat Protection and Pollution Prevention Provisions;
- Compliance and Enforcement Policy;
- Guidelines for the Use of Explosives In or Near Canadian Waters;
- National Fact Sheets – Brook Trout (Specifically);
- Newfoundland Factsheets for;
    - Effects of Silt on Fish and Fish Habitat
    - Blasting - Fish and Fish Habitat Protection
    - Forwarder Trails
    - Temporary Bridges
    - Resource Road Construction
    - Instream Work in the Dry Cofferdams
    - Streambank Stabilization
    - Instream Work in the Dry – Temporary Diversion and Elevated Pipes
- Freshwater Salmonid Habitat Requirements; and
- Freshwater Intake End-of-Pipe Fish Screen.

Specific mitigative measures can be drawn from these documents to help minimize construction affects. For example, siltation control structures (i.e. silt curtains, cofferdams and/or sediment fences) will be constructed prior to beginning any activities involving disturbance of the soil, work along the shoreline or near areas of high runoff potential. Construction activities will be coordinated to avoid periods of heavy precipitation and not coincide with sensitive periods for fish. Mitigative measures will be implemented prior to any grubbing or excavation to direct any natural drainage around work areas, avoiding sediments above ambient suspended particle concentration in runoff waters.

Soil disturbance will be minimized by limiting the area exposed at any one time, stabilizing exposed soil with anti-erosion devices (i.e. rip rap, filter fabrics, gravel or wood chips) and revegetation of disturbed areas. Grubbing of the organic vegetation mat and/or the upper soil horizons will be restricted to the minimum area required. The organic vegetation mat and upper soil horizon material that has been grubbed will be spread in a manner so as to cover inactive exposed areas. Further, a 50 m buffer zone of undisturbed natural vegetation between construction areas and all waterbodies outside the Project Area will be maintained to prevent sediments from entering local waterways.

No runoff will be allowed to freely flow into any water body. Runoff during construction will be directed to adequate vegetated areas or settling ponds within the Project boundaries to slow flow and allow particles to precipitate out. Any natural vegetated areas receiving runoff will first be assessed to ensure they can adequately handle anticipated volumes and is not habitat for any species of concern.

Settling Ponds will be designed according to DFO's Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993). The number and size of ponds required during construction will be based on final area of disturbance and calculations of maximum runoff anticipated. Ponds both for construction and operations, will be built with required safety factors, adhering to guidelines with respect to such design standards as the accommodation of storms (1:5, 1:10, and 1:100 years storms), effective capacity, retention times and location. Their operation and maintenance will include regular inspection and assessment of accumulated sediment load, removing it when required.

Construction runoff near blasting operations may also have the potential to contain nitrogenous residues if ammonia-based explosives are used. Any releases that may enter freshwater will meet the required limit of 0.019 mg/L for ammonia (Canadian Water Quality Guidelines for the Protection of Aquatic Life, CCME 2006). Currently there is no set limit for waters entering marine waters (CCME 2006). Settling ponds used for construction will be designed to allow for chemical degradation of nitrogenous wastes.

Runoff water from any settling ponds will adhere to the guidelines set by DFO, containing less than 25 mg/L of suspended solids (or non-filterable residue) above the background suspended solids levels of the receiving waters during normal dry weather operation, and less than 75 mg/L of suspended solids above background levels during design storm events. Suspended solids in effluent will be regularly tested to ensure compliance.

Dust Emissions

Dust emission during the construction phase will be localized to the areas where overburden is being cleared to allow for construction of all permanent infrastructures and road construction. Any areas with a high dust potential will be sprayed with water to decrease the chance of particles becoming airborne. Where and when applicable (e.g. during a dry summer), calcium chloride may also be used for dust suppression on operational roads. The use of calcium chloride will be in accordance with the guidelines outlined in Environment Canada's Best

Practices for the Use and Storage of Chloride-Based Dust Suppressants (EC 2007), referring to how, when and quantity to apply. Waste oil shall not be used for dust control.

Vehicle-related dusting from access roads will be largely confined to the construction stage while large trucks are transporting equipment and material. Once construction is completed, the dusting potential will be low, as the majority of on-site movement will be company vehicles following designated paved roadways. Dust suppression procedures will be implemented in all areas to comply with the NL Criteria for Acceptable Air Quality (which allows a total suspended particulate concentration of 80 µg/m3 and 120 µg/m3 for 1 hour and 24-hour exposure, respectively).

With the above government and industry approved mitigation measures implemented and incorporated into NLRC construction and operation plans, it is anticipated that the pathway between siltation, erosion and dust and fish and fish habitat will be eliminated. Further assessment is therefore not required.

Blasting

Blasting will be associated with construction activities such as site preparation of the refinery complex, the marine terminal and possibly for road construction.

The detonation of explosives may result in a number of adverse impacts on fish and marine mammals and their habitats (Wright and Hopky 1998). Wright and Hopky (1998) describe several potential pathways which include the production of post-detonation compressive shock waves, vibrations, production of sediment and residue. The effects can affect many life stages, the degree depending upon many factors such as type of explosive, size and pattern of the charge(s), method of detonation, distance from the point of detonation, water depth and species of fish.

Typical potential effects on fish include damage to swim bladders, rupture/haemorrhage of kidney, liver, spleen and sinus venous as well as damage to incubating eggs.

In addition to direct damage, both wild and aquacultured species also display avoidance behaviour to noise (Chapman and Hawkins 1969; Schwartz and Greer 1984; Pearson et al. 1992) and can be negatively affected by intense sounds (such as those from blasting) or from prolonged exposure to certain types of acoustic disturbances (McCauley et al. 2003).

Two main variables should be examined when determining how sound and vibrations can affect aquatic wildlife. These are: 1) shock pressure, represented and measured in Peak Particle Velocity (PPV), and; 2) compressional seismic waves, measured as a pressure force (kPa). These phenomena can lead to disturbance or damage to fish by affecting their internal organs (Hawkins and Johnstone 1978; Whalberg and Westererberg 2005). Marine mammals are also sensitive to these effects, with whales being particularly sensitive to damage (CWR 2007). Marine mammals will be discussed separately in Section 4.9.

Peak Particle Velocity

DFO guidelines state that: "no explosive is to be detonated that produces, or is likely to produce a PPV greater than 13mm/second in a spawning bed during the period of egg incubation" (Wright and Hopky 1998). An estimate of PPV can be calculated using the equation (Oriard 2002):

$$PPV = 150(SD/W^{0.5})^{-1.6}$$

Where PPV is in inches per second, SD is the distance from the blast in feet, and W is the weight in pounds per delay. The PPV experienced by nearby fish can therefore be estimated for various charge weights. Table 4.39 provides a range of blast weights and distances to watercourses where they meet the PPV guideline.

Table 4.39 Summary of PPV values for various charge weights (kg) and related distance (m) to watercourses where they meet the 13mm/second guideline.

Charge (kg)	Distance from Watercourse (m)	PPV
0.5	11.2	12.90
1.0	15.8	12.95
5.0	35.3	12.96
10.0	49.9	12.97
25.0	78.9	12.97
50.0	111.5	12.99

By observing this DFO guideline, individual charges can be adjusted in terms of weight and timing. Since spawning is a fish's most sensitive life stage, these values would be considered very conservative for adult and rearing fish.

Compressional Seismic Waves

DFO guidelines further state that: "no explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change greater than 100kPa (14.5 psi) in the swimbladder of fish" (Wright and Hopky 1998). To calculate the minimum distance that an onshore blast could occur from fish habitat, the following equation can be used:

$$SD = 5.03(W)^{0.5}$$

Where SD is the distance from the blast in meters, and W is the charge weight per delay (Personal Communication, Keith Phelan: Hard Rock Newfoundland, 2006). Using this formula, the distance that the blast must be from fish habitat can be estimated for various charge sizes. Table 4.40 presents the results of those estimations. As shown, if the guidelines for PPV are followed, the instantaneous pressure change guideline will be maintained as well.

Table 4.40 Summary of minimum distance between charge and watercourse for various charge weights (kg) to meet the 100kPa guideline.

Charge (kg)	Distance from Watercourse (m)
0.5	3.56
1.0	5.03
5.0	11.25
10.0	15.91
25.0	25.15
50.0	35.57

Propagation of Sound from Air to Water

Although sound may propagate in air over several kilometers as a result of blast detonations, its effect relative to submerged fishes and marine mammals can be considerably less. Rayles Equation describes the reflective abilities of sound as it passes from one medium into another. Fresh water is far denser than air (1,000kg/m^3 and 1.2kg/m^3 respectively). Salt water is estimated at 1,027kg/m^3. Using Rayles Equation, the following results are obtained for freshwater.

Rayles Equation: R= (z2 - z1)

(z2 + z1)

Where: z1 = acoustic impedance of air = density (1.2 kg/m3) x the speed of sound in air (343 m/s) = 411.6

z2 = acoustic impedance of fresh water = density (1,000 kg/m3) x the speed of sound in fresh water (1,496 m/s) = 1,482,000

Solving for R, we get a value of 0.999. An R-value of less than 1.0 indicates a rigid boundary where most of the sound energy would be reflected off the surface with little transmission. Therefore, sound pressure released from a blast would not likely be enough to penetrate into a waterbody.

Construction

Blasting will be required during construction to remove areas of bedrock, primarily in the location of the refinery. Blasting protocols have been designed to be as efficient and effective as possible, using publications such as: Wright and Hopky's (1998) Technical Report for the Use of Explosives Near Canadian Fisheries Water, Guidelines for Protection of Freshwater Fish Habitat in Newfoundland and Labrador (Gosse et al. 1998) and DFO's Mitigation of Seismic Noise in the Marine Environment - Statement of Canadian Practice.

Guidance on blasting activities in or near the freshwater environment is provided in Gosse et al. (1998):

- Large charges should be subdivided into a series of smaller charges and time delayed to reduce the overall detonation to a series of smaller detonations;
- For multiple charges, time-delay (e.g. blasting caps) should be used to reduce the overall detonation to a series of single explosions separated by a minimum of 25 millisecond delay between charge detonation;
- The on-land setback distance from the blast site to the watercourse and the setback distance (zone) around the blast site in the watercourse are based on the maximum weight of the charge to be detonated at one instant in time and the type of fish and fish habitat in the area of the blast. Blasting activities are to take place at a minimum set distance from the watercourse as indicated in Table 4.41.

Table 4.41 Minimum required distances from a watercourse for blasting (confined charges).

Habitat	Weight of Explosive Charge (kg)					
	0.5	1	5	10	25	50
H1	7m	10m	15m	20m	35m	50m
H2	15m	20m	45m	65m	100m	143m

H1 – rearing/general fish habitat

H2 – spawning habitat where egg or early fry development is occurring

- If on-land blasts are required nearer to the watercourse than indicated above, then additional mitigative measures may be initiated which include the following:
    - Installation of bubble/air curtains to disrupt the shockwave. When bubble curtains are used, the curtain should surround the blast site and be started up only after fish have been moved outside the surrounded area;
    - Blasting should be undertaken at the time of least biological activity or biological sensitivity;
    - Isolation of the work area from fish movement;
    - Detonation of small scaring charges set off one minute prior to the main charge to scare fish away from the site; and
    - The use of noise generators to move fish out of the area.
- To confine the blast, sand or gravel should be used to backfill blast hoses to grade or to streambed/water interface;

- Blasting mats should be placed atop the blasting holes to minimize the scattering of blast debris;
- Ammonium nitrate based explosives (i.e. Ammonium Nitrate Fuel Oil mixtures or ANFO) should not be used in or near water due to the production of toxic by-products (ammonia); and
- All blasting and other associated equipment and products are to be removed from the blast area, including any debris that may have entered the aquatic environment.

In addition to the guidelines outlined above, NLRC will contract professional blasters for any blasting activity required during construction.

As a result of the extensive government and industry approved mitigation measures to be implemented and incorporated with respect to NLRC during construction, it is anticipated that the pathway between blasting and fish and fish habitat will be eliminated. Further assessment is therefore not required.

Loss of Fish Habitat

The Fisheries Act contains a prohibition with respect to the “harmful alteration disruption or destruction” of fish habitat (HADD). The Act permits the Minister to issue an Authorization under Section 35 (2) which will permit a “HADD” to occur. The issuance of an Authorization is at the discretion of the Minister; however the procedures involved in the issuance of an Authorization are well established. A HADD Authorization will be issued only in accordance with the Policy for the Management of Fish Habitat. The Policy has a Guiding Principle of “No Net Loss”, i.e. existing fish habitat will be protected, while unavoidable habitat alterations are to be balanced by development of new habitat or the increased productive capacity of existing habitat. An Authorization must be issued before any action can be taken to alter, disrupt or destroy fish habitat.

The location of the project footprint covers identified fish habitat (see Section 3.6.6 of the Existing Environment). The total amount of habitat directly within the Project Area has been quantified as per DFO guidelines and direction (see Bradbury et al. 2001 and McCarthy et al. 2007). The total areas have been calculated at 23.47units (1 unit = 100m2) of stream habitat equivalent and 15.5ha (1 ha = 100 units) of lacustrine habitat equivalent units as a result of the refinery footprint and infrastructure.

Effects Assessment: Residual Effects

Table 4.42 and Table 4.43 present the interactions between the Project and freshwater fish and fish habitat during construction activities as outlined above. As shown, all those other than habitat loss as a result of the infrastructure are reversible or are of minimal magnitude, extent and/or duration when proper mitigations are applied.

Table 4.42 Environmental effects assessment of construction on freshwater fish, Southern Head Refinery.

Valued Environmental Component: Freshwater Fish - Brook Trout, Atlantic Salmon								
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise (blasting)	A	Yes	0	2	2	3	I	1
Run-off, Siltation	A	Yes	0	2	2	1	R	1
Loss of Habitat	A	Yes	2	2	6	5	I	1
Site Access Road, Transmission Lines, Pipelines, Quarry Development								
Noise (blasting)	A	Yes	0	2	2	3	I	1
Run-off, Siltation	A	Yes	0	2	2	3	R	1
Stream Crossings	A	Yes	0	2	2	2	R	1
Refinery Complex								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Marine Terminal								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Intakes/ Outfalls								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Accidents or Malfunctions (Spills)	A	Yes	2	2	1	1	I	1

Table 4.43 Environmental effects assessment of construction on freshwater fish habitat, Southern Head Refinery.

Valued Environmental Component: Freshwater Fish Habitat								
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Site Preparation								
Noise (blasting)	A	Yes	0	2	2	3	R	1
Run-off, Siltation	A	Yes	0	2	2	1	R	1
Loss of Habitat	A	Yes	2	2	6	5	I	1
Site Access Road, Transmission Lines, Pipelines, Quarry Development								
Noise (blasting)	A	Yes	0	2	2	3	R	1
Run-off, Siltation	A	Yes	0	2	2	3	R	1
Stream Crossings	A	Yes	0	2	2	2	R	1
Refinery Complex								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Marine Terminal								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Intakes/ Outfalls								
Run-off, siltation	A	Yes	0	2	2	3	R	1
Accidents or Malfunctions (Spills)	A	Yes	2	2	1	1	R	1

4.7.2 Project Effects During Operations

Operation interactions with freshwater fish and fish habitat relate primarily to those activities that could interact due to pathways such as changes in water quality. With the use of desalination to provide freshwater to the refinery operations, there is minimal interaction with water quantity. Spills are addressed separately in Accidents and Malfunctions (Section 7.0).

Change in Water Quality

Changes in water quality could occur over the life of operations as a result of two possible pathways:

- Airborne deposition of contaminants; and
- Site runoff.

Airborne Deposition

Air emissions of the refinery will disperse from the Plant and depending on emission concentrations and stack/dispersion design, may deposit in or near watercourses such that they enter freshwater habitat. Acid rain results from industrial activities where sulphuric and nitric acids are produced by the release of sulphuric oxides (SO_x) and nitrogen oxides (NO_x) into the atmosphere. Acid rain induces the acidification of inland waters, which can result in damage to aquatic ecosystems that contain fish. Research conducted in Nova Scotia's Southern Upland area has determined the pathway typically involved in mortality of salmonids as well as levels of parameters that may affect overall mortality. In general, acidic rivers in Nova Scotia have low concentrations of calcium (<1mg/L), high concentrations of dissolved organic carbon (5-30 mg/L) and total dissolved aluminum in the range 100-350 µg/L (Lacroix and Kan 1986). The cause of mortality in these rivers has been demonstrated not to be aluminum-based but to be increased H+ ion concentrations coupled with low calcium ion concentrations in the environment (Lacroix and townsend 1987; Lacroix et al. 1990).

The primary site of ionic regulation in fish is the gill epithelium. In freshwater, the osmotic gradient across the gills results in the passive diffusion of water into the blood and of ions out of the blood. Passive losses of ions are typically countered by active uptake of Na+ and Cl- from the environment to maintain a balanced stated. When the pH levels of water decreases, active uptake of Na+ and Cl- is reduced and a net loss of both ions occurs. The increased passive loss of ions results from the displacement of Ca++ from binding sites on the gill epithelium by H+. The loss of ions results in a shift of water from the blood to the cells causing a reduction in blood volume. The reduced blood volume and increased number and size of the red blood cells causes a doubling of blood viscosity and arterial pressure, and death is a result of failure of the circulatory system (DFO 2000).

Mortality due to low pH exposure in freshwater varies with the life stage of salmon (DFO 2000). All freshwater stages are unaffected when pH >5.4 (DFO 2000). Significant mortality of fry can occur at a pH of approximately 5.0. Mortality of smolts also occurs at a pH of 5.0 but the rate has generally found to be lower. Mortality of parr and smolts is relatively high when pH declines to 4.6-4.7. Mortality of eggs and alevins does not typically begin until pH declines below 4.8. Levels of pH <5.0 have also been shown to interfere with the smelting process and seawater adaptation (DFO 2000).

It should be kept in mind that the calcium concentrations in rivers surveyed in Nova Scotia are generally lower than those recorded in and near Southern Head and that this low concentrations greatly affected mortality there. The levels of aluminum in the water in and around Southern Head are also generally lower than that recorded in Nova Scotia. Therefore, pH effects may be anticipated to be slightly less.

The main constituents of stack emissions from the refinery include combustion gasses exhausted from process furnaces and boilers, as well as hydrocarbon vapours vented from process equipment and storage tanks. Specifically, emissions of sulphur compounds may affect the quality of fish habitat within the air deposition boundary, particularly pH. Section 4.2 presents the results of the air dispersion modeling. NLRC will work with the communities and Salmon Stewardship group to monitor nearby ponds and rivers for pH.

Site Runoff

Site runoff will occur as a result of water accumulation (eg. rainwater and snowmelt) within the refinery area. Runoff, if not properly collected and treated, may leave the site and enter watercourses untreated.

Similar to water management during construction, any site runoff discharged from the project area will be required to conform to the Environmental Control Water and Sewage Regulations, 2003 under the Water Resources Act (O.C. 2003-231). As a result, site runoff will be collected by a series of drains and directed to onsite settling ponds. Settling ponds will be connected to the overall water treatment system for treatment and discharge. All settling ponds will be designed to adequately handle anticipated site runoff.

As a result of the extensive government and industry approved mitigation measures to be implemented and incorporated with respect to NLRC during operation, it is anticipated that the pathway between site runoff and fish and fish habitat will be eliminated. Further assessment is therefore not required.

Change in Water Quantity

Unpolluted and adequate stream flow is required by fish to use and maintain habitat suitability, accessibility, water temperature and other water quality parameters at acceptable levels. While desalination eliminates the project need for water withdrawal from the surrounding drainage basins, changes in water quantity could occur as a result of removing a portion of the Watson’s Brook drainage basin (estimated at 4.2 per cent). The area of Watson’s Brook within the project footprint would no longer contribute to the flows of Watson’s Brook as any water collected from the refinery site will be treated and discharged separately (i.e. not back into Watson’s Brook). Because the overall change in water flows within Watson’s Brook are minimal, it is anticipated that the pathway between changes in water quantity and fish and fish habitat will be eliminated. Further assessment is therefore not required.

Tables 4.44 – 4.45 present the interactions between the Project and freshwater fish and fish habitat during operation activities as outlined above. As shown, all those other than potential changes in fish habitat as a result of airborne deposition are reversible or are of minimal magnitude, extent and/or duration when proper mitigations are applied.

Table 4.44 Environmental effects assessment of operation on freshwater fish, Southern Head Refinery.

Valued Environmental Component: Freshwater Fish – Brook trout, Atlantic Salmon								
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Refinery Operations and Maintenance								
Airborne Deposition	A	Yes	0	2	6	5	R	1
Run-off, siltation	A	Yes	0	2	3	1	R	1
Marine Terminal Operations								
Run-off, siltation								
Accidents or Malfunctions	A	Yes	2	2	1	1	I	1

Table 4.45 Environmental effects assessment of operation on freshwater fish habitat, Southern Head Refinery.

Valued Environmental Component: Freshwater Fish Habitat								
			Evaluation Criteria for Assessing Environmental Effects					
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Airborne Deposition	A	Yes	0	2	6	5	R	1
Run-off, siltation	A	Yes	0	2	3	1	R	1
Marine Terminal Operations								
Run-off, siltation								
Accidents or Malfunctions	A	Yes	2	2	1	1	I	1

4.7.3 Mitigation

Mitigative measures for the above interactions have been designed to minimize their effects, but more importantly, to reduce/prevent any releases into the environment. The following section outlines mitigations that will be applied to the activities outlined in the matrix tables to reduce or eliminate the potential pathways described. Overviews of mitigative measures are outlined below, but are also provided in the EPP. These mitigations are a combination of standard industry-approved practices, regulatory requirements, permit requirements and site-specific mitigation practices.

Loss of Fish and Fish Habitat

As stated previously, the Fisheries Act contains a prohibition with respect to the "harmful alteration disruption or destruction" of fish habitat (HADD). The Act permits the Minister to issue an Authorization (under Section 35 (2)) which will permit a "HADD" to occur. An Authorization must be issued before any action can be taken to destroy fish habitat. In order to receive an Authorization, the following must occur:

- DFO determines that a HADD is likely, triggering assessment under the CEAA.
- The Proponent is required to quantify the habitat which will be affected by their undertaking. This quantification must reflect the productivity of the habitat, and take

into account the actual and potential use of the habitat by different fish species and life cycle stages. It must also identify all opportunities to avoid or mitigate potential habitat alteration, damage or disruption.

Once the habitat quantification is accepted by DFO, a HADD determination is made, i.e. a formal statement is made identifying the residual habitat which will be lost following the application of all reasonable mitigation measures. This determination establishes the basis for compensation. The Proponent develops a Compensation Plan in two stages:

- A Compensation Strategy
- A Compensation Plan

The targeted habitat with respect to a freshwater HADD determination was conducted using the Standard Methods Guide for the Classification/Quantification of Lacustrine Habitat in Newfoundland and Labrador (Bradbury et al. 2001) and the Classification and Quantification of Fish Habitat in Rivers of Newfoundland and Labrador (McCarthy et al. 2007).

Mitigative Measures

Freshwater habitat losses and compensation are primarily related to the loss of stream and pond habitat within the footprint of the refinery. All other interactions with the freshwater environment relate to culvert and bridge installations. These will be permitted and adhere to DFO's Newfoundland and Labrador Operational Statements and all permit requirements.

The total habitat-equivalent units of affected habitat that will be considered with respect to potential habitat compensation are summarized and presented in Table 4.46. It has been assumed that the salmonid that produces the highest HEU for each habitat will be used to generate the HADD determination by DFO.

Table 4.46 Summary of habitat equivalent units in HADD determination, NLRC Refinery, Southern Head.

Habitat Location	HADD Equivalent Units [1]	Habitat Location	HADD Equivalent Units [1]
	Lost (Stream)		Lost (Pond)
T1	16.55	Pond 2	2.17
T2	1.28	Pond 7	0.92
T2-1	1.27	Pond 8	3.91
T2-2	2.70	Pond 3	1.08
T3	1.67	Pond 1	7.42
Total	**23.47**		**15.5**

1 Stream habitat is quantified in units (one unit = $100m^2$) whereas pond habitat is quantified in hectares (one hectare = 100 units).

It is anticipated that several habitat rehabilitation activities will be conducted that will achieve a "no net loss" of productive aquatic habitat. The most preferred options are those that would occur within the same ecological unit (i.e. Watson's Brook). Options outside the ecological unit have also been identified if further rehabilitation is required. These generally entail habitat improvements in scheduled salmon rivers and their tributaries within the local Placentia Bay area.

Contact and communication has been ongoing with a locally-forming Placentia Bay river stewardship group. While they have not yet formally organized, local interest is high with coordination being provided through the Salmonid Association of Eastern Newfoundland (SAEN). Similar to past work conducted in the Placentia/Argentia area, this group will be a valuable source of information, contact and public involvement for any habitat improvement and rehabilitation works.

Watson's Brook

Additional stream surveys have been completed in Watson's Brook in order to get an understanding of the system and what may be some of the biological limiting factors that could be improved so that an increase in productive capacity could be achieved. Table 4.47 presents a summary of the habitat between the mouth of Watson's Brook and the first large pond in the system, a total of approximately 670m. This area would receive the full benefit of flows from the entire 28.63km^2 drainage basin. The majority of the main stem consists of bedrock/boulder dominated substrate. Reach 4 has considerable cobble and gravels (75per cent), however the remainder is limited in terms of suitable spawning substrate.

A preliminary investigation into the surficial geology of the southern Head peninsula was conducted to determine whether the lack of small, rounded substrate was a result of excess flows or availability. It was concluded that glacial action has stripped the Southern Head peninsula down to the bedrock surface in most areas including the area around Watson's Brook. Based on air photo interpretation, field mapping by AMEC staff and confirmation by the published Surficial Geology maps, the area around Watson's Pond from Winging Point southeast to the project footprint consists of 75per cent exposed bedrock, 15 per cent bog cover and 10 per cent till veneer. No surficial geological features were identified that would indicate the presence of a source of round or sub-round, gravel-sized aggregate along the banks of Watson's Brook. While hydrologic information is being produced, it is clear that gravels are limited in the Watson's Brook drainage basin.

Table 4.47 presents a summary of the habitat units within each lower reach of Watson's Brook and the velocity and substrate suitabilities for Atlantic salmon spawning. Photos of these areas can be found in the Component Study for Freshwater Fish and Fish Habitat. As shown, each reach consists of a gentle slope and many pockets and backwaters where placed gravels would stabilize and accumulate.

Table 4.47 Summary of habitat area and spawning suitability of Watson's Brook, Southern Head.

Reach	Habitat Area (units)	Atlantic Salmon Spawning						
		Existing			Anticipated			Net Increase
		Velocity Rating	Substrate Rating	HEU	Velocity Rating	Substrate Rating	HEU	
1	24.38	0.91	0.25	0.58	0.91	0.95	0.93	0.35
2	13.04	0.79	0.05	0.42	0.79	0.95	0.87	0.45
3	3.69	0.90	0.05	0.48	0.90	0.95	0.93	0.45
4	9.98	0.60	0.75	0.68	0.60	1.00	0.80	0.12
5	5.76	0.90	0.30	0.60	0.90	1.00	0.95	0.35
6	8.19	0.80	0.25	0.53	0.80	1.00	0.90	0.37
Total	**65.04**			**35.97**			**58.28**	**22.31**

Electrofishing results also support the current low productive capacity estimate of this habitat, with population estimates of 9-18 Atlantic salmon YOY/juveniles per unit of habitat and 0-2 brook trout YOY/juveniles per unit of habitat. It is anticipated that successful placement of spawning substrates in select areas will increase the spawning suitability and hence the productive capacity of Watson's Brook. It is estimated that spawning suitability could be increased in each reach from the current values to close to 1.00, thereby providing an overall net increase in suitability. If this increase is applied to all reaches, the result is a spawning habitat suitability increase of 22.31 equivalent units.

Lacustrine Habitat

In recent conversations with DFO the importance of headwater ponds within riverine systems, as well as for the value of fish and fish habitat within the ponds themselves has been discussed and is acknowledged. While the total amount of lacustrine headwater pond habitat within Watson's Brook is 123.98 ha, it has been shown above (Table 4.46) that approximately 15.5ha of lacustrine (headwater pond) HEU's may be impacted by the Project. We recognize that the loss of lacustrine habitat will require compensation and commit to further discussions with DFO in order to design a reasonable approach to lacustrine habitat compensation.

Feasibility

During construction, numerous pieces of equipment would be on-site and could be made available to assist in the placement gravels. In addition, many construction hands would also be available to limit machinery to those tasks where they would be absolutely required. This option is considered feasible.

Value Toward No Net Loss

Watson's Brook is limited in terms of suitable spawning substrates (i.e. gravels) and as such, the strategic addition of this substrate would increase the production capacity of the habitat. As shown above, the habitat improvement would be equivalent to a net increase of 22.31 units of spawning habitat equivalent units within the first six reaches of the brook.

Economic Viability

Although Watson's Brook is isolated to some degree, it is used by local anglers. An improvement to recreational angling opportunities, as a result of increased spawning production, is seen as a local, long-term economic benefit. In addition, on-site equipment during construction will also make this option economically viable to NLRC.

Public Acceptance

While public consultations will be conducted to present the local communities with the potential compensation options, it is felt at this time that any local improvement to Watson's Brook will meet with public acceptance. While other scheduled salmon rivers are more accessible, public consultations will be conducted to present the local communities with the potential compensation options. This option is viewed as being very acceptable to the public and to NLRC, as it involves multiple communities in the Come By Chance/Sunnyside area.

Other Compensation Options

While Watson's Brook is within the same ecological unit as the proposed HADD, several other local scheduled salmon rivers are within close proximity to the project and are more accessible to anglers. As such, they may provide more value to No Net Loss, economic viability and public acceptance. In this light, NLRC will engage the newly formed stewardship group and fisheries professionals to assess possible enhancement opportunities. The social and economic capacity of the identified improvements in salmon rivers is also inherent.

For example, Porter et al. (1974) indicates that North Harbour River has limited gravels (estimated at 3 per cent) and at least two low falls that may delay fish at extremely low water. DFO have also identified several potential habitat remediation options such as improper stream crossing installations near the communities of Butlerville and Goulds.

While all potential options outlined above will most likely improve salmonid habitat, all feasible options will be further assessed as part of the Compensation Plan in order to determine the best overall net gain in productive capacity. It should be kept in mind that any undertaking will need to be conducted in concert with all activities within the area so that long-term benefits are realized and potential conflicts reduced.

Feasibility

Assessment and engineering design will be conducted during the detailed Compensation Planning process; however typical instream habitat improvement/rehabilitation techniques are available and have been used in other parts of the province to increase the productive capacity of salmon rivers. While these activities will take place outside the construction area for the processing plant and infrastructure, local contracts would be put in place to assist with the identified tasks. In addition, interested local conservation and economic development groups will be encouraged to participate. This option is considered very feasible.

Value Toward No Net Loss

Habitat improvement options will need to be identified. There is no doubt that further habitat enhancements and rehabilitations can be identified for assessment in the local scheduled salmon rivers. The total available will be determined during detailed Compensation Planning, however habitat improvements to local scheduled salmon rivers has a very high value toward No Net Loss.

Economic Viability

The local scheduled salmon rivers are used by many local anglers from across the Avalon and Burin Peninsulas. Improvements to the recreational angling opportunities as a result of increased production due to improved or rehabilitated habitat are seen as a local, long-term economic benefit.

Public Acceptance

While public consultations will be conducted to present the local communities with the potential compensation options, initial communication with local representatives have been very positive. This option is viewed as being very acceptable to the public and to NLRC as it involves multiple communities in the Come-by-Chance/Sunnyside area.

4.7.4 Effects Assessment: Residual Effects

During Construction

Table 4.48 presents a summary of the significance of residual environmental effects due to construction of the Project. As shown, with standard construction mitigations, best-practices and the requirements of a Section 35(2) Authorization under the Fisheries Act, all residual adverse environmental effects are considered not-significant.

The preparation (earthworks, clearing, grubbing, levelling) and construction within the physical footprint of the plant has the potential to negatively affect fish and fish habitat. The loss of fish and fish habitat associated with the physical footprint will require an Authorization under Section

35(2) of the Fisheries Act and as such will require an acceptable Fish Compensation Plan prior to any habitat alteration, disruption or destruction of fish habitat. Therefore the residual effects associated with the preparation and construction of the physical undertaking footprint has been determined to be not-significant.

During Operations

Table 4.49 presents a summary of the significance of residual environmental effects due to operation of the Project. As shown, with standard construction mitigations and the requirements of a Section 35(2) Authorization under the Fisheries Act all residual adverse environmental effects are considered not-significant.

The residual effects associated with operation air emissions have been determined to be not-significant; however, model results may not reflect actual deposition. This has resulted in a medium level of confidence and therefore monitoring of deposition in nearby ponds will be conducted as part of normal operating procedures. The monitoring program will sample ponds for deposited constituents at a frequency such that any increases in concentrations can be documented before adverse effects are realized. This will allow time for adequate remediation to be implemented, if required.

Table 4.48 Significance of Potential Residual Environmental Effects of Construction on Freshwater Fish and Fish Habitat VEC.

Valued Environmental Component: Freshwater Fish and Fish Habitat				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood[a]**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Loss of Habitat	NS	3		
Accidents or Malfunctions (Spills)	NS	3		

[a] Only applicable to significant effect.

Table 4.49 Significance of Potential Residual Environmental Effects of Operation on Freshwater Fish and Fish Habitat VEC.

Valued Environmental Component: Freshwater Fish and Fish Habitat				
Project Activity	Significance Rating	Level of Confidence	Likelihood[a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Site Preparation				
Airborne Deposition	NS	2		
Accidents or Malfunctions (Spills)	S	2	1	3

[a] Only applicable to significant effect.

Decommissioning interactions with freshwater fish and fish habitat will relate primarily to those potential pathways such as siltation, erosion and dust as a result of regular construction activities to remove material and infrastructure from the project area. These would be similar in nature to those considered during construction.

4.7.5 Accidents and Malfunctions

Oil spilled on land can often reach lakes, rivers and wetlands where it can cause damage to both freshwater fish and habitat. The severity of an oil spill can depend on a variety of factors in the nature of the product spilled, the habitat in the area, air/water temperature and weather conditions.

Aquatic environments are made up of complex interrelationships between plant and animal species and their physical environment. Harm to the physical environment will often lead to harm for one or more species in a food chain, which may lead to damage for other species further up the food chain.

The United States National Park Service compiled an Environmental Contaminants Encyclopedia (Irwin et al. 1997), which summarizes many of the processes and pathways associated with a potential oil spill. A brief summary of the relevant information is presented below along with information from other sources such as CCME (2006).

Crude oils vary in physical characteristics such as color, viscosity and specific gravity. Color ranges from light yellow-brown to black. Viscosity varies from free-flowing to a substance that will barely pour. Specific gravity is used to classify crude oil as light, medium (intermediate) or heavy. Crude oil is rarely used in the form produced at the well, but is converted in refineries into a wide range of products such as gasoline, kerosene, diesel fuel, jet fuel, domestic and industrial fuel oils. The following definitions have been used to generally describe the various petroleum products and crude oil fractions:

Light Oils (Diesel, No. 2 Fuel Oils, Light Crudes):

- Moderately volatile; will leave residue (up to 1/3 of spilled amount);
- Moderate concentrations of toxic (soluble) compounds;
- Will "oil" intertidal resources with long-term contamination potential;
- Has potential for subtidal impacts (dissolution, mixing, sorption onto suspended sediments);
- No dispersion necessary; and
- Cleanup can be very effective.

Medium Oils (Most Crudes):

- About 1/3 will evaporate within 24-hours;
- Maximum water-soluble fraction is 10-100 ppm;
- Oil contamination of intertidal areas can be severe/long term;
- Impact to waterfowl and fur-bearing mammals can be severe;
- Chemical dispersion is an option within 1-2 days; and
- Cleanup most effective if conducted quickly.

Heavy Oils (Heavy Crude Oils, No. 6 fuel, Bunker C):

- Heavy oils with little or no evaporation or dissolution;
- Water-soluble fraction likely to be <10 ppm;
- Heavy contamination of intertidal areas likely;
- Severe impacts to waterfowl and fur-bearing mammals (coating and ingestion);
- Long-term contamination of sediments possible;
- Weathers very slowly;
- Dispersion seldom effective; and
- Shoreline cleanup difficult under all conditions.

A comprehensive review of the physicochemical properties of several oils and oil products found their persistence in the aquatic environment to rank as follows (from most persistent to least persistent): Residual asphaltenes > Heavy crude oil > Medium crude oil > Fuel oil #6 > Light crude oil > Lube oils > Fuel oil #2 > Jet fuel > Gasoline.

Effects On Fish And Fish Habitat

Crude petroleum and its products are a complex mixture of organic chemicals and contains within it less persistent and more persistent fractions. The range between these two extremes is greatest for crude oils. Since petroleum is such a complex mixture of thousands of substances with different physical and chemical properties, summarizing the toxicity or general hazard of petroleum in general or even a particular oil is difficult.

Crude oil and petroleum products vary considerably in their toxicity and the sensitivity of fish to petroleum varies according to species. The toxicity of crude oil can be interpreted as the toxicity of a complex mixture of inorganic and organic chemicals. However, a great deal of uncertainty exists in the use of dose-response relationships based on crude oil as a whole mixture. An alternative approach, which is often used, is the "indicator chemical approach". This involves selecting a subset of chemicals from the whole mixture that represents the "worst-case" in terms of mobility and toxicity. This approach can be used with crude oil with the subsets of chemicals being volatile organics such as benzene, toluene, ethylbenzene, and xylenes (known as BTEX; if present) and polycyclic aromatic hydrocarbons (PAHs). BTEX are of interest because they are soluble in water, highly mobile in the environment and represent the more volatile and soluble components of crude oil. In addition, benzene is an EPA-defined class A carcinogen. PAHs are not highly mobile but are of interest because they are prevalent in crude oil, represent the heavier or less volatile crude oil components and several are known animal carcinogens.

Benzene

If benzene is released in water, environmental fate processes may result in rapid removal from the water column. Half-lives for evaporation and volatilization have been estimated to be 5 and 2.7 hours respectively. It can be degraded by a variety of aquatic micro-organisms with rates depending on many factors including temperature and acclimation of the microbial community. Half-lives range from 33 to 384 hours for aerobic biodegradation and 28 to 720 days for anaerobic biodegradation in water. Benzene is not expected to concentrate in aquatic organisms or to significantly adsorb to sediments or soil. The CCME guideline for water quality for the protection of aquatic life is 370μg/L.

Toluene

If toluene is released in water, it will remain there for days and possibly weeks. It is removed from water by volatilization and biodegradation at a rate dependant on temperature, mixing conditions and the existence of acclimated micro-organisms. Toluene does not tend to hydrolyze or adsorb to sediments and will not bio-concentrate in aquatic organisms. The interim CCME guideline for water quality for the protection of aquatic life is 2.0μg/L.

Ethylbenzene

Ethylbenze may volatilize within a few hours after release, but can remain for a few weeks, depending on local conditions. The average volatilization half-life from surface water is 3.1 hours. Ethylbenzene may absorb to sediment but bio-concentration in fish is considered unlikely. The interim CCME guideline for water quality for the protection of aquatic life is 90μg/L (ppb).

Xylene (General)

Xylene is a volatile, organic, monocyclic aromatic compound. It is widely used as an industrial solvent where it usually a mixture of ortho-, meta-, and para- isomers. There are no CCME guidelines for water quality for the protection of aquatic life. There is some information available from the US National Parks Service (Environmental Contaminates Encyclopaedia, Irwin et al. 1997) and it has been reported that the LC50 for rainbow trout (*Oncorhynchus mykiss)* was 13.5ppm for 24hr exposure and 8.2ppm for 96hr exposure.

Polycyclic Aromatic Hydrocarbons (PAH)

PAHs are non-polar, hydrophobic compounds that do not ionize. As such, they tend to adsorb onto sediments and/or other solid phases in aquatic environments. Volatilization, photolysis, hydrolysis, microbial degradation and adsorption and subsequent sedimentation determine the fate of PAHs in the environment. Sorption to sediment substrates plays an important role in PAH transport and distribution. PAHs are subject to biodegradation by various micro-organisms that live in soils, sediment or suspended in the water column.

Aquatic organisms can accumulate PAHs from water, sediment and ingestion of food items. Literature suggests that bio-concentration is highly variable with algae and molluscs, which cannot metabolize PAHs rapidly, exhibiting higher rates than fish and crustaceans which can more readily metabolize PAHs. The interim CCME guidelines for water quality for the protection of aquatic life are:

- Acenaphthene 5.8µg/L
- Acridine 4.4µg/L
- Anthracene 0.012µg/L
- Benz(a)anthracene 0.018µg/L
- Benzo(a)pyrene 0.015µg/L
- Chrysene no recommended guideline
- Fluoranthene 0.04µg/L
- Fluorene 3.0µg/L
- Naphthalene 1.1µg/L
- Phenanthrene 0.4µg/L
- Pyrene 0.025µg/L
- Quinoline 3.4µg/L

Construction Mitigations

Fuel handling and use are standard activities at any construction site. As such, there are Best Management Practices, permit requirements and regulations in place to ensure that risks associated with fuel use and spills are minimized. In the event that a spill does occur, these same procedures ensure that its extent and impact are minimized. Outlined below are standard fuel handling practices and regulations that would apply to construction activities.

Fuel, and other hazardous substances, will only be handled, stored, or disposed of by persons who are trained and qualified to do so in accordance with the manufacturer's instructions and governmental laws and regulations. Diesel and gasoline use, transportation and storage will be conducted in accordance with the NL Storage and Handling of Gasoline and Associated Products Regulations (2003). Bulk storage (fuel caches) of gasoline/diesel will be conducted using industry approved vessels that are in a state of good repair and whose integrity is regularly inspected and maintained. Fuel caches will abide by the Environmental Guidelines for Fuel Cache Operations as stipulated by the Department of Environment and Labour. Stored waste oil will be handled and stored by a licensed disposal agent in accordance with the Used Oil Control Regulations, and be regularly disposed of to prevent accumulation.

Bulk storage tanks used during construction will be properly dyked to prevent release of spills or leaks. Dyking of fuel caches is required at temporary or permanent sites when:

- fuel is to be located in sensitive areas (e.g. domestic water supply areas, sensitive wildlife areas, ecological reserves, archaeological sites); and
- where filling/refilling of drums is proposed or carried out.

Bulk fuel storage facilities will have clean-up kits with the following list of fuel/oil spill clean-up equipment:

- Wajax fire pump and 100 metres of hose;
- Two hand operated fuel pumps;
- Six recovery containers such as empty drums;
- Four long handled shovels;
- Two pick axes;
- Fifteen cubic metres of impervious soil (a silt or clay bearing gravel);
- Fifty metres of low density rope;
- Ten metres of containment boom;
- Twenty-five absorbent pads; and
- Two 60-kilogram packages of loose absorbent material such as dried peat, speedi-dry or sawdust.

Dyking is also recommended at a fuel cache when the size of storage is 100 drums or more, and the duration of storage is permanent. Regardless of the size of any fuel cache, all containers will be marked, indicating their contents. Fuel caches should be located on flat stable terrain at least 30 metres from the high-water mark of the nearest body of water.

Dykes will be built of clay or other impermeable material. A liner may be used if it is protected from punctures during installation. The preferred method for the elimination of water accumulation inside dykes is the use of a portable pump. If a valved system is used, the valve must be padlocked in the closed position when not supervised.

Hydrocarbon releases from machinery and vehicles can be minimized through regular maintenance to ensure they are in good working order and thoroughly checked for leakage. Precautions should include:

- Having operators present for the duration of refuelling;
- Refuelling equipment and vehicles at least 30 m from any water body, and over a non-permeable surface;
- Having basic petroleum spill clean-up equipment on-site, with adsorbents being used to recover any spills or leaks;
- Promptly containing, and cleaning up, all spills or leaks on land or in water and reporting them to the 24-hour environmental emergencies report system (1-800- 563-9089) as required by the Fisheries Act (1985);
- Not disposing of wastes in-or-near waterbodies, with no burning of waste without a permit.
- Water testing as per criteria listed in Schedule A of the Environmental Control Water and Sewage Regulations under the Water Resources Act (2003), before it is discharged into a water body.

On-site fuel spill kits must include absorbent pads, loose absorbent materials such as dried peat, speedi-dry or sawdust and a container for recovering the fuel/oil.

Any spill in excess of 70 litres must be reported through the 24-hour Spill Report Number 709-772-2083. When any fuel spill occurs, the source/flow will be stopped immediately if possible. This may entail repairing a leak, pumping out a tank or shutting off a valve. If oil is spilled onto soil, dyking may be necessary. If fuel enters water, absorbent booms or barriers such as fencing or netting with loose absorbent or straw must be used to contain the spill. If necessary, culverts may be blocked off by earth or wooden barriers to contain fuel, provided the threat of flooding is addressed.

As a result of the extensive government and industry approved mitigation measures and permitting to be implemented and incorporated with respect to NLRC during construction, it is anticipated that the pathway between any fuel spills will be extremely reduced. While accidental events can occur and in this case, a large fuel spill could cause significant impacts to fish and fish habitat, the likelihood of its occurrence is very remote. The quantity of fish and fish habitat in the area would also assist in reducing the likelihood that a spill would interact with this VEC in particular. Taking the likelihood of such an occurrence into account, the impacts from an oil spill during construction are considered not-significant.

Operation Mitigations

The Project will have a tank farm that will accommodate up to 21 days of crude feed storage and 14 days of product storage. Therefore the initial 300,000 barrels per day will have a storage value of approximately 6,000,000 barrels for crude oil and 620,000 barrels for product.

This large tank storage area will be dyked and lined to provide containment in the case of an accidental spill and to prevent hydrocarbon escape into the surrounding environment. An oil water separator will be fitted to the drainage system from the tank farm containment area, to separate hydrocarbon products from drainage water before being discharged to the environment. Sections 8.0 and 9.0 provide additional details regarding loss control and environmental protection practices.

As a result of the extensive government and industry approved mitigation measures and permitting to be implemented and incorporated with respect to NLRC during operation, it is anticipated that the pathway between any fuel spills will be extremely reduced. While accidental events can occur and in this case, a large fuel spill could cause significant impacts to fish and fish habitat, the likelihood of its occurrence is very remote. The quantity of fish and fish habitat in the area would also assist in reducing the likelihood that a spill would interact with this VEC in particular. Taking the likelihood of such an occurrence into account, the impacts from an oil spill during operation are considered not-significant.

4.7.6 Habitat Compensation Strategy

The Habitat Compensation Strategy has been discussed in the above Section 4.7.3, as well as in the Component Study for Freshwater Fish and Fish Habitat.

4.8 Marine Fish and Fish Habitat Effects Assessment

The potential effects identified are those interactions that have a reasonable probability of occurring. Each potential pathway is described below, as well as a description of which activity outlined in the matrix table they may be associated with. In this way, similar pathways for numerous activities are identified and described without unneeded duplication.

The spatial boundaries associated with the potential interactions and assessment of marine fish and fish habitat include the marine boundaries as described in Section 2.0 of this volume 3. In general, the Project boundaries with respect to marine fish and fish habitat include the shoreline and marine habitat within the direct footprint of the marine facilities and marine areas within any potential deposition or effluent zone of influence. This encompasses the locations of the marine terminal/tug berth and marine jetty, marine water intake, and marine outfall.

The temporal boundaries of the Project run from the start of construction through decommissioning, as also stated in detail in Section 2.0.

4.8.1 Project Effects During Construction

The project will require new marine facilities to be constructed to handle large ocean–going oil tanker and bulk carrier vessel traffic, and provide a seawater intake and marine outfall.

The new facilities will consist of the following primary elements:

- Marine Wharf;
- Heavy Lift Construction Dock;
- Tug Berth – Small Boat Basin;
- Bulk Materials – Dry Product Berth (Berth #1);
- Jetty Control Building and Emergency Response Warehouse;
- Offshore Berthing Facilities;
- Access Trestle;
- Jetty 1 (Berth #2 and Berth #3);
- Jetty 2 (Berth #4 and Berth #5);
- Marine Seawater Intake; and
- Marine Outfall.

The main facility is located to the west and slightly north of Come By Chance Point in Come By Chance Bay. The seawater intake and marine outfall are located to the east of Come By Chance Point. The combined marine footprint is approximately 113,000 m^2.

Construction activities associated within and adjacent to the marine environment will include:

- Clearing and grubbing (terrestrial);
- Major earth works to level the site which may involve blasting (terrestrial);
- Road construction (terrestrial and shoreline);
- Onshore infrastructure construction (terrestrial and shoreline);
- Marine infilling;
- Marine pile driving;
- Bulk vessel traffic;
- Barge movement and anchoring;
- Placement of steel piles/steel jackets;
- Placement of concrete structures (pedestals, blocks etc.); and
- Underwater pipeline construction

The construction of the marine facilities associated with the Newfoundland and Labrador Refinery Project could potentially result in the disturbance or direct mortality of fish or their habitat in the waters within the vicinity of Southern Head. Effects from incidents such as hydrocarbon spills or leaks or sediment degradation from increased siltation may result in:

- A change in the productive capacity of aquatic systems, and/or;
- The harmful alteration, disruption or destruction of fish habitat.

Direct mortality of motile species such as lobsters and fish during the marine facilities construction is unlikely, as these species will generally avoid the area once the noise and disturbance of construction activities begin. Loss of sessile invertebrate and plant species will result from the marine terminal's infill construction. Newfoundland and Labrador Refinery Corporation will adhere to all applicable DFO regulations and guidelines designed to preserve local fish and fish habitat. These include (but are not limited to) the:

- National Policy for the Management of Fish Habitat;
- Fisheries Act - Habitat Protection and Pollution Prevention Provisions;
- Compliance and Enforcement Policy;
- Environmental Control Water and Sewage Regulations under the Water Resources Act;
- CCME guidelines, including those outlined in The Canadian Water Quality Guidelines for the Protection of Aquatic Life;
- Canada Shipping Act;
- Storage and Handling of Gasoline and Associated Products Regulations;
- Used Oil Control Regulations;
- Land Development Guidelines for the Protection of Aquatic Habitat;
- Guidelines for the Use of Explosives In or Near Canadian Waters;

- Newfoundland Factsheets for:
  - Effects of Silt on Fish and Fish Habitat
  - Blasting - Fish and Fish Habitat Protection
  - Forwarder Trails
  - Temporary Bridges
  - Resource Road Construction
  - Instream Work in the Dry (Cofferdams)
  - Streambank Stabilization
  - Instream Work in the Dry – Temporary Diversion and Elevated Pipes
- DFO Marine Species Habitat Requirements; and
- DFO End-of-Pipe Fish Screen Requirements.

Siltation, Erosion, and Dust

Siltation, erosion (shoreline), and dust generation in relation to terrestrial and marine construction operations have the potential to enter into the marine environment during the construction phase of the project. Excess siltation can have a negative effect on the health of marine biota and can cause the loss or avoidance of critical/productive marine fish habitat. A potential pathway can also include airborne deposition (i.e. dust). Fine material can settle on substrates smothering sessile organisms, affecting physical processes, structural attributes and ecological conditions such as water clarity and overall habitat suitability. Suspended sediment can also cause damage to gills of fish (Gosse et al. 1998).

Any activities within marine waters will be conducted in strict compliance with all authorizations and/or permits as required by all federal and provincial agencies. Clean (containing less than 5 per cent fines, non-acid generating) blasted rock from the quarry site will be used for the marine terminal's base and infilling. Prior to any works, silt curtains will be put in place around marine activities to prevent sediment from entering the water column outside work areas. The silt barrier will be attached to a flotation boom and extend from the surface to a point as close to the seabed as possible. During the marine terminal's construction, infill will be dumped in place and not stockpiled along the shoreline, with placement not being conducted during periods of high wind, waves or precipitation. Armour stone will be placed progressively to minimize shoreline erosion and prevent the loss of infill material.

Water releases leaving the silt curtains, or any work area in or near the marine environment, will have suspended solids concentrations not exceeding 25 mg/L (monthly average) or 50 mg/L (grab sample) as per Section 36 of the Fisheries Act.

Losses of aggregate from spills, accidents or machinery malfunctions could increase the sediment load of the surrounding waters; resulting in adverse affects on the local flora and fauna. Prior to conveyance to the marine terminal all infill material will be washed, significantly lowering its fine particle content (<5 per cent) and diminishing its potential to release sediment or dust. Further, having all construction equipment maintained in a state of good repair and regularly inspected, to ensure maximum efficiency and to minimize the potential for malfunction, will mitigate losses. Only those employees properly trained to do so will operate all machinery. The EPP and contingency plans outline appropriate responses to accidental spills, with spill kits (containing such things as silt curtains and floating booms) available on barges or boats servicing the marine facilities and within the terminal itself.

Terrestrial siltation control structures (i.e. silt curtains, cofferdams and/or sediment fences) will be constructed prior to beginning any activities involving disturbance of the soil, work along the shoreline or near areas of high runoff potential. Construction activities will be coordinated to avoid periods of heavy precipitation and not coincide with sensitive periods for fish. Mitigative measures will be implemented prior to any grubbing or excavation to direct any natural drainage around work areas, avoiding sediments above ambient suspended particle concentration in runoff waters.

Soil disturbance will be minimized by limiting the area exposed at any one time, stabilizing exposed soil with anti-erosion devices (i.e. rip rap, filter fabrics, gravel or wood chips) and revegetation of disturbed areas. Grubbing of the organic vegetation mat and/or the upper soil horizons will be restricted to the minimum area required. The organic vegetation mat and upper soil horizon material that has been grubbed will be spread in a manner so as to cover inactive exposed areas. Further, a 50 m buffer zone of undisturbed natural vegetation between construction areas and all waterbodies outside the Project Area will be maintained to prevent sediments from entering local waterways.

No runoff will be allowed to freely flow into any water body. Runoff during construction will be directed to adequate vegetated areas or settling ponds within the Project boundaries to slow flow and allow particles to precipitate out. Any natural vegetated areas receiving runoff will first be assessed to ensure they can adequately handle anticipated volumes, and are not habitat for any species of concern.

Settling Ponds will be designed according to DFO's Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993). The number and size of ponds required during construction will be based on final area of disturbance and calculations of maximum runoff anticipated. Ponds both for construction and operations, will be built with required safety factors, adhering to guidelines with respect to such design standards as the accommodation of storms (1:5, 1:10, and 1:100 years storms), effective capacity, retention times and location. Their operation and maintenance will include regular inspection and assessment of accumulated sediment load, removing it when required.

Construction runoff near blasting operations may also have the potential to contain nitrogenous residues if ammonia-based explosives are used. Any releases that may enter freshwater will meet the required limit of 0.019 mg/L for ammonia (Canadian Water Quality Guidelines for the Protection of Aquatic Life, CCME 2006). Currently there is no set limit for waters entering marine waters (CCME 2006). If required, settling ponds used for construction will be designed to allow for chemical degradation of nitrogenous wastes.

Runoff water from any settling ponds will adhere to the guidelines set by DFO, containing less than 25 mg/L of suspended solids (or non-filterable residue) above the background suspended solids levels of the receiving waters during normal dry weather operation, and less than 75 mg/L of suspended solids above background levels during design storm events. Suspended solids in effluent will be regularly tested to ensure compliance.

The control of siltation, erosion and runoff from construction sites is addressed in many standard practices and guidelines such as the Guidelines for Protection for Freshwater Fish Habitat (Gosse et al. 1998), Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993) and the Environmental Guidelines for General Construction Practices (Water Resources Management Division 1997). All discharges of runoff from construction activities will also conform to the Environmental Control Water and Sewage Regulations, 2003 under the Water Resources Act (O.C. 2003-231).

Dust emission during the construction phase will be localized to the areas where overburden is being cleared to allow for construction of permanent infrastructure and road construction. Any areas with a high dust potential will be sprayed with water to decrease the chance of particles becoming airborne. Where and when applicable (e.g. during a dry summer), calcium chloride may also be used for dust suppression on operational roads. The use of calcium chloride will be in accordance with the guidelines outlined in Environment Canada's Best Practices for the Use and Storage of Chloride-Based Dust Suppressants (EC 2007), referring to how, when and what quantity to apply. Waste oil shall not be used for dust control.

Vehicle-related dusting from access roads will be largely confined to the construction stage while large trucks are transporting equipment and material. Once construction is completed, the dusting potential will be low, as the majority of on-site movement will be company vehicles following designated paved roadways. Dust suppression procedures will be implemented in all areas to comply with the NL Criteria for Acceptable Air Quality (which allows a total suspended particulate concentration of 80 µg/m3 and 120 µg/m3 for 1-hour and 24-hour exposure, respectively).

With the above government and industry approved mitigation measures implemented and incorporated into NLRC construction and operation plans, it is anticipated that the pathway between siltation, erosion and dust and fish and fish habitat will be eliminated.

Airborne Emissions/Deposition

Engine exhaust will be a potential source of atmospheric pollution related to vehicles and heavy equipment. A portion of the exhaust components has the potential to bind with air particulate matter and precipitation and eventually settle into the marine environment. All construction equipment will be well maintained and fitted with standard exhaust suppression devices to keep emissions at a minimum. The use of heavy equipment will peak during construction, with large trucks transporting building materials and equipment for the construction of the marine facilities. These vehicles will be mainly diesel powered, and will comply with the NL Regulation 39/04 Air Pollution Control Regulations 'Visible Emissions Standards'. These standards require diesel vehicles to meet SAE J1667 (Snap Acceleration Smoke Test Procedure for Heavy-Duty Diesel Vehicles; a measure of combustion efficiency) targets of visible emissions of 40 per cent for 1991 model vehicles and newer, and 55 per cent for 1990 model vehicles and older.

Ships exhaust will also comply with the Air Pollution Control Regulations as well as TC's regulation and standards for air pollution under the Canada Shipping Act. Ships will be in a state of good repair, with regular inspection and maintenance being performed by the assigned shipping contractor. Ships entering or leaving the Southern Head area will maintain a speed no more than 2 knots which will serve to minimize exhaust emissions, with the main power plant being turned off while the ship is moored.

Air emissions of the refinery will disperse from the Plant and, depending on emission concentrations and stack/dispersion design, may deposit in or near marine habitat. If deposition is at a rate or concentration that accumulation can occur (i.e. in substrates, food sources or fish), it can have a negative effect on fish and/or fish habitat.

The main constituents of stack emissions from the refinery include combustion gasses exhausted from process furnaces and boilers, as well as hydrocarbon vapours vented from process equipment and storage tanks. Specifically, emissions of sulphur compounds may affect the quality of fish habitat within the air deposition boundary.

Chemical Losses Affecting Water and Sediment Quality

Construction of the marine facilities will require the use of heavy machinery, vessels and barges, each with the potential to leak hydrocarbons into the surrounding waters. Chemical losses (e.g. fuels, greases, detergents) will be mitigated by taking a proactive approach to prevent leaks or spills. Hydrocarbon releases from machinery and vehicles can be minimized through regular maintenance to ensure they are in good working order and thoroughly checked for leakage. Heavy equipment used during construction (e.g. cranes dump trucks, loaders) will only be used on dry, stable, land or barges specifically designed for that purpose; with heavy equipment not operating from barges completing work below the high water mark during low tide. No refueling or repairs of construction equipment will be done on the marine terminal or within 30 m of any waterbody. Floating booms will be in place during all construction activities, which will contain potential leaks or spills. Spill kits, containing such items as absorbents capable of retaining and removing oil sheen and waste storage containers will be available on barges and boats required for construction and the terminal itself.

The loss of uncured concrete into marine water has the potential to adversely affect fish and fish habitat due to its high alkalinity. To mitigate losses, all concrete formwork required for the marine facilities construction will be made either onshore and put in place once dry, or be set in place within leak-proof forms in a manner that will prevent fresh concrete or cement paste from leaking into the ocean. Chutes or concrete pump delivery lines will have joints and connections sealed and locked and crews would ensure that concrete forms will not be overfilled. Tools are to be washed in freshwater that will be disposed in an approved location on land (and not within 30 m of any waterbody). Any wooden concrete forms or any other wooden structures built on or near the marine environment will be made of wood deemed safe for use as per the Guidelines to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region (Hutton and Samis 2000).

Equipment located on the marine facilities will contain only small quantities of hydrocarbons. Only hydraulic fluid and medium oils (for gearboxes) will be used. The hydraulic fluid storage is to be located at least 30 m from any waterbody within a secure equipment room provided with secondary containment of at least 110 per cent of the tank's capacity. Gearboxes will have catchment trays as would bearings where regular greasing occurs (as per manufacture's specifications). Any machinery requiring minor repairs will be taken to a suitable location on land to be fixed, with no repairs of mobile machinery being performed on the marine terminal or within 30 m of any waterbody. Only minor repairs and maintenance of 'non-mobile' equipment (such as greasing of loading/unloading gear) will be performed on-site. All major repairs will take place offsite at an approved facility.

Fuel, and other toxic substances (as defined under Schedule 1 of the Canadian Environmental Protection Act; CEPA), will only be handled, stored, or disposed by persons who are trained and qualified to do so in accordance with the manufacturers' instructions (e.g. Material Safety Data Sheets) and governmental laws, acts (e.g. CEPA), and regulations (e.g. Storage and Handling of Gasoline and Associated Products Regulations; Used Oil Control Regulations). Procedures will include:

- Having operators present for the duration of refueling;
- Refueling equipment and vehicles at least 30 m from any water body, and over a non-permeable surface;
- Having basic petroleum spill clean-up equipment on-site, with adsorbents being used to recover any hydrocarbon sheen on the water;
- Promptly containing, and cleaning up, all spills or leaks on land or in water and Reporting them to the 24-hour environmental emergencies report system (1-800-563-9089) as required by Environment Canada;

- Allowing no on-site bulk storage of fuel or oil;
- Not disposing of wastes in or near waterbodies; and
- Routine water testing as per criteria listed in Schedule A of the Environmental Control Water and Sewage Regulations (2003), under the Water Resources Act and ensuring any discharges from the site conform to CCME limits.

A Spill Contingency Plan will outline appropriate responses to accidental spills (such as those resulting from collisions, fires or structural failures), with spill kits (containing such things as floating booms and absorbents) being available on barges and service boats and the marine terminal itself. All water releases will meet the regulatory requirements of the Environmental Control (Water and Sewage) Regulations and the CCME limits (e.g. metals, dissolved oxygen, hydrocarbons).

Shipping

Shipping activities and maritime accidents (i.e. fuel spills, contaminated bilge discharge) could also affect marine fish and fish habitat through water quality degradation and habitat loss. Shipping activities will be contracted out to a third party, who will be contractually responsible for the vessels and shipping as well as its operation and maintenance. Newfoundland and Labrador Refining Corporation is committed to environmentally safe shipping practices, and will require the contractor to: not dump bilge or foreign ballast water outside the allowable restrictions of the Canada Shipping Act, have the ships registered with the ECRC, and require bulk carriers and tankers to carry oil spill clean up equipment (e.g. absorbents, inflatable dykes) with crew trained members in spill prevention and clean up techniques. Details of standard mitigations with respect to shipping activities are outlined in Section 7.2 and will be included in Newfoundland and Labrador Refining Corporation’s EPP.

Blasting

Blasting along the shoreline may be required in the initial stages of construction to facilitate access to the marine terminal site. The following discussions are geared primarily on the potential effects of lobster, which is the primary marine species in terms of compensation and monitoring efforts. Minimal information is available on the effects of acoustic stimuli and waterborne vibrations on aquatic invertebrates (Wiese 1976; Tautz and Sandeman 1980; Heinisch and Wiese 1987; Breithaupt and Tautz 1990); with none of it pertaining specifically to the American lobster. In terms of physical and/or behavioral impact of sound energy on decapod crustaceans, research of this nature is also limited. Further, while there are guidelines for the use of explosives near fish and their spawning habitat (Wright and Hopky 1998), no such guidelines exist for marine invertebrates.

It can, however, be assumed that the most sensitive stage for lobster will be during its molting, reproduction and incubation stages. For the American lobster, these stages occur during the summer months in shallow, nearshore, waters (Pezzack et al. 2001). Any blasting required for the marine terminal's construction will avoid these sensitive stages. It is assumed that by late summer/early fall, lobsters utilizing the Project area for spawning or rearing habitat will have completed this phase of their life cycle and have begun their retreat to deeper offshore waters where they are known to overwinter (Christian 1995). With respect to adult lobsters that may be in the vicinity of a blast, research has shown that even very high sound pressures do not significantly alter decopod's (e.g. lobsters and crabs) physiological parameters (Christian 2003). Therefore, the minimal use of small land-based charges required to construct the marine terminal are not anticipated to have any significant effect on lobsters residing in the immediate Project area.

Regardless of the lack of anticipated effects, blasting during the marine terminal's construction will adhere to all mitigative measures as outlined in Section 4.8.3 and will be done in accordance with all acts, regulations and guidelines described therein. This includes allowing no blasting to occur within the marine environment.

Loss of Fish Habitat

The construction of the marine facilities associated with the project will result in the permanent removal of a portion of existing marine fish habitat. This will be as a result of the infilling and marine footprints associated with construction of the marine terminal/tug berth, marine jetty, seawater intake pipeline, and marine outfall pipeline.

The following marine footprint is an estimate based upon preliminary design. Pending final design and on site marine surveys the numbers presented may vary. The current marine footprint estimate is 112,833 m2 and consists of the following components:

- Marine Terminal/Tug Berth = 86,238 m^2
- Marine Jetty = 11,695 m^2
- Marine Water Intake = 9,850 m^2
- Marine Outfall = 5,050 m^2

The Fisheries Act contains a prohibition with respect to the "harmful alteration disruption or destruction" of fish habitat (HADD). The Act permits the Minister to issue an Authorization under Section 35 (2) which will permit a "HADD" to occur. The issuance of an Authorization is at the discretion of the Minister; however the procedures involved in the issuance of an Authorization are well established. A HADD Authorization will be issued only in accordance with the Policy for the Management of Fish Habitat. The Policy has a Guiding Principle of "No Net Loss", i.e. existing fish habitat will be protected, while unavoidable habitat alterations are to be balanced by development of new habitat or the increased productive capacity of existing habitat. An Authorization must be issued before any action can be taken to alter, disrupt or destroy fish habitat.

A qualitative and quantitative characterization of the marine habitat was conducted within the footprint of proposed marine facilities associated with the construction and operation of the Project. The marine habitat characterization included substrate distributions, depth profiles, macrofauna and macroflora distributions, and baseline sediment and water chemistry. A complete and detailed habitat characterization based upon DFO's Interim Marine Habitat Information Requirements is provided in AMEC (2007) Newfoundland and Labrador Refinery Project, Southern Head, Placentia Bay, NL, Marine Habitat Characterization.

Based upon the results of field surveys, consultations with local fisherpersons, and discussions with DFO Habitat Branch it was concluded that the targeted habitat with respect to both a potential marine HADD determination and habitat compensation issues would be that utilized by the various life stages of lobster (Homarus americanus) (AMEC (2007) Newfoundland and Labrador Refinery Project, Southern Head, Placentia Bay, NL, Marine Compensation Strategy).

Suitable lobster habitat percentages were estimated to be 43 per cent for the Marine Terminal/Tug Berth, 0 per cent for the Marine Jetty, 6 per cent for the Marine Water Intake, and 12 per cent for the Marine Outfall. Based upon the estimated footprints provided by Newfoundland and Labrador Refining Corporation the resulting potential lobster habitat compensation estimates are 36,670 m2 for the Marine Terminal/Tug Berth, 0 m2 for the Marine Jetty, 591 m2 for the Marine Water Intake, and 606 m2 for the Marine Outfall. This resulted in an overall marine fish habitat compensation estimate of 38,729 m2 or 193 habitat units (200 m2).

DFO criteria for compensation are based on providing for the replacement of impacted habitat with similar habitat, preferably within the same aquatic system. The preferred compensation options are as follows:

6. Create habitat or increase the productive capacity of **like-for-like** habitat in same ecological unit;
7. Create habitat or increase the productive capacity of **unlike** habitat in same ecological unit; or
8. Create or increase productive capacity of habitat in a **different** ecological unit

Based upon these guiding principals it is anticipated that placement of armor stone associated with construction of the marine terminal and tug berth, marine jetty, marine water intake, and marine water outfall will provide a substantial portion of the required compensatory lobster habitat. This will constitute the application of Option 1, the creation of like-for-like habitat within the same ecological unit. The actual volume and extent of armour stone placement will be based upon the final construction engineering specifications to be provided by North Atlantic Refining Corporation. The armour stone to be utilized for construction purposes will be clean, non-acid generating granite of appropriate size preferably obtained from the nearby construction site.

The final determination of habitat created will be determined in consultation with DFO Habitat Branch and will be predicated upon the volume of armor stone placed within a depth profile of greater than two.

If it is determined that placement of armor stone will be insufficient in achieving the amount of habitat compensation required, Newfoundland and Labrador Refining Corporation is prepared to enter into discussions with DFO to assess the applicability and effectiveness of alternative methods to be employed within the same ecological unit. These would include, but not necessarily be limited to the creation of artificial reef habitat or the augmentation of habitat in relation to other species such as deep-sea scallop, by increasing habitat complexity via the strategic deposition of scallop shells.

A monitoring program will be employed to monitor the structural stability and habitat utilization of newly created lobster habitat. The monitoring program will be conducted over a 10-year period with monitoring occurring between June 1st and October 31st in years 1, 2, 3, 5, 7, and 10 after habitat creation.

The monitoring program will consist of but not necessarily be limited to the following:

- Video and photographic surveys;
- Visual inspections (monitoring any structural changes);
- A record of flora and fauna related succession with respect to utilization of the new habitat; and
- A record of lobster utilization of the new habitat.

In addition to the scientific/quantifiable monitoring initiatives it also anticipated that local lobster fishers will be involved in the monitoring process. This will involve the collection of quantifiable replicate fishing data with respect to lobster populations both within and outside of the newly created lobster habitat.

The proposed habitat compensation strategy will effectively replace the marine fish habitat impacted by construction of the marine facilities. This will ensure that the project will comply with DFO's Guiding Principle of "No Net Loss", i.e. existing fish habitat will be protected, while unavoidable habitat alterations will be balanced by development of new habitat or the increased productive capacity of existing habitat.

Effects Assessment: Residual Effects

Table 4.54Table 4.50 to Table 4.54 present the interactions between the Project and marine fish and fish habitat during construction activities as outlined above. As shown, all those other than habitat loss as a result of the infrastructure are reversible or are of minimal magnitude, extent and/or duration when mitigation methodologies are applied.

Table 4.50 Environmental Effects Assessment for Marine Water Resources During Marine Construction

Valued Environmental Component: Water Resources									
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						**Significance**
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**	
Site Preparation									
Air emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Run-off, Siltation	Change in Water Chemistry Turbidity (A)	Yes	1	1	1	1	R	1	
Vehicular traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Site Access Road, Transmission Lines, Pipelines, Quarry Development									
Air emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Run-off, Siltation	Change in Water Chemistry Turbidity (A)	Yes	1	1	1	1	R	1	
Vehicular traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Presence of new structures	Change in Water Chemistry (A)	Yes	0	1	1	1	I	1	
Refinery Complex									
Run-off, siltation	Change in Water Chemistry Turbidity (A)	Yes	1	1	1	1	R	1	
Vessel traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Vehicular traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Marine Terminal									
Air Emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Run-off, siltation	Change in Water Chemistry Turbidity (A)		2	1	1	1	R	1	

Valued Environmental Component: Water Resources									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
		Yes							
Vessel traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Vehicular traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Presence of new structures	Change in Water Chemistry Change in Circulation (A) Increase Habitat Complexity (P)	Yes	1	1	6	5	I	1	
Intakes/ Outfalls									
Location	Change in Water Chemistry (A)	Yes	0	1	6	5	I	1	
Run-off, siltation	Change in Water Chemistry Turbidity (A)	Yes	1	1	1	1	R	1	
Vehicular traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Presence of new structures	Change in Water Chemistry (A) Increase Habitat Complexity (P)	Yes	1	1	6	5	I	1	
Accidents or Malfunctions									
Air emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Storage and disposal of wastes, debris	Change in Water Chemistry Health Effects (A)	Yes	1	1	1	1	R	1	
Run-off, siltation	Change in Water Chemistry Turbidity (A)	Yes	2	1	1	1	R	1	
Oil Spill	Change in Water	Yes	3	1-2	1	2-4	R	1	

Valued Environmental Component: Water Resources									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
(Terminal)	Chemistry (A)								
Oil Spill (Red Island)	Change in Water Chemistry (A)	Yes	3	2-3	1	2-4	R	1	
Oil Spill (Approach Placentia Bay)	Change in Water Chemistry (A)	Yes	3	3-4	1	2-4	R	1	
Location of wastewater outfall	Change in Water Chemistry (A)	Yes	2	1	1	1	R	1	

Table 4.51 Environmental Effects Assessment for Fish and Fish Habitat (Commercial and Recreational Fisheries During Marine Construction

Valued Environmental Component: Fish and Fish Habitat (Marine) Commercial and Recreational									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
Site Preparation									
Noise	Avoidance (A)	Yes	1	1	1	1	R	1	
Site Access Road, Transmission Lines, Pipelines, Quarry Development									
Noise	Avoidance (A)	Yes	1	1	1	1	R	1	
Run-off, Siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Refinery Complex									
Run-off, siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Vessel traffic	Avoidance (A)	Yes	1	1	1	1	R	1	
Marine Terminal									
Air Emissions	Health Effects (A)	Yes	1	2	1	2	R	1	
Noise	Avoidance Health Effects (A)	Yes	1	1	6	1	R	1	
Run-off, siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Vessel traffic	Avoidance (A)	Yes	1	1	1	1	R	1	
Presence of new structures	Habitat Removal (A) Increase Habitat Complexity (P)	Yes	2	1	6	5	I	1	
Proximity to fish harvesting sites	Harvester Displacement (A)	Yes	2	1	6	5	I	1	
Intakes/ Outfalls									
Location	Avoidance (A) Attraction (P)	Yes	1	1	6	5	I	1	
Noise	Avoidance (A)	Yes	0	1	1	1	I	1	
Run-off,	Avoidance Health	Yes	1	1	1	1	R	1	

Valued Environmental Component: Fish and Fish Habitat (Marine) Commercial and Recreational									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
siltation	Effects (A)								
Presence of new structures	Avoidance (A) Attraction (P)	Yes	1	1	6	5	I	1	
Proximity to fish harvesting sites	Harvester Displacement (A)	Yes	1	1	6	5	I	1	
Accidents or Malfunctions									
Run-off, siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Oil Spill (Terminal)	Health Effects Mortality Tainting (A)	Yes	3	1-2	1	2-4	R	1	
Oil Spill (Red Island)	Health Effects Mortality Tainting (A)	Yes	3	2-3	1	2-4	R	1	
Oil Spill (Approach Placentia Bay)	Health Effects Mortality Tainting (A)	Yes	3	3-4	1	2-4	R	1	
Location of wastewater outfall	Health Effects Mortality Tainting (A)	Yes	1	1	1	1	R	1	

Table 4.52 Residual Environmental Effects Assessment for Marine Water Resources During Marine Construction

Valued Environmental Component: Water Resources				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Air emissions	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Vehicular traffic	NS	3	1	3
Loss of Habitat	NS	3	1	3
Site Access Road, Transmission Lines, pipelines, Quarry Development				
Air emissions	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Vehicular traffic	NS	3	1	3
Presence of new structures	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Refinery Complex				
Run-off, siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Vehicular traffic	NS	3	1	3
Marine Terminal				
Air Emissions	NS	3	1	3
Run-off, siltation	S	3	2	3
Vessel traffic	NS	3	1	3
Vehicular traffic	NS	3	1	3
Presence of new structures	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Intakes/ Outfalls				
Location	NS	3	1	3
Run-off, siltation	S	3	1	3
Vehicular traffic	NS	3	1	3
Presence of new structures	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Accidents or Malfunctions				
Air emissions	NS	3	1	3

Valued Environmental Component: Water Resources				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Storage and disposal of wastes, debris	NS	3	1	3
Run-off, siltation	S	3	2	3
Vehicular traffic	NS	3	1	3
Location of wastewater outfall	NS	3	1	3

Table 4.53 Residual Environmental Effects Assessment for Marine Fish and Fish Habitat (Commercial Fisheries) During Marine Construction

Valued Environmental Component: Fish and Fish Habitat (Marine) Commercial				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	S	3	2	2
Site Access Road, transmission lines, pipelines, Quarry Development				
Noise	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Refinery Complex				
Run-off, siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Marine Terminal				
Air Emissions	NS	3	1	3
Noise	S	3	3	3
Run-off, siltation	S	3	2	3
Vessel traffic	S	3	3	3
Presence of new structures	S (3)	3	3	3
Proximity to fish harvesting sites	S (3)	3	3	3
Intakes/ Outfalls				
Location	NS	3	3	3
Noise	S	3	2	3

Valued Environmental Component: Fish and Fish Habitat (Marine) Commercial				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Run-off, siltation	S	3	1	3
Presence of new structures	S	3	3	3
Proximity to fish harvesting sites	NS	3	1	3
Accidents or Malfunctions				
Run-off, siltation	S	3	1	2
Location of wastewater outfall	S	3	1	2

Table 4.54 Residual Environmental Effects Assessment for Marine Fish and Fish Habitat (Recreational Fisheries) During Marine Construction

Valued Environmental Component: Fish and Fish Habitat (Marine) Recreational				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Site Preparation				
Noise	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Loss of Habitat	NS	3	1	3
Site Access Road, Transmission Lines, Pipelines, Quarry Development				
Noise	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Refinery Complex				
Run-off, siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Marine Terminal				
Air Emissions	NS	3	1	3
Noise	NS	3	1	3
Run-off, siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Presence of new structures	S (3)	3	3	3

Valued Environmental Component: Fish and Fish Habitat (Marine) Recreational				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Proximity to fish harvesting sites	NS	3	1	3
Intakes/ Outfalls				
Location	NS	3	1	3
Noise	NS	3	1	3
Run-off, siltation	NS	3	1	3
Presence of new structures	NS	3	1	3
Proximity to fish harvesting sites	NS	3	1	3
Accidents or Malfunctions				
Run-off, siltation	NS	3	1	3
Location of wastewater outfall	NS	3	1	3

4.8.2 Project Effects During Operations

Marine terminal activities include the delivery of medium and heavy high-sulfur crude oils and the export from the refinery complex of refined products including gasoline, RBOB gasoline, jet/kerosene, ultra-low sulphur diesel, sulphur and coke.

The vessel loading and offloading systems will discharge tanker cargoes quickly and efficiently, minimizing emissions and vessel time at berth. Offloading of crude will be accomplished through the import piping systems. Large diameter pipelines and transfer systems will allow offloading rates up to 100,000 barrels per hour (BPH). Onboard ship pumps will move the crude to storage tanks. Connection to tankers will be made with marine crude oil/product loading arms specially designed for the full range of vessel sizes and motions at the berth. Product loading rates will generally allow vessels to be loaded in a 24-hour period.

Loading of the sulphur and coke is done via a closed conveyor system to eliminate dust emissions. The conveyor system will be connected to a ship loader on the berth. The ship loader will be designed for the full range of vessel sizes and motions at the bulk berth.

Marine terminal operations interactions with marine fish and fish habitat relate primarily to those activities that have the potential to result in changes to marine water and sediment quality.

Siltation, Erosion, and Dust

The ocean locale, a shoreline consisting primarily of exposed rock and vegetation, hard surfaces on access roads and all causeways, trestles, and the marine terminal/tug berth, nullifies the potential for dry, dusty conditions. The placement of armour stone and solid structures such as sheet piles, concrete, and steel caissons on the periphery of marine facilities eliminates the potential for shoreline and/or benthic erosion. During the operations phase it is anticipated that only small service vehicles with a low potential for dust generation will be used.

All areas of the marine terminal will conform to the NL Criteria for Acceptable Air Quality, which allows a total suspended particulate concentration of 80 µg/m3 and 120 µg/m3 for one hour and 24-hour exposure, respectively.

These factors combine to ensure that siltation, erosion, and dust will not have significant effects on fish and fish habitat during the operational phase.

Airborne Emissions/Deposition

During operations, exhaust emissions at the marine terminal will be confined to well-maintained, company-owned service trucks adhering to the Air Pollution Control Regulations (as above).

All operations equipment will be well maintained and fitted with standard exhaust suppression devices to keep emissions at a minimum. Electric generators and gas-powered tools will be regularly maintained and in good repair to ensure exhaust emissions are minimal. Ships exhaust will also comply with the Air Pollution Control Regulations as well as regulation and standards for air pollution under the Canada Shipping Act. Ships will be in a state of good repair, regularly inspected and maintained by the shipping contractor. Ships entering or leaving the marine terminal area will maintain a minimum speed of 2 knots, which will serve to minimize exhaust emissions, and the main power plant will be turned off while the ship is moored.

Garbage will be disposed of in a government-approval landfill and will not be incinerated at or near the marine terminal.

The relatively small amount of airborne emissions and the mitigative measures outlined above combine to ensure that airborne emissions will not have significant environmental effects.

Chemical Losses Affecting Water and Sediment Quality

Equipment located at the marine terminal during the operations phase will contain only small quantities of hydrocarbons. Only hydraulic fluid and medium oils (for gearboxes) will be used. The hydraulic fluid storage is to be located at least 30 m from any body of water within a secure equipment room provided with secondary containment of at least 110 per cent of the tank's capacity. Gearboxes will have catchment trays, as will bearings, where regular greasing occurs (as per manufacture's specifications). Any machinery requiring minor repairs will be taken to a suitable location on land to be fixed, with no repairs of mobile machinery being performed at the marine terminal or within 30 m of any water body. Only minor repairs and maintenance of non-mobile equipment (such as greasing of loading/unloading gear) will be performed on-site. All major repairs will take place offsite at an approved facility.

Fuel and other toxic substances (as defined under Schedule 1 of the Canadian Environmental Protection Act; CEPA), will be handled, stored, or disposed only by persons who are trained and qualified to do so in accordance with the manufacturers' instructions (e.g. Material Safety Data Sheets) and governmental laws, acts (e.g. CEPA), and regulations (e.g. Storage and Handling of Gasoline and Associated Products Regulations; Used Oil Control Regulations). Procedures will include:

- Having operators present for refueling;
- Refueling equipment and vehicles at least 30 m from any water body, and over a non-permeable surface;
- Having basic petroleum spill clean-up equipment on-site, with absorbents to recover any hydrocarbon sheen on the water;
- Promptly containing, and cleaning up, all spills or leaks on land or in water and reporting them to the 24-hour environmental emergencies report system (1-800-563-9089) as required by Environment Canada;
- Allowing no on-site bulk storage of fuel or oil;
- Not disposing of wastes in or near waterbodies, and;
- Routine water testing as per criteria listed in Schedule A of the Environmental Control Water and Sewage Regulations (2003), under the Water Resources Act and ensuring any discharges from the site conform to CCME limits.

A Spill Contingency Plan will outline appropriate responses to accidental spills (from collisions, fires, structural failures), with spill kits (containing such things as floating booms and absorbents) being available on barges and service boats and at the marine terminal.

There will be continual observations by tanker and terminal personnel to detect any abnormalities. The terminal will be equipped with floodlights and operational cameras and monitoring equipment to detect leakage, spills or a change in position of the tanker while at the berth. Weather, wind and wave conditions will also be continuously monitored via a permanent weather buoy deployed adjacent to the terminal. The monitoring equipment will be located in the control room which will be manned 24-hours a day. Established parameters will be used to determine when conditions warrant stopping the discharge operation. If operating personnel detect a problem or the parameters are exceeded, cargo operations will be stopped and an investigation will be conducted. Cargo operations will not resume until it is safe to so.

When the cargo transfer is completed, tanks will be inspected, documents will be signed and exchanged, and cargo transfer arms will be removed.

The terminal will have all appropriate equipment and support facilities including: central control room, loading and unloading facilities, mooring equipment, tugs, leak/gas detection, spill containment, firefighting equipment and spill response equipment. The facility will provide a safe working environment and project personnel will be trained to operate and maintain the Marine Terminal equipment and to be first responders in the event of an emergency.

Water released at the outfall will be processed in a treatment facility and will meet the regulatory requirements of the Environmental Control (Water and Sewage) Regulations and the CCME limits (e.g. metals, dissolved oxygen, hydrocarbons). Routine water quality monitoring of the effluent stream will be conducted as per Schedule A of the regulations.

Environmental Effects Assessment

The relatively low potential for siltation, erosion, dust, airborne emissions, and chemical losses that would affect water and sediment quality and the mitigative measures outlined above combine to ensure that there will be no significant environmental effects.

Table 4.55 to Table 4.59 present the interactions between the Project and marine fish and fish habitat during the operational activities at the marine terminal site. As shown, the potential for environmental effects are of a minimal magnitude, extent and/or duration when mitigation methodologies are applied.

Table 4.55 Environmental Effects Assessment for Marine Water Resources During Marine Operations

Valued Environmental Component: Water Resources									
Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**						**Significance**
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**	
Refinery Operations and Maintenance									
Air emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Run-off, Siltation	Change in Water Chemistry Turbidity (A)	Yes	1	1	1	1	R	1	
Storage and disposal of wastes, debris	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Marine Terminal Operations									
Air emissions	Change in Water Chemistry (A)	Yes	1	2	1	1	R	1	
Storage and disposal of wastes, debris	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	

Valued Environmental Component: Water Resources									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/Socio-Cultural and Economic Context	
Vessel traffic	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Marine Transportation									
Air emissions	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Storage and disposal of wastes, debris	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Vessel traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Intakes/Outfalls									
Maintenance	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Effluent characteristics	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Solid and Hazardous Wastes								1	
Storage and disposal of wastes, debris	Change in Water Chemistry (A)	Yes	1	1	1	1	R	1	
Vessel Traffic	Change in Water Chemistry (A)	Yes	0	1	1	1	R	1	
Accidents or Malfunctions									
Oil Spill (Terminal)	Change in Water Chemistry (A)	Yes	3	1-2	1	2-4	R	1	
Oil Spill (Red Island)	Change in Water Chemistry (A)	Yes	3	2-3	1	2-4	R	1	
Oil Spill (Approach Placentia Bay)	Change in Water Chemistry (A)	Yes	3	3-4	1	2-4	R	1	

Table 4.56 Environmental Effects Assessment For Marine Fish and Fish Habitat During Marine Operations

Valued Environmental Component: Fish and Fish Habitat (Marine) – Commercial and Recreational									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
Refinery Operations and Maintenance									
Air emissions	Health Effects (A)	Yes	1	1	1	1	R	1	
Run-off, Siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Marine Terminal Operations									
Noise	Avoidance Health Effects (A)	Yes	1	1	5	1	R	1	
Presence of new structures	Habitat Removal (A) Increase Habitat Complexity (P)	Yes	2	1	6	5	I	1	
Run-off, siltation	Avoidance Health Effects (A)	Yes	1	1	1	1	R	1	
Marine Transportation									
Noise	Avoidance Health Effects (A)	Yes	1	1	5	1	R	1	
Vessel traffic	Harvester Displacement Avoidance (A)	Yes	1	1	5	1	R	1	
Intakes/Outfalls									
Maintenance	Avoidance (A)	Yes	1	1	1	1	R	1	
Entrainment	Attraction Health Effects Mortality (A)	Yes	1	1	2	1	I	1	
Effluent characteristics	Health Effects (A)	Yes	1	1	1	1	R	1	
Solid and Hazardous Wastes									
Storage and disposal of wastes, debris	Health Effects Mortality (A)	Yes	1	1	1	1	R	1	
Maintenance	Health Effects (A)	Yes	1	1	1	1	R	1	
Vessel Traffic	Avoidance (A)	Yes	1	1	1	1	R	1	

Valued Environmental Component: Fish and Fish Habitat (Marine) – Commercial and Recreational									
Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects						Significance
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context	
Accidents or Malfunctions									
Oil Spill (Terminal)	Health Effects Mortality Tainting (A)	Yes	3	1-2	1	2-4	R	1	
Oil Spill (Red Island)	Health Effects Mortality Tainting (A)	Yes	3	2-3	1	2-4	R	1	
Oil Spill (Approach Placentia Bay)	Health Effects Mortality Tainting (A)	Yes	3	3-4	1	2-4	R	1	

Table 4.57 Residual Environmental Effects Assessment for Marine Water Resources During Marine Operations

Valued Environmental Component: Water Resources				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Air emissions	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Storage and disposal of wastes, debris	NS	3	1	3
Marine Terminal Operations				
Air emissions	NS	3	1	3
Storage and disposal of wastes, debris	NS	3	1	3
Vessel traffic	NS	3	1	3
Marine Transportation				
Air emissions	NS	3	1	3
Storage and disposal of wastes,	NS	3	1	3

Valued Environmental Component: Water Resources				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
debris				
Vessel traffic	NS	3	1	3
Intakes/Outfalls				
Vessel Traffic	NS	3	1	3
Location of pipes	NS	3	1	3
Maintenance	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	NS	2	1	2
Solid and Hazardous Wastes				
Storage and disposal of wastes, debris	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	S	2	1	2
Maintenance	NS	3	1	3
Vessel Traffic	NS	3	1	3
Accidents or Malfunctions	S (3)	2	1	2

Table 4.58 Residual Environmental Effects Assessment for Marine Fish and Fish Habitat (Commercial Fisheries and Aquaculture) During Marine Operations

Valued Environmental Component: Fish and Fish Habitat (Marine) – Commercial and Aquaculture				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Air emissions	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Marine Terminal Operations				
Noise	NS	3	1	3
Run-off, siltation	NS	3	1	3
Vessel traffic	NS	3	1	3

Valued Environmental Component: Fish and Fish Habitat (Marine) – Commercial and Aquaculture				
Project Activity	Significance Rating	Level of Confidence	Likelihood	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Marine Transportation				
Noise	NS	3	1	3
Vessel traffic	NS	3	1	3
Intakes/Outfalls				
Vessel Traffic	NS	3	1	3
Location of pipes	NS	3	1	3
Maintenance	NS	3	1	3
Entrainment	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	NS	3	1	3
Solid and Hazardous Wastes				
Storage and disposal of wastes, debris	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	NS	3	1	3
Maintenance	NS	3	1	3
Vessel Traffic	NS	3	1	3
Accidents or Malfunctions	S (3)	2	1	2

Table 4.59 Residual Environmental Effects Assessment for Marine Fish and Fish Habitat (Recreational Fisheries) During Marine Operations

Valued Environmental Component: Fish and Fish Habitat (Marine) – Recreational				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Noise	NS	3	1	3
Run-off, Siltation	NS	3	1	3
Vessel traffic	NS	3	1	3
Marine Terminal Operations				
Noise	NS	3	1	3
Run-off Siltation	NS	3	1	3

Valued Environmental Component: Fish and Fish Habitat (Marine) – Recreational				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Vessel traffic	NS	3	1	3
Marine Transportation				
Noise	NS	3	1	3
Vessel traffic	NS	3	1	3
Intakes/Outfalls				
Vessel Traffic	NS	3	1	3
Location of pipes	NS	3	1	3
Maintenance	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	NS	3	1	3
Solid and Hazardous Wastes				
Storage and disposal of wastes, debris	NS	3	1	3
Location of outfall pipes	NS	3	1	3
Effluent characteristics	NS	3	1	3
Maintenance	NS	3	1	3
Vessel Traffic	NS	3	1	3
Accidents or Malfunctions	S (3)	2	1	2

4.8.3 Mitigation

Mitigation measures that will be used during the construction and operation of the marine terminal to avoid or minimize potential effects on marine fish and fish habitat are described below. For each project activity, mitigation ensures that the potential effect can be not significant.

Potential effects to marine fish and fish habitat that may occur during the construction and operation of marine facilities include:

- Mortality of fish or destruction of habitat;
- Chemical losses affecting water and sediment quality.

Mitigations for these potential effects are listed below.

- Adherence to the HADD compensation strategy; compensating for the 38,729m2 of lobster habitat lost due the marine facilities construction.
- All activities will adhere to:
  - o National Policy for the Management of Fish Habitat;

  - Fisheries Act - Habitat Protection and Pollution Prevention Provisions
- Compliance and Enforcement Policy, and;
  - Environmental Control Water and Sewage Regulations under the Water Resources Act;
  - CCME guidelines, including those outlined in The Canadian Water Quality Guidelines for the Protection of Aquatic Life.
  - Canada Shipping Act;
  - Storage and Handling of Gasoline and Associated Products Regulations, and;
  - Used Oil Control Regulations.
- Utilizing clean fill: less than 5 per cent fines, non-acid generating) blasted rock from the terrestrial construction site,
- Prior to any works, silt curtains will be put in place around active work areas, extending from the surface to the seabed, Infill will be dumped in place and not stockpile along the shoreline, with placement not being conducted during period of high wind, waves or precipitation
- Armour stone will be placed progressively to minimize shoreline erosion and prevent the loss of infill material.
- Pilings will be placed by drilling, and not pile driving, with cuttings being returned to the surface to be settled-out in tanks onboard the barge rig.
- Cuttings will be disposed of either on approved site within the terrestrial construction site or in a local landfill.
- Water releases leaving the silt curtains, or any work area in or near the marine environment, will have suspended solids concentrations not exceeding 25 mg/L (monthly average) or 50 mg/L (grab sample) as per Section 36 of the Fisheries Act.
- Leaks and spills will be prevented through regular maintenance of vehicles and equipment.
- Heavy equipment (e.g. cranes dump trucks, loaders) will only be used on dry, stable, land or barges specifically designed for that purpose. Heavy equipment will operate from barges completing work above the high water mark during low tide.
- No refueling or repairs will be done on the marine terminal or within 30 m of any waterbody.
- Floating booms will be in place during all construction activities.
- Spill kits, containing such items as absorbents capable of retaining and removing oil sheen and waste storage containers, will be available on barges and boats required for construction and the terminal itself.
- Concrete forms will either be set on land and brought to the marine terminal site once cry, or wet concrete will be mixed offsite and set within leak proof forms.
- Tools will not be washed in any waterbody and not within 30 m of any waterbody.
- Any wooden concrete forms or any other wooden structures built on or near the marine environment will be made of wood deemed safe for use as per the Guidelines

to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region (Hutton and Samis 2000).

- Fuel, and other toxic substances (as defined under Schedule 1 of the Canadian Environmental Protection Act; CEPA), will only be handled, stored, or disposed by persons who are trained and qualified to do so in accordance with the manufacturers' instructions (e.g. Material Safety Data Sheets) and governmental laws, acts (e.g. CEPA), and regulations (e.g. Storage and Handling of Gasoline and Associated Products Regulations; Used Oil Control Regulations). Procedures will include:

    - Having operators present for the duration of refueling;
    - Refueling equipment and vehicles at least 30 m from any water body, and over a non-permeable surface;
    - Having basic petroleum spill clean-up equipment on-site, with adsorbents being used to recover any hydrocarbon sheen on the water;
    - Promptly containing, and cleaning up, all spills or leaks on land or in water and Reporting them to the 24-hour environmental emergencies report system (1-800-563-9089) as required by Environment Canada;
    - Allowing no on-site bulk storage of fuel or oil;
    - Not disposing of wastes in or near waterbodies, and;
    - Routine water testing as per criteria listed in Schedule A of the Environmental Control Water and Sewage Regulations (2003), under the Water Resources Act and ensuring any discharges from the site conform to CCME limits.

To mitigate effects to marine fish and fish habitat and commercial fisheries that may occur during shiploading and other shipping activities, the following mitigative measures are suggested.

- A Spill Contingency Plan and spill kits will be available on barges and service boats and the marine terminal itself. All water releases will meet the regulatory requirements of the Environmental Control (Water and Sewage) Regulations and the CCME limits (e.g. metals, dissolved oxygen, hydrocarbons).
- Aggregate losses from spills, accidents or machinery malfunctions will be minimized by fitting all conveyors servicing the marine terminal with hoods and maintaining all ship loading equipment in a state of good repair and regularly inspected to ensure maximum efficiency and to minimize the potential for malfunction. All machinery will be operated by only those employees properly trained to do so.
- The EPP and contingency planning outline appropriate responses to accidental spills, with spill kits (containing such things as silt curtains and floating booms) available on barges or boats servicing the marine terminal and the terminal itself.
- No bilge or ballast will be discharged at the marine terminal site or outside the bounds of the Canada Shipping Act and associated regulations.
- Ships will be registered with the ECRC, and all ships will carry oil spill clean up equipment (e.g. absorbents, inflatable dykes) with trained crew members in spill prevention and clean up techniques.

- Interactions between large vessels and local marine traffic will be minimized by several factors, mainly by having state-of-the-art navigation, radar, and communications equipment

To mitigate effects to marine fish and fish habitat and commercial fisheries that may occur during blasting, the following mitigative measures are suggested.

- The use of explosives near water will adhere to the guidelines of Wright and Hopky (1998) to avoid impacts to fish or fish habitat.
- Blasting will follow best practices with respect to blast protocols, explosives and their storage, with operations being in accordance will all acts, regulations and guidelines described therein.

Monitoring

If required by DFO Habitat Branch, a monitoring program will be employed to monitor the structural stability and habitat utilization of the newly created lobster habitat. The monitoring program will include such things as video and photographic surveys, visual inspections, and assessment of new habitat utilization by flora and fauna.

4.8.4 Accidents and Malfunctions

Newfoundland and Labrador Refinery Corporation is committed to the sustainable development of the Southern Head area and Placentia Bay in general and has, as per section 16(1) of the CEAA, assessed the potential for accidents or malfunctions related to the project. The primary pathway with respect to potential environmental effects upon marine fish and fish habitat is the accidental release of hydrocarbons.

Oil Dispersion in the Marine Environment

Dispersion in the marine environment depends on the composition of the oil and the surrounding environmental conditions. Oil is distributed on the surface by gravity and is controlled by viscosity and surface tension. During the first several days after a spill, a considerable part of oil transforms into the gaseous phase. Besides volatile components, the slick rapidly loses water-soluble hydrocarbons. The rest, the more viscous fractions, slow down the slick spreading (Stanislav, 1999).

Physical transport

An oil slick will usually drift in the direction of the wind. As it thins it disintegrates into fragments and will disperse over larger areas. Storms and rough seas will further breaking the oil into small droplets that area be transported further away from the spill.

Dissolution

Most oil components are water-soluble to a certain degree, especially low-molecular-weight aliphatic and aromatic hydrocarbons. Polar compounds formed as a result of oxidation of some oil fractions in the marine environment also dissolve in seawater. Compared with evaporation, dissolution takes more time. Hydrodynamic and physicochemical conditions in the surface waters strongly affect the rate of the process.

Emulsification

Emulsification of oil will depend on its composition and water turbulence. The most stable emulsions tend to be water-in-oil with 30 - 80 per cent being water. They can be found in the environment up to 100 days after a spill, with stability increasing as the temperature drops. The reverse emulsions, oil-in-water, are less stable because surface tension forces quickly decrease the dispersion of oil. The addition of emulsifiers will stabilize the oil and disperse it into small microscopic droplets. This accelerates the decomposition of oil into the water column.

Oxidation and destruction

Chemical transformation of oil on the surface and in the water column can be seen no earlier than a day after the oil enters the water. They mainly have an oxidative nature and often involve photochemical reactions to ultraviolet waves. These processes are catalyzed by some trace elements (e.g., vanadium) and inhibited by compounds of sulfur. The final products of oxidation (hydro peroxides, phenols, carboxylic acids, ketones, aldehydes, and others) usually have increased water solubility. Research has shown that they have increased toxicity as well [Izrael, Tsiban, 1988]. The reactions of photo oxidation, photolysis in particular, initiate the polymerization and decomposition of the most complex molecules in oil composition. This increases the oil's viscosity and promotes the formation of solid oil aggregates [GESAMP, 1977; 1993].

Sedimentation

Some of the oil is absorbed by suspended material and deposited on the bottom. This mostly happens in narrow inlets with wave action and lots of suspended matter. In deeper areas far from shore, sedimentation is a much longer process.

Simultaneously, the process of biosedimentation happens. Plankton filtrators and other organisms absorb the emulsified oil. The suspended forms of oil and its components undergo intense chemical and biological (microbial in particular) decomposition in the water column. However, this situation radically changes when the suspended oil reaches the sea bottom. It has been shown that once oil is buried its decomposition rate drops dramatically. The oxidation processes slow down, especially under anaerobic conditions in the bottom environment. The heavy oil fractions accumulated inside the sediments can be preserved for many months and even years.

Microbial degradation

About 100 known species of fungi and bacteria are able to use oil to sustain their growth and metabolism. The degree and rate of hydrocarbon biodegradation depends on how complex they are. Paraffin compounds will degrade faster than aromatic and naphthenic substances. The most important environmental factors that influence hydrocarbon biodegradation include temperature, concentration of nutrients and oxygen, and, of course, species composition and abundance of oil-degrading microorganisms.

Aggregation

Oil can aggregate in the form of petroleum lumps, tar balls or pelagic tar, and can be present in open and coastal waters as well as on the beaches. The composition can vary but its base most often includes asphaltenes (up to 50 per cent) and high-molecular-weight compounds of the heavy fractions of the oil.

Their color can be light gray, brown, dark brown, or black. Lumps generally range from 1mm to 10cm in size but can reach up to 50cm. Their surface serves as a substrate for developing bacteria, unicellular algae, and other microorganisms. Many invertebrates (e.g., gastropods, polychaetes, and crustaceans) resistant to oil's impacts often use them as shelter.

Oil aggregates can last from a month to a year in enclosed seas and up to several years in open seas. Their cycle is completed by degrading in the water column, on a beach or on the ocean bottom.

Self-purification

Under self purification the oil quickly loses its original properties and disintegrates into hydrocarbon fractions. They undergo radical transformations that slow after reaching thermodynamic equilibrium with the environmental parameters. Their content gradually drops as a result of dispersion and degradation. Eventually, the original and intermediate compounds disappear, forming carbon dioxide and water. Such self-purification eventually occurs in marine ecosystems if the toxic load does not exceed the systems limits.

Aquatic environments are made up of complex interrelationships between plant and animal species and their physical environment. Harm to the physical environment will often lead to harm for one or more species in a food chain, which may lead to damage for other species further up the food chain.

The United States National Park Service compiled an Environmental Contaminants Encyclopedia (Irwin et al. 1997), which summarizes many of the processes and pathways associated with a potential oil spill. A brief summary of the relevant information is presented below along with information from other sources such as CCME (2006).

Crude oils vary in physical characteristics such as color, viscosity, and specific gravity. Color ranges from light yellow-brown to black. Viscosity varies from free-flowing to a substance that will barely pour. Specific gravity is used to classify crude oil as light, medium (intermediate) or heavy. Crude oil is rarely used in the form produced at the well, but is converted in refineries into a wide range of products such as gasoline, kerosene, diesel fuel, jet fuel, domestic and industrial fuel oils. The following definitions generally describe petroleum products and crude oil fractions:

Light Oils (Diesel, No. 2 Fuel Oils, Light Crudes):

- Moderately volatile; will leave residue (up to 1/3 of spilled amount);
- Moderate concentrations of toxic (soluble) compounds;
- Will "oil" intertidal resources with long-term contamination potential;
- Has potential for subtidal impacts (dissolution, mixing, sorption onto suspended sediments);
- No dispersion necessary; and
- Cleanup can be very effective.

Medium Oils (Most Crudes):

- About 1/3 will evaporate within 24-hours;
- Maximum water-soluble fraction is 10-100 ppm;
- Oil contamination of intertidal areas can be severe/long term;
- Impact to waterfowl and fur-bearing mammals can be severe;
- Chemical dispersion is an option within 1 to 2 days; and
- Cleanup most effective if conducted quickly.

Heavy Oils (Heavy Crude Oils, No. 6 fuel, Bunker C):

- Heavy oils with little or no evaporation or dissolution;
- Water-soluble fraction likely to be <10 ppm;
- Heavy contamination of intertidal areas is likely;
- Severe impacts to waterfowl and fur-bearing mammals (coating and ingestion);
- Long-term contamination of sediments possible;
- Weathers very slowly;
- Dispersion seldom effective; and
- Shoreline cleanup difficult under all conditions.

A comprehensive review of the physicochemical properties of several oils and oil products found their persistence in the aquatic environment to rank as follows (from most persistent to least persistent): Residual asphaltenes > Heavy crude oil > Medium crude oil > Fuel oil #6 > Light crude oil > Lube oils > Fuel oil #2 > Jet fuel > Gasoline.

Oil Toxicity in the Marine Environment

Crude petroleum and its products are a complex mixture of organic chemicals containing less persistent and more persistent fractions. The range between these two extremes is greatest for crude oils. Since petroleum is such a complex mixture of thousands of substances with different physical and chemical properties, summarizing the toxicity or general hazard of petroleum in general, or even a particular oil, is difficult.

Crude oil and petroleum products vary considerably in their toxicity, and the sensitivity of fish to petroleum varies according to species. The toxicity of crude oil can be interpreted as the toxicity of a complex mixture of inorganic and organic chemicals; however, a great deal of uncertainty exists in the use of dose-response relationships based on crude oil as a whole mixture. An alternative approach that is often used is the "indicator chemical approach". This involves selecting a subset of chemicals from the whole mixture that represents the "worst-case" in terms of mobility and toxicity. This approach can be used with crude oil with the subsets of chemicals being volatile organics such as benzene, toluene, methylbenzene, and xylenes (known as BTEX, if present) and polycyclic aromatic hydrocarbons (PAHs). BTEX are of interest because they are soluble in water and highly mobile in the environment, and they represent the more volatile and soluble components of crude oil. In addition, benzene is an EPA-defined class-A carcinogen. PAHs are not highly mobile but are of interest because they are prevalent in crude oil; they represent the heavier or less volatile crude oil components, and several are known animal carcinogens.

Benzene

If benzene is released in water, environmental fate processes may result in rapid removal from the water column. Half-lives for evaporation and volatilization have been estimated to be 5 and 2.7 hours respectively. It can be degraded by a variety of aquatic micro-organisms with rates depending on many factors including temperature and acclimation of the microbial community. Half-lives range from 33 to 384 hours for aerobic biodegradation and 28 to 720 days for anaerobic biodegradation in water. Benzene is not expected to concentrate in aquatic organisms or to significantly adsorb to sediments or soil. The CCME guideline for water quality for the protection of aquatic life is 370μg/L.

Toluene

If toluene is released in water, it will remain there for days and possibly weeks. It is removed from water by volatilization and biodegradation at a rate dependant on temperature, mixing conditions and the existence of acclimated micro-organisms. Toluene does not tend to hydrolyze or adsorb to sediments and will not bio-concentrate in aquatic organisms. The interim CCME guideline for water quality for the protection of aquatic life is 2.0μg/L (freshwater; no guideline is available for seawater).

Ethyl benzene

Ethylene may volatilize within a few hours after release, but can remain for a few weeks, depending on local conditions. The average volatilization half-life from surface water is 3.1 hours. Methylbenzene may absorb to sediment but bio-concentration in fish is considered unlikely. The interim CCME guideline for water quality for the protection of aquatic life is 90μg/L (ppb) (freshwater; no guideline is available for seawater).

Xylene (General)

Xylene is a volatile, organic, monocyclic aromatic compound. It is widely used as an industrial solvent where it usually a mixture of ortho-, meta-, and para- isomers. There are no CCME guidelines for water quality for the protection of aquatic life. There is some information available from the US National Parks Service (Environmental Contaminates Encyclopedia, Irwin et al. 1997) and it has been reported that the LC50 for rainbow trout (*Oncorhynchus mykiss)* was 13.5ppm for 24-hour exposure and 8.2ppm for 96-hour exposure.

Polycyclic Aromatic Hydrocarbons (PAH)

PAHs are non-polar, hydrophobic compounds that do not ionize. As such, they tend to adsorb onto sediments and/or other solid phases in aquatic environments. Volatilization, photolysis, hydrolysis, microbial degradation and adsorption and subsequent sedimentation determine the fate of PAHs in the environment. Sorption to sediment substrates plays an important role in PAH transport and distribution. PAHs are subject to biodegradation by various micro-organisms that live in soils or sediment or are suspended in the water column.

Aquatic organisms can accumulate PAHs from water, sediment and ingestion of food items. Literature suggests that bio-concentration is highly variable with algae and molluscs, which cannot metabolize PAHs rapidly, exhibiting higher rates than fish and crustaceans which can more readily metabolize PAHs. The interim CCME guidelines for water quality for the protection of aquatic life are (freshwater, no guideline is available for seawater);

- Acenaphthene 5.8μg/L
- Acridine 4.4μg/L
- Anthracene 0.012μg/L
- Benz(a)anthracene 0.018μg/L
- Benzo(a)pyrene 0.015μg/L

- Chrysene no recommended guideline
- Fluoranthene 0.04μg/L
- Fluorene 3.0μg/L
- Naphthalene 1.1μg/L
- Phenanthrene 0.4μg/L
- Pyrene 0.025μg/L
- Quinoline 3.4μg/L

Oil Toxicity – American Lobster

This section summarizes the effects of an oil spill on a commercial lobster fishing area and an associated experiment conducted to discern the effects of oil exposure upon lobster (*Homerus americanus*), which is the primary marine species in terms of proposed compensation and monitoring efforts at the Southern Head marine terminal site.

In 1993 the wreck of the oil tanker *Braer* caused an oil spill off the southern tip of Shetland, Ireland, an area of similar lobster habitat and comparable weather patterns to Southern Head. It spilled 85 000 tonnes of crude oil and 500 tonnes of bunker (heavy fuel) oil. Immediately following the grounding, while oil was spilling from the wreck, the concentration in the area close to the wreck was measured at some hundreds of parts per million (ppm; 1 ppm/1ml of oil per tonne of water). In the days following the spill the waters around the wreck site exhibited oil concentrations as high as 50 ppm (20,000 times 'normal' levels), but by ten days after the spill this had fallen to about 4 ppm. Approximately 120 tonnes of dispersants were sprayed within a few days of the spill, but compared to the effects of the wave action at the time this would have had a negligible effect on the oil, dispersing at most only 2-3per cent of the amount spilled.

As a result, the lobster fishery was closed for two years, reopening in spring 1995. Lobster fishers immediately noticed a decline in their catch and that the amount of young lobsters caught had decreased drastically (Laurenson and Wishart, 1996).

Consequently an experiment was carried out to discern the effects of oil on adult, juvenile and larval lobsters and on lobster eggs. The experiment used three laboratory conditions: control (no oil fraction); 4 ppm; and 10 ppm (increased to 50 ppm after 120 hrs).

There were no mortalities among the adult lobster and very few among the juvenile lobster during the tests. Their behaviour, however, changed dramatically as the level of oil increased. The movement, level of aggression, responsiveness to stimuli, and feeding of adults and juveniles were all reduced. Even though few died in the test, this behaviour over a prolonged period could inadvertently result in their death: They could be preyed upon by moving slowly and not acting aggressively, or die of starvation by not eating.

The lobster eggs and larval lobsters exhibited a high mortality. There was also a significant decrease in larval activity. Many eggs were lost from berried lobsters, possibly from damage to the connective tissue that holds the egg mass together. Larvae were also discovered semi-hatched which could indicate premature hatching due to the oil or an acute toxic effect once hatched.

This experiment demonstrated that exposure to the same concentrations of oil lost from the Braer can have significant effects on lobsters. From the experiment it was found that the most impact would be felt on the younger stages of the lobster life cycle. This would result in a decreased catch once the commercial fishery resumed. The results also indicated that bunker oil has a much more toxic effect on lobsters then crude oil.

The spill also had adverse effects on local salmon farms and shellfish. Fisherpersons were still reporting oil in their catches in 1996 (three years after the spill event). Oil was also detected at distances farther than the modelling had predicted. The tides had spread the oil underwater around the 900 miles of Shetland coastline.

4.8.5 Habitat Compensation Strategy

The marine habitat compensation scheme has been duscussed under the above Section 4.8.3, which discusses mitigation measures related to effects on marine fish and fish habitat, as well as in the Component Study for Marine Fish and Fish Habitat.

4.9 Marine Mammals/River Otters and Sea Turtles Effects Assessment

4.9.1 Project Effects During Construction

During construction of the oil refinery and the marine terminal, there are five main types of activities that may impact marine mammals (including river otters) and sea turtles: noise, vessel traffic (physical presence), presence of structures, run-off and siltation, and air emissions.

Of these construction activities, noise has greatest potential for impact, as noise is associated with almost every aspect of construction and this VEC is known to be sensitive to noise. There is little systematic information available for reactions of marine mammals and especially sea turtles to pile driving, installation of sub-sea structures, and the presence of multiple vessels (Richardson et al. 1995; Nowacek et al. 2007). Data exist for response of some marine mammals to blasting and single vessel operations.

Noise

To assess the potential effects of noise from construction activities on the marine mammals and turtles, this section provides the following: a summary of the types of noise; a description of the hearing abilities of marine mammals and sea turtles; and consideration of the potential for masking and disturbance by construction noises, the possibility of hearing impairment, the possibility of strandings and mortality, and non-auditory physiological effects.

Categories of Noise Effects

The effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson et al. 1995):

- The noise may be too weak to be heard at the location of the animal, i.e., lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both;
- The noise may be audible but not strong enough to elicit any overt behavioural response, i.e., the mammals may tolerate it;
- The noise may elicit behavioural reactions of variable conspicuousness and variable relevance to the well-being of the animal; these can range from subtle effects on respiration or other behaviours (detectable only by statistical analysis) to active avoidance reactions;
- Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, unpredictable in occurrence, and associated with situations that the animal perceives as a threat;
- Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes, and environmental sounds such as surf noise or, closer to the surface, ice noise.

- Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity, or other physical or physiological effects. Received sound levels must far exceed the animal's hearing threshold for any temporary threshold shift to occur. Received levels must be even higher for a risk of permanent hearing impairment.

<u>Hearing Abilities of Marine Mammals and Sea Turtles</u>

The hearing abilities of marine mammals are functions of the following (Richardson et al. 1995; Au et al. 2000):

- Absolute hearing threshold at the frequency in question (the level of sound barely audible in the absence of ambient noise) the "best frequency" being the frequency with the lowest absolute threshold;
- Critical ratio (the signal-to-noise ratio required to detect a sound at a specific frequency in the presence of background noise around that frequency;
- The ability to localize sound direction at the frequencies under consideration; and
- The ability to discriminate among sounds of different frequencies and intensities.

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments also show that they hear and may react to many anthropogenic sounds including some that will be produced during construction.

Toothed Whales. Hearing abilities of some toothed whales (odontocetes) have been studied in detail (reviewed in Chapter 8 of Richardson et al. [1995] and in Au et al. [2000]). Hearing sensitivity of several species has been determined as a function of frequency. The small to moderate-sized toothed whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) report that a Gervais' beaked whale showed evoked potentials from 5 to 80 kHz, with the best sensitivity at 80 kHz.

Baleen Whales. The hearing ability of baleen whales have not been measured directly. Behavioural and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000). Baleen whales also reacted to sonar sounds at 3.1 kHz and other sources centered at 4 kHz (see Richardson et al. 1995 for a review). Frankel (2005) noted that migrating gray whales reacted to a 21–25 kHz whale-finding sonar. Some baleen whales reacted to pinger sounds up to 28 kHz, but not to pingers or sonars emitting sounds at 36 kHz or above (Watkins 1986). In addition, baleen whales produce sounds at frequencies up to 8 kHz and, for humpbacks, to > 15 kHz (Au et al. 2001). The anatomy of the baleen whale inner ear seems to be well adapted for detection of low-frequency sounds (Ketten 1991, 1992, 1994, 2000). The absolute sound levels that they can detect below 1 kHz are probably limited by increasing levels of natural ambient noise at low frequencies. Ambient noise energy is higher at low frequencies than at mid frequencies. At frequencies below 1 kHz, natural ambient levels tend to increase with decreasing frequency. The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small toothed whales that have been studied directly.

Pinnipeds. Underwater audiograms have been obtained using behavioural methods for three species of phocid seals, two species of monachid seals, two species of otariids, and the walrus (reviewed in Richardson et al. 1995: 211ff; Kastak and Schusterman 1998, 1999; Kastelein et al. 2002). Compared to odontocetes, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies, and poorer sensitivity at the best frequency.

At least some of the phocid (hair) seals have better sensitivity at low frequencies (~ 1 kHz) than do odontocetes. Below 30–50 kHz, the hearing thresholds of most species tested are essentially flat down to about 1 kHz, and range between 60 and 85 dB re 1 µPa. Measurements for a harbour seal indicate that, below 1 kHz, its thresholds deteriorate gradually to ~97 dB re 1 µPa at 100 Hz (Kastak and Schusterman 1998). The northern elephant seal appears to have better underwater sensitivity than the harbour seal, at least at low frequencies (Kastak and Schusterman 1998, 1999).

River Otters. There is no available information on river otter hearing abilities[7] (or sea otter hearing; Ketten 1998). River otters are known to emit a snarling growl or hissing bark when disturbed and a shrill whistle when in pain. When at play or traveling, they sometimes emit a low purring grunt. An alarm call, in the form of an explosive snort is made by expelling air through the nostrils. Otters also may use a bird-like chirp for communication over long distances, but the most common sound heard is low-frequency chuckling (see Lariviere and Walton 1998). Unfortunately, the frequencies of these calls are not documented.

Sea otters seem to produce some of the same airborne sounds as river otters (Kenyon 1975; McShane et al. 1995). The in-air vocalizations of sea otters have most of their energy concentrated at 3 to 5 kHz (McShane et al. 1995; Thomson and Richardson 1995; Richardson et al. 1995). Sea otter vocalizations are considered to be most suitable for short-range communication among individuals (McShane et al. 1995).

Sea Turtles. The limited available data indicate that the frequency range of best hearing sensitivity by sea turtles extends from roughly 250–300 Hz to 500–700 Hz (Ridgway et al. 1969; Bartol et al. 1999). Sensitivity deteriorates as one moves away from this range to either lower

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[7] The following reference was requested but has not been received: Gunn, L.M. 1988. A behavioral audiogram of the North American river otter (Lutra canadensis). M.S. thesis, San Diego State Univ., San Diego, CA. 40 p.

or higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz.

Sound Thresholds for Hearing Impairment

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds (see Richardson et al. 1995). The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable Temporary Threshold Shift (TTS). The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage. Current U.S. National Marine Fisheries Service (NMFS) policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds exceeding 180 and 190 dB re 1 mPa (rms), respectively (NMFS 2000). [Note that NMFS is considering alternative criteria—see Federal Register/Vol. 70(7): 1871-1875.][8] Those criteria have been used in establishing the safety (power-down) zones for seismic surveys in some parts of Canada. However, those criteria were established before there was any information about the minimum received levels of sounds necessary to cause TTS in marine mammals. The 180 dB criterion for cetaceans is probably quite conservative (i.e., lower than necessary to avoid auditory injury), at least for delphinids. Most sound levels produced by construction and operational activities for the Project are much lower than those produced during seismic surveys. In the absence of new criterion and to ensure a conservative approach, 180 and 190 dB criteria are used when attempting to mitigate potential impacts of noise on marine mammals (and sea turtles).

Land-based Blasting (Site Preparation)

Blasting will not occur in marine areas. However, blasting in the refinery footprint during site preparation has the potential to generate a shock wave that could propagate into the marine water column. It is expected that blasting operations will occur over 48 months. The short rise time to a high peak pressure of shock pulses from explosives appears to be responsible for much of the damage to marine mammals during these detonations (Ketten 1995) and there is potential for behavioural disturbance (Richardson et al. 1995). Humpback whale responses to underwater (sub-bottom) explosions (associated with construction activity) in Trinity Bay, Newfoundland, were monitored for a 19-day period in June 1992 (Todd et al. 1996). Surveys (photographic when possible) were conducted before, during and after explosions. Data were

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[8] NMFS is developing new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to which different marine mammal groups are sensitive, and other relevant factors. For preliminary information about this process, and about the structure of the new criteria in marine and terrestrial mammals see Wieting (2004) and Southall et al. (2007).

used to calculate residency, resighting rates, and net movement toward or away from the noise source. Acoustic recordings of the explosions as well as whale vocalizations were acquired. Explosives (Tovex™) ranged from 30-5,500 kg and averaged 960 kg. Todd et al. (1996) reported that received sound levels (although erroneously called source levels) typically were 140-150 dB re 1 μPa (maximum 153 dB) near 400 Hz. The authors estimate a source level of 209 dB re 1 μPa at 1 m. It is not clear what acoustic metric is used (i.e., rms, 0-peak, peak-peak) and what broadband sound levels resulted from the blasts. Behavioral observations of humpbacks *in situ* on their foraging grounds suggest that the whales were not reacting to the intense acoustic stimuli from the detonations (Todd et al. 1996). It is unclear if an increase in humpback entrapments in fishing nets in the area were related to underwater explosions. Two dead humpbacks with severe auditory damage were found near the site of repeated sub-bottom blasting. The damage was similar to that in humans exposed to severe blast injury. It is likely the humpbacks were killed as a result of exposure to shock waves (Ketten 1995).

Toothed whales, including belugas, bottlenose dolphins, false killer whales and killer whales, exposed to small explosive charges (received sound level of 185 dB re 1 μPa in one study) found limited or no effect on these marine mammals (Richardson et al. 1995). Larger explosions can kill dolphins: Chinese river dolphins, Irrawaddy dolphins, and finless porpoises have been killed by explosions in rivers (see p. 307 in Richardson et al. 1995).

Pinnipeds seem quite tolerant of noise pulses from small explosives (Richardson et al. 1995). Firecracker-like explosives initially startle seals and sea lions and often induce them to move away, but avoidance wanes after repeated exposure. Northern fur seals breeding on land did not exhibit any obvious response to nearby (0.6-2 km) blasts from quarries (Gentry et al. 1990). South American fur seals, sea lions and grey seals exposed to blasting operations showed little or no reactions. Close exposure to blasts may cause hearing damage or other injuries, but there are few confirmed reports of this (Richardson et al. 1995). There are several reports that pinnipeds near explosives (detonated in the water) were killed but this has not been shown for blasts on land.

There are no systematic data available for effects of blasting on river otters or sea turtles. However, Hussain and Choudhury (1997) did not find any signs of smooth-coated otters (*L. perspicillata*) within 5 km of construction sites and areas where stone quarrying and sand mining were occurring. They also noted that otters that left disturbed areas returned to these sites later. Sea otters exposed to a shock wave (from an underground nuclear test) with a peak pressure of 237-246 dB were killed (see p. 308 in Richardson et al. 1995).

There is little chance of masking of any marine mammal sounds, as blasting operations will be intermittent in nature and the sound pulse is very short.

Details about explosive types and locations are not available at the time of writing of this EIS; however, blasting parameters will be such that they adhere to the DFO guidance outlined in

"Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters" (Wright and Hopky 1998). Most notably, these guidelines suggest that the maximum pressure should not exceed 100 kPa and that a setback distance from the land-water interface should be determined to restrict peak ground velocities to less than 13 mm/s. Common practice is to undertake a blast impact assessment prior to execution of the project and design the blasting to conform with these guidelines. During construction the pressures from blasting will be monitored at the shoreline and in the water. If the noise exceeds that specified in the guidelines, adjustments will be made to the blasting procedures. It is anticipated that blasting will be more than 30 m from the shoreline and/or sea level. This will be monitored and contractors advised of the guidelines and actions required under the site Environmental Protection Plan.

A blast impact assessment will be undertaken to determine appropriate setback distances and ensure that 100 kPa is not exceeded. In addition, the sound levels in the water column will be evaluated to determine a safety zone for marine mammals. Received sound levels of 180 dB and 190 dB re 1 µPa rms for cetaceans and phocids, respectively, will be used as a guide for these zones (see NMFS 2000), which will be monitored for 30 minutes prior to blasting operations near the marine environment, and blasting operations will be temporarily suspended if a marine mammal, river otter or sea turtle is sighted within or about to enter the zone. In addition, blasting operations will not commence if a river otter (or terrestrial wildlife) is sighted in a designated safety zone.

Effects Assessment. During site preparation, which is estimated to take place over four years, the effects of on-land blasting (with mitigation measures in place) on toothed and baleen whales' health could range from negligible to low magnitude over a geographic extent of <1 km^2. The risk of exposing toothed or baleen whales to sound levels known to be high enough to cause temporary or permanent hearing impairment is very unlikely, given that the blasting assessment will ensure that 100 kPa is not exceeded and that blasting will not be permitted if a cetacean is sighted within a designated safety zone (180 dB re 1 µPa rms). Some toothed and baleen whales may avoid the area adjacent to nearshore blasting sites. Disturbance effects from single blasting events should be low magnitude over a geographic extent of 1-10 km^2 to 101-1000 km^2. The duration of blasting is predicted to be 37-72 months during which explosives will be used periodically and effects are considered reversible (Table 4.60). Given the mitigation measures, it is predicted that there will be no significant negative effect on toothed and baleen whales from the use of explosives at the proposed refinery site (Table 4.61). The level of confidence associated with this assessment is high.

Seals, including the harbour seal, which is a year-round resident, have not been reported in the immediate construction area. During site preparation, the effects of on-land blasting (with mitigation measures in place) on seal health could range from negligible to low magnitude over a geographic extent of <1 km^2. The risk of exposing seals to sound levels known to be high enough to cause temporary or permanent hearing impairment is very unlikely given that the blasting assessment will ensure that 100 kPa is not exceeded and that blasting will not be permitted if a seal is sighted within a designated safety zone (190 dB re 1 μPa rms). Some seals may avoid the area. Disturbance effects from single blasting events should be negligible to low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of blasting is predicted to be 37-72 months and effects are considered reversible (Table 4.62). Given the mitigation measures, it is predicted that there will be no significant negative effect on seals (Table 4.63), and the level of confidence associated with this assessment is high.

Based on field studies, river otters use coastal haul-out sites in the area of the proposed oil refinery. Little to nothing is known about what sound levels may induce hearing impairment (or other injury) or elicit a behavioural response in river otters. Blasting operations will be temporarily halted if a river otter is sighted within a designated safety zone (180 dB re 1 μPa rms). Based on available information, they will likely avoid the area. During site preparation, the effects of on-land blasting on river otter health could range from a negligible to low magnitude over a geographic extent of <1 km^2. Disturbance effects from single blasting events should be low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of blasting is predicted to be 37-72 months and effects are considered reversible (Table 4.64). It is predicted that there will be no significant negative effect on river otters if appropriate mitigation measures are implemented (Table 4.65). The level of confidence associated with this assessment is medium.

Sea turtles have not been reported in the immediate area. Most sea turtles have been observed in the outer portion of Placentia Bay but they could occur near the Project Area. It is uncertain how they might be affected, but mitigation measures should minimize potential impacts. Blasting operations will be temporarily halted if a sea turtle is sighted within a designated safety zone (180 dB re 1 μPa rms). During site preparation, the effects of on-land blasting on sea turtle health could range from a negligible to low magnitude over a geographic extent of <1 km^2. Disturbance effects from single blasting events should be negligible to low magnitude over a geographic extent of 1-10 km^2 to 100-1000 km^2. Blasting will occur over 37-72 months, and effects are considered reversible (Table 4.66). It is predicted that there will be no significant negative effect on sea turtles if appropriate mitigation measures are implemented (Table 4.67). The level of confidence associated with this assessment is high.

Vessel Noise (Marine Terminal)

During the construction phase, vessel noise will be concentrated in the area of the marine terminal and jetty. These facilities will be constructed in a 30-month period, with most marine components installed in the first 20 months.

Wharf construction, including the tug and dry products berths, will require 18 months to complete the primary structures and an additional 12 months to install equipment and piping. The design involves the use of bulkhead walls consisting of caissons filled with rock and affixed to rock mattresses. Rock mattresses will be put in place with a barge. Caissons will be floated into place using small tugs, and once in position, will be sunk to the rock mattress and filled with rock. At any one time, there would not be more than six vessels operating. These vessels would primarily include barges with capacities (DWT) of no more than 10,000 tonnes outfitted with construction equipment such as cranes, pile drivers, and rock placement activity. Smaller support vessels such as tugs would be used for positioning of barges and for transporting workers.

Within 8-10 months of the marine wharf construction, construction will begin (concurrently) on the jetties, which are located 300-400 m from shore. Jetty construction is anticipated to take 12 months for the installation of marine components and eight months for the installation of topside mechanical equipment. [For 10 months, subsea construction of the marine wharf and jetties could overlap but the total number of vessels involved is not expected to exceed six.] Each jetty will consist of jackets that sit on the seabed with piles driven through them. Some portions of the jackets will require drilling for placement of tension legs. Drilling is expected to occur via a self-elevating platform or jack-up barge (that typically has four legs) placed on the seafloor with the platform above sea level. Drilling will be completed after all the jackets are in place and will carry on for two months. [Pile-driving activities are discussed below.] Vessel traffic during jetty construction will consist of tugs for positioning of jackets and shuttling of personnel, barges equipped with craneage for placement of heavy components, barges equipped with rock placing equipment, and a self-elevating platform.

Broadband source levels for most small ships, including tugs and barges, are ~170-180 dB re 1µPa at 1 m (Richardson et al. 1995). Pile-driving sounds are considered in a separate sub-section. Specific sound levels or estimates are not available for the specific vessels or the cumulative noise levels from vessels but it is expected that the greatest and most continuous noise source during construction of the marine terminal will be tugs and barges.

Vessels (e.g., tugs and barges) supporting the Northstar artificial oil production island in the Alaskan Beaufort Sea contributed more to the underwater sound field than sounds from construction, drilling, and oil production activities (Blackwell and Greene 2006). Sound pressure levels during vessel operations were variable and depended on the activity and distance from the island; the highest received broadband (10–10,000 Hz) level (147 dB re 1 µPa) was recorded while a sealift was near the island (Blackwell and Greene 2006). Sound pressure levels were lowest in the absence of vessels and ranged from 90 to 115 dB re 1 µPa (Blackwell and Greene 2006). Recorded broadband airborne sounds were strongest 300 m from the island and reached 62 dBA re 20 µPa (Blackwell and Greene 2006).

Table 4.60 Effects assessment of construction activities on marine mammal (toothed and baleen whale) VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise (blasting)	Effects on health (A)	Setback distance; delay start; monitoring	0-1	1	?	4	R	2
Noise (blasting)	Disturbance (A)	Setback distance; delay start; monitoring	1	2-4	?	4	R	2
Site Access Road, transmission lines, pipelines, Quarry Development								
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic [a]								
Marine Terminal								
Noise (pile driving)	Effects on health (A)	Bubble curtain; delay start if in safety zone; monitoring	0-1	1	4	2	R	2
Noise (pile driving)	Disturbance (A)	Bubble curtain; delay start if in safety zone; monitoring	1	2-3	4	2	R	2
Noise (vessels)	Disturbance (A)	No approach	1	2-3	6	3	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	3	R	2
Vessel traffic (physical presence)	Disturbance (A)	Alter course	0-1	1-2	6	3	R	2
Presence of new structures[b]								
Intakes/ Outfalls								
Noise	Disturbance (A)	No approach	1	2-3	?	3?	R	2
Run-off, siltation	Prey availability	Silt curtains	0-1	1-2	?	4	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
	(A)							
Accidents or Malfunctions[b]								

Note: ? = Uncertain at this time.

a Considered under Marine Terminal

b Considered under assessment of Operations

Table 4.61 Summary of Residual Impact Predictions of Construction Activities on Marine Mammal (Toothed and Baleen Whale) VEC

Valued Environmental Component: Marine Mammals – Toothed Whales and Baleen Whales				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	NS	3	-	-
Refinery Complex				
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Marine Terminal				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Presence of new structures[a]			-	-
Intakes/ Outfalls				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Accidents or Malfunctions [a]				

Table 4.62 Effects assessment of construction activities on marine mammal (seals) VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise (blasting)	Effects on health (A)	Setback distance; delay start; monitoring	0-1	1	?	4	R	2
Noise (blasting)	Disturbance (A)	Setback distance; delay start; monitoring	0-1	2-3	?	4	R	2
Run-off, Siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Run-off, Siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic [a]								
Marine Terminal								
Air Emissions	Effects on health (A)		0	1	6	4	R	2
Noise (pile driving)	Effects on health (A)	Bubble curtain; delay start if in safety zone; monitoring	0	1	4	2	R	2
Noise (pile driving)	Disturbance (A)	Bubble curtain; delay start if in safety zone; monitoring	0-1	2-3	4	2	R	2
Noise (vessels)	Disturbance (A)	No approach	0-1	2-3	6	3	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	3	R	2
Vessel traffic (physical presence)	Disturbance (A)	Alter course	0-1	1-2	6	3	R	2
Presence of new structures[b]								
Intakes/ Outfalls								
Noise	Disturbance (A)	No approach	1	2-3	?	3?	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of new structures[b]								
Accidents or Malfunctions[b]								

Note: ? = Uncertain at this time.

a Considered under Marine Terminal

b Considered under assessment of Operations

Table 4.63 Summary of residual impact predictions of construction activities on marine mammal (seal) VEC.

Valued Environmental Component: Marine Mammals – Seals				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	NS	3	-	-
Run-off, Siltation	NS	3	-	-
Run-off, Siltation	NS	3	-	-
Refinery Complex				
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Marine Terminal				
Air Emissions	NS	3	-	-
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Presence of new structures[a]	NS	3	-	-
Intakes/ Outfalls				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Vehicular traffic	NS	3	-	-
Presence of new structures[a]	NS	3	-	-

Table 4.64 Effects assessment of construction activities on marine mammal (river otter) VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Air emissions	Effects on health (A)		0	1-2	6	4	R	2
Noise (blasting)	Effects on health (A)	Setback distance; delay start; monitoring	0-1	1	?	4	R	2
Noise (blasting)	Disturbance (A)	Setback distance; delay start; monitoring	1	2-3	?	4	R	2
Lights	Disturbance (A)		1	1-2	6	4	R	2
Run-off, Siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vehicular traffic	Disturbance (A)		1	2	5	4	R	2
Air emissions	Effects on health (A)		0	1-2	6	4	R	2
Noise	Disturbance (A)		1	1-2	6	4	R	2
Lights	Disturbance (A)		1	1-2	6	4	R	2
Run-off, Siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vehicular traffic	Disturbance (A)		1	2	5	4	R	2
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic[a]								
Vehicular traffic	Disturbance (A)		1	2	6	4	R	2
Marine Terminal								
Air Emissions	Effects on health (A)		0	1-2	6	3	R	2
Noise (pile driving)	Effects on health (A)	Bubble curtain; delay start if in safety zone; monitoring	0-1	1	4	2	R	2
Noise (pile	Disturbance (A)	Bubble curtain; delay start if in safety zone;	1	2-3	4	2	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
driving)		monitoring						
Noise (vessels)	Disturbance (A)	No approach	1	2-3	6	3	R	2
Lights	Disturbance (A)		1	1-2	6	4	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	3	R	2
Vessel traffic (physical presence)	Disturbance (A)	Alter course	0-1	1-2	6	3	R	2
Vehicular traffic	Disturbance (A)		1	2	5	4	R	2
Presence of new structures[b]								
Intakes/ Outfalls								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vehicular traffic	Disturbance (A)		1	2	5	4	R	2
Presence of new structures[b]								
Accidents or Malfunctions [b]								

Note: ? = Uncertain at this time.

a Considered under Marine Terminal

b Considered under assessment of Operations

Table 4.65 Summary of residual impact predictions of construction activities on marine mammal (river otter) VEC.

Valued Environmental Component: Marine Mammals – River Otter				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Air emissions	NS	3	-	-
Noise	NS	2	-	-
Lights	NS	3	-	-
Run-off, Siltation	NS	3	-	-
Vehicular traffic	NS	2	-	-
Site Access Road, transmission lines, pipelines, Quarry Development				
Air emissions	NS	3	-	-
Noise	NS	2	-	-
Lights	NS	2	-	-
Run-off, Siltation	NS	3	-	-
Vehicular traffic	NS	2	-	-
Refinery Complex				
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Vehicular traffic	NS	2	-	-
Marine Terminal				
Air Emissions	NS	3	-	-
Noise	NS	2	-	-
Lights	NS	2	-	-
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Vehicular traffic	NS	2	-	-
Presence of new structures[a]				
Intakes/ Outfalls				
Location	NS	3	-	-
Run-off, siltation	NS	3	-	-
Vehicular traffic	NS	2	-	-

Table 4.66 Effects assessment of construction activities on sea turtle VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise (blasting)	Effects on health (A)	Setback distance; delay start; monitoring	0-1	1	?	4	R	2
Noise (blasting)	Disturbance (A)	Setback distance; delay start; monitoring	0-1	2-3	?	4	R	2
Site Access Road, transmission lines, pipelines, Quarry Development								
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic[a]								
Marine Terminal								
Noise (pile driving)	Effects on health (A)	Bubble curtain; delay start if in safety zone; monitoring	0-1	1	4	2	R	2
Noise (pile driving)	Disturbance (A)	Bubble curtain; delay start if in safety zone; monitoring	1	2-3	4	2	R	2
Noise (vessels)	Disturbance (A)	No approach	0-1	2-3	6	3	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	3	R	2
Vessel traffic (physical presence)	Disturbance (A)	Alter course	0-1	1-2	6	3	R	2
Presence of new structures[b]								
Intakes/ Outfalls								
Noise	Disturbance (A)	No approach	0-1	2-3	?	3?	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4?	R	2
Accidents or Malfunctions [b]								

Note: ? = Uncertain at this time.

a Considered under Marine Terminal

b Considered under assessment of Operations

Table 4.67 Summary of residual impact predictions of construction activities on sea turtle VEC.

Valued Environmental Component: Sea Turtles				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	NS	3	-	-
Site Access Road, transmission lines, pipelines, Quarry Development				
Refinery Complex				
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Marine Terminal				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-

Valued Environmental Component: Sea Turtles				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Presence of new structures[a]	NS	3	-	-
Intakes/ Outfalls				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-
Accidents or Malfunctions[a]				

a Considered under Marine Terminal

Vessels such as crew boats, tugs, and self-propelled barges could be detected underwater as much as 30 km offshore (Blackwell and Greene 2006). The only vessel noticeably quieter underwater is the hovercraft (Blackwell and Greene 2005).

Marine mammal responses to ships are presumably responses to noise, but visual or other cues are also likely involved. Marine mammal response (or lack thereof) to ships and boats (pre-1995 studies) are summarized in Richardson et al. (1995), p. 252-274. More recent studies are summarized below.

Baleen Whales. Au and Green (1997, 2000) concluded that it was unlikely that the sound levels from whale-watching vessels would have serious effects on humpback whales in Hawaiian waters. They found that whale-watching vessels had source levels only 8 to 10 dB stronger than the level of background humpback whale sounds produced at the peak of the whale season (Au and Green 2000).

The vocal activity of humpback whales may change in response to approaches by motor boats. Two humpback whales sang shorter versions of their songs when exposed to engine noise; three humpbacks interrupted their songs after the motor boat switched gears but resumed singing when the motor was in neutral (Sousa-Lima et al. 2002). Sample size was small in this study.

The response of humpback whales to whale-watching vessels in Hervey Bay, Australia, was monitored in 1994 in an attempt to develop design criteria for vessels to minimize disturbance to whales (McCauley and Cato 2001). It was found that rapid increases in vessel noise produced more responses by humpbacks. The behaviour of southward migrating humpback whales in

Hervey Bay in response to whale-watching vessels was monitored in 1988 and 1989 (Corkeron 1995). Whale pods, both with and without calves, were more likely to dive rather than slip beneath the water surface when vessels were within 300 m. Corkeron indicates that it is uncertain whether short-term behavioural changes would be accompanied by longer-term avoidance. This study provides no information on the types of whale-watching vessels and their sound levels.

Marine mammal monitoring was undertaken from a high-speed catamaran car ferry transiting the Bay of Fundy during the summers 1998-2002 (Dufault and Davis 2003). The ferry had no propellers but used four water jets for power and sailed at speeds of 40 kts. The majority of baleen whales (including fin, humpback and minke whales) sighted from the ferry appeared to exhibit avoidance behaviour including heading away, changing heading, or diving (Dufault and Davis 2003). Avoidance responses were greater for humpback whales than for the other species of baleen whales.

The influence of whale-watching vessels on the behaviour of migrating (southbound and northbound) gray whales in Baja California, Mexico, during the winters of 1998 and 1999 was investigated by Heckel et al. (2001). The presence of vessels appeared to affect direction (whale headings were more variable) and velocity (became more variable) but results were inconsistent for whales migrating north vs. south. Also, a head-on approach by whale-watching boats significantly affected whale swimming direction and velocity vs. approaches towards the rear or flanks of the whale. This study provides no information on the types of whale-watching vessels and their sound levels. The authors also identify the small sample size, especially for the northbound migrating gray whales, as a potential issue.

Increased vessel traffic (primarily fishing vessels) at two known calving sites for gray whales in the Gulf of California, Mexico, has been attributed to the absence of whales in recent years (Findley and Vidal 2002). Semi-continuous dredging to clear and deepen the channel leading into the bays also likely contributed to the abandonment of the area.

Based on a study of fin whale response to a small (4.5 m long) inflatable boat powered by a 25 hp outboard engine, Jahoda et al. (2003) recommend that exposure of fin whales (in the Ligurian Sea) to vessel traffic, including whale-watching vessels, be carefully monitored. The study monitored 25 fin whales in their feeding ground during approaches by the inflatable boat within 5-10 m, moving with sudden speed (0-26 km/h) and directional changes for an hour. Whales were also monitored before and after the sudden approach from distances >200 m and at low speeds (5 km/h). Fin whales responded to the close approach of the boat by apparently ceasing feeding, beginning to travel at increased speed, and reducing the amount of time spent on the surface. One hour after close approach, the fin whales had not resumed to pre-disturbance behaviours. The authors note fin whale response may be, entirely or in part, a response to biopsy sampling, which was occurring as well. No source or received sound levels from the inflatable boat were provided.

The responses of North Atlantic right whales in the Bay of Fundy to ships, sounds from conspecifics, and a signal designed to alert the whales were monitored using multi-sensor acoustic recording tags (Nowacek et al. 2004). The whales reacted overtly to a signal designed to alert them to avoid ship strikes; they swam strongly to the surface, likely increasing rather than decreasing the risk of collision. The whales reacted mildly to controlled exposure to sounds of conspecifics, but showed no response to controlled sound exposure to ships as well as actual ships (Nowacek et al. 2004). It is thought that right whales, particularly in the Bay of Fundy, may be susceptible to collisions with ships as they may have difficulty in locating the direction of the ship because of echos off the sea bottom and surface (Terhune and Verboom 1999). Right whales may swim into the acoustic shadow (quietest location, usually ahead of the ship at the surface; Blue et al. 2001) of an on-coming ship, thus making them more susceptible to collisions (Terhune and Verboom 1999).

Based on the studies cited above and those reviewed in Richardson et al. (1995), when baleen whales receive low-level sounds from distant (or stationary) vessels, they typically exhibit little response. When they are exposed to strong or rapidly changing vessel noise, they often change their normal behaviour and swim away. Avoidance responses are not always effective in preventing collisions, particularly for right whales.

Toothed Whales. Reports of sperm whales' reactions to boat noises vary to both extremes, with most studies showing little evidence of disturbance. André et al. (1997) were unable to elicit any reaction from sperm whales off the Canary Islands in response to playbacks of engine noise (source level of 180 dB re 1 μPa/Hz, generated from the engine of a 15 m, 19-gross-ton ship traveling at 25 knots) at a distance of 100 m from the animals during their investigations to discover a noise that could potentially deter sperm whales from ferry routes. Those investigators speculated that the sperm whales they were investigating in the Canary Islands may have lost hearing sensitivity to the low frequencies generated by ships' engines and propellers because of the heavy marine traffic. As mentioned above, those investigators were successful at eliciting reactions in response to a higher frequency 10-kHz pulse. André et al. (2001) presented, in abstract form, the results of an examination of the ears of two sperm whales killed after collisions with ferries in the Grand Canary Islands. They found the ears of both animals to have reduced auditory nerve volumes (not specified further). In addition, in one animal, the inner ear had patches of dense tissue. The researchers suggested that these results, as confirmed by histological analyses, were consistent with auditory nerve degeneration and fibrous growth in response to long-term exposure to low-frequency sounds from shipping. Details of this investigation have not been published.

There were 87 sightings of sperm whales during the 1992–1994 GulfCet shipboard surveys in the north central and western Gulf of Mexico (Würsig et al. 1998). However, sperm whale reactions were recorded for only 15 of those sightings, as the researchers reported that reactions tended to be "non-existent" unless the vessel approached the animals within several hundred meters. Of the 15 sightings of sperm whales during which responses were recorded, on 11 occasions the sperm whales were reported to have exhibited no reaction. During the other four encounters, the sperm whales dove abruptly. All four of those occurred within 200 m of the ship. Sperm whales were never reported to approach the survey vessel. The authors of that report estimated the sound levels of their survey vessels in the 20–1,000 Hz frequency range to be on the order of 120–150 dB re 1 µPa at 200 m and 105-125 dB re 1 µPa at 9-10 km. These estimates were based not on direct measurements, but on comparisons with supply vessels of similar sizes.

A couple of different groups have looked at the effects of whale watching boats on sperm whales. (1) Richter et al. (2003) reported that male sperm whales off Kaikoura, New Zealand, had shorter mean and median blow intervals in the presence of their research vessel and/or whale watching boats, and that the sperm whales in that study spent more time at the surface and changed heading more frequently in the presence of whale watching boats. Additionally, the whales exhibited a shorter time to first click in the presence of boats (defined as the time between when a whale was observed to lift its tail flukes from the water to initiate a deep dive and when it was first heard to click during that descent). Resident sperm whales, in general, appeared to show fewer reactions and less-pronounced reactions to whale watching vessels than did transient animals, suggesting habituation to the disturbance. (2) Sperm whales off the Azores were studied using land- and boat-based observations to assess the effects of whale watching boats, without any clear evidence of disturbance (Magalhães et al. 2002). In that study, there were 64 sightings of sperm whales during land-based observations. No changes in feeding or socializing/resting behaviours were observed during the 39 sightings when whalewatching boats were present. Changes in heading, spatial arrangement, diving patterns, frequencies of aerial displays, and swimming speed at times when a whalewatching boat was present versus absent were not statistically significant. A whalewatching boat was present during 30 of the 40 boat-based observations of sperm whales. Those investigators found significantly higher rates of changes in swimming speed and aerial displays when inappropriate maneuvers (including angle of approach, vessel speed, and minimum distance of approach) were made. The mean breathing interval of groups of mature female and immature whales was significantly longer in the presence of whalewatching boats only when they were accompanied by calves, and was not affected for groups without calves or for larger individuals. Finally, Gordon et al. (1998) reported that sperm whale calves often approached whale watching boats off Dominica.

Short-term effects of boats on coastal bottlenose dolphins have been documented in several studies, but long-term effects are as yet speculative. Janik and Thompson (1996) assessed the surfacing patterns of bottlenose dolphins in response to passing boats in the Moray Firth, Scotland, a heavily trafficked area connecting the Caledonian Canal with the North Sea. They compared the number of surfacings in the one-minute period prior to a boat passing within 50 m with the number in the one minute following. Significantly fewer dolphin surfacings were observed following the passing than prior to; however, 22 of their 34 encounters involved the same boat, which followed the dolphins and tried to stay in their vicinity. When the authors analyzed these separately, they found a significant effect on surfacing rate but no significant effect of other boat traffic.

There were 110 sightings of bottlenose dolphins during the shipboard portion of the 1992–1994 GulfCet program (Würsig et al. 1998). Reactions to the survey ship were reported for 88 of those encounters. Most of the reactions were positive, with the dolphins bowriding the vessel during 68 of the sightings and merely approaching on an additional six occasions. For the remaining 14 sightings, the dolphins displayed no reaction. No avoidance reactions were observed.

Cope et al. (1999) investigated the effects of boat traffic on coastal Atlantic bottlenose dolphins off South Carolina. The results of that study, presented in abstract form, suggest significant disturbance caused by dolphin-watching boats and motorboats, while kayaks, sailboats, ships, and ferries had no apparent effects on behaviour. Those investigators defined disturbance using four categories: no response, change in behaviour, change in direction of movement, and change in both. They found the level of disturbance to be significantly correlated with the number of boats and with boat speed. Greater speeds resulted in greater numbers of individuals at the surface, while the proportion of dolphins feeding and group size and cohesion were lower. Few details were given in this abstract presentation.

Scarpaci et al. (2000) made behavioural recordings along with simultaneous acoustic recordings of bottlenose dolphins in Port Phillip Bay, Australia, to assess the effects of commercial dolphin-swim boats. The investigators found that the dolphins whistled at significantly ($p = 0.001$) higher rates in the presence of boats, suggesting that the dolphins may have increased their level of whistling to maintain group cohesion. In another study off Port Phillip Bay, Scarpaci et al. (2001) used focal group observations from land to assess the dolphins' responses to boats. They found the dolphins fed less when vessels were present (9.5% of observations) than absent (19.7%). They also noted the proportion of observations of social behaviour to be highest when vessels were present.

Allen and Read (2000) examined bottlenose dolphin foraging in relation to boat traffic density in one heavily trafficked site and one rather pristine inshore site along the west central coast of Florida. Although boat densities were significantly greater at both sites during the weekend than on weekdays, frequencies of dolphin foraging were not significantly different between the two time periods at either site. Habitat selection, however, was significantly different between the weekend and weekday periods at the heavily trafficked site: The dolphins preferring dredged channels and spoil islands on weekdays, whereas their weekend distribution was random. Those investigators suggested that the dolphins decreased their use of primary foraging habitats when vessel densities were high, either to avoid vessels or in response to changes in prey densities that resulted from the high density of vessels.

Nowacek et al. (2001) studied the impact of boats on resident bottlenose dolphins in the inshore and nearshore waters of the Gulf of Mexico in *SARA*sota Bay, Florida. They used focal animal observations to assess individual responses to experimental boat approaches from a distance of 100 m. They found that those bottlenose dolphins had significantly ($p < 0.0001$) longer interbreath intervals during boat approaches than during control periods when no boats were within 100 m, and that experienced mothers (those with at least one calf ≥3 years of age) had the longest interbreath intervals during approaches. In addition, closer approaches resulted in significantly ($p < 0.01$) longer interbreath intervals, while boat speed and boat type had no effect. Those researchers also used video recording of the animals from an airship to assess subsurface behaviours during experimental approaches. They found significantly ($p < 0.0001$) more changes in interanimal distance, swimming speed, and heading during boat approaches than during control situations. These changes, for the most part, involved the animals moving closer together, swimming faster, and moving out of the path of the approaching boat. Changes in headings and interanimal distances were related to water depth, boat type, and boat speed. More changes occurred in heading and interanimal distance during slow approaches than during fast approaches, suggesting that duration of exposure impacted the probability of a reaction. Also, more changes in heading and interanimal distance occurred during erratic approaches, suggesting that unpredictability increased the likelihood of a reaction.

In a recent study, the bottlenose dolphins of northern Scotland were found to be more likely to breathe in synchrony when boats were present (Hastie et al. 2003). The authors of that report suggested that this could be related to an antipredator response, if the dolphins perceived the boats as a threat, or that increased synchrony may play a role in social cohesion during times when acoustic communication may be masked.

In the Bay of Islands, New Zealand, Constantine et al. (2004) evaluated the effects of dolphin-watching boats on bottlenose dolphins. The dolphins' behaviours were found to vary significantly ($p < 0.0001$) with the number of boats present. Resting behaviour seemed to be most affected, decreasing with increasing numbers of boats. Resting behaviour was observed only 0.5% of the time when three or more boats were present.

Ross and Markowitz (2001) studied the reactions of Hawaiian spinner dolphins to boat presence at Midway Atoll National Wildlife Refuge using shore-based observations. They compared aerial and surface behaviours before the arrival of a boat, during the boat presence, and for 15, 30, and 60 minutes after the boat had left, at distances of 100, 300, and 500 m. The results of that study, presented in abstract form, suggest that aerial and surface behaviours increased within 300 m and 100 m of a boat. This immediate increase in the frequencies of these behaviours declined by 60 minutes after the boat had left. There were 14 sightings of spinner dolphins during the shipboard portion of the 1992–1994 GulfCet program (Würsig et al. 1998). For all 14 of those sightings, the spinner dolphins were reported to have been bow-riding the survey vessel. No avoidance reactions were observed. There were 177 sightings of pantropical spotted dolphins, and response to the vessel was reported for 165 of those sightings. In general, the responses were positive. During 137 (83%) of those encounters, the dolphins were observed bow-riding and for an additional 18 sightings they were observed approaching the ship. On nine occasions they did not appear to react at all, while there was a single sighting during which they exhibited avoidance behaviour.

Reactions of beluga whales to ships and boats are highly variable depending on the circumstances, ranging from very tolerant to highly responsive (Richardson et al. 1995).

The effect of vessel noise on beluga whales in the St. Lawrence River estuary, Québec, Canada, was assessed by Lesage et al. (1999). They used controlled experiments to record the surface behaviour and vocalizations of beluga whales before, during, and after the passing of two different types of boats—an outboard motorboat moving rapidly and erratically on an unpredictable course, and a ferry moving regularly and slowly on a predictable route. Noise from the motorboat peaked at a frequency of 6 kHz but was strong up to 16 kHz, with a second peak at 11.5 kHz. The noise from the ferry, on the other hand, had its greatest sound levels below 6 kHz and its engines generated a tone at around 175 Hz. Beluga whales changed their vocalizations in response to both these vessels, using higher-frequency vocalizations, a greater redundancy in vocalizations (more calls emitted in a series), and a lower calling rate. The lower calling rate persisted for longer during exposure to the ferry than to the motorboat.

Investigators attempting to record beluga whale vocalizations off Norway found those whales to be surprisingly silent most of the time – for 72% of the recordings – suggesting that the relative silence of this usually vocal species could be attributed to the presence of the research vessel in an area where whales are not accustomed to boat traffic (Karlsen et al. 2002).

Harbour porpoises, in general, tend to show avoidance behaviour toward boats (see Richardson et al. 1995). Palka (1996) reported that some harbor porpoises showed avoidance reactions at greater than 700 m from a survey vessel in the Gulf of Maine.

Based on the studies cited above and those reviewed in Richardson et al. (1995), toothed whales sometimes show no avoidance reactions to vessels, and sometimes they approach vessels. However, avoidance can occur for some species, but this appears to be localized and short-term. At least in one study, dolphin resting behaviour was related to the number of vessels; resting behaviour decreased with increasing numbers of boats. Changes in vocalizations in response to vessel activity have been noted for some species.

Seals. When in the water (vs. hauled out), seals appear less responsive to approaching vessels. Some seals will approach a vessel out of apparent curiosity, including noisy vessels such as those operating airgun arrays (Moulton and Lawson 2002). Suryan and Harvey (1999) reported that Pacific harbor seals (*Phoca vitulina richardsi*) commonly left the shore when powerboat operators approached to observe them. These seals apparently detected a powerboat at a mean distance of 264 m, and seals left their haul-out sites when boats approached to within 144 m. Several young harp seals were observed within 10-300 m of the survey vessel used in the Study Area in 2006-2007 (Abgrall and Moulton in prep.). These seals were observed watching the vessel.

River Otters. To the best of our knowledge, there are no systematic data on river otter reactions to ships and boats. There is some limited information (with no details about sound levels) about responses of other otter species to other anthropogenic disturbance sources. The Eurasian otter (*Lutra lutra*) did not show changes in distribution or frequency of use of shelters in response to human disturbance, neither at a riverine locality (Green et al. 1984) nor in a coastal area (MacDonald and Mason 1980). Similarly, in Southeastern Brazil, human disturbance around shelters did not influence use by Neotropical river otters, *L. longicaudis* (Pardini and Trajano 1999). In contrast, an inverse relationship between human disturbance and the abundance of otter shelters were noted by O'Sullivan (1993) for *L. lutra* at a riverine site, and by Verwoerd (1987) for the African river otter, *Aonyx capensis*, in a coastal area. In a South Indian river system, smooth-coated otters (*L. perspicillata*) avoided areas with high levels of human disturbance by fishing activities and people; the frequency of visits to disturbed sites was lower than that to undisturbed sites, but the number of sites did not differ between disturbed and undisturbed areas (Shenoy et al. 2006). River otters have been observed to haul-out on (active) wharves in North Harbour and may be readily adaptable to areas of disturbance (D. Slade, retired Wildlife Officer, pers. comm.).

Sea Turtles. To the best of our knowledge, there are no systematic data on sea turtle reactions to ships and boats, but it is thought that response would be minimal relative to responses to seismic sound, given that noise levels are much reduced. Three studies (O'Hara and Wilcox 1990; Moein et al. 1994; McCauley et al. 2000) have focused on short-term behavioral responses of sea turtles in enclosures to single airguns; these studies showed that sea turtles generally tend to show avoidance of an operating airgun at some received level. McCauley et al. (2000) found evidence of behavioral responses (increased swimming speed) by caged green and loggerhead turtles when the received level from a single small airgun (20-in3 at 1500 psi) was 166 dB re 1 mPa rms and avoidance responses at 175 dB re 1 mPa rms. Captive loggerhead sea turtles maintained a standoff range of about 30 m in response to a 10 in3 airgun plus two 0.8 in3 "poppers" operating at 2000 psi (O'Hara and Wilcox 1990). Avoidance appeared to have occurred at levels around 175–176 dB re 1 mPa rms (McCauley et al. 2000) or a few dB lower. Moein et al. (1994) noted avoidance by enclosed loggerhead turtles in response to airgun sounds (up to 179 dB) at a mean range of 24 m; however, the avoidance response waned quickly. Moein et al. (1994) also noted that temporary threshold shift apparently occurred in confined loggerhead turtles exposed to many pulses from a single airgun <65 m away.

McCauley et al. (2000) estimated that, for a typical airgun array (2678 in3, 12-elements) operating in 100-120 m water depth, sea turtles may exhibit behavioral changes at approximately 2 km and avoidance around 1 km. Holst et al. (2005, 2006) reported behavioral changes and/or avoidance near a seismic vessel, but the distances or sound levels at which these responses occurred could not be determined.

Effects Assessment. Toothed whales (primarily dolphins) were regularly sighted south of the refinery site during most months boat-based surveys were conducted, but sightings were more common during summer. It is possible, and likely probable, that some dolphins will exhibit (at least localized) avoidance of the area around the marine terminal site. It is uncertain how long avoidance will persist or over what area. However, sound levels from vessels will be lower than those known to cause temporary hearing impairment. There is no clear evidence that odontocetes have abandoned significant portions of their range because of vessel traffic. There have been relatively few baleen whale sightings reported but baleen whales are more likely to occur there during summer, when little survey effort has occurred.

During marine terminal construction, which is estimated to take place over a 30-month period, it is likely that some toothed and baleen whales will exhibit avoidance of the area where vessels are involved in construction activities. Disturbance effects from vessel noise should be low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is predicted to be 13-36 months during which vessel noise will be continuous and effects are considered reversible (Table 4.60). It is predicted that there will be no significant negative effect on toothed and baleen whales from vessel noise (Table 4.61). The level of confidence is high.

Few seals have been observed near the site. Seals in the water often approach vessels but those hauled out will often flee to the water when a vessel approaches. During marine terminal construction, some seals may exhibit avoidance of the area where vessels are involved in construction activities. Disturbance effects from vessel noise should be negligible to low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is predicted to be 13-36 months during which vessel noise will be continuous and effects are considered reversible (Table 4.62). It is predicted that it will have no significant negative effect on seals (Table 4.63). The level of confidence associated with this assessment is high.

Based on field studies, river otters do use coastal haul-out sites in the area. Little to nothing is known about what sound levels would cause a river otter to avoid an area or exhibit another behavioural response. Based upon available information, they will likely avoid the area of vessel operations. During marine terminal construction they may exhibit avoidance of the area where vessels are involved in construction activities. Disturbance effects from vessel noise may be of low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is predicted to be 13-36 months during which vessel noise will be continuous and effects are considered reversible (Table 4.64). It is predicted that there will be no significant negative effect on river otters (Table 4.65). The level of confidence is medium.

Sea turtles have not been reported in the immediate area, but some have been observed in the outer portion of Placentia Bay. During construction, some sea turtles may avoid the area. Disturbance effects from vessel noise should be negligible to low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is predicted to be 13-36 months during which vessel noise will be continuous and effects are considered reversible (Table 4.66). It is predicted that there will be no significant negative effect on sea turtles from vessel noise (Table 4.67). The level of confidence associated with this assessment is high.

Pile-driving Noise (Marine Terminal)

Pile-driving, either vibratory or impact, will be required to install piles through jackets of the jetties in a minimum of 34 m water depth. Four months of pile driving (~6-8 hours per day) are anticipated; if, however, the design plans for the marine wharf change from installation of bulkhead walls to sheet pile cells, more pile-driving will be required, likely an additional eight months (assuming one pile driver operating 6-8 hours per day).

Impact pile-driving produces higher, impulsive noise levels whereas vibratory pile-driving produces continous sound at lower sound levels. Figure 4.25 summarizes the results of seven acoustic studies of impact pile (or pipe) driving (HDR Alaska et al. 2006). The highest received sound level recorded during these studies was 202 dB re 1 uPa (rms) at 14 m (HDR Alaska et al. 2006). Sound levels from most impact pile driving sources diminished below 180 dB at distances <300 m. The dominant frequency range of pile driving is most likely related to differences in the size, shape and thickness of the piles. Most of the pulse energy typically falls between 50-2000 Hz (HDR Alaska et al. 2006).

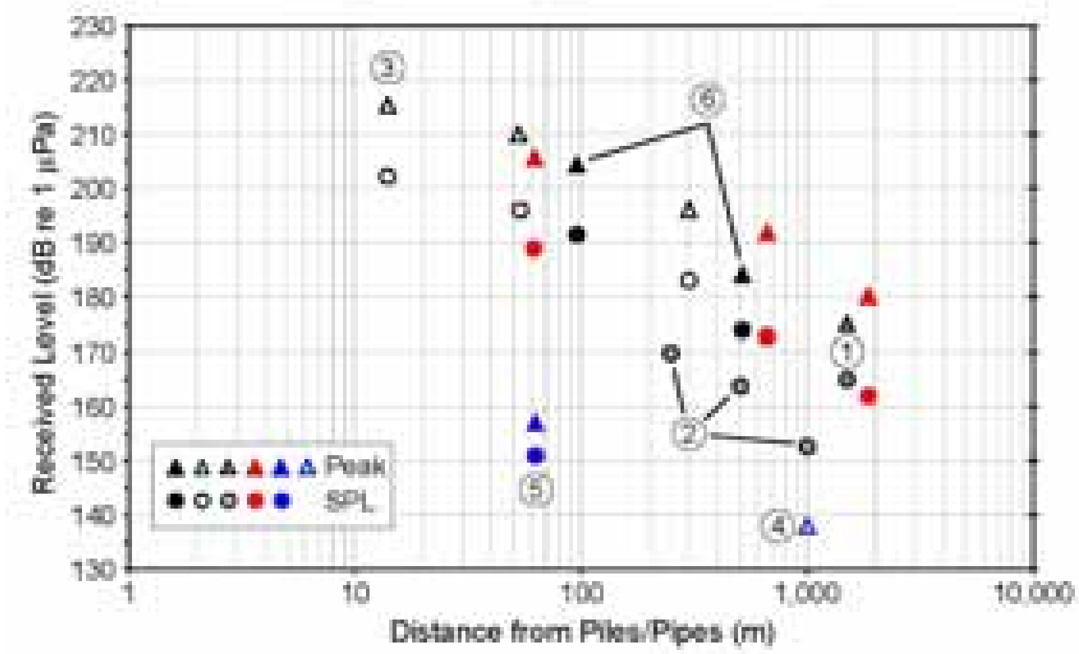

Figure 4.25 Summary of peak and sound pressure levels (SPL) of impact pile/pipe driving. based on HDR Alaska et al. (2006; red symbols); (1) Greene (1999); (2) Wursig et al. (2000); (3) Reyff et al. (2002); (4) Johnson et al. (1986); (5) Blackwell et al. (2004); and (6) Blackwell and Burgess (2004). From HDR Alaska et al. (2006).

Ringed seals exposed to pipe-driving pulses exhibited little or no reaction to impact pipe-driving sounds (Blackwell et al. 2004). There are no data on responses of other marine mammals (including river otters) and sea turtles. Given the frequencies reported for pile-driving activities, it is likely that baleen whales, toothed whales and sea turtles can detect the sounds but that toothed whales would be less sensitive to the low-frequency components where most of the acoustic energy occurs. Based on the literature for marine mammal response to low-frequency impulsive sounds (such as airgun pulses—see Richardson et al. 1995 and Nowacek et al. 2007), baleen and toothed whales would likely exhibit at least localized avoidance of the pile-driving sites. There is little risk for effects on health, given that sound levels typically recorded during impact pile-driving activities do not exceed 180 dB re 1 uPa (rms) beyond several hundred meters from the source. Vibratory pile driving sounds are typically much lower (e.g., HDR Alaska et al. 2006).

If sound levels from impact pile driving are expected to exceed 180 dB re 1 µPa rms, mitigation measures will be employed. The area around the jetty will be watched (for 30 min prior to start of pile driving) and impact pile driving will be temporarily delayed or halted if a toothed or baleen whale is sighted within a designated safety zone (180 dB re 1 µPa rms). In addition, the feasibility of using a bubble curtain to reduce sound levels will be investigated. Depending upon environmental conditions (e.g., current), the effect of a bubble curtain can have an effect ranging from negligible to reduction by as much as 20 dB (S. Blackwell, Greeneridge Sciences, pers. comm.). During periods of pile driving operations, which is estimated to take place over a 4-12-month period, the effects (with mitigation measures in place) on toothed and baleen whales could range from negligible to low magnitude over a geographic extent of <1 km^2. It is likely that some toothed and baleen whales will avoid of the area. Disturbance should be low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. Noise will be impulsive (or continuous if vibratory pile driving is used) and will likely occur for 6-8 hours a day, and effects are considered reversible (Table 4.60). There is no significant predicted effect (Table 4.61). The level of confidence is high.

Few seals have been observed near the site. Available evidence suggests that seals exhibit little to no response to pile driving activities; nonetheless, after the type of pile driving equipment is selected, if sound levels from impact pile driving are expected to exceed 190 dB re 1 μPa rms, mitigation measures will be employed. The area around the jetty will be watched (for 30 min prior to start of pile driving) and impact pile driving will be temporarily delayed or halted if a seal is sighted within a designated safety zone (zone where sound levels may exceed 190 dB re 1 μPa rms). The effects (with mitigation measures in place) on seal health would be negligible over a geographic extent of <1 km^2. Some seals may avoid the immediate area where pile driving is occurring. Disturbance effects should be negligible to low over a geographic extent of 1-10 km^2 to 10-100 km^2. Effects are considered reversible (Table 4.62). It is predicted that there will be no significant negative effect on seals (Table 4.63). The level of confidence is high.

Based on field studies, river otters use coastal haul-out sites in the area. Little to nothing is known about what sound levels would cause a river otter to avoid an area or exhibit another behavioural response. Based upon available information, they will likely avoid the area. If noise is expected to exceed 180 dB, the area around the jetty will be watched (for 30 min prior to start of pile driving) and impact pile driving will be temporarily delayed or halted if a river otter is sighted within a designated safety zone (180 dB re 1 μPa rms). The effects (with mitigation measures in place) on river otter health would be negligible to low magnitude over a geographic extent of <1 km^2. Disturbance effects from pile driving may be of low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. Effects are considered reversible (Table 4.64). No significant negative effect is predicted (Table 4.65). The level of confidence is medium.

Sea turtles have not been reported in the immediate area but have been observed in the outer portion of Placentia Bay. It is uncertain how sea turtles (if they occurred near the coast of the refinery site) would be affected by pile driving operations but their documented response to impulsive airgun sounds may be indicative. If sound levels from impact pile driving are expected to exceed 180 dB re 1 μPa rms, mitigation measures will be employed. The area around the jetty will be watched (for 30 min prior to start of pile driving) and work will be temporarily delayed or halted if a sea turtle is sighted within a designated safety zone (zone where sound levels may exceed 180 dB re 1 μPa rms). During periods of pile driving operations, the effects (with mitigation measures in place) on sea turtle health would be negligible to low magnitude over a geographic extent of <1 km^2. Disturbance effects from pile driving may be of low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration is predicted to be 1-12 months during which noise will be impulsive (or continuous if vibratory pile driving is used) but will likely occur for 6-8 hours a day, and effects are considered reversible (Table 4.66). There are no predicted significant negative effect (Table 4.67). The level of confidence is high.

Vessel Traffic (non-noise impacts)

During construction, up to six vessels (mostly tugs and barges) will be in attendance at the marine terminal site. Vessels will be stationary or traveling slowly during construction activities. There is minimal chance that marine mammals (including river otters) or sea turtles will be affected by the physical presence of these vessels, including potential collisions between the VEC and vessels. It is likely that marine mammals will avoid the immediate area because of increased sound levels. Vessel operators will avoid (alter course) if a marine mammal or sea turtle swims in front of the vessel.

During marine terminal construction, which is estimated to take 30 months, the effects of the physical presence, including the risk of collision, of vessels on marine mammals (including river otters) and sea turtles could range from a negligible to low magnitude in the area of the marine wharf and jetty (geographic extent of <1 km^2 to 1-10 km^2; Tables 4.60, 4.62, 4.64, 4.66). It is predicted that there will be no significant negative effect on marine mammals or sea turtles (Tables 4.61, 4.63, 4.65, 4.67). The level of confidence is high.

Presence of Structures

New structures will be introduced into the marine environment, including an outfall and an intake pipe as well as the marine wharf and jetties. Coastal (including intertidal) habitat will be infilled with rock over a maximum area of 84,000 m^2. Construction of the refinery and access roads will lead to the loss of habitat for river otters. These structures will persist for the life of the Project (>25 years) and their physical presence is assessed in Section 4.8 of this EIS.

Run-off, Siltation

It is possible that run-off and siltation may impact marine mammals and sea turtles by reducing the availability of some prey; the likelihood of such an impact is low, especially given that most marine mammals and turtles, spend little time near or at the refinerty site. In addition, run-off and siltation will be controlled during construction. Silt curtains will be used to contain suspended materials. During construction, the effects of run-off and siltation from the refinery complex, marine terminal, intakes and outfall locations (with appropriate mitigation measures in place) on marine mammals (including river otters) and sea turtles could range from a negligible to low magnitude over a geographic extent of <1 km^2 to 1-10 ^{km2}. Any effect of exposure to run-off or siltation or decreased prey availability would be reversible (Tables 4.60, 4.62, 4.64, 4.66).

It is predicted that there will be no significant negative effect on marine mammals or sea turtles (Tables 4.61, 4.63, 4.65, 4.67). The level of confidence associated with this assessment is high.

Air Emissions

During construction, air emissions will be limited to those produced by construction equipment and vessels (at the marine terminal).

Seals are not known to have haul-out sites near the site and they may avoid the immediate area due to noise from construction activities. Any impacts from air emissions on seals are expected to be negligible, over a small geographic extent (<1 km^2), for a duration of 37-72 months (Table 4.62). Impacts are judged to be not significant and the "level of confidence" associated with this assessment is high (Table 4.63).

River otters may be exposed to air emissions during site preparation and construction. Like seals, otters will likely avoid the immediate area. Any impacts from air emissions on river otters are expected to be negligible, over a small geographic extent (<1 km^2 to 1-10 km^2), for a duration of 37-72 months (Table 4.64). Impacts are judged to be not significant and the level of confidence associated with this assessment is high (Table 4.65).

Lighting

It is uncertain how river otters will respond to lighting at construction sites. There is increased potential of an impact because this species is most active at night and during crepuscular hours. They become more noctural in spring, summer and fall and more diurnal in winter (Lariviere and Walton 1998). Assuming the worst-case scenario, that river otters avoid areas with artificial lighting, it is predicted that lighting will have a low magnitude effect (disturbance) over a geographic extent of 1-10 km^2 and a duration of 37-72 months (Table 4.64). Impacts are judged to be not significant and the "level of confidence" associated with this assessment is medium (Table 4.65).

Vehicular Traffic

It is uncertain how river otters will respond to vehicular traffic. Assuming that otters avoid areas with traffic, it is predicted that impacts will be of low magnitude effect (disturbance) over a geographic extent of 1-10 km^2 and a duration of 37-72 months (Table 4.64). Impacts are judged to be not significant and the level of confidence associated with this assessment is medium (Table 4.65).

4.9.2 Project Effects During Operations

There are several types of activities that may impact marine mammals and sea turtles: noise, vessel traffic (emphasis on the risk of collision), presence of structures, run-off, siltation, air emissions, effluent characteristics and lights.

Of these operation activities, noise has greatest potential to impact most species of marine mammals and sea turtles. Increased tanker (and associated tug) traffic also increase the risk of a collision between marine mammals, most notably large baleen whales, and tankers. The physical presence of the marine wharf, the oil refinery and its access roads will result in habitat loss for river otters.

Noise

During the operation phase, the primary source of noise will be from tankers, bulk carriers and tugs. On a daily average, two tankers are expected to use the marine terminal with a maximum potential of seven (expected to occur infrequently). Near the refinery site, vessels will decrease speed to 4 knots for maneuvering as they approach the marine terminal. Tugs will be used to position tankers at the jetties.

Ships, including large tankers, are major contributors to overall background noise in the ocean. Sound levels and frequency characteristics are loosely related to ship size and speed. Most sound is generated from propeller cavitation, propeller singing, and propulsion or other machinery. Large vessels like tankers create stronger and lower-frequency sounds because of their greater power, large drafts, and slower-turning engines and propellers. Source levels (of the dominant tone) for tankers range from 169-190 dB re 1μPa at 1 m (Richardson et al. 1995). Broadband source levels of supertanker noise (VLCC tankers are in this class; i.e., >250,000 DWT) can exceed 205 dB re 1μPa at 1 m if components down to ~2 Hz are included. Each additional tanker (assuming it is the same type of tanker) essentially doubles the sound pressure, and results in an approximate 3 dB increase in overall sound level. It is anticipated that 41 VLCC tankers and 27 Suezmax size tankers (150,000 DWT) per year will deliver crude oil to the refinery site. Smaller tankers and bulk carriers will be used to deliver products. Noise from ships is considered continuous (vs. impulsive) for which there are no guidelines or regulations in place to provide sound threshold levels for hearing impairment in marine mammals.

There are no systematic data available for marine mammal or sea turtle response to tankers or bulk carriers. However, observed responses of marine mammals to other types of vessels are likely representative of how they might behave; these responses were reviewed in Section 4.9. Some marine mammals will probably exhibit a larger zone of avoidance around large tankers, given that sound levels will be higher. There is increased likelihood that vessel noise may mask the ability of marine mammals to hear natural sounds at the same frequencies, including calls from conspecifics. Also, considering the life of the project (>25 years) and that tanker traffic will be consistent from day to day, some marine mammals, especially those that occur year-round, may habituat to tanker noise.

Effects Assessment. Toothed whales (primarily dolphins) were regularly sighted in the Study Area, including south of the refinery site, during most months boat-based surveys were conducted, but sightings were more common during summer. It is probable that some dolphins will exhibit (at least localized) avoidance of the area around the marine terminal site and other areas where tankers are transiting to the refinery. It is uncertain how long avoidance will persist or over what area. Other dolphins may exhibit little avoidance response and may even approach vessels. The dolphin species whose hearing has been studied have relatively poor hearing sensitivities at frequencies below 1 kHz, where most of the acoustic energy from vessels is focused. There is no clear evidence that odontocetes have abandoned significant portions of their range because of vessel traffic. There have been relatively few baleen whale sightings in the area, but baleen whales are more likely to occur there and along other areas of the tanker traffic route during summer when little survey effort has occurred. Baleen whales, including humpback, fin and minke whales, are likely to avoid an area of at least one kilometre to several kilometers around vessels. Some individuals may avoid larger areas. There is limited evidence to suggest that certain species of baleen whales (gray whales) abandon areas (bays and lagoons) which are heavily disturbed (by vessel and other industrial activity; see p. 264 in Richardson et al. 1995). However, baleen whales are consistently sighted in the Study Area despite tanker traffic (plus other vessels) associated with the Cone By Chance refinery and the Transhipment facility. The long-term effect of tanker and other vessel traffic on marine mammals and sea turtles is unknown.

During the 25-year operation of the marine terminal, it is likely that toothed and baleen whales will exhibit avoidance of at least a localized area where tankers, bulk carriers, and tugs are operating. These vessels will not make rapid changes in direction or speeds, and this might minimize cetacean response. Disturbance (e.g., avoidance, potential masking) effects from vessel noise are predicted to be low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is >72 months during which vessel noise will likely be continuous and effects are considered reversible (Table 4.69). It is predicted that there will be no significant negative effect on toothed and baleen whales (Table 4.70). The level of confidence associated with this assessment is medium.

Few seals have been observed near the marine terminal site where most of the vessel traffic will be concentrated. Small numbers of seals are expected to occur along the tanker traffic route in the eastern portion of the Study Area. Seals in the water often approach vessels but those hauled out will often flee to the water when a vessel approaches. During operation of the marine terminal, some may exhibit avoidance of the area where tankers, bulk carriers, and tugs are operating. Disturbance effects from vessel noise should be negligible to low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of operations is >72 months, during which noise will likely be continuous and effects are considered reversible (Table 4.71).

It is predicted that there will be no significant negative effect on seals (Table 4.72). The level of confidence associated with this assessment is high.

Based on field studies, river otters use coastal haul-out sites in the area. They also use haul-out sites along the tanker traffic route in the eastern portion of the Study Area. Little to nothing is known about what sound levels would cause a river otter to avoid an area or exhibit other behavioural responses. It is noteworthy that otters use haul-out sites and the nearshore waters of eastern Southern Head, which is <1.5 km from the existing Come By Chance marine terminal where oil tankers regularly dock. Based on available information, river otters will likely avoid at least the immediate area of vessel operations. During operations, river otters may exhibit avoidance of the area. It is also quite possible they will habituate to increased vessel traffic. Disturbance effects may be of low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. The duration of vessel operations is >72 months during which vessel noise will likely be continuous and effects are considered reversible (Table 4.73). No significant negative effect is predicted (Table 4.74). The level of confidence associated with this assessment is medium.

Sea turtles have not been reported in the immediate area, but rather in the outer portion of Placentia Bay, including the tanker traffic route. Some sea turtles may exhibit avoidance of the area. Disturbance effects should be low magnitude over a geographic extent of 1-10 km^2 to 10-100 km^2. For the duration of operations vessel noise will be continuous and effects are considered reversible (Table 4.75). It is predicted that there will be no significant negative effect on sea turtles (Table 4.76). The level of confidence associated with this assessment is high.

Vessel Traffic

Up to 425 vessels (ranging from bulk carriers of 20,000 DWT to VLCC tankers of 350,000 DWT) will visit the refinery annually. Bulk carriers will account for 9 to 24per cent of total vessel traffic. VLCC tankers (~330 m in length, breadth of 58 m, depth of 31 m, and draught of 22.7 m) will be the largest tanker to deliver crude oil to the refinery and it is estimated that 41 of these ships per year will visit the site. A daily average of two tankers will use the terminal with a maximum potential of seven.

Tankers typically cruise at 11-15 knots on the open ocean. Those entering Placentia Bay will have to decrease speed to 8 knots to rendezvous with the pilot boat near Red Island, and will then proceed to the head of the bay at cruising speed, decreasing to 4 knots for maneuvering as they approach the marine terminal. If tankers are delayed at the pilot station (e.g., due to bad weather), vessels will jog in the traffic lanes at speeds of 4-6 knots.

It is possible that an additional ~900 tankers will enter Placentia Bay every year (~500 combined from the North Atlantic refinery at Come By Chance and the Transshipment Terminal at Arnold's Cove, and up to 400 at the proposed Newfoundland LNG Ltd. Grassy Point Liquefied Natural Gas Transshipment and Storage Terminal). Approximately 40 ferry crossings also occur in Placentia Bay every year.

Although most marine mammals typically avoid moving ships, there is some risk of collision. It is uncertain if such collisions have occurred in Placentia Bay. Large whales (no known blue or right whales) strand in Placentia Bay throughout all seasons of the year. In the absense of necropsies, it is difficult to ascertain the reasons for stranding, including mortality due to blunt force trauma from a vessel collision (W. Ledwell, Whale Release and Stranding Program, pers. comm.). Evidence suggests that a greater rate of mortality and serious injury in cetaceans correlates with a greater speed at the time of a ship strike (Laist et al. 2001; Vanderlaan and Taggart 2007). Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at or above 14 knots (Laist et al. 2001). Vanderlaan and Taggart (2007), using a logistic regression modelling approach based upon vessel strike records, found that for vessel speeds greater than 15 knots, the probability of a lethal injury (mortality or severely injured) approaches 1. The probability of lethal injury declined to approximately 20% at speeds of 8.6 knots (Vanderlaan and Taggart 2007). In a review of 58 large whale ship strikes in which the vessel speed was known, the average speed that resulted in mortality or serious injuries to the whale was found to be 18.6 knots (Jensen and Silber 2003). The frequency of strikes more than doubled when vessel speeds were 13-15 knots as opposed to 10 knots or less (Jensen and Silber 2003). While all sizes and types of vessels can collide with whales, most lethal or severe injuries are caused by vessels >80 m in length (Laist et al. 2001).

Fin whales are the most commonly reported whale to be stuck by vessels, followed by humpback whales and North Atlantic right whales (Jensen and Silber 2003; Vanderlaan and Taggart 2007); however, the North Atlantic right whale was the most commonly struck per capita per year (Vanderlaan and Taggart 2007). Blue whales, fin whales, and humpback whales were struck in similar proportions to each other, but to a lesser degree than North Atlantic right whales (Vanderlaan and Taggart 2007). Minke whales, sei whales, and sperm whales were not as frequently stuck, proportionally, but have been reported (Vanderlaan and Taggart 2007), and in the case of minke whales, strikes are quite common in Placentia Bay. Published accounts suggest that most whales are not seen beforehand or are seen at the very last minute (Laist et al. 2001).

While nearly all species of large whale have been victims of collisions with ships (Laist et al. 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007), right whales are especially vulnerable likely because of characteristic behaviours during which they may be less aware of their surroundings. These behaviours include: surface active group (SAG) activity (individuals interacting at the surface with frequent physical contact); skim feeding (swimming slowly at the surface with mouth open); and logging (resting motionlessly at the surface), an activity frequently observed in nursing mothers (Knowlton 1997). Controlled exposure experiments in the right whale summer feeding area in the Bay of Fundy showed that right whales did not respond to the playback of the sound made by a 120-m container ship passing within 100 m when they were apparently able to hear it (Nowacek et al. 2004). More than one third (35.5%, 16/45) of the documented right whale deaths from 1970 to 1999 were the result of ship strikes (Knowlton and Kraus 2001), and almost half (47.4%) of the documented right whales deaths in from 1990 to 1999 were the result of ship strikes. The majority of right whales suffering serious injuries (fatal and non-fatal) had propeller cuts, gashes, or severed flukes (Knowlton and Kraus 2001). In spite of the attention this issue has received and the measures that have been implemented, there were seven deaths between 2000 and 2005 (Right Whale News 2005a). From January 2004 to April 2005, eight right whale deaths were recorded. Three of those were definitively caused by ship strikes, and a fourth was likely caused by a ship strike (Right Whale News 2005b). Two deaths were of pregnant females with near-term foetuses (NOAA Fisheries 2004). In 2006, there were six known right whale deaths (Right Whale News 2007); four of these were from ship strikes and one whale died as a result of entanglement in fishing gear (New England Aquarium 2007). In an attempt to reduce mortalities due to vessel strikes, several mitigation measures have been employed or are proposed, including shifting shipping lanes to avoid areas where right whales occur in high numbers (Right Whale News 2007) and imposing vessel speed restrictions in certain coastal U.S. waters during certain times of the year (Federal Register 2006). As previously discussed in Section 3.7.4, right whales are considered very rare in the Study Area.

Based on available information, it is likely that most marine mammals will avoid the immediate area around vessels (see preceeding section), thereby minimizing the risk of collision. In addition, tankers and carriers will travel at speeds typically less than those associated with ship strikes of large cetaceans and will not make rapid changes in direction. In areas where tankers may occur in higher numbers (marine terminal area, near the pilot rendezvous site) and risk for collision could be higher, tankers will travel at a much reduced speed, minimizing the risk of collision.

The risk of a tanker (or bulk carrier) colliding with a toothed whale or baleen whale and causing serious injury or mortality is low. It is likely that toothed and baleen whales will exhibit avoidance of at least a localized area where tankers, bulk carriers, and tugs are operating. Effects on toothed or baleen whale health (injury, mortality) should be negligible to low magnitude over a geographic extent of 1-10 km^2. The duration of vessel operations is 25 years or more, during which effects from collisions, if they happened, may not be reversible at the individual level but would be reversible at the population level (Table 4.69). It is predicted that there will be no significant negative effect on toothed and baleen whales from vessel collisions (Table 4.70). The level of confidence associated with this assessment is high.

Seals and river otters are not considered at risk from collisions. They will likely move away from a vessel. Effects on seal and river otter health (injury, mortality) from collisions are predicted as negligible over a geographic extent of 1-10 km^2. The duration of operations is 25 years or more, during which effects from collisions if they happened may not be reversible at the individual level but would be reversible at the population level (Tables 4.71, 4.73). It is predicted that there will be no significant negative effect on seals or river otters from vessel collisions (Tables 4.72, 4.74). The "level of confidence" associated with this assessment is high.

Sea turtles have not been reported in the immediate but have been observed in the outer portion of Placentia Bay, including the tanker traffic route. During operation of the terminal, it is possible that a tanker (or other vessel associated with the oil refinery) may collide with and injure a sea turtle but the likelihood is considered low given the small number of turtles that occur in the area and that turtles may exhibit avoidance of the area where tankers, bulk carriers, and tugs are operating. Effects on sea turtle health (injury, mortality) from vessel collisions are predicted as negligible to low magnitude over a geographic extent of 1-10 km^2. The duration of vessel operations is >72 months (25 years or greater) during which effects from collisions if they happened may not be reversible at the individual level but would be reversible at the population level (Table 4.75). It is predicted that there will be no significant negative effect on sea turtles from vessel collisions (Tables 4.76). The level of confidence associated with this assessment is high.

Presence of Structures

New structures will be introduced into the marine environment including an outfall and an intake pipe as well as the marine wharf and jetties. Coastal, including intertidal habitat, at the proposed marine wharf site will be infilled with rock over a maximum area of 84,000 m^2. This will exclude river otters and seals from hauling out at these sites. Other marine mammals and sea turtles are not expected to be impacted by this in-filled area given that they do not occur in this habitat. The jetties and outfall/intake pipes are located farther from shore (300-400 m and 500 m/950 m, respectively) and marine mammals and sea turtles could interact with these structures. Species that occur in the Study Area are not known as bottom feeders so there is little potential for interaction with subsea structures and there is no risk of entanglement in structures. Effects of the presence of these structures are considered negligible.

Numerous otter rubs were located within the boundaries of the Project Area and several others were located nearby (Figure 3.84; Table 4.68). More than one river otter would use a particular haul-out site. Table 4.68 summarizes the haul-out sites located during field studies in support of this EIS and their proximity to the proposed refinery infrastructure. Two two haul-out sites which occur in the footprint of the wharf will be in-filled and this otter habitat will be lost, including an "extensive" haul-out site. In addition, other haul-out sites located on the coast in the Project Area will have access to inland areas blocked by the physical presence of the refinery (and perhaps access roads). Otters actively use the Watson Brook area for foraging and portions of this habitat will also be lost.

Table 4.68 Summary of river otter haul-out sites in and near the proposed oil refinery infrastructure.

Haul-out Site	Distance to Closest Infrasture	Degree of Use [a]
R15	<200 m from wharf	Extensive
R16	in footprint of wharf	Extensive
R17	in footprint of wharf	Old
R18	<100 m from refinery	Low
R19	<100 m from refinery	Moderate
R20	<100 from intake pipe	Old
R21	inland pathways in refinery footprint	Low
R22	<200 m from refinery	Low
R23	<200 m from refinery	Moderate
R24	<200 m from refinery	Moderate
R25	<100 from outfall pipe	Low
R26	<200 m from refinery	Extensive
R27	<200 m from refinery	Old
R53	<200 m from refinery	Low
R60	<100 m from refinery	Low
R61	<200 m from refinery	Moderate
R62	<100 m from access road	Moderate

a As defined in Goudie and Jones (2007): Extensive = large in area, muddy, much digging into slope; Moderate = rubbing confined to trail systems and or slides; low = small in area, minimal patches; old = old abandoned site now grown over.

Although the river otter population at the head of Placentia Bay is often reported as dense and that it supports active trapping by local residents, the population as a whole is not known. This data gap influences the reliability of the effects assessment. Also, it is not known if river otters excluded from habitat can successfully relocate to other areas. If they have a large home range (>100 km) as suggested by Cote et al. (in prep.) it is possible they could move to another portion of their range. However, change in distribution has a number of possible consequences, including restriction in feeding opportunities (time and space), increased energetic costs of moving, and increased concentration of individuals, which increases intraspecific competition and/or risk of disease. Such consequences could affect condition of individual animals (e.g., Dzubin 1984; Temple et al. 1996).

It appears that river otters may use the eastern side of Placentia Bay from Bordeaux Island northwards less that the areas to the west; Goudie and Jones (2007) speculate that this could be due to increased industrial activity, infrastructure, and associated shipping in that area. However, the eastern side of Come By Chance Bay may also have less suitable habitat (e.g., beaches vs. rock promontories; D. Slade, retired Wildlife Officer, pers. comm.). It is possible that all 16 haul-out sites within and near the Project Area will be abandoned over a geographic extend of 1-10 km^2 for a duration of 25+ years. The magnitude of this impact could be high (in this case effects would likely be exclusion due to loss of habitat or disturbance) but over a small geographic extent (Table 4.73). It is predicted that there will be no significant negative effect on river otters in the Study Area from habitat loss (Tables 4.74); however, the level of confidence associated with this assessment is low due to data gaps. It is recommended that haul-out sites in and near the Project Area be re-visited in a follow-up monitoring program to investigate whether the sites will indeed be abandoned and whether there is evidence of increased otter activity in areas adjacent to the refinery site.

Run-off, Siltation

It is possible that run-off and siltation may impact marine mammals and sea turtles by reducing the availability of some prey; the likelihood of such an impact is very low during operational phase of the refinery, especially given that most marine mammals and turtles spend little time near or at the site. During the operation of the refinery, the effects of run-off and siltation (with appropriate mitigation measures in place) on marine mammals (including river otters) and sea turtles would be negligible over a geographic extent of <1 km^2 to 1-10 km^2. Any effect of exposure to run-off or siltation or decreased prey availability would be reversible (Tables 4.69, 4.71, 4.73, 4.75). It is predicted that there will be no significant negative effect on marine mammals or sea turtles (Tables 4.70, 4.72, 4.74, 4.76). The level of confidence associated with this assessment is high.

Air Emissions

Air emissions from the refinery facilities during the operational phase have little potential to impact marine mammals and sea turtles (see SENES 2007) given that:

- predicted air concentrations are so low that the inhalation pathway is considered negligible;
- chemicals emitted from the proposed refinery do not have the potential to biomagnify; and
- predicted pollutant concentrations in nearby water bodies are so low that consuming water (in the case of river otters) is not considered a pathway of exposure

Most marine mammals and sea turtles will spend little time in the area where emissions concentrations are predicted to be highest. With appropriate mitigation measures in place (i.e., minimizing air emission concentrations and amounts), effects of air emissions during operations (>25 years) are assessed as negligible over a geographic extent of <1 km^2 for toothed and baleen whales, seals, river otters and sea turtles (Tables 4.69, 4.71, 4.73, 4.75). It is predicted that there will be no significant negative effect on marine mammals or sea turtles (Tables 4.70, 4.72, 4.74, 4.76). The level of confidence associated with this assessment is high.

Effluent Characteristics

During operation of the oil refinery, effluent will be discharged though the outfall pipe located west of Southern Head point. The pipe is 400 m long with a 100 m diffuser. All effluent will meet the requirements outlined in the provincial Environmental Control Water and Sewage

Regulations. Although the types and actual concentrations of various substances in the treated effluent are not currently available, substances could include heavy metals, benzene, and PAH, but concentrations will be less than those outlined in provincial regulations. Species of marine mammals and sea turtles that occur in Placentia Bay do not typically feed directly on the bottom where the outfall pipe will be located, so the risk of direct interaction is reduced. There is some risk that marine mammals and to a much lesser extent, sea turtles, may be exposed to these substances via consumption of prey . Metal bioavailability is generally low when the metals are absorbed onto particles or complexed with organic molecules, as generally occurs in natural waters (e.g., Hinwood et al. 1994). Concentrations of heavy metals in the effluent outflow are unlikely to be high enough to harm marine animals (Neff et al. 1980 in Hinwood et al. 1994) if provincial guidelines are met. It is important that effluent outflow be monitored during the operational phase to ensure discharge composition and levels are met. With appropriate mitigation measures in place, effects of effluent during operations are assessed as negligible to low over a geographic extent of <1 km^2 for toothed and baleen whales, seals, river otters and sea turtles (Tables 4.69, 4.71, 4.73, 4.75). It is predicted that there will be no significant negative effect on marine mammals or sea turtles from effluent during operation of the refinery complex (Tables 4.70, 4.72, 4.74, 4.76). The level of confidence associated with this assessment is medium. The characteristics of the effluent require further consideration as the engineering plans progress.

Lights

It is uncertain how river otters will respond to lighting. There is increased potential of an impact because this species is most active at night and during crepuscular hours. Assuming that river otters avoid areas with artificial lighting, it is predicted that lighting will have a low magnitude effect (disturbance) over a geographic extent of 1-10 km^2 and a duration of >72 months (Table 4.73). Impacts are judged to be not significant and the "level of confidence" associated with this assessment is medium (Table 4.74).

Table 4.69 Effects assessment of operation activities on the marine mammal (toothed and baleen whale) VEC.

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Refinery Operations and Maintenance								
Air emissions	Effects on health (A)	Minimize output	0	1	6	5	R	2
Run-off, Siltation	Prey availability (A)	Control measures	0	1-2	?	5	R	2
Vessel traffic [a]								
Marine Terminal Operations								
Vessel traffic [a]								
Marine Transportation								
Noise (vessels)	Disturbance (A)		1	2-3	6	5	R	2
Vessel traffic (physical presence)	Effects on health (A)	Maintain consistent speed/direction; reduce speed	0-1	2	1	5	R [b]	2
Intakes/Outfalls								
Effluent characteristics	Effects on health (A)	Treatment regulations	0-1	1	6	5	R	2
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	2
Oil spill at jetty	Effects on health (A)	Spill response; contingency plan	0-1	4	1	2	R	2
Oil spill near Red Island	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2
Oil spill in outer Placentia Bay	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2

a Considered under Marine Transportation; b Potentially irreversible at the individual level

Table 4.70 Summary of residual impact predictions of operation activities on marine mammal (toothed and baleen whale) VEC.

Valued Environmental Component: Marine Mammals – Toothed Whales and Baleen Whales				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Air emissions	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	2		
Marine Terminal Operations				
Vessel traffic	NS	2		
Marine Transportation				
Noise (vessels)	NS	2		
Vessel traffic (physical presence)	NS	3		
Intakes/Outfalls				
Effluent characteristics	NS	2		
Solid and Hazardous Wastes				
Location of outfall pipe	NS	3		
Accidents or Malfunctions				
Oil spill	NS	3		

Table 4.71 Effects assessment of operation activities on the marine mammal (seal) VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Air emissions	Effects on health (A)	Minimize output	0	1	6	5	R	2
Run-off, Siltation	Prey availability (A)	Control measures	0	1-2	?	5	R	2
Vessel traffic [a]								
Marine Terminal Operations								
Vessel traffic [a]								
Marine Transportation								
Noise (vessels)	Disturbance (A)		0-1	2-3	6	5	R	2
Vessel traffic (physical presence)	Effects on health (A)	Maintain consistent speed/direction; reduce speed	0	2	1	5	R [b]	2
Intakes/Outfalls								
Effluent characteristics	Effects on health (A)	Treatment regulations	0-1	1	6	5	R	2
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	2
Accidents or Malfunctions								
Oil spill at jetty	Effects on	Spill response; contingency	0-1	4	1	2	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
	health (A)	plan						
Oil spill near Red Island	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2
Oil spill in outer Placentia Bay	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2

a Considered under Marine Transportation; b Potentially irreversible at the individual level

Table 4.72 Summary of residual impact predictions of operation activities on marine mammal (seal) VEC.

Valued Environmental Component: Marine Mammals - Seals				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Air emissions	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Marine Terminal Operations				
Vessel traffic	NS	3		
Marine Transportation				
Noise (vessels)	NS	3		
Vessel traffic (physical presence)	NS	3		

Valued Environmental Component: Marine Mammals - Seals				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Intakes/Outfalls				
Effluent characteristics	NS	2		
Solid and Hazardous Wastes				
Location of outfall pipe	NS	3		
Accidents or Malfunctions				
Oil spill	NS	3		

Table 4.73 Effects assessment of operation activities on the marine mammal (river otter) VEC.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Presence of structures	Habitat loss (A)		3	2	6	5	I	2
Air emissions	Effects on health (A)	Minimize output	0	1	6	5	R	2
Lights	Disturbance (A)		1	2	6	5	R	2
Run-off, Siltation	Prey availability (A)	Control measures	0	1-2	?	5	R	2
Vessel traffic [a]								

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Marine Terminal Operations								
Presence of structures	Habitat loss (A)		3	2	6	5	I	2
Lights	Disturbance (A)		1	2	6	5	R	2
Vessel traffic [a]								
Marine Transportation								
Noise (vessels)	Disturbance (A)		1	2-3	6	5	R	2
Vessel traffic (physical presence)	Effects on health (A)	Maintain consistent speed/direction; reduce speed	0-1	2	1	5	R [b]	2
Lights	Disturbance (A)	Minimize lighting	1	2	6	5	R	2
Intakes/Outfalls								
Lights	Disturbance (A)		1	2	6	5	R	2
Effluent characteristics	Effects on health (A)	Treatment regulations	0-1	1	6	5	R	2
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	2
Accidents or Malfunctions								
Oil spill at jetty	Effects on health, mortality (A)	Spill response; contingency plan	2-3	4	1	2-3	I [c]	2
Oil spill near Red Island	Effects on health, mortality (A)	Spill response; contingency plan	2-3	5	1	2-3	I [c]	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Oil spill in outer Placentia Bay	Effects on health, mortality (A)	Spill response; contingency plan	2-3	5	1	2-3	I[c]	2

a Considered under Marine Transportation; b Potentially irreversible at the individual level; c Potentially reversible at the population level.

Table 4.74 Summary of residual impact predictions of operation activities on marine mammal (river otter) VEC.

Valued Environmental Component: Marine Mammals – River Otter				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Presence of structures	NS	1		
Air emissions	NS	3		
Lights	NS	2		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Marine Terminal Operations				
Presence of Structures	NS	1		
Lights	NS	2		
Vessel traffic	NS	3		
Marine Transportation				
Noise (vessels)	NS	2		

Valued Environmental Component: Marine Mammals – River Otter				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Vessel traffic (physical presence)	NS	3		
Lights	NS	2		
Intakes/Outfalls				
Lights	NS	2		
Effluent characteristics	NS	2		
Solid and Hazardous Wastes				
Lights	NS	2		
Location of outfall pipe	NS	3		
Accidents or Malfunctions				
Oil spill	S	1		

Table 4.75 Effects assessment of operation activities on the sea turtle VEC.

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Refinery Operations and Maintenance								
Air emissions	Effects on health (A)	Minimize output	0	1	6	5	R	2

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Run-off, Siltation	Prey availability (A)	Control measures	0	1-2	?	5	R	2
Vessel traffic [a]								
Marine Terminal Operations								
Vessel traffic [a]								
Marine Transportation								
Noise (vessels)	Disturbance (A)		1	2-3	6	5	R	2
Vessel traffic (physical presence)	Effects on health (A)	Maintain consistent speed/direction; reduce speed	0-1	2	1	5	R [b]	2
Intakes/Outfalls								
Effluent characteristics	Effects on health (A)	Treatment regulations	0-1	1	6	5	R	2
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	2
Accidents or Malfunctions								
Oil spill at jetty	Effects on health (A)	Spill response; contingency plan	0-1	4	1	2	R	2
Oil spill near Red Island	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2
Oil spill in outer Placentia Bay	Effects on health (A)	Spill response; contingency plan	0-1	5	1	2	R	2

a Considered under Marine Transportation; b Potentially irreversible at the individual level

Table 4.76 Summary of residual impact predictions of operation activities on the sea turtle VEC.

Valued Environmental Component: Sea Turtles				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Air emissions	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Marine Terminal Operations				
Vessel traffic	NS	3		
Marine Transportation				
Noise (vessels)	NS	3		
Vessel traffic (physical presence)	NS	3		
Intakes/Outfalls				
Effluent characteristics	NS	2		
Solid and Hazardous Wastes				
Location of outfall pipe	NS	3		
Accidents or Malfunctions				
Oil spill	NS	3		

4.9.3 Mitigation

Mitigation measures and monitoring proposed to minimize impacts on marine mammals, including river otters, and sea turtles are summarized in Table 4.77.

Table 4.77 Summary of proposed mitigation measures and monitoring for marine mammals and sea turtles.

Project Activity	Project Phase	Potential Effect	Mitigation/Monitoring
Land-based blasting (noise)	Construction	Effects on health (hearing impairment), disturbance	Adhere to DFO guidelines (Wright and Hopky 1998): setback distance, <100 kPa; monitor 180/190 dB 30 min prior to blast; delay start if cetacean, sea turtle, river otter in 180 dB zone or seal in 190 dB zone
Pile driving (noise)[a]	Construction	Effects on health (hearing impairment), disturbance	Potential use of bubble curtain if conditions permit; monitor 180/190 dB 30 min prior to pile driving; delay start or shut down if cetacean, sea turtle, river otter in 180 dB zone or seal in 190 dB zone.
Vessels (noise, physical presence)	Construction, Operations	Disturbance	Alter course to avoid mammal/turtle; no approach
Vessel presence (collision risk)	Construction, Operations	Effects on health, mortality	Maintain consistent speed and travel direction; reduce speed when possible
Run-off, siltation	Construction, Operations	Effects on prey availability	Silt curtain, control measures
Air emissions	Operations	Effects on health	Best available technology, follow-up monitoring
Presence of new structures	Construction, Operations	Loss of river otter haul-out sites	Follow-up monitoring
Effluent	Operations	Effects on health	Meet provincial regulations, monitor output
Accidents and malfunctions	Construction, Operations	Effects on health, mortality	Spill response; contingency plan; follow-up monitoring

4.9.4 Accidents and Malfunctions

The impact of an oil spill depends on its composition, environmental conditions, and the species of marine mammal exposed. Current literature, including laboratory and field studies, has demonstrated that most marine mammals, with the exception of fur seals, polar bears, and sea otters, are not very susceptible to deleterious effects of oil. However, newborn hair seal pups and weak or highly stressed individuals may be vulnerable to oiling. Although river otters that inhabit coastal areas are not technically considered marine mammals, as are their counterparts the sea otter, they are vulnerable to oiling because they rely on fur (not blubber) for insulation, and oiling greatly reduces the insulative properties of otter fur (Costa and Kooyman 1982 in Loughlin et al. 1996). In addition, coastal river otters in the Placentia Bay feed on intertidal and subtidal fish and invertebrates and thus have an increased likelihood of exposure to residual oil. Other marine mammals exposed to oil are generally not at risk because they rely on a layer of blubber for insulation, and oiling of the external surface does not appear to have any adverse thermoregulatory effects (Kooyman et al. 1976; 1977; Geraci 1990; St. Aubin 1990). Population-level effects on most marine mammal species in the Study Area are unlikely, as no significant long-term and lethal effects from external exposure, ingestion, or bioaccumulation of oil have been demonstrated. The following review has been sub-divided cetaceans (whales, dolphins), seals, otters and sea turtles.

Cetaceans

There is no clear evidence that implicates oil spills, including the much-studied Santa Barbara and *Exxon Valdez* spills, with mortality of cetaceans (Geraci 1990). Migrating gray whales were apparently not adversely affected by the Santa Barbara spill. There appeared to be no relationship between the spill and mortality of marine mammals. The higher than usual counts of dead marine mammals recorded after the spill was a result of increased survey effort related to the spill (Geraci 1990). The conclusion was that whales were either able to detect the oil and avoid it or were unaffected by it (Geraci 1990).

There was a significant decrease in the size of a killer whale pod resident in the area of the *Exxon Valdez* spill, but no clear cause and effect relationship between the spill and the decline could be established (Dahlheim and Matkin 1994). There were no evident effects on humpback whales in Prince William Sound after the *Exxon Valdez* spill (von Ziegesar et al. 1994). There was no apparent change in abundance or movement of humpback whales out of Prince William Sound resulting from the spill (Loughlin et. al. 1996).

Avoidance and Behavioural Effects

Studies of both captive and wild cetaceans indicate that they can detect oil spills. Captive bottlenose dolphins (*Tursiops truncatus*) avoided most oil conditions during daylight and darkness, but had difficulty detecting a thin sheen of oil (St. Aubin et al. 1985). Wild bottlenose dolphins exposed to the *Mega Borg* oil spill in 1990 appeared to detect, but did not consistently avoid contact with, most oil types (Smultea and Würsig 1995). This is consistent with other cetaceans behaving normally in the presence of oil (Harvey and Dahlheim 1994; Matkin et al. 1994). Humpback whales were not observed swimming in oil from the *Exxon Valdez* spill, whereas killer whales were observed swimming in oiled water (Loughlin et al. 1996). It is possible that cetaceans swim through oil because of an overriding behavioural motivation (for example, feeding). Some evidence exists that indicates dolphins attempt to minimize contact with surface oil by decreasing their respiration rate and increasing dive duration (Smultea and Würsig 1995).

Oiling of External Surfaces

Whales rely on a layer of blubber for insulation and oil has little if any effect on thermoregulation. Effects of oiling on cetacean skin appear to be minor and of little significance to the animal's health (Geraci 1990). It can be assumed that if oil contacted the eyes, effects would be similar to that observed in ringed seals (conjunctivitis, corneal abrasion, and swollen nictitating membranes) and that continued exposure to eyes could cause permanent damage (St. Aubin 1990).

Ingestion and Inhalation of Oil

Whales could ingest oil with water or contaminated food, or oil could be absorbed through the respiratory tract. Rorquals (e.g., blue, fin, sei, humpback and minke whales) are active feeders that lunge through clouds of prey, taking in large quantities of water and prey, then ejecting the water and filtering the prey. Species such as the humpback whale, right whale, beluga (*Delphinapterus leucas*), and harbour porpoise that sometimes feed in restricted areas (for example, bays) may be at greater risk of ingesting oil (Würsig 1990). Some of the ingested oil is voided in vomit or feces but some is absorbed and could cause toxic effects (Geraci 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982); marine mammals extensively metabolize aromatic compounds in their livers and metabolites are excreted. Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982). Only small traces of oil were found in the blubber of a gray whale and liver of a killer whale exposed to Exxon Valdez oil (Bence and Burns 1995).

Cetaceans may inhale vapours from volatile fractions of oil from a spill, particularly refined products. The most likely effects of inhalation of these vapours would be irritation of respiratory membranes and absorption of hydrocarbons into the bloodstream (Geraci 1990). Stressed individuals that could not escape a contaminated area would be most at risk.

Fouling of Baleen

In baleen whales, crude oil could coat the baleen and reduce filtration efficiency. However, effects are minimal and reversible. Baleen experimentally fouled with oil did not change enough to alter its filtration efficiency (St. Aubin et al. 1984) and most adherent oil was removed within 30 min after fouling (Geraci and St. Aubin 1985 in Geraci 1990). The effects of oiling of baleen on feeding efficiency appear to be only minor (Geraci 1990).

Summary of Oiling Effects

There is no direct evidence that implicates oil spills with cetacean mortality. Both toothed and baleen whales present in the affected area could experience sublethal effects, through oiling of mucous membranes or the eyes if they swim through a slick. As discussed above, these effects are reversible and would not cause permanent damage to the animals. There is a possibility that the baleen of whales could be contaminated with oil, thereby reducing filtration efficiency. However, effects would be minimal and reversible.

Impact Assessment

Whales may interact with spilled hydrocarbons but are not considered to be at high risk to the effects of exposure. There is no clear evidence that implicates oil spills with cetacean mortality. Both toothed and baleen whales present in the affected area could experience sublethal effects, through oiling of mucous membranes or the eyes if they swim through a slick. These effects are reversible and would not cause permanent damage. There is a possibility that the baleen of whales could be contaminated with oil, thereby reducing filtration efficiency; however, effects would be minimal and reversible. Some species are likely present in Placentia Bay year round, but most species likely occur there during summer months. However, there are limited available data for winter time. For cetaceans, it is likely that only small proportions of populations are at risk at any time.

Depending on the time of year, location of toothed and baleen whales within the affected area, and type and location of an oil spill, the effects of an oil release on the health of cetaceans is predicted to range from negligible to low magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km^2 are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the areal extent of the 0% probability contours depicted in Section 7.2. As indicated above, this estimate is quite conservative and any effects on cetaceans will likely occur over a much smaller area. For all spill scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 4.69). It is predicted that there will be no significant negative effect on cetaceans from an accidental release of oil in the Study Area (Table 4.70).

The oil spill countermeasures contained in the Proponent's contingency plan and the associated disturbance would likely reduce the number of cetaceans exposed to oil.

Seals

Reports of the effects of oil spills and blowouts have shown that some mortality of hair seals may have occurred as a result of oil fouling; however, large scale mortality has never been observed (St. Aubin 1990). The largest effect of a spill was on young hair seals in cold water (St. Aubin 1990).

Effects on seals have not been well studied at most spills because of lack of baseline data and/or the brevity of the post-spill surveys. There is little information about the mortality rate of harp seals exposed to oil from a ruptured storage tank in New Brunswick in 1969. It is believed that 10,000 to 15,000 harp seals were coated with oil but the exact number of dead seals recovered is unknown (Sergeant 1991). The release of fuel oil from the *Arrow* into Chedabucto Bay, Nova Scotia, in 1970 resulted in the fouling of 500 seals within the bay and 50 to 60 harbour and 200 grey seals on Sable Island (200 km south of the spill). Twenty-four seals were found dead and some had oil in their mouths and stomachs (Anon. 1970; 1971 in St. Aubin 1990). Oiled grey and harbour seals were found on the coast of Nova Scotia and Sable Island again in 1979 when the oil tanker *Kurdistan* sank in Cabot Strait. No causal relationship between oiling and death was determined (Parsons et al. 1980 in St. Aubin 1990). No mortalities were reported after a well blowout near Sable Island in 1984 and only two oiled grey seals were observed (St. Aubin 1990).

Intensive and long-term studies were conducted after the *Exxon Valdez* spill in Alaska. There may have been a long-term decline of 36% in numbers of moulting harbour seals at oiled haul-out sites in Prince William Sound, following the spill (Frost et al. 1994). Frost et al. (1994) estimated that at least 302 harbour seals likely died as a result of the EVOS. Harbour seal pup mortality at oiled beaches was 23 to 26%, which may have been higher than natural mortality (Frost et al. 1994). However, attributing cause to the decreasing trend in harbour seal numbers since the spill (4.6% per year) is complicated because seal populations were declining prior to the spill (Frost et al. 1999). Indeed, Hoover-Miller et al. (2001) reassessed the impact of the EVOS on harbour seals and concluded that available evidence did not support high mortality but was more consistent with seals avoiding some oiled haul-out sites. Only 14 dead seals (11 pups) were recovered following the spill and the cause of death in most cases could not be determined nor could the natural rate of mortality. Analysis of all pre- and postspill trend count data for harbour seals strongly suggest that effects of EVOS were limited and transitory (Hoover-Miller et al. 2001).

Avoidance and Behavioural Effects

There is conflicting evidence on whether seals detect and avoid spilled oil. Some oiled seals hauled out on land are reluctant to enter the water, even when disturbances from intense cleanup activities occur nearby (St. Aubin 1990; Lowry et al. 1994). In contrast, several thousand grey and harbour seals apparently left Chedabucto Bay, Nova Scotia, after the grounding of the Arrow (Mansfield 1970 in St. Aubin 1990), although this movement may have been caused by the increased human disturbance during cleanup activities rather than by the presence of oil (St. Aubin 1990). Harbour seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994). Other seals have been observed swimming in the midst of oil spills (St. Aubin 1990). Oiling of both mother and pups does not appear to interfere with nursing (Lowry et al. 1994).

Oiling of External Surfaces

Adult and juvenile hair seals (includes harbour, grey, harp and hooded seals) are at virtually no risk of thermal regulatory effects from oil fouling because their blubber, not their fur, provides insulation (Kooyman et al. 1976, 1977; St. Aubin 1990). It is questionable whether young seal pups, which rely on their birth coat and brown fat stores, could survive the deleterious effects of oiling (St. Aubin 1990). Contact with oil on the external surfaces can cause increased stress and can irritate the eyes of ringed seals (Geraci and Smith 1976; St. Aubin 1990). Harbour seals oiled during the Exxon Valdez spill had difficulty keeping their eyes open and experienced conjunctivitis (Spraker et al. 1994). These effects seem to be temporary and reversible, but continued exposure of oil to eyes could cause permanent damage (St. Aubin 1990). Damage to a seal's visual system would likely limit foraging abilities, as vision is an important sensory modality used to locate and capture prey (Levenson and Schusterman 1997). Mucous membranes that line the oral cavity, respiratory surfaces, and anal and urogenital orifices are also sensitive to oil exposure (St. Aubin 1990). Seals fouled externally with heavy oil may also encounter problems with locomotion. The flippers of young harp seals and grey seal pups were impeded by a heavy coating of oil that became stuck to their sides (Davis and Anderson 1976; Sergeant 1991). This led to the drowning of the grey seal pups. The coating of seals and their subsequent deaths were also observed in seals exposed to heavy bunker oil during the Arrow and Kurdistan spills (Engelhardt 1987 in Lowry et al. 1994).

Oil Ingestion and Inhalation

Seals can ingest oil if their food is contaminated or by nursing contaminated milk. Oil can also be absorbed through the respiratory tract (Geraci and Smith 1976; Engelhardt et al. 1977). Some ingested oil is voided in vomit/feces or metabolized at rates that prevent significant bioaccumulation (Neff 1985 in Hartung 1995) but some is absorbed and can cause toxic effects (Engelhardt 1981). These effects may include minor kidney, liver and brain lesions (Geraci and Smith 1976; Spraker et al. 1994). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982, 1985). Seals exposed to an oil spill and especially a blowout are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980; 1982) and any effects are probably reversible (Spraker et al. 1994). There were no significant quantities of oil in the tissues (liver, blubber, kidney and skeletal muscles) of harbour seals exposed during the Exxon Valdez spill (Bence and Burns 1995).

Seals are also at risk from hydrocarbons and other chemicals that evaporate from spills and blowout areas. Seals generally keep their nostrils close to the water surface when breathing, so they are likely to inhale vapours if they surface in a contaminated area. Grey seals that presumably inhaled volatile hydrocarbons from the Braer oil spill exhibited a discharge of nasal mucous, but no causal relationship with the oil was determined (Hall et al. 1996). Laboratory studies of ringed seals indicate that the inhalation of hydrocarbons may cause more serious effects like kidney and liver damage (St. Aubin 1990). However, exposure conditions were much higher than would be expected in a natural setting.

Factors Affecting the Severity of Oil Exposure

Seals that are under some type of natural stress, such as lack of food or a heavy infestation by parasites, could die as a result of the additional stress of oiling (Geraci and Smith 1976; St. Aubin 1990). Seals that are not under natural stress would most likely survive oiling.

Seals exposed to heavy doses of oil for prolonged periods could die. In cases where oil goes ashore, harbour seals may be particularly at risk because they exhibit site fidelity (Boulva and McLaren 1979; Yochem et al. 1987). Prolonged exposure from oil at a preferred haul-out site could cause death. However, Jenssen (1996) reported that oil has produced little visible disturbance to grey seal behaviour and there has been little mortality despite the fact that approximately 50 per cent of grey seal pups at Norway's largest breeding colony are polluted each year by oil.

Summary of Oiling Effects

Seals are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals. Few seals are expected to be exposed to oil from an accidental release in the Study Area and most seals do not exhibit large behavioural or physiological reactions to limited surface oiling, incidental exposure to contaminated food, or ingestion of oil.

Impact Assessment

Seals may interact with spilled oil but are not considered to be at high risk from the effects of oil exposure. However, some evidence implicates oil spills with seal mortality, particularly young seals. As previously discussed, seals are present (in small numbers) for at least part of the year, and the harbour seal may occur there year-round. Most seals do not exhibit large behavioural or physiological reactions to limited surface oiling, incidental exposure to contaminated food, or ingestion of oil.

Depending on the time of year and type of oil spill, the effects of an oil release on seals could range from negligible to low magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km*2* are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the areal extent of the 0% probability contours depicted in Section 7.2. This estimate is quite conservative and any effects on seals will likely occur over a much smaller area. For all scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 4.71). It is predicted that there will be no significant negative effect on seals from an accidental release of oil in the Study Area (Table 4.72).

The oil spill countermeasures contained in the Proponent's contingency plan and the associated disturbance would likely reduce the number of seals exposed to oil.

River Otters

Most research on effects of oiling on river otters has occurred as a result of the *Exxon Valdez* oil spill (EVOS). In March 1989, 39,000 metric tons of crude oil were spilled in Prince William Sound, which eventually spread along 3500 km of coastline, including river otter habitat. Bowyer et al. (2003) provide a review and synthesis of the EVOS research on river otters and this publication is summarized below. The authors of this publication repeatedly note the difficulties in interpreting study results because of the absence of pre-spill or baseline data on many aspects of the river otter biology in the area.

Mortality

Following the EVOS, beach surveys revealed 12 river otter carcasses. Bowyer et al. (2003) state that the "…number of carcasses of river otters counted immediately following EVOS are a gross underestimate of the actual mortality" as beach surveys would not have detected most dead otters. Toxicological analyses of several of the carcasses indicated river otters died from acute effects of oiling. The magnitude of mortalities is uncertain but it is thought that high rates of mortality did not occur immediately following the EVOS (Testa et al. 1994). Because population estimates for river otters were unavailable prior to the EVOS, Testa et al. (1994) compared population estimates at oiled vs. non-oiled (actually lightly oiled) sites and no differences were detected. It is possible that mortality in river otters that occurred after 1990 could have resulted from a combination of direct physiological effects from chronic exposure to oil, decreased foraging efficiency, and increased energy demands as a result of a larger home-range (see below). However, it does not appear that recruitment and survival were depressed after 1997 (Bowyer et al. 2003).

Avoidance and Behavioural Effects

Differences in habitat selection have been demonstrated for river otters during EVOS studies. Bowyer et al. (1995) showed that otters avoided oiled beaches and that otters in oiled areas selected steep tidal slopes and large rocks where oil did not accumulate for at least a year after the spill. These differences decreased seven years after the spill (potentially earlier), suggesting that river otters were recovering from deleterious effects (Bowyer et al. 2003).

Home-range size increased for river otters in areas exposed to the EVOS vs. non-oiled areas (Bowyer et al. 1995) which supports the observations that some shoreline habitats were avoided in oiled areas. Follow-up analyses in 1997-99 showed that home-range sizes had decreased.

Oil Ingestion

Ingestion of oil can happen when an animal grooms its coat after swimming through an oil slick or ingesting prey (fish) that has oil in its tissues. The extent of uptake via the latter method depends on the fish’s ability to metabolize hydrocarbons. Ormseth and Ben-David (2000) showed that river otters ingesting oil via grooming had an increased passage rate of digesta and reduced assimilation of hydrocarbons. In laboratory conditions, chronic exposure to low doses of weathered crude oil, resulted in physiological damage, notably a reduction in hemoglobin and white blood cells and an increase in several liver enzymes (Ben-David et al. 2000). This damage, particularly the reduction in hemoglobin led to a decrease in aerobic dive limit and a potential increase in foraging time. Also, there was an increase in energetic costs of terrestrial locomotion. These chronic physiological effects could result in a decrease in body condition of free-ranging river otters. This is supported by an observed reduction of body mass of otters at oiled vs. non-oiled sites.

Blood parameters, liver enzymes (i.e., biomarkers), and fecal porphyrins of free-ranging river otters were measured shortly after the spill and years later. Early studies (1989-1992) indicated elevated levels of haptoglobin (Hp), interleukin-6immunoreactive (IL-6 ir), aspartate aminotransferase (AST) and several liver enzymes between oiled and non-oiled sites. Bowyer et al. (2003) suggest that elevated levels of these biomarkers provide strong evidence that otters were experiencing subtle and chronic effects from the spill. By 1992, enzyme levels had decreased and did not differ between oiled and non-oiled sites. By 1996, levels of Hp and fecal porphyrins (potentially associated with malnutrition) had decreased, indicating a recovery in river otters.

Diet and Prey Availability

River otter diet differed between oiled and non-oiled sites after the EVOS. At oiled sites, the crustacean component increased and the fish component of the diet (preferred diet of otters) decreased. This change in diet may have been attributable to the lower availability of fishes or alternatively a reduction in the ability of otters to dive and forage as a result of exposure to oil (see Bowyer et al. 2003). Overall reduction of fish in the diet of river otters at oiled sites likely resulted in the lower body mass observed in otters at oiled vs. non-oiled sites (Bowyer et al. 1994). No differences in diet were observed in 1996-97, providing evidence that river otters were recovering from the EVOS (Bowyer et al. 2003).

Summary of Oiling Effects

It is uncertain how many river otters experienced acute mortality due to exposure to the EVOS. Beach surveys, which yielded 12 carcasses immediately after the spill, are not considered a reliable method for locating dead river otters. River otters that inhabited oiled areas after the EVOS had lower body mass, elevated biomarkers in their blood, higher levels of fecal porphyrins, a less diverse diet, larger home ranges, and selected habitats differently than otters living in areas that were not heavily oiled. These effects were not evident or significant in later studies conducted in 1996-99, although river otters continued to be exposed to low levels of crude oil. Bowyer et al. (2003) concluded, albeit cautiously, that river otters had recovered from the more “pernicious effects of EVOS”.

Impact Assessment

River otters particularly in inner Placentia Bay may be at high risk to the effects of oil exposure given that there are haul-out sites near the proposed oil refinery and that this species is known to forage near the coast. Indeed, river otters have numerous haul-out sites in inner Placentia Bay which overlap with the area where oil may occur from a spill at the proposed jetty Risk of exposure is likely reduced for spill scenarios near Red Island and Cape St. Mary’s.

Depending on the time of year and type of oil spill, the effects of an oil release on river otter health could range from a medium to high magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km^2 are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the areal extent of the 0% probability contours depicted in Section 7.2. This estimate is quite conservative and effects on river otters will likely occur over a much smaller area. For all spill scenarios considered, the duration is predicted to be 1-12 months to 13-36 months; effects are considered irreversible at the individual level but likely reversible at the population level (Table 4.73). It is predicted that there will be a significant negative effect on river otters from an accidental release of oil in the Study Area (Table 4.74). However, the level of confidence associated with this assessment is low given the data gaps concerning river otter abundance and mortality response to oil exposure. In the unlikely event that an oil spill occurs and river otters are exposed to oil, follow-up monitoring will be undertaken to verify or refute the impact prediction.

The oil spill countermeasures contained in the Proponent’s contingency plan and the associated disturbance would likely reduce the number of river otters exposed to oil.

Sea Turtles

It is not known whether sea turtles can detect and avoid oil slicks. Gramentz (1988) reported that sea turtles did not avoid oil at sea, while those exposed to oil under experimental conditions had a limited ability to avoid it (Vargo et al. 1986).

Loggerhead sea turtles experimentally exposed to oil had marked gross and histologic lesions present in the skin. Most effects were reversed by the tenth day following cessation of oil exposure (Bossart et al. 1995). Other effects of oil on sea turtles include reduced lung diffusion capacity, decreased oxygen consumption, decreased digestion efficiency, and damaged nasal and eyelid tissue (Lutz et al. 1989).

A study was undertaken to assess the effects of exposure of juvenile loggerhead sea turtles to weathered (South Louisiana) crude oil (Lutcavage et al. 1995). Ten turtles were used, five each in treatment and control groups. The treatment group was exposed to an oil slick (surface of the tank completely covered) for five days. In oiled turtles, there was no evidence of reduced oxygen uptake by the blood or tissues but white blood cells increased and red blood cells decreased. Loggerheads exposed to oil sloughed off layers of skin, especially around the neck and flippers. After their removal from oil, skin continued to peel off for one to two weeks and recovered its normal leathery texture only about one month after exposure. Other effects were also reversed in less than a month after exposure to oil. The authors concluded that the long-term impacts of oiling on sea turtles remain completely unknown.

There are few field observations of sea turtles exposed to oil. After the *Ixtoc 1* blowout in 1979, seven live (six green sea turtles, one Kemp's ridley) and three dead sea turtles (two green, one Kemp's ridley) were recovered (Hall et al. 1983). Of the live turtles, Hall et al. (1983) report that "…some were treated and one was released." Two of the three carcasses had oil in the gut but no lesions. There was no evidence of aspirated oil in the lungs but hydrocarbon residues were found in kidney, liver, and muscle tissue of all three dead turtles. The authors suggested prolonged exposure to oil may have disrupted the feeding behaviour and weakened the turtles, which perhaps contributed to their death.

Most effects of oil on sea turtles seem reversible, but there is a possibility that foraging abilities may be inhibited by exposure to oil.

Impact Assessment

Sea turtles (predominantly leatherbacks) occur regularly in small numbers in outer Placentia Bay, primarily during summer to early fall. Few turtles have been recorded near the proposed refinery site. If a spill occurs, there is a low likelihood that sea turtles will be exposed to oil, particularly from an accidental release near the proposed jetty site. Based on available information (albeit limited), effects of oil on sea turtles will likely be reversible, but there is a possibility that foraging abilities may be inhibited by exposure to oil.

Depending on the time of year and the location of an oil spill, the effects of an oil release on sea turtles could range from a negligible to low magnitude over varying geographic extents. Maximum geographic extents of >101-1000 km^2 and 1001-10,000 km^2 are predicted for spills at the proposed jetty location and Red Island area/outer Placentia Bay, respectively based on the aerial extent of the 0% probability contours depicted in Section 7.2. This estimate is quite conservative and any effects on sea turtles will likely occur over a much smaller area. For all spill scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 4.75). It is predicted that there will be no significant negative effect on sea turtles from an accidental release of oil in the Study Area (Table 4.76).

The oil spill countermeasures contained in the Proponent's contingency plan and the associated disturbance may reduce the number of sea turtles exposed to oil.

4.10 Species at Risk Effects Assessment

4.10.1 Project Effects During Construction

Terrestrial

Freshwater Fish

One American eel was found within the Refinery footprint. The habitat compensation strategy is provided in Section 4.7.3.

Landbirds

Terrestrial species considered at risk have not been sighted in the Project Area; however, suitable habitat does exist for Short-eared Owl (Special Concern), Gray-cheeked Thrush (Vulnerable under provincial ESA), Rusty Blackbird (Special Concern) and Red Crossbill (Endangered). It is possible that Peregrine Falcons (*anatum*: Special Concern; *tundrius*: Threatened) may occur in and near the Project Area during their fall migration but they were not observed during field studies in support of this EIS.

A recovery strategy for Red Crossbill (Environment Canada 2006) is available but no critical habitat has been defined. Mitigation and monitoring designed to minimize potential effects of construction activities on COSEWIC and/or *SARA*-listed terrestrial birds were outlined in Table 4.34. In addition, if nesting sites are found for at risk species, an appropriate buffer zone will be established (if possible) around the site to minimize disturbance.

With these mitigation measures in place and as per the detailed effects assessment in Section 4.6.1, Project Effects during Construction, construction activities are predicted to have no significant effect (see Tables 4.78, 4.79) on Short-eared Owl, Gray-cheeked Thrush, Rusty Blackbird, Red Crossbill, and Peregrine Falcon. In summary, potential effects of the proposed construction activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.78 Effects assessment of construction activities on terrestrial bird species considered at risk.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise	Disturbance (A)		1	2	6	4	R	1
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Loss of Habitat	Effects on health (A)	Avoid nest sites if possible	1	2	6	4	I	1
Noise	Disturbance (A)		1	2	6	4	R	1
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Refinery Complex								
Noise	Disturbance (A)		1	2	6	4	R	1
Lights	Disturbance (A)		1	2	5	4	R	1
Vehicular traffic	Disturbance (A)		1	2	6	4	R	1
Presence of new structures	Collision (A)	Minimize lighting; monitor	1	2	6	4	I	1
Marine Terminal								
Noise	Disturbance (A)		1	1	6	4	R	1
Lights	Disturbance (A)		1	1	5	4	R	1
Vehicular traffic	Disturbance (A)		1	1	6	4	R	1
Presence of new structures	Collision (A)	Minimize lighting; monitor	1	1	6	4	I	1
Intakes/ Outfalls								
Lights	Disturbance (A)		1	1	6	4	R	1
Accidents or Malfunctions								

Table 4.79 Summary of residual impact predictions of construction activities on terrestrial bird species considered at risk.

Valued Environmental Component: terrestrial birds SAR				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Site Preparation				
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Loss of Habitat	NS	2	-	-
Site Access Road, transmission lines, pipelines, Quarry Development				
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Refinery Complex				
Noise	NS	3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Presence of new structures	NS	2	-	-
Marine Terminal				
Noise	NS	2	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Presence of new structures	NS	2	-	-
Intakes/ Outfalls				
Noise	NS	2	-	-
Lights	NS	2	-	-

Lichens

The proposed refinery at Southern Head could negatively affect lichen populations through habitat loss and air emissions. Many species of epiphytic lichens require mature forest conditions and are particularly sensitive to the effects of habitat alteration (Cameron 2002; Rheault et al 2003). Habitat modification and loss can affect lichens' ability to survive, to disperse and to develop, and when these factors affect a species with a limited distribution the consequences can be relevant for the entire population. Lichens, particularly cyanolichens, are also extremely susceptible to the impacts of air pollution, owing to their reliance on airborne nutrients and water, and to their lack of protective structures such as cuticles found in vascular plants. Trees and other vascular plants are affected by pollution, but are generally slower to show impacts than lichens (McCune 2000). Air emissions from the refining of petroleum products constitute a major source of contaminants that affect lichens (Cameron et al. 2007). In addition, any development of industrial facilities in lichen habitat would contribute to habitat loss and alteration.

Cyanolichens in the Project Area

Cyanolichens are lichens that host blue-green algae as a symbiont. Several cyanolichens have been documented in the Project Area, including the rare boreal felt lichen (*Erioderma pedicellatum*). This species is listed as Vulnerable by the Newfoundland and Labrador Endangered Species Act and as a species of Special Concern by COSEWIC, and is listed on Schedule 1 of *SARA*. Two areas of concentration of *E. pedicellatum* have been identified in Newfoundland: the centre of the Avalon Peninsula and the Bay d'Espoir area. It is acknowledged in the provincial management plan for boreal felt lichen in Newfoundland that information on distribution and abundance of this species reflects search efforts (Keeping and Hanel 2006). Unknown, and perhaps important, areas for boreal felt lichen may exist in unsurveyed areas of the island. Greater survey effort in suitable habitat will likely lead to the discovery of more lichens. Boreal felt lichen was found in the area of the proposed access road along the western side of the peninsula, approximately 300 to 500 m east of the proposed road right-of-way. Surveys for rare lichens were also conducted in forested habitats on the east and west sides of Southern Head, the headland of Southern Head (including the proposed refinery footprint), and areas adjacent to Hollett's Cove and Doughboy Cove. No *E. pedicellatum* were found during these surveys. However, this species is also likely present at other sites in the proposed access road area and likely within the footprint of the development given that the associate cyanolichen species have been located there (see Goudie and Munier 2007). Additional surveys for boreal felt lichen will be conducted along the proposed access roads and in the refinery footprint prior to commencement of construction activities so that these sensitive species can be avoided where possible. Other cyanolichen species in the Project Area are not currently listed at risk either federally or provincially.

Other species of cyanolichens documented in the Project Area include *Coccocarpia palmicola*, *Lichinodium sirosiphoideum*, *Lobaria pulmonaria*, *Lobaria*. *scrobiculata*, *Lobaria. quercizans*, *Degelia plumbea*, and *Fuscopannaria ahlneri*. The liverwort *Frullania tamarisci*, thought to host the contact of the fungal hyphae of *E. pedicellatum* with the blue-green bacteria *Scytonema sp*. (Maass and Yetman 2002), was observed widely in the Project Area. Cyanolichens at Southern Head were primarily documented on balsam fir (all Erioderma, Coccocarpia, Lichinodium, Fuscopannaria) and white spruce (Lobaria spp. only), and most forested habitat in the area is closed coniferous stands. Within Newfoundland, *E. pedicellatum* is found predominantly on mature, over-mature, or dead balsam fir trees that are common in the Project Area (Figure 4.26). Overall, epiphytic lichens tend to favour mature conifer forests (Cameron 2002).

Effect of Habitat Loss on Lichens

The loss of habitat, particularly of balsam fir forest stands, brought about by site preparation and construction is a major threat to lichens in the Project Area. Epiphytic lichens tend to be associated with undisturbed stands of conifers, many of them requiring mature or old growth conditions (Cameron 2002). *E. pedicellatum* generally occur in cool, moist, mature balsam fir stands in the transitional zone from lower sphagnum-rich bogs and drier mid-slope forest (Keeping 2006). The extent that proposed activities would lead to a direct loss of habitat for Erioderma and other lichens is illustrated in Figure 4.26. It is estimated that <1 km^2 of balsam fir habitat will be lost directly due to clearing of the proposed oil refinery site (0.30 km^2) and access roads (>0.11 km^2).

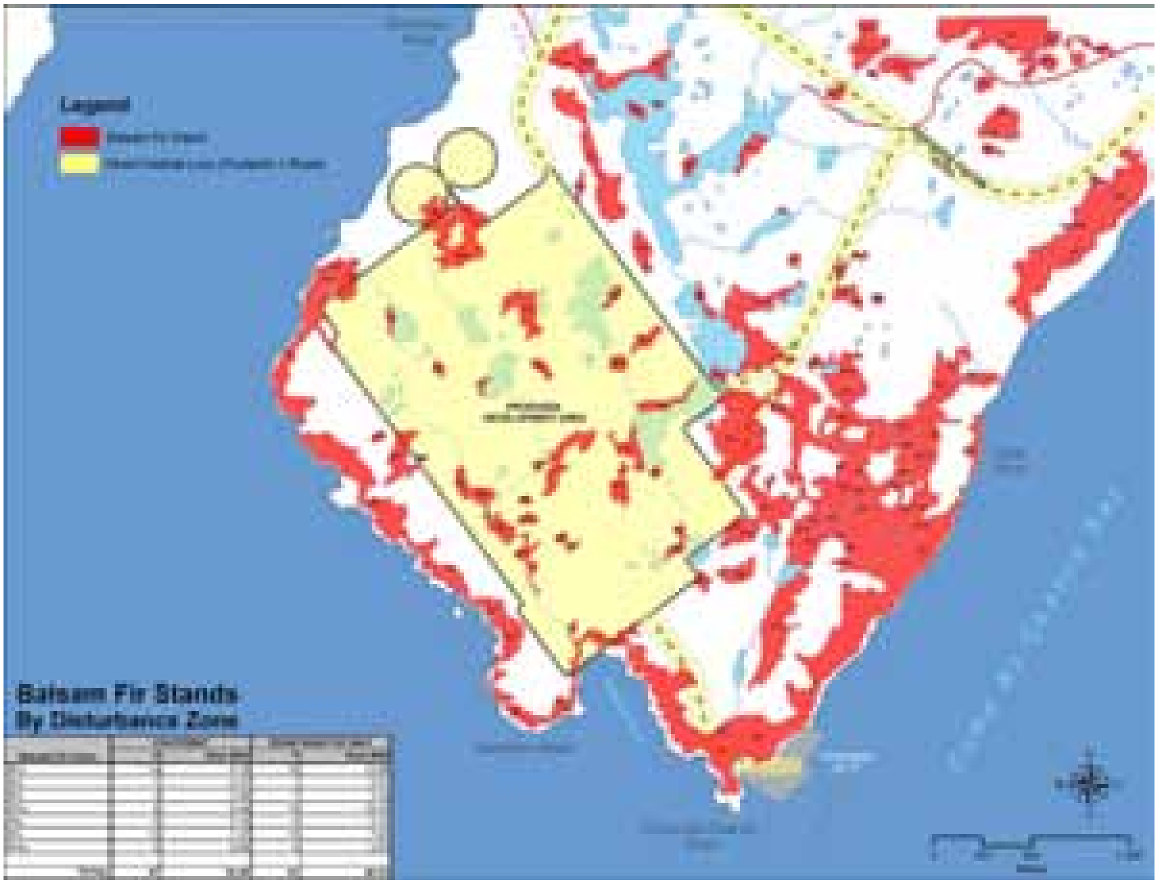

Figure 4.26 Balsam Fir Stand Displacement. Balsam Fir Stands in the Project Area Replaced by the Proposed Oil Refinery Complex at Southern Head, Placentia Bay.

Indirect Effects of Habitat Disturbance

Fragmentation and alteration of the forests near the refinery complex would amplify the negative effects sustained by the lichens due to habitat loss. Lichens depend on certain forest structure and climatic conditions for their establishment and continued survival, and these can be altered by development in surrounding areas. The activity and growth of lichens are directly associated with microclimatic conditions, which change depending on distance to forest edges (Rheault et al, 2003). It is believed that logging and the resulting decrease in moisture levels in adjacent stands contributed to the demise of *E. pedicellatum* in Sweden (Maass and Yetman 2002). Studies in northwestern Quebec have shown that epiphytic lichens occurring within 50 m of human-made clearings were significantly less common than those in the forest interior (Rheault et al, 2003). This suggests that lichens in forest stands near proposed site-clearing areas could be indirectly affected by stand cutting and fragmentation due to alterations to their micro-habitat. This type of fragmentation would also increase human access to balsam fir stands for activities such as domestic wood cutting. This could damage lichens directly by having phorophytes or potential phorophytes cut, and indirectly through further habitat alteration. The remnants of wood cutting have been observed in the course of all vegetation surveys on Southern Head, and construction in the area will make sites more readily available for human activity.

Suitable habitat must be present and available for colonization for lichen populations to remain viable, and epiphytic lichens are often poor dispersers (Sillett et al. 2000). As forest stands become fragmented due to construction activity, the chances of lichen propagules reaching appropriate habitat to establish new colonies will be diminished. Patch isolation has been negatively correlated with colonization for a number of different species, including both vegetatively and sexually reproducing lichen species (Johansson and Ehrlén 2003). Species such as *E. pedicellatum* that require specific microhabitats and/or ecological associations to develop are particularly susceptible to the effects of habitat degradation.

Effects Assessment

Interactions that are expected between proposed construction activities and lichen health in the Study Area include air emissions and habitat loss (see Table 4.81). The impact of air emissions was not considered significant during the construction phase of the refinery, potential effects from air emissions are of primary concern during the operational phase of the Project; effects are discussed in detail in Project Effects During Operations (Section 4.10.2). Habitat loss will be the greatest effect on lichens during the construction phase. To minimize effects, balsam fir forest stands will be left intact in as much as possible along the road right of ways. Loss of habitat due to site preparation was predicted to have a medium to high magnitude impact on lichens over a geographic range of less than 1 km^2. While the duration of the site preparation is expected to be 37-72 months, the effect of habitat loss will be irreversible, and will be taking place in a relatively pristine area – or, at least, an area not adversely affected by human activity (Table 4.80). For lichen species not considered at risk, this level of impact over a small geographic extent is considered not significant. However, the level of confidence associated with this assessment is medium given the data gaps concerning overall abundance and distribution of lichens in Newfoundland.

Prior to road and refinery construction, more detailed surveys of the entire infrastructure footprint will be conducted to locate *E. pedicellatum* so that these sites can be avoided as much as possible. Balsam fir stands will be left intact as much as possible during construction of the access roads. In addition, along access roads, a buffer zone of at least 20 m will be left around sites with boreal felt lichens as recommended in the provincial management plan (Keeping and Hanel 2006). If *E. pedicellatum* is found in the proposed refinery footprint after additional surveys, these lichens will be transplanted to suitable habitat in consultation with Dr. C. Scheidegger, a recognized international expert on boreal felt lichens who has previously had success in transplanting this species (I. Goudie, LGL Ltd., pers. comm.). With these mitigation measures in place, loss of habitat due to site preparation is predicted to have a medium to high magnitude impact on the boreal felt lichen over a geographic range of less than 1 km^2. While the duration of the site preparation is expected to be 37-42 months, the effect of habitat loss will be irreversible (Table 4.80). With intensive surveying of the refinery and access road footprints, avoidance or transplantation of any *E. pedicellatum*, it is predicted that impacts due to habitat loss will not be significant. However, considering the numerous data gaps surrounding this species, particularly its abundance and distribution in Newfoundland, the level of confidence associated with this assessment is low (Table 4.81). Follow-up monitoring on the health and distribution will be undertaken after construction activities.

Table 4.80 Construction Interaction. Assessment of Construction Activities on Terrestrial Lichen (*E. pedicellatum*) VEC

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Air emissions	Effects on health (A)	Minimize SO_2 NO_X, & metal, emissions	1	1	1	4	R	1
Loss of Habitat	Mortality (A)	Minimize balsam fir removal; avoid *E.p.* by >20 m; transplant *E.p.*	2-3	1	1	4	I	1
Site Access Road, transmission lines, pipelines, Quarry Development								
Air emissions	Effects on health (A)	Minimize SO_2 NO_X, & metal, emissions	1	1	1	4	R	1
Refinery Complex								
Air Emissions	Effects on health (A)	Minimize SO_2 NO_X, & metal, emissions	1	1	1	4	R	1

Table 4.81 Construction Residual Effects. Summary of Residual Impact Predictions of Construction Activities on Terrestrial Lichen (E. pedicellatum) VEC.

Valued Environmental Component: Species At Risk – *E. pedicellatum*				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Air emissions	NS	2	--	--
Loss of Habitat	NS	1	--	--
Site Access Road, transmission lines, pipelines, Quarry Development				
Air emissions	NS	2	--	--
Refinery Complex			--	--
Air Emissions	NS	2	--	--

Marine

Birds

Marine-associated birds considered at risk which occur or may occur in the Study Area include Harlequin Duck (Special Concern), Barrow's Goldeneye (Special Concern), Ivory Gull (Endangered), Piping Plover (Endangered) and Red Knot (Endangered). The Barrow's Goldeneye, Piping Plover and Ivory Gull are rare in Placentia Bay, with only one or two sightings in recorded history. There is of lack of habitat for the Plover,) and the bay is beyond the normal range for Barrow's Goldeneye and Ivory Gull. Only Harlequin Duck and Red Knot are known to occur on a regular basis. A recovery strategy is not in place for Red Knot; this species is not yet listed on Schedule 1 of *SARA*. Harlequin Ducks occur regularly at and near Cape St. Marys during winter and have recently been sighted near Lamaline on the Burin Peninsula during surveys in support of this EIS. Red Knot, a shorebird species, was sighted at Come By Chance lagoon and Southern Harbour estuary during shore-based surveys in support of this EIS. These sightings occurred during fall migration. Little suitable habitat for Red Knot exists for this species in the area of Southern Head. Construction activities at the proposed refinery site and the marine terminal are not expected to interact with Harlequin Ducks and pose little risk to Red Knot or other species of marine-associated birds considered at risk. Mitigation and monitoring designed to minimize potential effects of construction activities on COSEWIC and/or *SARA*-listed marine-associated birds were outlined in Table 4.34.

With these mitigation measures in place and as per the detailed effects assessment in Section 4.6.1, Project Effects during Construction, construction activities are predicted to have no significant effect (see Tables 4.82, 4.83) on marine-associated bird species considered at risk. In summary, potential effects of the proposed construction activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.82 Effects assessment of construction activities on marine-associated birds considered at risk.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, Siltation	Prey availability (A)	Silt curtains	0	1-2	2	?	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Noise	Disturbance (A)		0-1	2	6	4	R	1
Lights	Disturbance (A)		0	2	6	4	R	1
Run-off, Siltation	Prey availability (A)	Silt curtains	0	1-2	?	4	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Presence of new structures	Loss of habitat (A)		1-3	1	6	4	I	1
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0	1-2	?	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Vehicular traffic	Disturbance (A)		0	2	6	4	R	1
Presence of Structures	Loss of habitat (A)		1-3	2	6	4	I	1
Marine Terminal								
Noise	Disturbance (A)		0-1	2	6	3	R	1
Lights	Disturbance (A)		0	2	6	3	R	1
Run-off, siltation	Prey availability (A)	Silt curtains	0	1-2	?	3	R	1
Vessel traffic	Disturbance (A).		0-1	2	6	3	R	1
Vehicular	Disturbance (A)		0	2	6	3	R	1

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects: Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
traffic								
Presence of new structures	Loss of habitat (A)		1	1	6	3	I	1
Intakes/ Outfalls								
Noise	Disturbance (A)		0	1	6	4	R	1
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, siltation	Prey availability (A)	Silt Curtain	0	1-2	6	?	R	1
Presence of new structures	Prey availability (A)		0	1	6	4	R	1

Table 4.83 Summary of residual impact predictions of construction activities on marine-associated birds considered at risk.

Valued Environmental Component: Marine-associated birds SAR				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Lights	NS	3		
Run-off, Siltation	NS	3		
Site Access Road, transmission lines, pipelines, Quarry Development				
Noise	NS	3		
Lights	NS	3		

Valued Environmental Component: Marine-associated birds SAR				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Run-off, Siltation	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Refinery Complex				
Run-off, siltation	NS	3		
Vessel traffic	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Marine Terminal				
Noise	NS	3		
Lights	NS	3		
Run-off, siltation	NS	3		
Vessel traffic	NS	3		
Vehicular traffic	NS	3		
Presence of new structures	NS	3		
Intakes/ Outfalls				
Noise	NS	3		
Lights	NS	3		
Run-off, siltation	NS	3		
Presence of new structures	NS	3		
Accidents or Malfunctions[a]				

Mammals and Sea Turtles

As described in Section 3.7.5 there are four marine mammal species and one species of sea turtle considered at risk by COSEWIC and/or listed under Schedule 1 of *SARA*. The blue whale and the North Atlantic right whale are considered Endangered under Schedule 1; based on available information both are considered rare in the Study Area. Fin whales, listed as Special Concern, are expected to occur regularly in the Study Area, particularly during summer months. Harbour porpoise, listed as Special Concern by COSEWIC and under consideration for listing on Schedule 1 of *SARA,* are likely common (at least in small numbers) during all seasons. Leatherback sea turtles have regularly been sighted in the Study Area but typically south of the proposed marine terminal site and primarily during summer months.

There are no available recovery strategies or action plans in place for marine mammals in Atlantic Canada. A recovery strategy for leatherback sea turtles is available (ALTRT 2006) but no critical habitat has been defined. Mitigation and monitoring designed to minimize potential effects of construction activities on COSEWIC and/or *SARA*-listed marine mammals and sea turtles may include:

- Adherence to DFO guidelines for blasting (setback distances to ensure sound pressure does not exceed 100 kPa in the water column);
- Use of bubble curtain around pile drivers to minimize sound levels;
- Acoustic monitoring to ensure sound levels do not exceed 100 kPa from blasting and for establishing 180 and 190 dB safety zones;
- Acoustic measurements to determine if sound levels from pile driving exceed 180 dB and if so, determine 180 and 190 dB safety zones;
- Visual monitoring by a trained individual of safety zones (180 and 190 dB) 30 min prior to nearshore blasting and pile driving activities;
- Delay of pile driving or blasting operations if any marine mammal or sea turtle is sighted within a designated safety zone; and
- Cessation of pile driving if a marine mammal or sea turtle enters a designated safety zone.

With mitigation measures in place and as per the detailed effects assessment in Section 4.9.1, construction activities are predicted to have no significant effect (physical or behavioural; see Tables 4.84, 4.85) on blue whales, right whales, fin whales, harbour porpoises, or leatherback sea turtles.

In summary, potential effects of the proposed construction activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.84 Effects assessment of construction activities on marine mammal and sea turtles considered at risk by COSEWIC and/or *SARA*.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Site Preparation								
Noise (blasting)	Effects on health (A)	Setback distance; delay start; monitoring	0-1	1	?	4	R	2
Noise (blasting)	Disturbance (A)	Setback distance; delay start; monitoring	0-1	2-3	?	4	R	2
Site Access Road, transmission lines, pipelines, Quarry Development								
Refinery Complex								
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic[a]								
Marine Termnal								
Noise (pile driving)	Effects on health (A)	Bubble curtain; delay start if in safety zone; monitoring	0-1	1	4	2	R	2
Noise (pile driving)	Disturbance (A)	Bubble curtain; delay start if in safety zone; monitoring	1	2-3	4	2	R	2
Noise (vessels)	Disturbance (A)	No approach	1	2-3	6	3	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2
Vessel traffic (physical presence)	Disturbance (A)	Alter course	0-1	1-2	6	3	R	2
Presence of								

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
new structures[b]								
Intakes/ Outfalls								
Noise	Disturbance (A)	No approach	0-1	2-3	?	3?	R	2
Run-off, siltation	Prey availability (A)	Silt curtains	0-1	1-2	?	4	R	2

Note: ? = Uncertain at this time.

a Considered under Marine Terminal

b Considered under assessment of Operations

Table 4.85 Summary of Residual Impact Predictions of Construction Activities on Marine Mammal and Sea Turtles Considered at Risk by COSEWIC and/or *SARA*.

Valued Environmental Component: Marine Mammals/Sea Turtles – *SARA* Species				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Site Preparation				
Noise	NS	3	-	-
Refinery Complex				
Run-off, siltation	NS	3	-	-
Vessel traffic	NS	3	-	-
Marine Terminal				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-

Valued Environmental Component: Marine Mammals/Sea Turtles – *SARA* Species				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Vessel traffic	NS	3	-	-
Presence of new structures[a]				
Noise	NS	3	-	-
Intakes/ Outfalls				
Noise	NS	3	-	-
Run-off, siltation	NS	3	-	-

a Considered under assessment of Operations

b Considered in Section 7.0

4.10.2 Project Effects During Operations

Terrestrial

Landbirds

Mitigation and monitoring designed to minimize potential effects of operation activities on COSEWIC and/or *SARA*-listed terrestrial birds were outlined in Table 4.34. In addition, if nesting sites are found for at risk species during construction of the refinery and its access roads, an appropriate buffer zone will be established (if possible) around the site to minimize disturbance.

With these mitigation measures in place and as per the detailed effects assessment in Section 4.6.2, Project Effects during Operation, activities are predicted to have no significant effect (see Tables 4.86, 4.87) on Short-eared Owl, Gray-cheeked Thrush, Rusty Blackbird, Red Crossbill, and Peregrine Falcon. In summary, potential effects of the proposed construction activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.86 Effects assessment of operation activities on terrestrial bird species considered at risk.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Air emissions	Effect on habitat, health (A)	Reduce emissions	1	4	6	5	I	1
Noise	Effect on habitat, disturbance (A)	Avoid nest sites if possible	1	2	6	5	R	1
Lights	Disturbance (A)	Minimize lighting	1	2	5	5	R	1
Vehicular traffic	Disturbance (A)		1	2	6	5	R	1
Run-off, siltation	Habitat change (A)	Control measures	0-1	1	?	?	R	1
Marine Terminal Operations								
Lights	Disturbance (A)	Minimize lighting	1	1	5	5	R	1
Marine Transportation								
Noise	Disturbance (A)		1	1	6	5	R	1
Lights	Disturbance (A)	Minimize lighting	1	1	5	5	R	1

Table 4.87 Summary of residual impact predictions of operation activities on terrestrial bird species considered at risk.

Valued Environmental Component: terrestrial birds SAR				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Air emissions	NS	1	-	-
Noise	NS	2-3	-	-
Lights	NS	2	-	-
Vehicular traffic	NS	2	-	-
Run-off, siltation	NS	3	-	-
Marine Terminal Operations				
Lights	NS	2	-	-
Marine Transportation				
Noise	NS	2-3	-	-
Lights	NS	2	-	-
Intakes/ Outfalls				
Solid and Hazardous Wastes				
Accidents or Malfunctions				

<u>Lichens</u>

Effects of Air Emissions on Lichens

The value of lichens as indicators of air pollution, particularly acid rain, fertilizers, sulphur dioxide (SO_2), nitrogen oxides (NO_X) and metals, has been documented in thousands of scientific papers (Hendersen 2000). Their sensitivity stems from their reliance on airborne nutrients and water, and lack of protective structures such as cuticles found in vascular plants. Correlation of high concentrations of atmospheric SO_2 with lichen decline is well established

(Wiseman and Wadleigh 2002). As ambient SO_2 pollution increases, so does the sulphur level in the lichens and the resulting damage to their thalli (Wadleigh and Blake 1999). Trees and other vascular plants are affected by pollution, but are generally slower to show effects than lichens (McCune 2000). One of the major sources of air pollution affecting lichens is oil refining (Cameron et al. 2007). Isotopic analysis done on lichen samples demonstrate that the existing oil refinery at Come by Chance is a source of sulphur, nitrogen, nickel and vanadium contamination (Appendix C *in* Goudie and Munier 2007).

Cyanolichens in the Project Area

Cyanolichens are particularly susceptible to atmospheric pollution such as SO_2 and NO_X and have undergone a severe decline in areas subject to acid rain, including eastern North America (Richardson and Cameron 2004; Cameron et al. 2007). Their high sensitivity is due to the dependence of cyanolichens on nitrogen fixation using the enzyme nitrogenase, which is intolerant of air pollution in general and of SO_2 in particular (Maass and Yetman 2002; Cameron et al. 2007). The lichens thus become deprived of nitrogenous substances and then become even more susceptible to airborne contaminants. Several cyanolichens have been documented in the Project Area (see Section 4.10.1, Effects of Construction Activities; Cyanolichens in the Project Area), including the rare boreal felt lichen (*E. pedicellatum*). As previously discussed, this species is listed under legislation as at risk. Cyanolichens are particularly sensitive to acid rain, sulphur dioxide, and nitrogen oxides (Cameron et al. 2007). Cyanolichens, including the boreal felt lichen, were found predominantly on mature, over-mature, or dead balsam fir trees which are common in the Project Area.

Lichens are differentially affected by airborne contaminants, with some species more vulnerable to its effects than others (Cameron et al. 2007). The rare boreal felt lichen is among the most susceptible of the cyanolichens to air pollutants, and has been documented adjacent to the proposed access road north of the refinery. It shares the highest rank on the relative sensitivity scale with species of the genus Lichinodium (Maass and Yetman 2002), which also occurs in the Project Area but is not considered at risk. The disappearance of *E. pedicellatum* from southern Nova Scotia is thought to have been caused by the effects of long-range air pollution (Keeping 2006). Contributing to this high sensitivity is the reliance of *E. pedicellatum* on conifers as phorophytes, which generally have little buffering capacity to the effects of acid precipitation due to their already low pH values (Richardson and Cameron 2004). Indeed, while spruce trees can potentially hostthe lichen, it is increasingly rare that they do, because their particularly acidic bark reduces the ability of the lichen to survive when stressed by acidic pollution (Maass and Yetman 2002). *Lobaria scrobiculata, L. pulmonaria, and L. quercizans* are three more cyanolichen species found in the Project Area considered intolerant to airborne contaminants. It was noted that the most sensitive of these three species, *L. scrob*iculata, was sighted less frequently than the others in the Southern Head area, and tended to be in advanced states of necrosis (Goudie and Munier 2007, Appendix B). Other lichens found in the area that are known to be particularly sensitive to atmospheric pollution include *Coccocarpia palmicola* and *Fuscopannaria ahlneri* (Maass and Yetman 2002).

Projected Air Emissions from Proposed Refinery

Levels of SO_2, NO_2, CO, PM_{10}, and $PM_{2.5}$ have been preliminarily modeled for six locations close to Southern Head (Delisle and Allard 2007). Contaminants were modeled for their projected maximum average emissions over defined time frames (1-hour, 3-hour, 24-hour, or annual). None of the emissions created by the proposed refinery, when added to background emission levels, would surpass the regulatory standard set by the Department of Environment and Conservation, Government of Newfoundland and Labrador. A possible exception to this is at the property line, where the background emissions of SO_2 were not modeled but are assumed to be high due to emissions from the refinery at Come By Chance. The Department of Environment and Conservation estimates that hourly and 3-hour average SO_2 emissions may already exceed air quality standards a few times a year (Delisle and Allard 2007).

Emissions falling within regulatory ranges can still potentially have negative effects on epiphytic lichens such as the at-risk *E. pedicellatum*. While the annual standard is set at 60 µg SO2 /m3, it has been suggested that some epiphytic lichens are considered susceptible to annual emissions as low as 10 µg SO_2 /m3 (Ardo et al. 2000), which is below the projected refinery emissions at the property line (21µg/m3). The long range average concentrations of SO_2 defined as causing no injury, chronic injury and acute injury to epiphytic lichens in the Sudbury area of Ontario were less than 0.002 ppm SO_2 (< 5.7 µg/m³); 0.06-0.03 ppm SO_2 (17.2-85.8 µg/m³); and above 0.03 ppm SO_2 (> 85.8 µg/m³), respectively (LeBlanc and Rao 1973). There is no information available on any potentially interactive or synergistic effects of the pollutants on lichen health. Short term, high concentrations of contaminant emissions can damage vegetation, but annual emissions projections are the most meaningful time frame projected because they reflect the cumulative amounts taken in by lichens over a relatively long period.

More specific air emissions values can be found in Section 4.2, in Tables 4.5 and 4.6.

<u>Geographic Extent of Effects</u>

Epiphytic lichens tend to be associated with undisturbed conifer stands, with *E. pedicellatum* generally occurring in cool, moist, mature balsam fir stands in the transitional zone from lower sphagnum-rich bogs and drier mid-slope forest (Keeping 2006). A considerable area of stands of balsam fir will be implicated in the dispersal zone of SO_2 emissions from the proposed refinery. This overlap would be expected to negatively affect the lichens in tree stands supporting cyanolichens, including *E. pedicellatum*.

Contaminated emissions will spread beyond the footprint of the refinery and access roads, affecting epiphytic lichens in a larger regional extent. Figures depicting contour levels of air pollutant emissions can be found in Section 4.2 Air Emission Modeling.

The geographic area in which lichens will be impacted by emissions from the proposed refinery is difficult to predict, given the variable sensitivities among different lichen species to pollution, and the variability within species at different geographic locations (Cameron et al. 2007). Boreal felt lichen was found in the general area of the proposed access road along the western side of the peninsula, approximately 300 to 500 m east of the proposed road right-of-way, where annual SO2 emissions are projected to be particularly high.

Sulphur emissions from the Come By Chance refinery have been shown to affect lichens 50 km away (Wadleigh and Blake 1999); however, that study was conducted when refinery emissions were over 2.5 times higher than their contemporary levels (B. Lawrence, Dept. of Environment and Conservation, pers. comm.). More recent analyses conducted as part of this assessment show that lichens sampled within 5 km from the current Come by Chance refinery show an "isotopic signature" – a composition that specifies the refinery as the source of sulphur pollution. Lichens from sites over 5 km tended not to show much influence from the Come By Chance refinery. The concentration of sulphur in lichens closest to the proposed refinery (i.e., sites on Refinery Road, within 3 km of the current refinery) are significantly higher than concentrations in samples from all other sites, with respective average sulphur concentrations of 762±193 ppm (n=2) compared to 472±84 ppm (n=22; Goudie and Munier 2007). The annual emissions of SO_2 projected for the proposed refinery (6 589 tonnes/year) are considerably less than those being emitted by the existing refinery (12 800 tonnes/year); however, the effects on local lichens would be the cumulative amount of contaminants emitted from both refineries.

It must be kept in mind that the above-described lichen analyses were performed on Alectoria species, which are epiphytic, fruticose lichens found within the Project Area. It is difficult to compare the relative pollution sensitivity of these species to that of cyanolichens; the high surface area of Alectoria increases their vulnerability to pollutants, while the nitrogen-fixing mechanism of Erioderma and other cyanolichens make them particularly vulnerable to sulphur pollution. It is likely that Erioderma are more sensitive to pollutant emissions than are Alectoria, particularly in humid coastal areas such as the Project Area, which lessens the sensitivity of fruticose lichens to pollution (R. Cameron, Protected Areas Branch, Government of Nova Scotia, pers. comm.).

Effects Assessment

Air emissions from operations of the refinery complex will negatively affect cyanolichens in the Project Area. Contaminants emitted from the refinery's maintenance and operation will adversely affect (*E. pedicellatum*) to a medium to high magnitude over a geographic extent - potentially as large as 101-1000 km^2. Lichens would be continuously exposed to these emissions for the decades that the refinery is in operation and producing emissions. Thus the impact on *E. pedicellatum* may be considered significant at the population level and irreversible (at least at the individual level), and this will occur in a relatively pristine area or area not adversely affected by human activity (Table 4.88).

There is a high level of confidence that air emissions will negatively affect *E. pedicellatum* in and immediate to the Project Area, and the probability that this effect will occur is high based on a high level of scientific certainty (Table 4.89). However, the distance from the refinery where effects may occur is less clear. There is also considerable uncertainty in terms of the numbers of Erioderma in the potentially affected area, on the island in general, and thus in the percentage of Erioderma that may be affected; i.e., there is potential for a significant effect on Erioderma but there is considerable uncertainty in this prediction at the population level. The Proponent proposes to mitigate this to a non-significant level by the following steps (NLRC 5-point Erioderma Conservation and Protection Plan): conduct wider scale surveys than conducted to date in the potentially affected area; develop and implement a transplant plan to move those Erioderma most likely to suffer negative effects; continue to refine the design and the air emission modeling to achieve a smaller potential area of effect; participate in a program designed to protect and enhance Erioderma habitat in Newfoundland; and develop and implement a lichen monitoring plan to assess the accuracy of predictions.

Table 4.88 Operation Interaction. Effects Assessment of Construction Activities on Terrestrial Lichen (E. pedicellatum) VEC

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Air emissions	Effects on health (A); mortality (A)	Reduce SO_2 emitted	2-3	4	6	5	I	1

Table 4.89 Summary of residual impact predictions of operation on terrestrial lichen (E. pedicellatum) VEC

Valued Environmental Component: Species At Risk – Lichen (*E. pedicellatum*)				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Air Emissions	S*	1	3	1

*Potential to reduce to not significant using the NLRC 5-point conservation and protection plan

Marine

Routine operation activities are not expected to interact with Harlequin Ducks and pose little risk to Red Knot or other species of marine birds considered at risk. Mitigation and monitoring designed to minimize potential effects of operation activities on COSEWIC and/or *SARA*-listed marine-associated birds were outlined in Table 4.34.

With these mitigation measures in place and as per the detailed effects assessment in Section 4.6.2, Project Effects during Operation, operation activities are predicted to have no significant effect (see Tables 4.90, 4.91) on marine-associated bird species considered at risk. In summary, potential effects of the proposed routine operation activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.90 Effects assessment of operation activities on marine-associated species considered at risk.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Lights	Disturbance (A)		0	1	6	4	R	1
Run-off, siltation	Prey availability (A)	Silt Curtain	0	1-2	?	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Marine Terminal Operations								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Marine Transportation								
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Intakes/Outfalls								
Noise	Disturbance (A)		0	1	6	4	R	1
Lights	Disturbance (A)		0	1	6	4	R	1
Vessel traffic	Disturbance (A).		0-1	1-2	6	4	R	1
Location of outfall pipes	Prey availability (A)		0	1	6	4	R	1
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	1

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Effluent characteristics	Prey availability (A)		0	1	6	5	R	1
Oil spill at jetty	Effects on health, mortality (A)	Spill response; contingency plan	3	4	1	2-3	I[a]	2
Oil spill near Red Island	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2
Oil spill in outer Placentia Bay	Effects on health, mortality (A)	Spill response; contingency plan	3	5	1	2-3	I[a]	2

Table 4.91 Summary of residual impact predictions of operation activities on marine-associated birds considered at risk.

Valued Environmental Component: Marine-associated birds SAR				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Refinery Operations and Maintenance				
Lights	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	3		
Storage and disposal of wastes, debris	NS	3		

Valued Environmental Component: Marine-associated birds SAR				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Marine Terminal Operations				
Air emissions	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Marine Transportation				
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Vessel traffic	NS	3		
Intakes/Outfalls				
Noise	NS	3		
Lights	NS	3		
Vessel Traffic	NS	3		
Maintenance	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Solid and Hazardous Wastes				
Noise	NS	3		
Lights	NS	3		
Storage and disposal of wastes, debris	NS	3		
Location of outfall pipes	NS	3		
Effluent characteristics	NS	3		
Maintenance	NS	3		
Vessel Traffic	NS	3		
Accidents or Malfunctions				
Oil spill	S	2		

Mammals and Sea Turtles

During operation of the oil refinery, two primary potential sources of impact on marine mammal (blue whale, right whale, fin whale, harbour porpoise) and turtle species (leatherback sea turtle) at risk are vessel noise and risk of collision with vessels. These project activities were assessed in Section 4.10. The blue and the North Atlantic right whale are considered Endangered under Schedule 1 of *SARA;* based on available information blue whales and especially right whales are considered very rare in the Study Area. Fin whales, listed as Special Concern, are expected to occur regularly in the Study Area, particularly during summer months. Harbour porpoise listed as Special Concern by COSEWIC and under consideration for listing on Schedule 1 of *SARA* are likely common (at least in small numbers) in the Study Area, during all seasons. Leatherback sea turtles have regularly been sighted in small numbers in the Study Area but typically south of the proposed marine terminal site and primarily during summer months.

There are no recovery strategies or action plans for the four marine mammal species considered at risk by COSEWIC and/or listed under Schedule 1 of *SARA* in Atlantic Canada. A recovery strategy for leatherback sea turtles is available (ALTRT 2006) but no critical habitat has been defined. Mitigation designed to minimize potential effects of operation activities on COSEWIC and/or *SARA*-listed marine mammals and sea turtles include adherence to effluent and air emissions regulations and vessel maintenance of consistent speed and direction (when possible) and reduced speed in areas with increased vessel traffic.

With these mitigation measures in place and as per the detailed effects assessment in Section 4.10, operation activities are predicted to have no significant effect (see Tables 4.92, 4.93) on blue whales, right whales, fin whales, harbour porpoises, or leatherback sea turtles.

In summary, potential effects of the proposed operation activities are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

Table 4.92 Effects assessment of operation activities on marine mammal and sea turtles considered at risk by COSEWIC and/or *SARA*.

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Refinery Operations and Maintenance								
Air emissions	Effects on health (A)	Minimize output	0	1	6	5	R	2
Run-off, Siltation	Prey availability (A)	Control measures	0	1-2	?	5	R	2
Vessel traffic [a]								
Marine Terminal Operations								
Vessel traffic [a]								
Marine Transportation								
Noise (vessels)	Disturbance (A)		1	2-3	6	5	R	2
Vessel traffic (physical presence)	Effects on health (A)	Maintain consistent speed/direction; reduce speed	0-1	2	1	5	R [b]	2
Intakes/Outfalls								
Effluent characteristics	Effects on health (A)	Treatment regulations	0-1	1	6	5	R	2
Solid and Hazardous Wastes								
Location of outfall pipes	Prey availability (A)		0	1	6	5	R	2

a Considered under Marine Transportation; b Potentially irreversible at the individual level

Table 4.93 Summary of Residual Impact Predictions of Operation Activities on Marine Mammal and Sea Turtles Considered at Risk by COSEWIC and/or *SARA*.

Valued Environmental Component: Marine Mammal/Sea Turtle – *SARA* Species				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Refinery Operations and Maintenance				
Air emissions	NS	3		
Run-off, Siltation	NS	3		
Vessel traffic	NS	2		
Marine Terminal Operations				
Vessel traffic	NS	2		
Marine Transportation				
Noise (vessels)	NS	2		
Vessel traffic (physical presence)	NS	3		
Intakes/Outfalls				
Effluent characteristics	NS	2		
Solid and Hazardous Wastes				
Location of outfall pipe	NS	3		

4.10.3 Mitigation

Mitigations for terrestrial and marine species at risk have been discussed in previous effect assessment sections for specific VECs.

4.10.4 Accidents and Malfunctions

As previously discussed in Section 4.6.4, Accidents and Malfunctions, an oil spill in the Study Area could significantly impact marine-associated birds, including the eastern population of Harlequin Ducks (Special Concern on Schedule 1 of *SARA*) and the Red Knot, rufa subspecies (COSEWIC Endangered; see Tables 4.90, 4.91). Harlequin Ducks would be most susceptible to an oil spill near Cape St. Mary's during winter months as the largest known wintering grounds for the species in Newfoundland and among the largest wintering areas in eastern North America occurs there. Even with mitigation measures (contingency plan including clean-up) in place, it is still possible that many Harlequin Ducks would experience mortality due to oiling; this could have major consequences for the Eastern population of this species. In the unlikely event that an oil spill occurs, follow-up monitoring will be undertaken in an attempt to assess the impacts on Harlequin Ducks. The recently listed (as Endangered by COSEWIC; not presently listed on the *SARA* but could be upgraded during the life of the Project) Red Knot is a shorebird species and as such spends most of its time while stopped during migration in a nearshore setting; it has been sighted (in small numbers) during late summer/early fall at the Come By Chance lagoon and the Southern Harbour estuary. It may also occur at other areas of suitable habitat in the Study Area, although this type of habitat is not common there. If these birds contacted oil they would likely experience acute mortality; they may also be at risk to more chronic effects of oiling. However, Newfoundland is east of the primary migration corridor for this species and as such only a very small proportion of the population would occur in the Study Area at a given time. It is unlikely that the mortality of several individuals would significantly affect the population but this is uncertain. The oil spill countermeasures contained in the Proponent's contingency plan and the associated disturbance with clean-up may reduce the number of Red Knot individuals exposed to oil. It should be noted that the Red Knot is probably less vulnerable than Harlequin Duck to oil spills as they have more opportunity to avoid oiled areas. In addition, their localized habitat in lagoons and estuaries is amenable to protection by booms. In the unlikely event that an oil spill occurs, follow-up monitoring (shore-based surveys) will be undertaken in an attempt to assess the impacts on Red Knots. It is not the Proponent's intent to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)) and all possible safeguards will be in place to minimize the risk of an oil spill.

As assessed in detail in Section 4.9.4, Accidents and Malfunctions and summarized in Tables 4.92 and 4.93, an oil spill in the marine environment is predicted to not significantly impact baleen (blue, right and fin whales) and toothed whales (harbour porpoise) and sea turtles (leatherback), including species considered at risk. Blue and right whale occurrence in the Study Area is considered rare, and baleen and toothed whales are not susceptible to the effects of oiling. Leatherbacks occur regularly in small numbers in outer Placentia Bay primarily during summer to early fall, and some may be exposed to oil if a spill were to occur, but effects are considered reversible. The oil spill countermeasures contained in the Proponent's contingency plan and the associated disturbance with clean-up may reduce the number of marine mammals and sea turtles exposed to oil.

4.11 Decommissioning and Rehabilitation Effects Assessment

NLRC is committed to rehabilitation during construction, operations, maintenance and decommissioning. All rehabilitation work will be carried out according to applicable NLRC specifications and direction from appropriate regulatory agencies.

4.11.1 Construction

The Department of Environment and Conservation's Environmental Guidelines for General Construction Practices will be followed for all construction activities. Site clearing will be localized within the Project footprint to ensure minimal vegetation disturbance. Excavated surfaces at risk of erosion will be protected by using adequate slopes to minimize slumping. Slopes will be inspected after each precipitation event for erosion and immediate steps taken to restore slopes and correct any slumping. This will ensure soils and other excavated material do not get carried into surrounding water bodies. Slopes for finished grade surfaces will be in accordance with the recommendations of geotechnical specialists and will be surface-finished accordingly to provide long-term stability.

All surface root mat, topsoil, grubbing, peat, and weathered glacial till will be removed prior to the cut/fill operation. Unsuitable material (USM) will be placed on the south east edge of the project site, providing a berm to act as a visual screen of the project area from the shoreline. Organic material will be stockpiled in the same area and will be used for surface preparation of the berm and other areas to be re-vegetated.

Blasting operations are required during the site work phase of the project only, and will not be required for operations. Overblasting will not be permitted; blasting will be undertaken in a manner that will secure any elements or features designated to remain. To minimize the seismic impact, blasting patterns and procedures will be used to reduce the shock wave and noise. Time-delay blasting may be used as necessary to control debris scatter. Prior to blasting the site will be surveyed to identify the presence of any sensitive animals. Presence of such animals will result in a delay until such time that they are no longer present.

Temporary facilities required for construction will be removed upon the completion of the project. Portable trailers for office space and for use by workers for shelter and dining will be removed from service and relocated by contractors for re-use at other project sites. Portable water supply equipment and portable sanitary toilets will be removed from service and relocated to other project sites by the respective contractors.

Temporary oil and fuel storage tanks will be decommissioned and relocated for use at other project sites. All product and vapours will be removed from the storage tanks, which will then be dismantled and removed from site by the supplier/contractor. Any contaminated material under or around the tanks will be excavated and removed for treatment and disposal. The site will then be returned to a condition acceptable to the Department of Environment and Conservation. This will be done in accordance with the Storage and Handling of Gasoline and Associated Products Regulations under the provincial Environmental Protection Act.

All construction equipment will be demobilized and removed from site by the respective contractors for storage or re-use on other projects.

4.11.2 Operation and Maintenance

The most advanced technologies, "Best Available Technology that is Economically Achievable (BATEA)," will be integrated into refinery operations. All measures will be taken to ensure as few adverse impacts as possible on the environment.

In the case of an accidental release to the environment, appropriate actions and measures will be taken to return the environment to its condition prior to the release. An Environmental Protection Plan (EPP) will be developed for the construction phase of the Project. The EPP will include contingency plans for events such as accidents and malfunctions and fuel and hazardous materials spills.

4.11.3 Decommissioning and Abandonment

It is intended that the Southern Head refinery will operate for at least 25 years, commencing in 2011. The project will be designed for ease of decommissioning and abandonment, and a comprehensive decommissioning plan will be developed.

A Rehabilitation and Closure Plan will be developed during the design phase. One focus of the plan is the improvement or elimination of environmental damage and liabilities, and restoring the land to its original use or an acceptable alternative.

The following rehabilitation measures will occur during the decommissioning and abandonment phase:

- Hazardous chemicals, reagents and materials will be removed for proper disposal.
- Pipelines and equipment will be drained and cleaned.
- Oil and fuel storage tanks will be decommissioned, all product and vapours will be removed from the storage tanks, which will then be dismantled and removed from site by the supplier/contractor.
- Buildings and other infrastructure which will no longer be required once the refinery is closed will be properly demolished and removed.
- An assessment of soil contamination in the facility of the buildings and other facilities will be completed and appropriate remediation measures will be implemented to address contaminated soil.

- Fencing will be removed, road surfaces scarification will be completed, culverts and stream crossings will be removed and natural drainage patterns will be restored wherever practical.
- Re-vegetation will occur where practical, including seeding and reforestation through the introduction of vegetation and organic material on site.

5.0 CUMULATIVE EFFECTS ASSESSMENT

5.1 Cumulative Effects Assessment

Although a cumulative effects assessment (CEA) is not prescribed within the Newfoundland and Labrador Environmental Protection Act, it is typically included in Environmental Impact Statement guidelines for EAs conducted under the provincial legislation and it is required to be considered and conducted with all federal EAs.

The Newfoundland and Labrador Refinery Project Guidelines (June 19, 2007) request

“ Consideration of any cumulative effects on valued ecosystem components that are likely to result from the project in combination with other projects or activities that have been or will be carried out (e.g., existing and proposed shipping and industrial activity in Placentia Bay) will be discussed in the EIS/CSR.”

Specifically the Guidelines asked NLRC to consider at least “ the existing facilities of North Atlantic Refining and the NTL Transshipment Facility, as well as the LNG Transshipment Facility, the VBNC Long Harbour Commercial Plant and potential aquaculture sites.”

In addressing cumulative environmental effects, the Guidelines asked NL Refinery to consider the following:

- Temporal and spatial boundaries;
- Interactions among the Project’s environmental effects;
- Interactions between the Project’s environmental effects and those of existing projects and activities; and
- Mitigation measures employed toward a no-net-loss or net-gain outcome.

5.1.1 Methodology

The Operational Policy for Addressing Cumulative Environmental Effects under CEAA (CEA Agency 1999) was issued by CEAA to provide clarification and guidance to RAs on how cumulative environmental effects should be considered in EAs conducted under CEAA. Under this policy, the CEA Agency endorses the *Cumulative Effects Assessment Practioners Guide* (CEA Agency 1999) and the *Reference Guide for the Canadian Environmental Assessment Act: Addressing Cumulative Environmental Effects (2004)*.

A general practice for assessing cumulative effects is that the future projects:

- Have a reasonable possibility of occurring;
- Have been registered with either the Department of Environment and Conservation and/ or CEAA; and

- Should reflect the most likely future scenarios.

The discussion of cumulative effects will be structured as follows:

- Review the project inclusion list;
- Definition of the spatial and temporal boundaries for the CEA;
- Identification of VECs;
- Predicted cumulative effects;
- Cumulative effects management;
- Characterization of cumulative effects; and
- Monitoring and follow-up.

Project Inclusion List Selection

The Guideline specified several projects and ongoing operations that should be considered in the assessment of cumulative effects: these include the existing refinery, the crude oil transshipment terminal and the proposed LNG transshipment terminal at Grassy Point, the VBNC nickel processing plant in Long Harbour and potential new aquaculture operations. Relevant information about each of the operations, projects or sector on the inclusion list is provided below.

5.1.2 Newfoundland Transshipment Terminal

Newfoundland Transshipment Terminal employees approximately 40 people and is responsible for the construction, management and operation of a transshipment terminal at Whiffen Head, Newfoundland. Construction of the Transshipment Facility began in April 1997 and was completed in September 1998. An expansion to accommodate the Terra Nova oilfield project was completed in September 2000. The terminal presently handles Hibernia and Terra Nova crude oil.

The marine facilities include an approach causeway, tug basin, trestle, and two jetties, with berthing and marine topside facilities (crude transfer and control system). It is equipped with 2 berths accommodating 35,000 - 159,000 dwt tankers. The terminal receives approximately 350 tankers a year, 110 are the dedicated 150 000 dwt shuttle tankers and the others are smaller vessels.

The tank farm has six crude oil storage tanks, each with 500,000 BBL working capacity (total capacity of 6,000,000 BBL) and an intricate interconnecting pipeline and support structure. NTL anticipates that the Transshipment Terminal will be a regional facility and will provide storage for other fields as they are brought to production.

Onshore facilities include a tank farm, tank heating system, interconnecting flowlines, supporting facilities, storm water handling system and fire protection system.

The terminal is a designated Oil Handling Facility and has on site capability for a 100 tonne spill. ECRC has a stockpile of equipment to respond to a 150 tonnes spill stored at the NTL site.

5.1.3 North Atlantic Refinery Limited

The North Atlantic Refinery, purchased in 2006 by Harvest Energy Trust, employs approximately 700 people. It is a 108,000 barrel per day sour crude oil refinery located on the north side of Come By Chance Bay, across the bay from the site of the proposed new NLRC refinery.

The refinery includes a marine terminal with 2 jetties that can accommodate tankers from 90 000 to 326 000 dwt. The marine terminal includes two tugs and tug basin. The terminal receives approximately 325 tankers a year.

There is a 150 tonne oil spill response capability on site.

For several years the refinery produced large amounts of sulphur dioxide, as much as 64 000 tonnes a year. Since a major process overhaul, emissions have been greatly reduced Emissions of sulphur dioxide were reduced to 14 000 tonnes by 2006. The refinery intends to reduce emissions farther to 12 000 tonnes a year.

5.1.4 Grassy Point Liquified Natural Gas (LNG) Transshipment Terminal

Newfoundland LNG Limited proposes to develop a Liquefied Natural Gas (LNG) Transshipment and Storage Terminal to provide low-cost, high availability LNG transshipment and storage capacity to northeastern United States (US) and Canada.

The Grassy Point LNG Transshipment and Storage Terminal will provide facilities for LNG cargo transfer, LNG storage and a lay-up site for in-transit LNG carriers. The marine facility will enable larger vessels to offload their cargo and commence the return voyage. The terminal will provide storage for loading of smaller or specialized LNG carriers that are able to enter most LNG terminal ports in the US.

The on-water foot print of the marine structures will encompass a water lot boundary running southwest approximately 2,250 m from the eastern boundary of the existing NTL water lot boundary. The boundary will then turn southeast and extend approximately 700 m terminating at the southern most point of land at Adams Head.

The project will involve the construction and operation of a wharf and three jetties with berthing capabilities for vessels up to 265 000 dwt. In the early years, e.g., 2010, the terminal will receive approximately 104 tankers a year and by ten years will handle approximately 400 LNG tankers a year.

The construction of the three berths will be phased in over approximately 10 years. The berths will extend to a depth of 15 m and will not require dredging. A single berth will be constructed initially followed by additional berths as the LNG demand increases. Each berth will consist of a service platform, mooring dolphins, berthing dolphins, access trestle connecting the loading platform to shore and walkways connecting the mooring and berthing dolphins. The service platform will be equipped with fixed loading arms to facilitate loading and unloading of LNG product.

The marine terminal will include a tug basin. The dedicated tug basin will require a minimum of 7 m water depth and be capable of berthing two or three tugs. Dredging may be required for the tub basin, but the material will be disposed of on land. During the construction phase, the tug basin will also serve as an offloading point for construction supplies.

The site will have eight LNG storage tanks. The planned storage tanks will have up to 160,000 m3 capacity each.

The expected life of the project is 50 years. The project will require approximately 136 people for operation.

The proposed schedule of site activities is as follows: construction from late 2007 through early 2010 with operations beginning later in 2010.

The peak power requirement at the terminal will be approximately 60 to 96 megawatts during transshipment operations. This power will come from the local power grid via an overhead transmission line to the site or on site power generation.

Water requirements for the facility are being evaluated and may include freshwater from nearby ponds or desalination.

5.1.5 Voisey's Bay Nickel Company Commercial Processing Plant

VBNC proposes to construct, operate and eventually decommission a nickel processing plant at Long Harbour, NL to produce nickel, copper and cobalt for the commercial market. VBNC are proposing either a Hydromet Plant or alternatively a Matte Plant.

The project infrastructure will include a wharf, laydown areas, preparation and process buildings, storage and transportation structures for raw materials, reagents, wastes and finished products. Project features in the marine environment include an expansion to the existing port facility and a marine outfall into Long Harbour.

The existing wharf will be repaired and upgraded by additional infilling to a width of a maximum of 90 m to create a two-berth wharf that will accommodate two ships. Some minor dredging will be required in the area of the existing wharf to remove small volumes of infill sediment and some scrap steel. It is estimated that dredging of approximately 1.5 meters is required.

Hydromet Plant Scenario

Nickel concentrate and limestone will be transported from the dock via unheated covered conveyors and stored in unheated, ventilated, A-frame structure. Limestone will be stored in the same building but segregated from the concentrate.

The hydromet plant will require an area of about 65 hectares (650,000 m2). This area includes the infrastructure on both tiers, while the area required for residue ponds and the residue pipeline will add an additional 85 hectares (850,000 m2). Design production capacity will be 500,000 tonnes per year (t/y) of nickel, 3,270 t/y of copper and 2,460 t/y of cobalt.

Matte Plant Scenario

Nickel-bearing matte and limestone will be transported from the dock via unheated covered conveyors and stored in unheated, ventilated, A-frame structure, which will provide matte storage and limestone storage.

The matte plant will require an area of about 65 hectares (650,000 m2). This area includes the infrastructure on both tiers, while the area required for the sub-aerial disposal of the gypsum residue from the refinery would require and additional 40 hectares (400,000 m2). Design production capacity will be 500,000 t/y of nickel, 17,800 t/y of copper and 900 t/y of cobalt.

Construction is scheduled to begin by early 2009 and continue through 2011, and be fully operational by 2012.

Water requirements will be met from Rattling Brook Big Pond. Power will be provided by Newfoundland and Labrador Hydro infrastructure via an existing substation at Long Harbour (from 300,000 (55) MWh/y (MW) for the matte plant to 370,000 (67) MWh/y (MW) for the hydromet plant .

5.1.6 Placentia Bay Aquaculture

According to the most recent (April 2007) DFA data there are currently 13 licensed aquaculture operations within Placentia Bay. Applications for another 8 sites are awaiting DFA approval. There are currently five licensed mussel farming operations and eight licensed Atlantic cod grow-out sites.

The following table presents an overview of recent activity levels, current licence status based on information from DFA and consultations with industry participants.

Table 5.1 Current Activity Status of Placentia Bay Aquaculture Sites (April 2007).

Company/Operator	Location	Species	Current Status
Keating, Joseph (Baie Sea Farms)	Crawley Island, Long Harbour	Blue Mussels	Operation has had commercial sales for the last 5 years or more; owner has plans to expand production from current levels
Keating, Joseph (Baie Sea Farms)	Crawley Island	Blue Mussels	Operation has had commercial sales for the last 5 years or more; operator has plans to expand production from current levels
Keating, Joseph (Baie Sea Farms)	St. Croix Bay	Blue Mussels	Operation has had commercial sales for the last 5 years or more; operator has plans to expand production from current levels
Warren, Christopher J.	Big South West Cove, Merasheen Island	Blue Mussels	Operation has had commercial sales for the last 5 years or more; operator has applied to DFA for site expansion, expects to increase production of mussels
Warren, Christopher J.	Merasheen Island	Blue Mussels	Operation has had commercial sales for the last 5 years or more; operator has applied to DFA to add oyster farming activities to the site
Hollett, Mervin	Port Royal Arm	Blue Mussels	Licence status/approval is uncertain pending DFO review of objections from scallop fisher(s) operating near the site; no commercial sales to date; operator hopes to begin mussel farming in 2007 or 2008 if DFA/DFO approvals are obtained; if so, operator anticipates commercial sales of 400-500,000 pounds in 4-5 years
Leonard, Peter	Southern Harbour	Atlantic Cod	Licence has been renewed but no commercial sales to date; operation presently inactive, no equipment on site; operations may resume pending DFO allocation of cod for grow-out; potential for commercial sales will depend on the same factors that have affected growth of other PB cod grow-out operations (availability of growing stock, feed supply and market conditions)
Norman, Bernard	Jerseyman Island	Atlantic Cod	Licence has been renewed, but operation is currently inactive, no commercial sales to date; equipment (four Polar cages) still on site; operator hopes to begin farming steelhead trout in 2008
Pomeroy, Donald A. and Barry, John Jr.	Petite Forte Harbour	Atlantic Cod	Licence status is uncertain and operator is awaiting word from DFA and NWPA

Company/Operator	Location	Species	Current Status
			application renewal; no equipment presently on site; operator may renew cod farming if approved
Jones, Ambrose	Petite Forte	Atlantic Cod	Licence status uncertain; commercial sales reported for two or three years, but ceased cod farming activities in 2004; future operations uncertain
Merasheen Mussel Farms Inc.	Barren Island	Blue Mussels	Awaiting DFA approval
Merasheen Mussel Farms Inc.	Jean de Gaunt Island	Blue Mussels	Awaiting DFA approval
Merasheen Mussel Farms Inc.	Presque Harbour	Blue Mussels	Awaiting DFA approval
Merasheen Mussel Farms Inc.	Rose au Rue	Blue Mussels	Awaiting DFA approval
Merasheen Mussel Farms Inc.	Dog Harbour	Blue Mussels	Awaiting DFA approval
Merasheen Mussel Farms Inc.	Merasheen Island	Oyster	Awaiting DFA approval; operator has applied to add oyster activities to existing mussel operations at this site
Warren, Christopher	Big South West (Expansion)	Blue Mussels	Awaiting DFA approval (expansion of existing site already licenced by DFA)
Moulton, Clayton	Flat Island Harbour	Atlantic Cod	DFA licence has lapsed; site was commercially active for only one year (2001-2002)
Pevie, Joseph and Pearson, Christopher	Woody Island	Atlantic Cod	No commercial sales since 2001; licence lapsed in 2006
Pomeroy, Donald A. and Barry, John Jr.	Gaultoin's Cove (near Great Paradise)	Atlantic Cod	Operator reports that DFA licence for this site has probably lapsed; last commercial sales were in 2003
Sapphire Sea Farms Ltd.	Dunville	Atlantic Cod	DFA reports that site licence lapsed several years ago

Source: DFA, Newfoundland and Labrador (DFA Grand Falls, April 2007); Canning and Pitt, Inc. industry consultations November 2006 and April 2007

5.2 Spatial and Temporal Boundaries

In order to focus the CEA, spatial and temporal boundaries have been clearly defined. The spatial focus is on major existing or planned projects within Placentia Bay that will noticeably increase the use the vessel traffic lanes and/or be situated at the north end of Placentia Bay.

The time frame is those projects that have either been registered (e.g. the LNG Plant at Grassy Point) or have a reasonable chance of occurring (e.g. aquaculture licence applications being considered) within the time frame of this Project. Decommissioning is not discussed because of the inability to know project closure for each of the projects and, therefore, the possibility of project overlap with any degree of certainty.

The temporal boundaries are from 2008 through 2033, 25 years. The twenty-five years is based on the 25 year design life of the refinery: the LNG terminal would operate for approximately 50 years, the nickel plant would have a design life of 30 years (30 years was the figure given in the Project Registration: however, more recent estimates, used in the cumulative effects assessment in Volume 4 suggest operations would terminate in 2026, i.e., under 20 years).

5.3 Identification of VECs

The VECs considered in the cumulative effects assessment have been identified through review of the residual effects assessment for the refinery project and consideration of the temporal and spatial activities of the projects and operations on the inclusion list that was provided in the Guidelines.

VECs for the cumulative effects assessment were selected based on the results of the effects assessment for the Refinery Project and a consideration of the activities which resulted in these effects and are present in the other projects on the inclusion list. The VECs considered are Air Quality; Seabirds; and Species At Risk (SAR).

5.4 Predicted Cumulative Effects

This interaction between residual project effects identified for the refinery project and similar environmental effects of other projects or activities are considered.

With the addition of three industrial projects in the same general area as an existing refinery and crude oil transshipment terminal, it would be expected that there would be a cumulative effect on air quality, that could affect the human health and/or species of lichens.

The increase in number of vessels in the bay increases the potential for an oil spill. An oil spill can cause physical and physiological harm to plants and animals, ranging from temporary effects to mortality. The increase in vessel traffic will be throughout the traffic lane (which is located on the east side of Placentia Bay). Most of the traffic associated with the existing and proposed projects will continue past the end of the traffic lanes on into Come By Chance Bay.

Commercial fisheries and aquaculture have been assessed in the Socio-economic Assessment, Volume 4. That assessment acknowledges that, while at present, there is no aquaculture in the Refinery Project Area, aquaculture operations can be affected by an oil spill even if not directly damaged, through market perception.

5.4.1 Air Quality

The cumulative effects of air emissions from the projects that would overlap with the proposed Refinery (NARL and NTL) have been incorporated into the air quality monitoring done for the Refinery assessment and discussed in Sections 4.2 and 4.4.

With the use of BATEA, optimal fuel mix, careful selection of equipment and ongoing maintenance and monitoring, emissions beyond the Refinery property will not exceed either the provincial regulations or the more stringent World Health Organization thresholds and there is no residual effect. The assessment is shown in Section 4.4.

5.4.2 Seabirds

Assessment of the effects of the proposed Refinery on seabirds have been discussed in Section. Only an oil spill could produce a significant adverse effect (See Section 4.6.4). The additional vessel traffic associated with the projects on the inclusion list would increase the potential risk of an oil spill.

5.4.3 Species At Risk

While there are several species that are listed with either or both of the federal or provincial government (Section 3.6.7 and 3.7.5), only two species of birds and the lichen, *Erioderma*, were found during surveys for NLRC. The bird species could be affected by an oil spill and are considered in that discussion with regard to the Seabird VEC while the lichen can be affected by air pollution, in particular sulphur dioxide, and is discussed under the Air Quality VEC.

A few specimens of *Erioderma* were found in proximity to the planned access road on the western side of the Southern Head peninsula. NLRC plans additional surveys for this species at other locations within the refinery property boundaries and is considering a possible monitoring program using *Erioderma* and associated species. *Erioderma* is affected by air pollution: the effects of the combined emission of the proposed refinery with existing air quality were considered in Section 4.10.

5.5 Cumulative Effects Management

In most cases, management or mitigation of effects lies with several projects and authorities, local through to international.

5.5.1 Air Quality

There are a number of current initiatives by both industry and government to reduce air emissions. The Canadian government has recently proposed a Regulatory Framework for Air Emissions: this would affect all industry sectors and encourage and/or regulate decreases in emissions.

The air dispersion modeling done for the proposed refinery was based on conservative assumptions that did not incorporate BATEA: therefore, it is anticipated that actual emissions will be lower than those indicated in the model. As well, the existing refinery at Come By Chance has committed to further reductions in level of emissions. Both refineries operate under regulation and permits from the provincial government and will respond to any changes in regulation of air emissions.

The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) is developing options to address the reduction of air pollution from ships, focussing on new regulations in relation to the emissions of NOx, SOx, volatile organic compounds and particulate matter. The aim is to finalize and approve the draft amendments to MARPOL Annex VI at MEPC 57 (Spring 2008), and to adopt the amendments at MEPC 58 (Autumn 2008) in accordance with an agreed timetable.

5.5.2 Oil Spill

The increase in number of tankers travelling through the bay will increase the potential for an oil spill. However, there will be an accompanying increase in response capability through designation of facilities as Oil Handling Facilities and the requirement for on-site response equipment. As well, the federal government is developing regulations that will have OHFs develop and implement oil spill prevention plans in addition to the present practice of having spill response plans only.

The existing refinery and transshipment terminal have a mutual aid arrangement in place that would see response capability form both locations used in the event of a spill. It is anticipated that mutual aid arrangements would be expanded to include the new projects. At a recent meeting of the Placentia Bay Traffic Committee, the existing facilities (refinery and NTL) and both the proposed refinery and proposed LNG transshipment terminal were represented and discussion of a bay-wide approach to contingency planned was initiated. NLRC will work with the Committee and with the other facilities' operators to develop an integrated approach to contingency planning that includes the communities in pre-planning, training and exercises in order to maximize response effectiveness.

NLRC has requested a TERMPOL Review: this voluntary inter-agency review of operational plans and design of the marine terminal facilities will effectively serve as a pre-operational safety audit. The LNG Terminal will also undergo a partial TERMPOL Review.

The TERMPOL Reviews will also consider the operations of the existing vessel traffic management system. Transport Canada manages the TERMPOL Review process and has also undertaken a quantitative oil spill risk assessment for the south coast of Newfoundland, including Placentia Bay. Enhancements of the existing oil spill regime, navigation and/or vessel traffic system may well result.

NLRC has been working with area fishers to address traffic concerns and will approach the other operators and the Harbour Authority to consider a vessel traffic management plan for Come By Chance Bay.

5.6 Characterization of Cumulative Effects

The potential effects of an oil spill on both Red Knot and Harlequin Duck (and other species of seabirds) has been discussed in some detail in Section. An oil spill in the Study Area could significantly impact marine associated birds, including the eastern population of Harlequin Duck. While individual Red Knot could be affected during a spill, the main population is not found in the Study Area.

The residual cumulative effect is a potential significant adverse effect on seabirds in the event of an oil spill. It has been determined using the same criteria for determining the significance of residual project effects (e.g. direction, magnitude, geographic extent, duration, frequency, reversibility, level of confidence, certainty, mitigation success, and significance).

5.7 Monitoring and Follow-up

The objective of follow-up activities is to verify the accuracy of cumulative effect predictions and the effectiveness of mitigation. Monitoring of cumulative effects would not be the sole responsibility of NLRC but will be developed and implemented jointly with authorities and /or in association with the operations and projects on the inclusion list.

5.8 Predicted Cumulative Effects

The predicted cumulative effects are air emissions, increased vessel traffic and increased risk of an oil spill.

6.0 DECOMMISSIONING AND ABANDONMENT

The design life of the refinery is 25 years. However, with continuous maintenance, re-fit, expansion, upgrading, modifications, etc., the actual operating life of the refinery will be much longer and could extend to 50 years or more. Upon completion of its operating life, the refinery will be decommissioned. The decommissioning and abandonment phase will help to reduce and remediate the environmental impacts of infrastructure and activities. Re-usable equipment and machinery will be transported to other locations. Above-ground installations will be removed and underground installations will be either removed or left in place, depending on the environmental benefits of either option. Environmental contamination, if any, will be remediated in accordance with applicable environmental guidelines. Upon abandonment, the site will either be rehabilitated to a semi-natural state or used for an alternate industrial or commercial development.

The following sections outline the management strategy that will be adopted during the decommissioning and abandonment phase. Updated details of the decommissioning procedure will be outlined in the Rehabilitation and Closure Plan, which will be prepared prior to decommissioning and adhere to applicable environmental regulations and standards. Environmental protection procedures will also be included. Preliminary considerations and current best management practices for refinery decommissioning and abandonment are discussed in the following sections, focusing on complete removal of operations and rehabilitation of the natural environment and will meet or exceed the regulatory requirements in place at the time.

For a list of applicable legislation and environmental standards for the decommissioning and abandonment phase see Volume 2, Section 7.1.

6.1 Rehabilitation

Decommissioning will be completed in several stages to allow for organized rehabilitation of the site and appropriate environmental control. Site rehabilitation will begin with deconstruction of the refinery and the residual contents. Deconstruction will involve complete removal of all storage tanks, piping systems and equipment and may involve complete demolition and excavation of roads, paved areas, structures and other associated works. After removal, remediation or clean-up of contaminated areas will be performed. The site will then undergo remodelling to recreate a stable surface and rehabilitate natural drainage patterns for surface runoff. Revegetation of the area will be performed.

Project construction will result in impacts of varying degree and duration. Construction-related impacts will be addressed in the Environmental Protection Plan (EPP) for the construction phase, which will cover matters such as erosion and sedimentation control, site water control, temporary watercourse crossing procedures, emergency spill response, vehicle fuelling and maintenance, vehicle cleaning, waste collection and fire prevention, among others. Implementation of the measures covered in the EPP is expected to minimize or eliminate avoidable impacts, while reducing the risk of accidental impacts and making future site decommissioning and rehabilitation more straightforward.

The majority of unavoidable impacts are expected to be temporary and minor. However, a number of construction activities (e.g., removal of small ponds and excavation and levelling of the site) will result in permanent impacts. These changes will be made in such a way to mitigate the impacts on the surrounding area; the extent of the mitigation measures will depend on-site conditions and design considerations.

Proposed rehabilitation and monitoring requirements for each of these potential impacts are outlined below.

Temporary Installations:

- Construction machinery and temporary structures not intended for long-term use during operations will be removed from the project site following completion of construction.
- Temporary structures and equipment suitable for continued use on-site will be moved to a permanent location.
- Construction laydown areas will be selected within the boundaries of the site where possible; laydown areas outside the site will be assessed to identify applicable rehabilitation measures.
- Temporary waste handling, storage and other facilities will be converted for permanent use or decommissioned.
- Exposed soil areas will be revegetated as outlined below.

Soil Erosion:

- Temporary erosion and sedimentation control measures will be installed and maintained by the contractor throughout the construction phase.
- Upon completion of the construction phase, a detailed inspection of the site will be performed by a qualified professional with demonstrable experience in erosion and sedimentation control.

Slope Stability:

- Upon completion of the construction phase a qualified professional will perform a detailed inspection of the site.
- Borrow pits, quarries and excavations will receive particular attention, as these areas will be decommissioned following construction.
- Steep slopes will be stabilized using bench-and-terrace construction where necessary.

- Shallower slopes will be re-graded and track-walled, or stabilized by other measures.
- Obvious threats to human or wildlife safety such as pits or unstable precipices will be fenced and posted with warning signage.

Mired Areas:

- Mired areas may result from the use of wheeled or tracked vehicles in areas where the groundwater table lies close to the ground surface, in poorly drained areas, or in wetland/bog areas.
- Upon completion of the construction phase, the site engineer will identify mired areas. Drainage improvements or fill (preferably from an on-site source) will be used in the rehabilitation.

Alteration of Natural Surface Drainage:

- The site grading/drainage plan, developed during the design phase, will be implemented during construction and post-construction.
- All permanent drainage control features will be in place and functioning upon completion of construction.
- The site engineer will ensure that these features are stabilized and functioning as designed.
- Minor rehabilitation of surface drainage patterns may be required upon completion of the construction phase.
- Removal of temporary roads and fill areas (e.g., construction laydown areas) is recommended if they impede surface drainage or impound runoff.

Revegetation of Cleared or Disturbed Areas:

- Upon completion of the construction phase, a detailed inspection of the site will be performed by a qualified professional to identify cleared areas that require revegetation.
- Temporary roads, laydown areas, and other areas of exposed soils will be scarified and hydroseeded using an appropriate seed mix, as specified by the Newfoundland and Labrador Department of Transportation and Works.
- Slopes that require revegetation will be track-walled and hydroseeded.
- Natural revegetation and succession will be allowed to take place, except in areas that must remain cleared for operational, accessibility, or security reasons; or in areas where rapid re-establishment of woody vegetation is required to maintain slope stability.

Dust accumulation on foliage:

- If the site engineer observes areas where rainfall is not sufficient to wash away accumulations of construction-related dust on foliage, the foliage will be sprayed with clean water.

Releases of Hydrocarbons or Substances of Environmental Concern:

- Although all measures will be taken to prevent any releases of hazardous materials, any accidental releases that may occur during construction will be documented and addressed immediately, in accordance with the Construction Contingency/ Emergency Response Plan.
- Impacted soil is expected to be excavated and disposed of in accordance with applicable regulations.
- Upon removal of contaminants, impacted areas will be assessed for further rehabilitation and remediation if necessary.

6.2 Environmental Assessment

Approximately three years prior to decommissioning, the site will be subject to a comprehensive environmental assessment. All records of spills, leaks and other environment-related incidents should be reviewed. Non-intrusive investigation will be carried out on the entire site to determine unforeseen contaminated areas. Where contamination is expected, intrusive testing will be performed. This information is input to a Rehabilitation and Closure Plan. At the same time the Remedial Action Plan will be designed to protect human and ecological health in accordance with current Provincial and Federal legislation and guidelines, as outlined in Volume 2, Section 7.1.

6.3 Deconstruction / Demolition

Site rehabilitation will begin with the removal of machinery and structures. As outlined in *Newfoundland and Labrador's Storage and Handling of Gasoline and Associated Products Regulations*, all petroleum hydrocarbon-related storage tank systems, including piping, will be emptied and removed. The extent of removal of other infrastructure will depend on the intended use of the site after abandonment and the environmental hazards associated with removing and/or leaving the materials in place. The site will be evaluated to determine if portions of structures, such as foundations and concrete slabs, should be left intact to prevent further environmental damage.

Materials that result from deconstruction and demolition will be handled, stored and disposed or recovered according to legislation and best management practices. Decommissioning waste will be reduced where possible by reuse and recycling. Careful deconstruction can preserve machinery, structures and materials for use in similar applications. Salvageable metals, glass, asphalt, concrete and wood will be recycled by approved contractors and facilities. Materials that cannot otherwise be reused, recycled or used in energy recovery applications will be disposed of in construction and demolition disposal sites, where available, or landfilled.

Once deconstruction and demolition are complete, the site will be cleared of all waste materials. Temporary housing, waste collection and sewage installations will be moved off-site. All machinery and tools will be transported to alternate locations.

6.3.1 Remediation of Contaminated Areas

As required under *Newfoundland and Labrador's Environmental Protection Act* (Government of Canada, 1999) the site will be assessed for environmental contamination. Remediation will be performed based primarily on the Atlantic RBCA protocol, and in accordance with other provincial and federal legislation of the time. The Rehabilitation and Closure Plan will outline the actions to be taken during remediation. Details of the plan will depend on activities and incidents that occur during the lifespan of the project, and will therefore be created during the later stages of the project life. Any environmental incidents that cannot be addressed during refinery operation will be recorded, monitored and incorporated into the Rehabilitation and Closure Plan.

6.3.2 Rehabilitation of Surface Stability and Drainage Patterns

Once remedial action has been taken on contaminated areas, the site will be remodelled where necessary to improve stability of soils and the underlying geology, and to encourage the natural flow of surface runoff. This will be done to eliminate hazards associated with inconsistent or unstable land, and to prevent excessive erosion.

Stabilization will restore or improve the structural integrity of the site so that it can be used in future commercial or industrial applications, or reclaimed by the natural environment without posing risk to animals or humans. Stabilization may include the construction or alteration of embankments to create stable slopes, vegetation to encourage stability and reduce erosion, and the installation of rip-rap revetment where necessary.

Runoff will be managed by restoring the flow of water into brooks and natural ditches. Culverts installed during site preparation and construction will be assessed to determine their suitability in the natural environment. Any infrastructure that remains on-site will be maintained and replaced when necessary. Any infrastructure that inhibits natural surface or groundwater flow, will be removed from the site and properly reused, recycled or otherwise disposed of.

6.3.3 Revegetation

Revegetating a site encourages growth of plants and creates an environment for animal habitat. Vegetation also helps to stabilize embankments, reduce surface runoff, prevent soil erosion and improve the overall health and quantity of soil on-site.

Native vegetation will be restored to areas where excavation and remodelling occur. Areas where soil and rock materials are compacted will be scarified to allow for aeration and increase soil moisture content. Hardy plants, bushes or trees will be planted where stabilization is required. Redundant roadways will be removed and seeded with vegetative cover. Other exposed soils will be revegetated with appropriate seeding. Any infrastructure that unnecessarily prevents the recovery of vegetation will be removed.

6.3.4 File official site closure documents

Closure documents will be submitted to regulatory authorities. These documents will summarize the activities that took place on-site and discuss in detail the rehabilitation measures. Any remaining areas of concern will be explained. Additional monitoring and maintenance plans will be included in the closure document. Close contact will be kept with regulatory authorities regarding the condition of the site.

6.3.5 Post-Decommissioning Monitoring

The following is an outline of post-decommissioning monitoring programs proposed for the site at this time. Additional details and monitoring commitments will be provided in the Rehabilitation and Closure Plan.

6.3.6 Erosion Control Monitoring

The condition of temporary erosion control measures installed during decommissioning will be monitored, and repairs undertaken, until the site decommissioning supervisor authorizes their removal.

6.3.7 Slope Stability Monitoring

Monitoring of areas where corrective measures were implemented will continue until the slopes are deemed stabilized by the site decommissioning supervisor.

6.3.8 Revegetation Monitoring

The success of revegetation efforts will be assessed for two full growing seasons following seeding or tree planting (if applicable). Areas that remain exposed or where vegetation density is inadequate will be scarified and re-seeded (either manually or by hydroseeding) or replanted with appropriate tree seedlings.

6.3.9 Monitoring of Remediated Areas

During decommissioning, appropriate techniques will be applied to remove contamination that threatens human and ecological health. Upon completion of remedial measures, samples of environmental components such as soil, water, river and ocean sediment and wildlife will be taken to demonstrate compliance with regulations.

Monitoring of areas impacted by hydrocarbons or substances of environmental concern will be performed in accordance with the Remedial Action Plan, or as directed by the regulatory authority. Generally, areas that were remediated during decommissioning will require only confirmatory sampling to demonstrate regulatory compliance at the end of the remediation program. In locations where the Rehabilitation and Closure Plan does not require active remediation of contaminants, or where active remediation was found to be impractical, a long-term monitoring program may be undertaken to ensure that the site does not pose future risk to human health or the environment.

7.0 ACCIDENTS AND MALFUNCTIONS

Accidents and malfunctions are also addressed in Volume 2, Project Description and Planning, Section 9.0. This section focuses on potential spills associated with construction and operations. The potential for a spill and the response during decommissioning is considered similar to construction and will not be discussed separately.

7.1 Construction

7.1.1 Land

Accidents and malfunctions that could potentially affect the marine environment during the construction phase include:

- Release of oil through:
  - Fuel delivery truck upset
  - Fuel storage tank leak
  - Fuel transfers to storage tanks and construction equipment
  - Equipment and vehicle spills (fuel tanks, oil reservoirs, lines)
  - Leak from a small container (i.e. barrel, portable container etc.)
- Fire and explosion
- Chemical release from a container

Fuel storage tanks and drum storage areas will be constructed with adequate secondary containment as required by Newfoundland and Labrador Department of Environment and Conservation regulations, with adequate setbacks from water courses, water bodies and the sea, so that the spill migration pathways will have sufficient barriers to prevent a release to the sea or other water body.

The probability of spills to the sea from mobile construction equipment, fuel trucks and vehicles will be reduced by risk reduction measures such as:

- Contractor selection;
- Equipment selection and screening before construction;
- Having a systematic preventative maintenance program with record-keeping;
- Mandatory daily inspection of fuel/oil tanks and lines by equipment operators;
- Posting and enforcing speed limits for vehicles and fuel trucks;
- Introducing risk reduction procedures for equipment re-fuelling operations;
- Having construction workers consider the everyday risks and taking precautions;

- Holding daily tool-box talks and tail-gate safety meetings about spill prevention to raise awareness.

Oil containment and recovery equipment will be available on-site in the event of a spill on land, into watercourses and to the sea.

Fuel storage tanks and drum storage areas for construction will be built with sufficient setback from watercourses, ponds and the sea. Fire and. explosion is not expected to cause spills to the sea because the product would most likely be consumed by combustion.

Chemical storage areas will be located well away from watercourses and ponds and will have secondary containment. If a chemical is spilled, contaminated soil will be removed expeditiously so that there is no migration through groundwater. Mobile distribution of chemicals will use secondary containment where reasonable; where it is not the quantity of chemicals will be restricted to a small volume.

With these risk reduction and spill prevention measures, the residual oil volume released to the marine environment attributable to land-based construction of the refinery and tank installations, access roads and quarries, will be reduced to less than 1 m^3 for the construction phase. The chemical spill volume to the sea from the same activities will be reduced to negligible.

7.1.2 Marine

Activities during marine construction have greater potential to affect the marine environment than construction on land. The construction of wharves, jetties, trestle and oil pipelines will all involve the use of barges, tugs and other boats. Mobile construction equipment, fuel trucks and vehicles will be operating on land that slopes to the sea.

The sources of potential spills to the sea are the same as for land construction, with the addition of any spill from tugs, barges and other support vessels.

Spill prevention measures will also be implemented by the marine construction contractors. These precautions will include:

- Secondary containment for all tanks, reservoirs and lines onboard each tug and barge;
- Drip trays and sorbent materials placed under connection points during fuel transfers using hoses;
- Standard procedures with checklists for oil transfers including routine equipment preparation and integrity inspection before each transfer and communications before and during transfers;
- Accountability by fuel handlers (both suppliers and receivers) will be delegated by having oil transfer checklists signed before transfers can proceed; and
- A mandatory watch will be required on both sides of each fuel transfer (for transfers over seawater).

The risk reduction measures will lower the probability of spills to the sea; infact, it is expected that spills will be less than 1 m^3.

Chemicals used on ships and barges will be restricted to minor volumes with pre-planned controls for spill prevention and for spill containment on-board. Because of the small volumes being used any chemical spills will be contained onboard and no spills to the sea are expected.

Spill containment equipment and response personnel will be on-site for fuel and chemical transfer operations having potential for a release to the sea.

7.1.3 Decommissioning

It is expected that decommissioning will take the same amount of time as construction. It will be a controlled operation to reduce the risk of accidents and any pollution release.

Decommissioning will have the same spill risks and volumes as for the land and marine construction components.

The volume estimate for spills to the sea from on-land decommissioning activities was a potential volume of 1 m^3 and from decommissioning of the marine terminal another 5 m^3. A spill prevention program with risk reduction measures will further reduce the probability.

7.2 Operations

7.2.1 Land

Pollution releases to the environment from the refinery operations could occur through:

- Refinery process upset;
- Fire and explosion;
- Structural damage to a storage tank;
- Structural damage to a pipeline;
- Structural damage to a small volume container;
- Small operational spills from construction equipment and vehicles; or
- Fuel truck upset

The spill prevention measures for the construction phase will also be implemented for operations. All fixed storage facilities for fuel, lubricants and chemicals will have secondary containment. Movement of fuels, oils and chemicals will be restricted to smaller volumes where practical to reduce the extent of a spill. Secondary containment will be used wherever reasonable and practical.

Refinery tanks for crude oils and refined products will have secondary containment in accordance with Newfoundland and Labrador Department of Environment and Conservation regulations. This will prevent a spill from reaching the sea.

One scenario that could see oil from a storage tank moving beyond the secondary containment would be a tank fire with a boil-over as water in the bottom of a tank boils from the heat of the fire. Probability will be reduced by monitoring water levels and decanting a regularly. The residual probability of a release to the sea is very low.

The Refinery will keep earth-moving equipment that, in the event of a spill on land, could build containment barriers to prevent spilled oil from entering the sea. A stock of concrete road dividers and sand bags will be kept on site for use as barriers when the ground is frozen. Packed snow can also be used.

The risk of a spill to the sea will be very low.

7.2.2 Marine

Refinery Marine Terminal Operations

Accidents and malfunctions that could result in the release of pollutants from the refinery marine terminal include:

- Oil pipeline or loading arm rupture or leak;
- Loss of containment during transfer of fuel, lubricants or waste oil between a tanker truck and a ship or barge;
- Fire and explosion; or
- Loss of containment from a tanker or ship berthed at the Refinery (oil, a chemical or soot).

Other causes of spills in the petroleum sector appear in the tables below.

Table 7.1 Cause of spills in the petroleum sector

Cause		%
Pipe leak	8854	33
Valve fitting	3144	12
Overflow	2685	10
Process upset	2408	9
Above ground tank leak	1283	5
Discharge	1065	4
Underground tank leak	719	3
Overturn	608	2
Container leak	585	2

Cause		%
Cooling system leak	25	0
Other	1165	4
Unknown	4395	16
TOTAL	26936	100

Source: Environment Canada (1998)

Pipe leaks are the primary cause of spills in the petroleum sector (33%).

Table 7.2 Number of spills by reason in petroleum sector

Cause		%
Equipment failure	6616	24
Corrosion	6432	24
Human error	4990	18
Material Failure	856	3
Gasket joint	483	2
Damage by equipment	467	2
Other	3345	13
Unknown	3687	14
TOTAL	26976	100

Source: Environment Canada (1998)

Equipment failures (24%), corrosion (24%) and human error (18%) account for two-thirds of the reasons for spills in the petroleum sector (Environment Canada, 1998).

A forecast of the frequency of spills based on historical statistics, will appear later in this section.

Incident prevention is a NLRC policy and priority. Investment in the Refinery will be substantial. NLRC recognizes that the potential consequences from an incident include:

- Damage to the environment;
- Damage to reputation;
- Damage to the refinery marine terminal;
- Damage to the refinery; and
- Business interruption.

Any or all of these consequences could be very significant. NLRC will implement measures during design, construction and operations, to reduce the risks.

Termpol

As part of its risk reduction plan, NLRC will participate in the Termpol Review Process led by Transport Canada to identify and consider the hazards and risks from tanker operations while at sea and while docked. Some of the risk areas include potential tanker grounding, collision, fire and explosion and the tanker interactions with the terminal.

Grounding risks include rocks and shoals along the tanker routes. Collision risks include other vessels and floating objects (icebergs, multi-year ice, man-made objects). Tanker interactions hen berthed will be studied along with the management framework and Refinery regulations that will govern the preparedness and safety aspects for oil transfers.

The Termpol review will examine each component of the tanker traffic management system,including: tanker routes, traffic lanes, traffic density, convergence and separation, anchorages, potential traffic conflict and risk areas, navigation aids, pilotage and tanker escort, traffic services, communications, ship detection, tracking and identification systems, tanker requirements and operating procedures.

The probability and consequences of marine pollution incidents will also be considered. Given the known limits of spill response, prevention will be a priority focus.

In the event of a spill, the preparedness and response capability must be competent within the known operational limits of response. Preparedness for response includes:

- Spill management personnel and systems;
- Availability, preparedness and organization of logistics support resources;
- Having competent field response personnel;
- Training;
- Exercises to demonstrate capability;
- Capability of equipment;
- Equipment condition;
- Health and safety training, and risk reducing procedures; and
- Waste storage, handling and disposal systems.

The spill response capabilities of tankers, the Refinery, the Spill Response Organization certified by Transport Canada, and government agencies must be considered. Each has a responsibility to make every response as effective as possible.

The Termpol panel will recommend measures to further reduce the risk (both the probability and the consequences) of tanker incidents. Recommendations will also be made for risk reduction when tankers are berthed and transferring oil cargoes.

Marine Operations

Accidents and malfunctions that could affect the marine environment include release of cargo from a tanker at sea, due to:

- Structural damage to the tanker from
  - Grounding,
  - Collision with another ship or barge,
  - Storm induced wave forces,
  - Collision with a floating object (iceberg, multi-year sea-ice, a floundered wreck, a lost shipping container, a buoy, other),
  - Fire or explosion on or adjacent to the tanker;
- Equipment malfunction; or
- Procedure failure (resulting in an accidental or intentional discharge).

Accidents and malfunctions that may affect the marine environment could include the release of cargo from a tanker at berth at the Refinery or near its berth, due to

- Structural damage to the tanker from
  - Grounding,
  - Collision with another ship, barge, jetty or wharf,
  - Collision with a floating object;
- Fire or explosion
  - On the jetty or dockside,
  - On the tanker,
  - At a pipeline in the immediate vicinity of the berth,
  - At an oil storage tank;
- Equipment malfunction; or
- Procedure failure (such as overfilling a tank).

Frequency statistics for different sizes (volume) of marine oil spills from a tanker during the life of the Refinery project appears later in this section.

7.2.3 Potential for Marine Oil Spills

Using recent historical spill statistics and projecting that same performance we can forecast the frequencies of spills to the marine environment during the life of the Refinery.

Frequency of Marine Oil Spills

Bercha (2002) has examined tanker spill statistics for a 35-year period from 1974 to 1999 and has assembled a table of oil spill frequencies for different size ranges. Table 7.3 "gives a summary of the worldwide and US tanker oil statistics. All numbers represent the spill frequency of either inbound or outbound journeys for tankers. The numbers must be doubled to calculate the spill frequency of the tankers on a trip or voyage basis, which would include both an outbound portion (when the tanker is loaded) and an inbound portion (when the cargo is unloaded). If for example, 278 large spills (>1000 bbl) occurred on a worldwide basis from 1964 to1999 and the volume of crude oil moved during this period was 239.67 billion barrels, the spill frequency would be 278/239.67 or 1.16 spills per billion barrels, half of which would occur on outbound portions of journeys and half on the inbound. A trip or a voyage includes the outbound and inbound portion. The average size of worldwide crude oil tanker is 826,000 bbl. (Bercha, 2002)"

Table 7.3 Crude Oil Tanker Spills of Various Sizes and Locations over a 35-year period from1974 to 1999 (Bercha, 2002)

Location	Size range (bbl)	Spills/billion bbl Loaded or unloaded	Spills/10,000 Voyages or trips	Average Spill Size (bbl)	Median Spill Size (bbl)
Worldwide					
All locations	>200,000	0.05	0.83	539,000	382,000
All locations	>100,000	0.12	1.98	374,000	244,000
All locations	>10,000	0.295	4.87	178,700	66,000
In port	>10,000	0.09	1.49	175,500	49,500
At sea	>10,000	0.205	3.39	180,200	71,400
All locations	>1000	0.58	9.58	93,900	11,300
In port	>1000	0.245	4.05	68,300	6,300
"At Sea" total	>1000	0.335	5.53	112,400	17,000
"At Sea" – open water >50nmi	>1000	0.60	1.00		
"At Sea" – restricted water <50nmi	>1000	0.275	4.54		
	50 to 999	1.5	24.8	233	132
	1 to 49	7.8	129	10	5
U.S. Coastal Waters					
all locations	>10,000	0.215	3.6	62,100	20,000
in port	>10,000	0.100	1.65	23,700	20,000
at sea	>10,000	0.115	1.90	96,700	43,200
all locations	>1000	0.515	8.51	28,000	7,000
in port	>1000	0.335	5.53	10,000	6,000
At sea	>1000	0.18	2.97	61,900	16,100

Note:

Statistics are based on a 35-year period from 1974 to 1999

Based on the Bercha (2002) table above, the spill frequencies assumed for the tanker operations associated with the NLRC project are presented in Table 7.4 below.

Table 7.4 Spill frequencies assumed for tankers associated with NLRC project operations

Location	Size range (bbl)	Spills/billion bbl Loaded or unloaded	Spills/10,000 Voyages or trips	Average Spill Size (bbl)	Median Spill Size (bbl)
All locations	>200,000	0.05	0.83	539,000	382,000
All locations	>100,000	0.12	1.98	374,000	244,000
All locations	>10,000	0.215	3.6	62,100	20,000
"At Sea" – restricted water <50nmi	>1000	0.275	4.54		
	50 to 999	1.5	24.8	233	132
	1 to 49	7.8	129	10	5

Frequency statistics from past spills can forecast the spill frequencies from crude oil tankers during the life of the NLRC project. This estimate assumes that what happened in the past could happen again in the future at the same frequency. The spill sizes most likely to occur in port are highlighted.

Table 7.5 Forecasted Spill Frequency from Incoming Crude Oil Tankers

Spill Size (bbl)	Oil Spill Frequency of occurrence over 35 years* Per billion barrels loaded or unloaded (F_{35})	Oil Spill Frequency of occurrence over 25 years per billion barrels loaded or unloaded (F_{25}) **	Billion Barrels to be loaded or unloaded in 25 years By NLRC Refinery ***	Oil Spill Frequency of occurrence for 2.7375 Barrels imported over 25 years F_{25} x 2.7375	Average Size of Spill* (Barrels)	Median Size of Spill * (Barrels)
>200,000	0.050	0.03571	2.7375	0.09777	539,000	382 000
>100,000	0.120	0.08571	2.7375	0.2346	374,000	243 600
>10000	0.215	0.15357	2.7375	0.4204	62,100	20 000
>1000	0.275	0.19643	2.7375	0.5377		7 000
50 to 999	1.500	1.07143	2.7375	2.9330	233	132
1 to 49	7.800	5.57143	2.7395	15.2518	10	5

*Source: from Bercha (2002) and shown in Table 7.3 above

** F25 = F35 x 25/35; 25 is the life of the refinery, 35 is the period in years for the spill statistics

*** Over its 25-year life the Refinery will import 2.7375 Billion barrels (at an average of 300,000 barrels per day)

The spill frequency for Outgoing Refined Product tankers can also be forecasted by projecting the historical experience forward in the same manner:

Table 7.6 Forecasted Spill Frequency for Outgoing Refined Product Tankers

Spill Size (bbl)	Oil Spill Frequency of occurrence over 35 years* Per billion barrels loaded or unloaded (F_{35})	Oil Spill Frequency of occurrence over 25 years per billion barrels loaded or unloaded (F_{25})**	Billion Barrels to be loaded or unloaded by NLRC in 25 years	Oil Spill Frequency of occurrence for 2.7375 Barrels oil exported over 25 years	Average Size of Spill* (Barrels)	Median Size of Spill * (Barrels)
>200,000	0.050	0.03571	2.7375	0.09777	539,000	382 000
>100,000	0.120	0.08571	2.7375	0.2346	374,000	243 600
>10000	0.215	0.15357	2.7375	0.4204	62,100	20 000
>1000	0.275	0.19643	2.7375	0.5377		7 000
50 to 999	1.500	1.07143	2.7375	2.9330	233	132
1 to 49	7.800	5.57143	2.7395	15.2518	10	5

*Source: (Bercha 2002) and Table 7.3 above

** F25 = F35 x 25/35; 25 years is the life of the refinery, 35 years is the period for the spill statistics

*** Over its 25-year life the Refinery will export 2.7375 Billion barrels

World Oil Statistics For Tankers

The International Tanker Owners Pollution Federation (ITOPF) maintains a database of information on approximately 10,000 spills from tankers, combined carriers and barges. Some 85 per cent of the spills were less than seven tonnes.

The number of large spills over 700 tonnes for 1970-2006 is shown in Figure 7.1. The average number of large oil spills during the 1990s was less than one third of that during the 1970s. The dramatic reduction has been due to the combined efforts of the tanker industry and governments (largely through the International maritime Organization (IMO)) to improve safety and pollution prevention.

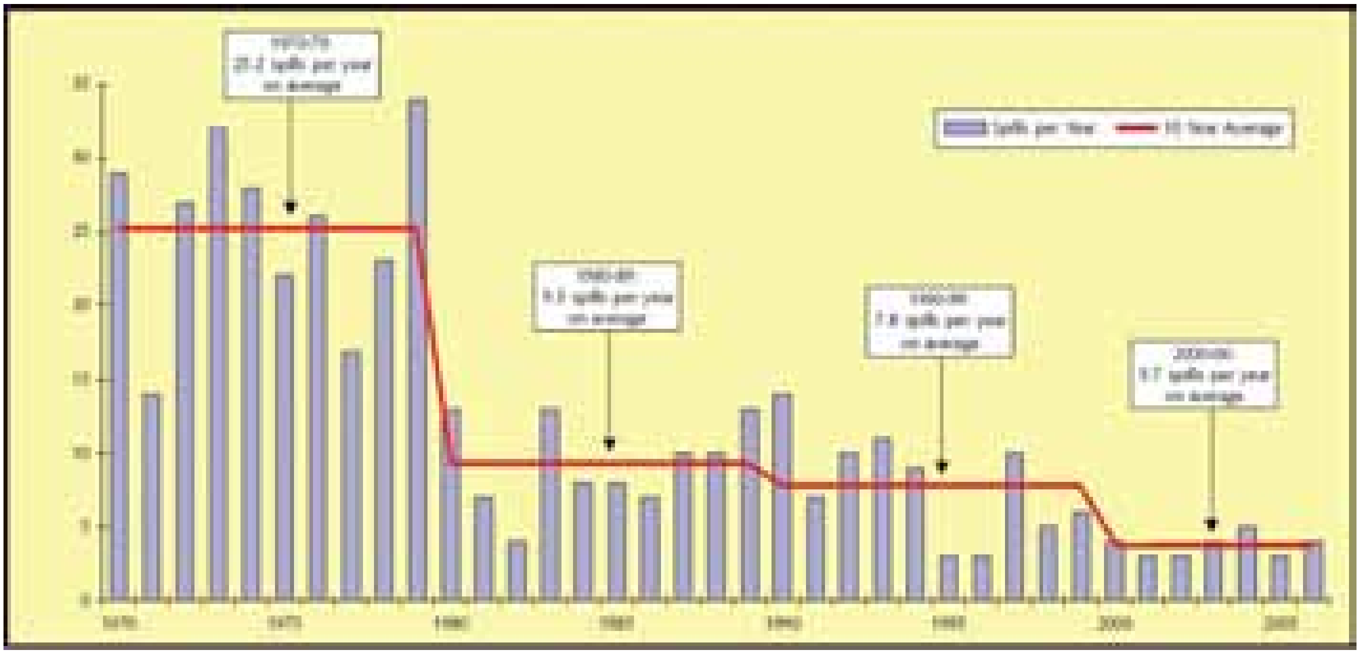

Figure 7.1 Number of large spills over 700 tonnes, 1970 to 2006 (ITOPF Handbook 2007/2008)

Figure 7.2 shows the quantities of oil spilled between 1970 and 2006. The total amount of oil spilled each year varies considerably, with a few very large spills being responsible for a high percentage of the total annual quantity (ITOPF, 2007). The spill trend since 1990 and the record for the past 10 years are very significant worldwide and for the project. There is a definite downward trend, attributed to a risk-based approach to management. Numerous measures have been taken by governments and industry to reduce the risks associated with tanker hazards. That coupled with better technologies and better operational management practices is showing favourable results.

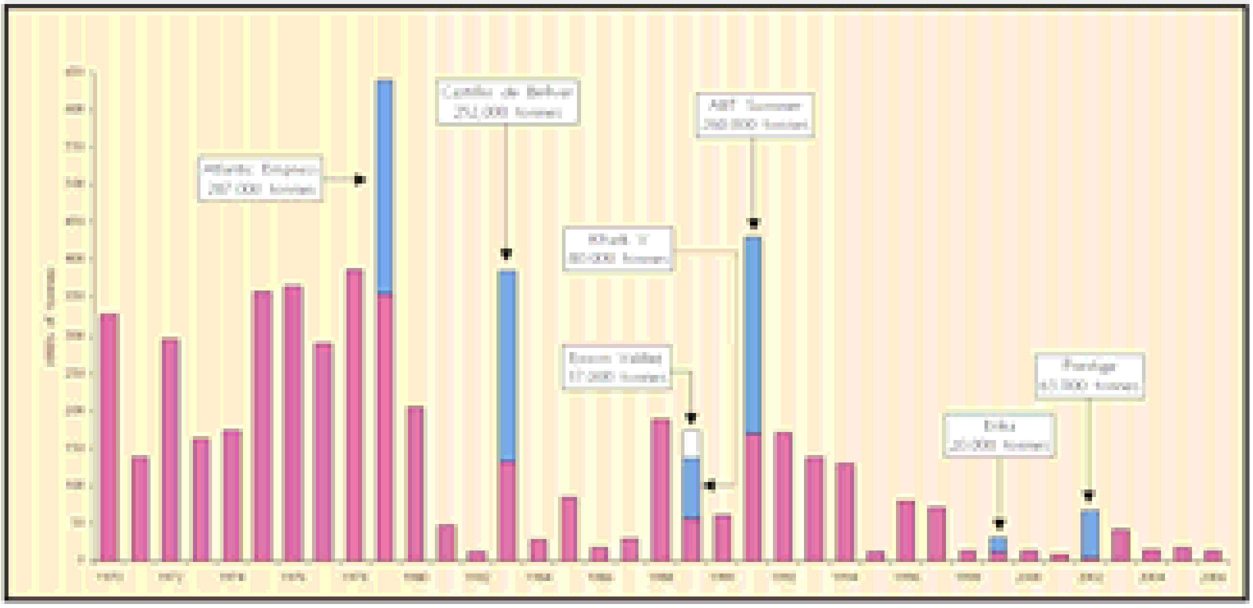

Figure 7.2 Quantities of oil spilled, 1970-2006 (ITOPF Handbook 2007/2008)

Canadian Oil Spill Statistics

At the time of this writing, statistics for oil spills from Canadian oil handling facilities (as defined under the Canada Shipping Act), have been requested from Transport Canada along with the volumes of oil handled per year. With this information in hand, NLRC can calculate the probability of spills in different size categories per billion barrels handled based on past experience. Projections based on these statistics can forecast the potential spill risks faced by the Refinery (non-tanker), which will be of value in planning risk reduction measures.

An Environmental Risk Assessment Study of the south coast of Newfoundland has been commissioned by Transport Canada. The report is expected to be released before the end of 2007. It is expected that this study will provide up-to-date probability statistics. It is also expected that the Canadian spill record will show improvement over the past 12 years since the Government of Canada implemented the International Maritime Organization (IMO) provisions for pollution prevention beginning with the International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (which entered into force in 1995), and amended the Canada Shipping Act with a focus on ship safety and incident prevention. These reports will be useful inputs for the upcoming Termpol Review requested by NLRC.

Newfoundland Oil Spill Statistics

While awaiting the rish assessment, NLRC has researched the spill records for Placentia Bay to validate the spill frequency projections made above. The Canadian Coast Guard (CCG) has maintained a database of oil spills since 2002. NLRC has looked at spill statistics provided by the CCG as well as from an existing refinery and a large marine terminal both operating on Placentia Bay.

Based on the CCG database, from Jan 1, 2002, to June 30, 2007, there have been 12 spills from tankers and oil handling facilities (OHF) on Placentia Bay. Tankers sitting at an OHF berth had seven spills for a total volume of 1.911 m^3. Two tanker spills occurred at anchorage in the Port of Come By Chance away from an OHF (total volume was 21 litres). OHFs had one spill with a volume of 1 l.

An analysis of these spills over 5.5-year period is presented in Table 7.7 below:

Table 7.7 Analyses of Taker Spills on Placentia Bay from January 1, 2002 to June 30, 2007

Spill Source	Number of Spills	Actual Spill Volume (m^3)	Actual Spill Volume (Barrels)	Number of Spills Forecasted for NLRC Tankers Inside the Port of Come By Chance over a 5.5 year period
Tanker spills at OHF berth	7	1.911	12.4	
Tanker spills at anchorage	3	0.022	0.1	
Total Tanker Spills	**10**	1.933	12.5	**8.006**
OHF spills	1	0.001	0.01	
Total tanker and OHF spills	11	1.934	12.57	
Tanker Spills per year	**1.818**			**1.456**
OHF Spills per year	0.182			
OHF & tanker spills per year	2			
Spills >200,000 barrel	0	0	0	0.043
Spills > 100,000 barrels	0	0	0	0.103
Spills > 10000 barrels	0	0	0	0.185
Spills 50 to 999 barrels	0	0	0	0.237
Spills 1-49 barrels	2	1.908	12.40	1.295
Spills under 1 barrel	9	0.026	0.17	Forecast unavailable
TOTALS		1.934	12.57	

(Derived from spill statistics supplied from Canadian Coast Guard database)

From this short period, it appears that NLRC forecast statistics reasonably match the actual experience. One assumption made earlier (that all small spills from tankers less than 999 barrels would occur within the Port of Come By Chance) is in full agreement with the CCG spill records. None of the spills occurred along the tanker route outside the Port of Come By Chance. The forecasted number of NLRC tanker spills was slightly less than the actual experience but they were for the next higher spill size. Unfortunately the data sample size is not large enough, and the sample period is too short, for statistical validity. The fact that nine of the actual spills were less than one barrel (where NLRC has made no forecast) explains part of the variation.

Although the spill records span a short period, a comparison can still be made between the performance of tankers associated with one of the oil handling facilities (OHF) and the forecast based on the Bercha statistics used to make the NLRC projections.

During the period 2002-2006 one OHF on Placentia Bay had a received volume of 491,617,000 barrels and a similar export volume of oil with five spills attributable to tankers visiting that facility during that period.

The spills occurred either at berth or at anchorage. Based on that information, the frequency is five spills per 983,234,000 barrels (imported and exported). This equates to 5.085 spills per billion barrels in *and* out or 2.5425 spills per billion barrels imported *or* exported

Using Table 7.8 below, a tanker spill forecast for the subject OHF has been made for comparison with the actual spill record for tankers associated with that same facility. The spill records are from 2002 to 2006. The statistics used for the forecast are from Bercha (2002).

Table 7.8 Comparison of a Tanker Spill Forecast with Actual Spill records for tankers associated with an existing Oil Handling Facility located on Placentia Bay

	Forecast for One OHF on Placentia Bay *				Actual Spills	
Spill Size (Barrels)	**Oil Spill Frequency of occurrence over 35 years* Per billion barrels loaded or unloaded (F_{35})**	**Oil Spill Frequency of occurrence over Five Years** per billion barrels loaded OR unloaded (F_5)**	**Oil Spill Frequency of occurrence over 5 years per billion barrels loaded AND unloaded 2 x (F_5)**	**Median Size of Spill * (Barrels)**	**Actual Volume of Oil spilled in each Spill Size category (Barrels)**	**Number of Actual Spills in each size category from tankers associated with the OHF**
>200,000	0.050	0.00714	0.01428	382 000	0	0
>100,000	0.120	0.01714	0.03428	243 600	0	0
>10000	0.215	0.03071	0.06142	20 000	0	0
>1000	0.275	0.03928	0.07856	7 000	0	0
50 to 999	1.500	0.21429	0.04286	132	0	0
1 to 49	7.800	1.11429	**2.22858**	5	10.334	1
< 1					0.143	4
Totals	**9.960**	**1.42285**	**2.45998**		**10.5**	**5**

* Forecast uses statistics from (Bercha 2002) ** F5 = F35 x (5/35)

It is clear that the spill record for tankers associated with the selected OHF is good. The number of spills in the 1- 49 barrel classification was one when the forecast number based on probability was 2.228. The actual volume spilled in that category was 10.334 barrels. A forecast using the median spill volume and frequency would give 11.1 barrels. Bercha (2002) did not include statistics for tanker spills below one barrel, so that comparison cannot be made. This case study gives credibility to the NLRC spill frequency forecast for spills in the Port of Come By Chance.

The same OHF also provided its own record of non-tanker spills from the facility for the period 1998 to 2006. The OHF had five spills during that 9-year period, with a total volume of 0.305 litres (average size 0.06 litres). The spills occurred over an imported oil volume of 554,817,000 barrels and the same volume exported. The OHF spill rate is equivalent to nine spills per billion barrels imported or 4.51 spills per billion barrels handled by the OHF (imported and exported).

From Bercha 2002, the forecast for spills in the 1-49 barrel size category per billion barrels loaded or unloaded is 7.8 spills. The OHF record is equivalent to nine spills per billion barrels loaded or unloaded. From Bercha 2002, the average spill size was 10 barrels per spill. The average spill size for the OHF was 0.06 litres, substantially less.

One can say without reservation that the spill record of this OHF is superior to the world spill record. This can be attributed to diligent risk management practices of the facility, the tankers that visit the facility and their owners.

NLRC will focus a high level of attention on managing its spill risks within the refinery and jetty operations with tankers. NLRC believes that such an approach will be reflected in a spill performance record below the level of international spill statistics (which in the past 10 years has been declining in number and volume).

Spill Location, Size, and Return Period

A projection can be made for the combined spill frequencies for each spill size over the 25-year life of the Refinery project (for combined inbound and outbound tankers) and the more likely location of occurrence for each spill size. This forecast based on past history appears in Table 7.9. The assumed spill locations will be discussed later in this sub-section.

Table 7.9 Spill size, frequency and likely spill locations

Spill Size (bbl)	Crude Oil Spill Frequency of occurrence over 2.7375 Barrels imported and 25 years	Refined Oil Spill Frequency of occurrence over 2.7375 Barrels exported and 25-years	Total number of spills forecasted for each spill size category over 25-year project life	Assumed Spill Locations
>200,000	0.0978	0.0978	0.1956	Along tanker routes
>100,000	0.2346	0.2346	0.4692	Along tanker routes
>10000	0.4204	0.4204	0.8404	Along tanker routes
>1000	0.5377	0.5377	1.0754	Shared between the tanker routes and at the refinery or anchorage (0.5377 each)
50 to 999	2.9330	2.9330	5.8860	At refinery or anchorage
1 to 49	15.2518	15.2518	30.5036	At refinery or anchorage
		Total	38.9702	
Forecasted number of tanker spills that might occur during the project				38.97
Forecasted number of tanker spills when at the Refinery or at anchorage in the Port of Come By Chance (less than 2000 barrels) **				36.9
Forecasted number of tanker spills along tanker routes away from the Port of Come By Chance ** (greater than 1000 barrels) **				2.04

*** based on the spill location assumptions

The return period for potential tanker spills in the different size categories has been calculated from the information in Table 7.9 above. The NLRC return periods are shown in Table 7.10. The return periods forecasted for tanker spills associated with the NTL transshipment terminal project are also presented for comparison purposes.

Table 7.10 Expected Return Period from tanker spills associated with NLRC

Spill Size Category	Barrels	Tanker Spill Frequency for NLRC Refinery Project	Recurrence Period for NLRC Project tanker operations	Recurrence Period for NTL Project tanker operations*
Exceptionally large spills	> 200,000	0.1956	1 in 127.8 years	1 in 100 yrs
Very large spills	> 10,000	0.8404	1 in 24.1 years	1 in 27 yrs
Large spills	> 1,000	1.0754	1 in 23.2 years	1 in 16 yrs
Medium	50 to 999	5.8860	1 in 3.6 years	1 in 6 yrs
Small spills	< 50	30.5036	1 in 0.667 years	1 per yr

** Source – NTL (1997) Termpol Review Process report (from executive summary)

Reader should note that spills under 1 barrel have not been forecasted by NLRC

Where are potential spills likely to occur? For the likely spill locations one can make some assumptions based on logic for each spill size category. It is assumed that:

- Tanker spills greater than 1,000 barrels will occur along the tanker routes away from the Port of Come By Chance. Large spills from a tanker (greater than 1000 barrels or153.8 tonnes) are not likely to occur inside the Port of Come By Chance. Some reasons are:
    - The tankers will have double hulls and with reduced transit speed and tug escort and assistance any collision would be a relatively low energy contact.
    - The marine environment in the Port of Come By Chance is relatively sheltered so no large wave heights are expected that would cause structural failure of a tanker.
    - There are tugs to assist the tankers when needed.
    - Ship traffic is controlled in this area.
    - Communications infrastructure in this area is excellent.
    - Speed limits for tankers are very low.
    - Tankers will be screened (vetted) based on their performance to reduce risks.
- All tanker spills less than 1,000 barrels will occur at the NLRC Refinery jetty or at the anchorages inside the Port of Come By Chance near the refinery.
- Small spills less than 999 barrels are not likely to occur at sea when a tanker is steaming as there are generally no operations on deck that could spill such volumes to the sea.
- Small spills less than 999 barrels are most likely to occur inside the Port of Come By Chance because the activities that lead to such spills will occur here.
- Intentional discharges to the sea (such as illegal bilge pumping) are not included in this discussion.

The largest potential marine spill that might occur from the refinery itself is thought to be in the order of 1,667 barrels (from 42-inch crude oil transfer pipeline)

With respect to the likely location of tanker spill, the following text from ITOPF (2003) supports the thinking above.

Major spills (greater than 1000 tonnes) are usually associated with serious casualties such as groundings, collisions, structural failures, fires and explosions, and typically occur offshore or outside ports. The volume of oil transported within a given area is not of itself an indication of spill risk from casualties but if this is combined with other factors such as high vessel traffic densities, or hazards such as bad weather and narrow, congested straits, there is a good correlation with previous major spill incidents (Moller et al, 2003).

Intermediate spills (between 100 and 1000 tonnes) usually occur in ports or their approaches, either during routine oil transfer operations such as loading, discharging and bunkering or as a result of less severe casualties such as low-energy collisions, groundings and berthing accidents. The large differences in risk for intermediate spills appear to be strongly related to the amounts of oil imported and exported by individual countries, rather than to the (global) region as a whole. Countries which import large quantities of oil appear to be at greater risk than those who are major exporters. The reasons for this are not clear, but may be related to factors such as the comparatively more severe weather and sea conditions in the importing countries and crew fatigue at the end of laden tanker voyages (Moller et al, 2003).

Based on these assumptions, the forecasted number of potential tanker spills inside the Port of Come By Chance in the vicinity of the NLRC refinery during its 25-year project life is estimated at 36.39. The number of tanker spills that might be spilled along the tanker routes is estimated at 2.58. The tanker routes include the incoming legs into Canadian waters as well as the outgoing legs from Canadian waters. The probability figures used are for half the length of each tanker journey (incoming or outgoing), which generally would extend well beyond the 200-mile limit.

Figure 7.3 is a map of the NLRC refinery site showing probability contour lines for oil contact on the sea surface after a spill from the jetty. This probability contour map was extrapolated from similar maps prepared for the oil handling facility at Whiffen Head to understand the probable drift of hypothetical spills from that facility (NTL, 1997). The probability maps for Whiffen Head were derived by forecasting a large number of hypothetical oil spills under different wind and tide conditions using a computer forecasting model. Figures 7.4 and 6.5 show the likely tanker routes through Canadian waters while on route to and from the NLRC refinery.

Figure 7.3 Probability of Ocean Surface Contact After an Oil Spill from the NLRC Refinery Jetty at Southern Head

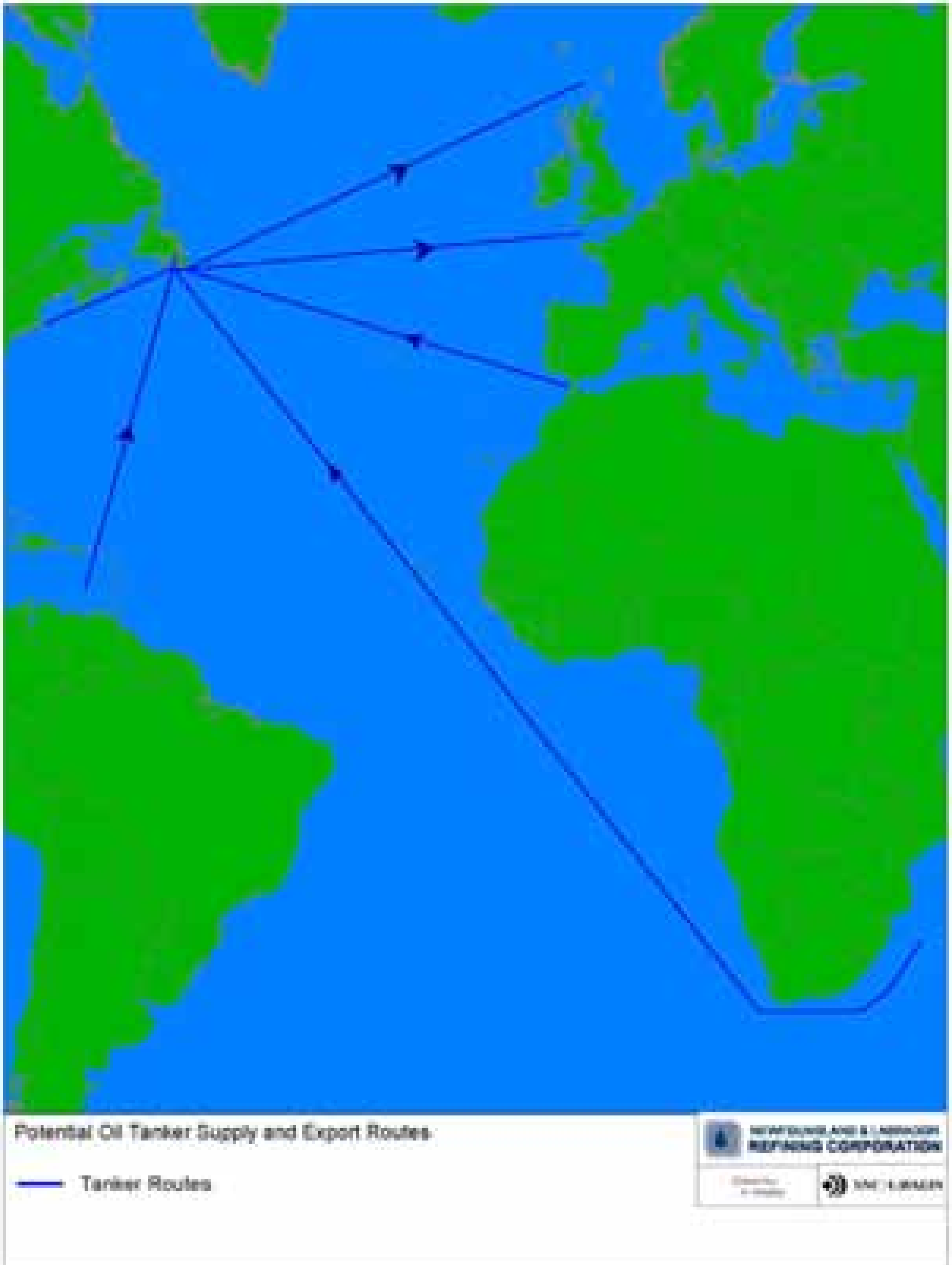

Figure 7.4 World Tanker Routes

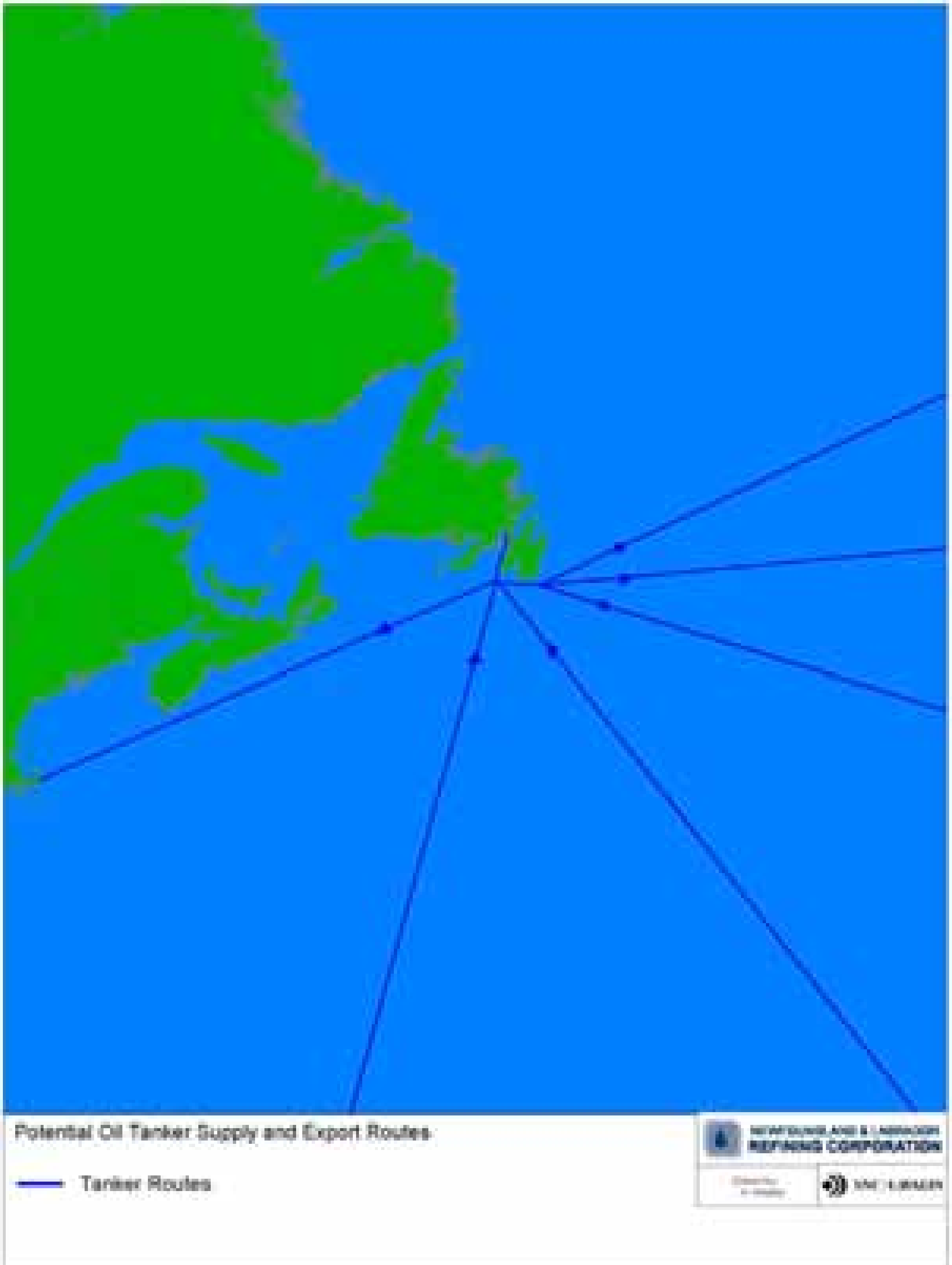

Figure 7.5 Convergence of Tanker Routes in Canadian Waters

Figures 7.6, 7.7 and 7.8 show the probability contours for hypothetical spills at two points along the tanker routes. One point was near Red Island in Placentia Bay. Two probability maps have been prepared for this location – one for a spill under winter conditions and the other for summer conditions. The third map shows probability contours for a hypothetical spill location along the main tanker route at the outer reaches of Placentia Bay (NTL, 1997). Oil spill drift forecasting is further discussed later in Section 7 in a subsection entitled *Spilled Oil Drift*.

These maps illustrate the probability of contact from a hypothetical spill and give an idea of the extent and consequences of a tanker spill anywhere along the tanker routes. Having an understanding of the consequences of a spill has prompted NLRC to participate in a Termpol Review process (to be led by Transport Canada) to further consider the hazards that may adversely affect tanker operations. The Termpol Review will consider what measures are needed to further reduce risks of tanker incidents in light of the current and forecasted traffic along the tanker routes. The overriding objective will be to prevent tanker incidents and spills.

An earlier Termpol Review, conducted in 1997, looked at the transport of oil by tanker from oilfields on the Grand Banks for temporary storage and transhipment through the marine terminal at Whiffen Head. Because of the review, many risk reduction measures were implemented, including enhancements to the vessel traffic management system. That work has resulted in an improved tanker safety record for the Placentia Bay area that continues today.

In 2002, the tanker *Eastern Power* was at risk of breaking up at sea off Newfoundland with a full cargo of crude oil destined for an OHF in Placentia Bay. The tanker was not allowed into Canadian waters and was diverted to calmer waters where her cargo was transferred to another tanker. This case is evidence that the current tanker management control system is focused on incident and spill prevention in Canadian waters.

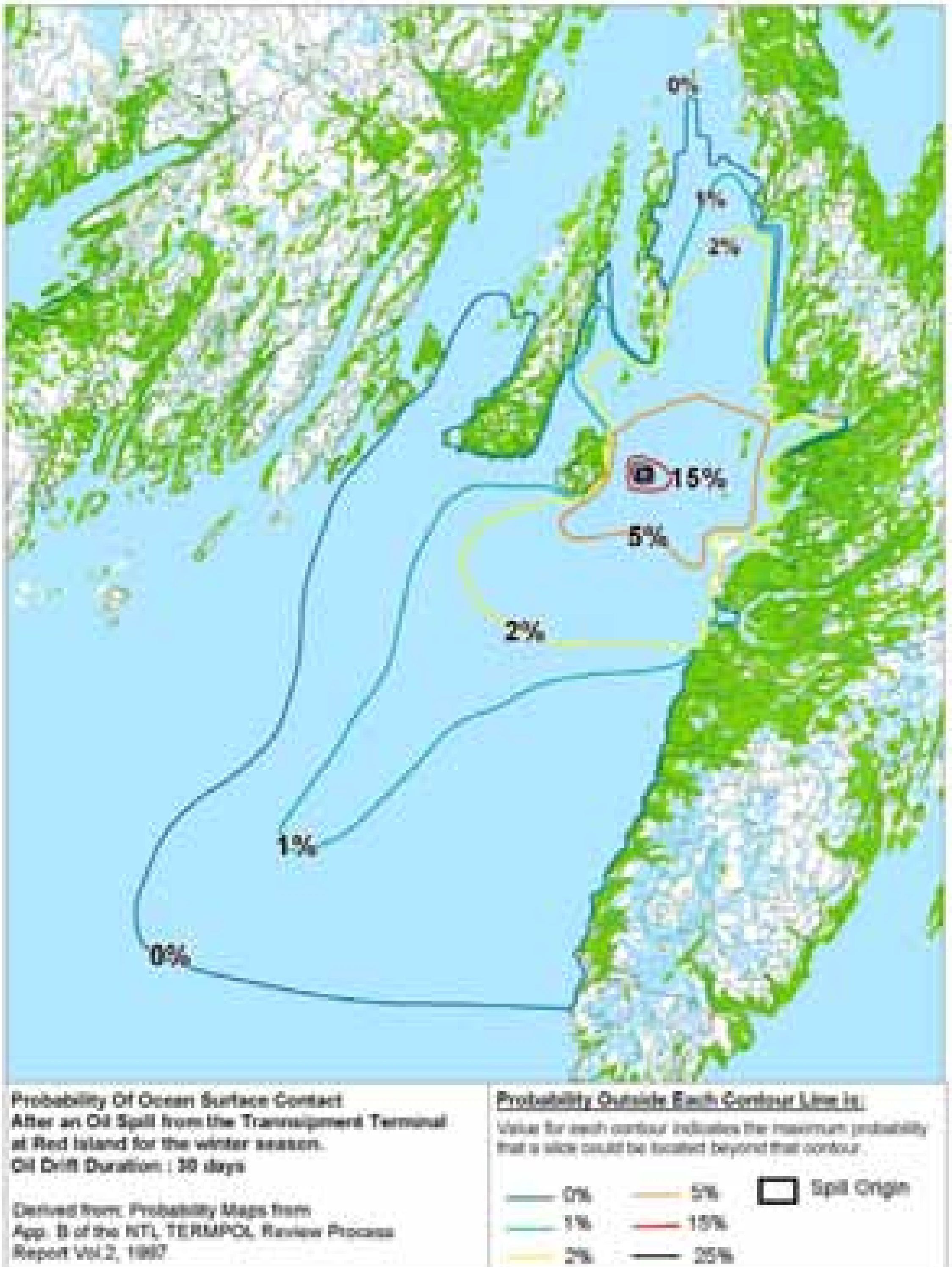

Figure 7.6 Probability of Ocean Surface Contact After an Oil Spill from the Transshipment Terminal at Red Island for the winter season

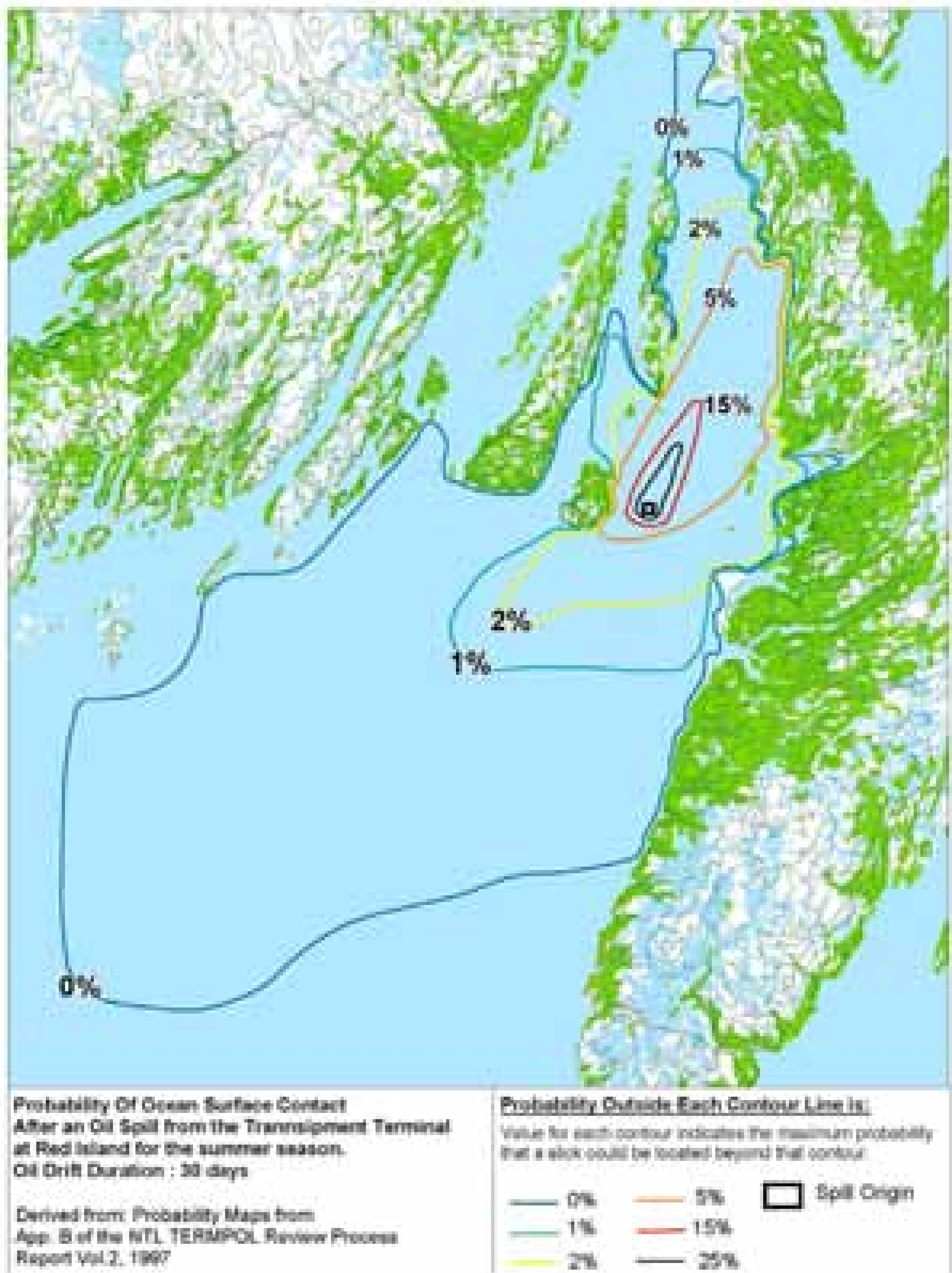

Figure 7.7 Probability of Ocean Surface Contact After an Oil Spill from the Transshipment Terminal at Red Island for the Summer Season

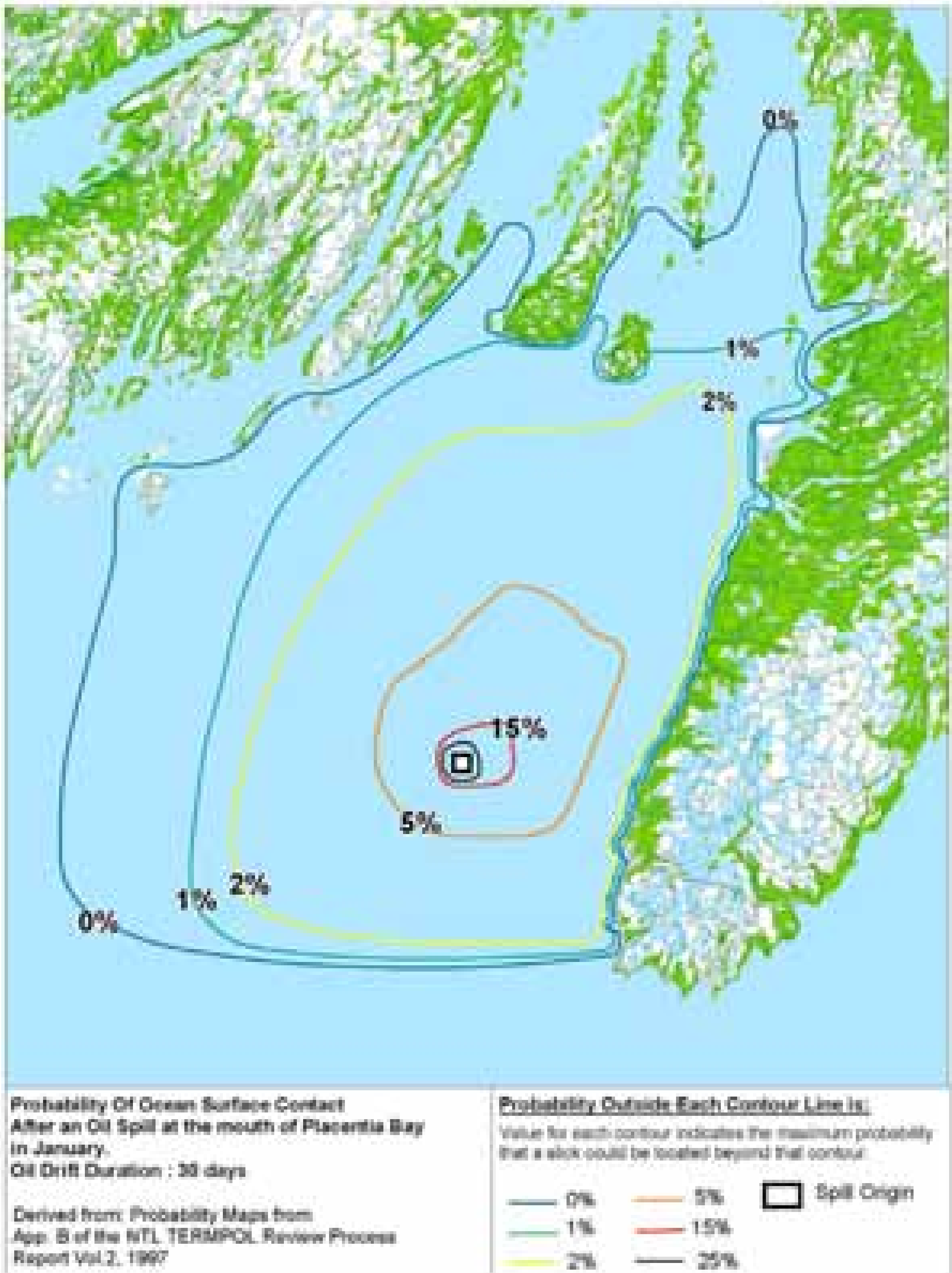

Figure 7.8 Probability of Ocean Surface Contact After an Oil Spill at the mouth of Placentia Bay in January

7.2.4 Fate of Oil Spilled at the Head of Placentia Bay

Weathering of spilled oil

NLRC has prepared an assessment of the weathering properties and behaviour of the crude oils and refined oil products that will be handled by the NLRC Refinery and transported to and from its location (NLRC, 2007). NLRC plans to import Arabian medium and heavy crude oils (and other similar crude oils) as well as No. 6 Fuel Oil. As the refinery is not yet in production, the properties of the refined oil products that will be exported are not known. Properties and material safety data sheets (MSDS) will be developed for these products. In the interim, surrogate refined oil products were used in the properties assessment.

The ADIOS2 oil weathering software was downloaded from the US National Oceanic and Atmospheric Administration website (NOAA, 2007) and used to predict properties of these oils that are of value in planning the development of oil spill response capability and strategies.

The oil weathering properties of interest for each oil type after a spill are:

- % Evaporation over time;
- % Dispersed over time;
- % Remaining over time;
- Change in oil density over time as it weathers;
- Change in water content over time for oil floating on the sea surface as the oil emulsifies;
- Change in oil viscosity over time; and
- Benzene content in the air at the spill site and its dissipation over time (for health and safety).

Figure 7.9 below illustrates the oil weathering processes that affect the oil properties, behaviour and fate after an oil spill.

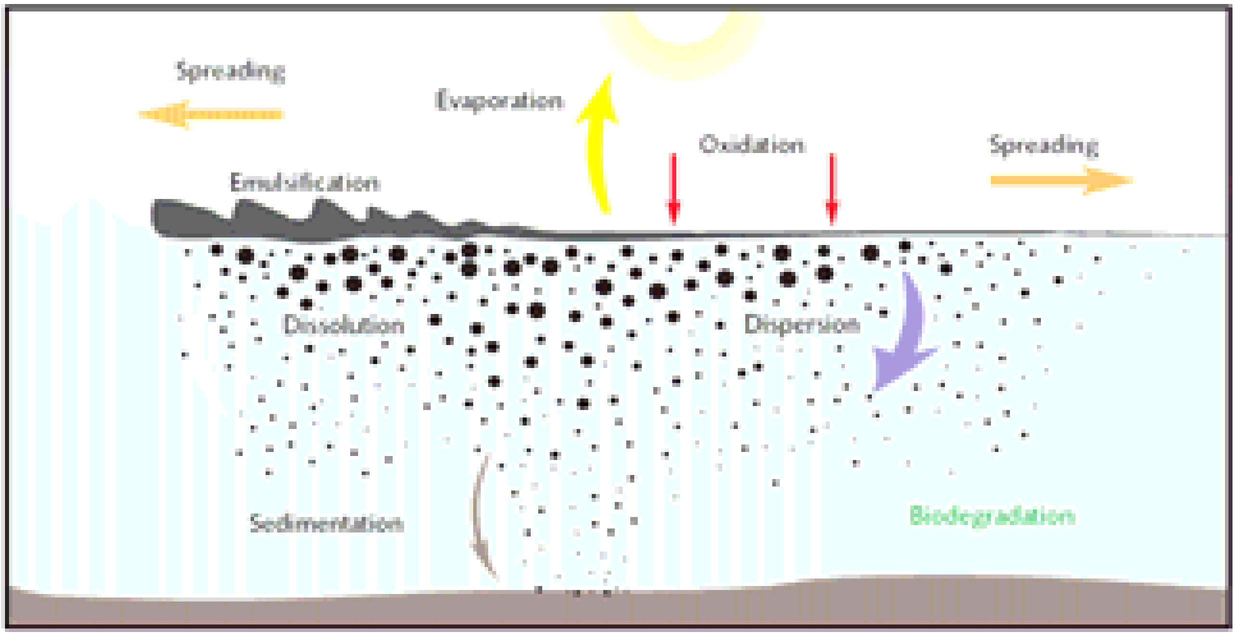

Figure 7.9 Oil Weathering Processes (source: ITOPF 2007)

In the NLRC properties assessment, each of the properties of interest was forecasted including their change over time (using the ADIOS2 software) and tabulated in the report.

It was determined that Arabian crude oils will evaporate about 30 - 33% after a spill. These will emulsify with water content of 85 - 90% and reach a viscosity of 200,000 - 400,000 centistokes (cSt) as they weather. The density of Arabian crude oils after a time of weathering increases to about 1.015 kg/cu m. The increase in density as the Arabian crudes weather indicates that these oils will over time reach a point where they will float on seawater, may be neutrally buoyant and over-washed in brackish waters, and will sink in fresh water. If the emulsified oils absorb sediment or debris along shorelines, their density will increase.

No. 6 Fuel oil has a normal density of 950 to 990 kg per m^3, which after 120 hours of weathering reaches a density of 998 – 1005, depending on the sea water temperature. All weathered oil densities will float on seawater. If the No. 6 fuel oil picks up sediment or debris along shorelines, its density will increase and it may become neutrally buoyant or sink in seawater. No. 6 fuel oil will often sink in fresh water, except when water temperatures are high.

Each off the refined products has a much higher evaporation rate than the Arabian crudes and the No. 6 fuel oil. The expected percent evaporated for gasoline is 99.5 - 100%; for jet fuel/kerosene it is 66 - 98% and for diesel fuels 27 - 46% evaporated. The densities of the NLRC refined products after weathering are in the range of 891 to 970 kg per m^3, so they will always float. The volatility for the refined oils is high. A containment and recovery operation will be mounted for diesel fuel once air quality monitoring indicates it is safe for personnel to proceed from a health and safety point of view. The volatility of kerosene and gasoline is too high for safe containment and recovery operations.

The NLRC oil properties assessment study is an appendix to the draft Oil Pollution Emergency Plan (OPEP) prepared by NLRC.

General Behaviour and Potential Effects

"Most of the oil weathering processes, such as evaporation, dispersion, dissolution and sedimentation, lead to the disappearance of oil from the surface of the sea, whereas others, particularly the formation of water-in-oil emulsions ("mousse") and the accompanying increase in viscosity, promote its persistence. The speed and relative importance of the processes depend on factors such as the quantity and type of oil, the prevailing weather and sea conditions, and whether the oil remains at sea or is washed ashore. Ultimately, the marine environment assimilates spilled oil through the long-term process of biodegradation" (ITOPF, 2007).

The oils handled by NLRC include two crude oils (Arabian medium and Arabian heavy), a heavy distillate (No. 6 fuel oil) and several light distillates (gasoline, jet fuel/kerosene and low sulphur diesel fuel).

Crude Oils

"Crude oils contain a wide range of compounds, from light to heavy; thus they are affected by many fate processes. Evaporation can remove about one-third of the volume of a medium crude oil slick within the first day, but there will always be a significant residue. Many crudes will emulsify readily, a process that greatly reduces subsequent weathering rates. As a result, crude oil spills close to shore often strand and persist on shorelines, particularly on permeable substrates such as gravel beaches and sheltered habitats such as marshes. Crude oils tend to adsorb heavily onto intertidal sediments, with the risk of subsequent erosion of oiled sediments from the shoreline and deposition in nearshore habitats. Under high-energy nearshore conditions, oil and sediments can mix and be transported to the bottom sediments. For spills that are transported offshore, the slicks eventually break up into fields of tarballs that can be transported long distances because they are so persistent. The water-soluble fraction of crude oils, include a wide range of poly-aromatic hydrocarbons (PAH). Dissolution from slicks and stranded oil can persist for weeks to years." (Committee on Oil in the Sea, 2003, p 114).

Heavy Distillates

"Heavy distillates such as No 6 fuel oil and bunker C…lose only up to 10% of their volume by evaporation. Some products are so viscous that they cannot form emulsions, but many emulsify shortly after release. They show low natural dispersion because the oil is too viscous to break into droplets. These oils have the lowest water soluble fraction; thus loadings to the water column are generally low under slicks. Spills of heavy distillate quickly break up into thick streamers and then fields of tar balls that are highly persistent. The heavy distillate can be transported hundreds of miles, eventually stranding on shorelines and posing significant impacts to birds and other marine animals.... Because of their high density, these releases are more likely to sink after picking up sediment, either by mixing with sand in the surf zone or after stranding on sandy shorelines. Some heavy distillates are so dense that they are heavier than brackish or sea water and will not float when spilled." (Committee on Oil in the Sea, 2003, pp 114).

"The composition and resulting toxicity of heavy fuel oils varies depending on the amount and type of cutter stock used. Following accidental spillage of this oil, the lighter more volatile components will be lost by evaporation, dissolution and biodegradation. The water soluble fraction, which principally contains aromatic hydrocarbons and polar compounds, will be responsible for the acute toxicity effects on organisms. The remaining heavy fraction will become attached to the substrate or sequestered in the sediments. Little long term impact has been observed in the supra-littoral, littoral or pelagic zones following a spill. The tar-like residue will persist for many years, however, in the sediments with possible re-suspension and continued impact on benthic organisms."(CONCAWE, 1998)

Light Distillates

"Light refined products such as diesel, No. 2 fuel oil, jet fuels and kerosene, are narrow-cut fractions that have low viscosity and spread rapidly into thin sheens. They do not tend to form emulsions except under very cold conditions. They evaporate more slowly (compared to gasoline) and incompletely; therefore, they are ranked as "medium" in terms of horizontal transport or movement. As low-viscosity, moderately persistent oils, light distillates tend to disperse readily into the water column by even gentle wave action. Thus they have the highest potential of any oil type for vertical mixing. There is also a greater potential for dissolution to occur, from both surface sheens and droplets dispersed in the water column. The water soluble fractions are dominated by two- and three-ringed PAH, which are moderately volatile and may affect aquatic biology. Thus, spills of light distillates have the greatest risk of impacting water column resources. Light distillates are not very adhesive; therefore they do not adhere strongly to sediments or shoreline habitats. Loading levels on the shoreline are relatively low because of the thinness of the sheens on the water surface and the low adhesion of stranded oil. The constituents of these oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation. Long-term persistence in sediments is greatest under heavy loading and reducing conditions where biodegradation rates for anaerobic bacteria are low." (Committee on Oil in the Sea, 2003, pp 114).

"While it is clear that oil spills can cause environmental damage, it is impossible to extrapolate to the nature and extent of damage that will be caused. Because of the interactions of a great number of factors, two spills in the same place will have very different environmental consequences depending on the time of year, the prevailing weather conditions and the effectiveness of the clean-up response." (Dicks 1999)

"The range of biological impacts after an oil spill can encompass:

- Physical and chemical alteration of natural habitats, such as oil incorporation into sediments;
- Physical smothering effects on flora and fauna
- Lethal or sub-lethal toxic effects on flora and fauna
- Changes in biological communities resulting from oil effects on key organisms, such as increased abundance of intertidal algae following death of limpets which normally graze the algae" (Dicks,1999).

Factors which Determine Level of Impact and Speed of Recovery

The factors important to determining oil spill impacts and recovery rates include oil type; oil loading on shorelines; shoreline composition; weather and sea conditions; season; the biological species and communities in the area; the relative sensitivities of species, biological communities and human activities; and the nature of the spill countermeasures.

Type of oil

As indicated above, "different crude oils and oil products vary widely in their physical and chemical properties. Severe toxic effects are generally associated with hydrocarbons with low boiling points (particularly aromatics) because these hydrocarbons are most likely to penetrate and disrupt membranes. The greatest toxic damage will therefore tend to be caused by spills of light oil (such as gasoline) or fresh crude. However the most toxic components are also those that evaporate and disperse into the atmosphere most rapidly once the oil is released and so any toxic effects on marine life are likely to be highly localized and short lived." (Dicks, 1999).

"Spills of viscous heavy crude oils, such as some crudes and heavy fuel oil, may blanket areas of shore and kill organisms primarily through smothering (a physical effect) rather than through acute toxic effects. This is also the case with viscous water-in-oil emulsion ("mousse"). If thick layers of oil or mousse are not cleaned up they may incorporate sand, gravel and stones and harden into relatively persistent asphalt pavements." (Dicks, 1999).

Biological characteristics of the area

"Open waters of the oceans and the associated pelagic and seabird communities have rarely shown any (long-term) impact from spills. The high dilution potential of this habitat provides a major mitigating factor. Even though laboratory research has shown that planktonic organisms which live in surface waters can be variously affected by oil, no long-term effects have been demonstrated due to their huge regenerative potential, as well as immigration from outside the affected area. The regenerative potential is fundamental to the important role plankton plays in the food chains of the world's seas and oceans." (Dicks, 1999).

"Concerns are often expressed about the effects of spills on fish and shellfish eggs and larvae which are found in the plankton, especially as their sensitivity to oil pollution has been demonstrated in laboratory toxicity tests. However there is no definitive evidence that oil induced mortalities of fish and shellfish eggs and larvae in the open sea have resulted in significant effects on future adult populations. This is not surprising because oil-induced mortalities of eggs and young life stages are often of little significance compared with huge natural losses each year (through predation, temperature changes and storms)." (Dicks, 1999).

"Probably the most vulnerable of the organisms which uses open waters are sea birds, which are easily harmed or killed by floating slicks. Although oil ingested during preening may be lethal, the most common cause of death is from drowning, starvation and loss of body heat following damage to plumage by oil. Nevertheless, research has rarely shown any detectable impact from spills on breeding populations, even when mortalities from oil contamination are known to have been high. Shore birds, notably waders, are also at risk though are less likely to become seriously and lethally oiled than seabirds that live and feed on the open sea." (Dicks, 1999).

"Whales, dolphins and seals in the open sea are not particularly at risk from oil spills. Marine mammals that breed on shorelines are, however more likely to encounter oil. Species at particular risk are those which rely on fur for conservation of body heat (such as otters). If the fur becomes matted with oil, they cannot regulate their body heat and may die of hypothermia or overheating." (Dicks, 1999).

"Shorelines, more than any other part of the marine environment, are exposed to the effects of oil as this is where it naturally tends to accumulate. The degree of oil retention by a shore considerably affects the short-term impact and duration of damage. Retention depends upon the condition of the oil and beach type (e.g. rock, sand, shingle, mud flats). More viscous oils tend to be retained in greater quantities as surface accumulations than less viscous oils. Broken uneven and gently sloping shorelines with a large tidal range can hold more oil than steep, smooth shores with a small tidal range." (Dicks, 1999).

"Rocky and sandy shores which are exposed to wave action and the scouring effects of tidal currents are amongst habitats which are most resilient to the effects of a spill, and they tend to self-clean relatively rapidly. These shorelines have communities of highly adaptable species, especially grazers and filter-feeders. If grazers are killed by oil, seaweeds rapidly settle, followed by a slow return of grazers by re-colonisation and new recruitment. Recovery to an apparently normal balance is often achieved in 1 – 5 years, but the complete reestablishment of a shore can take many years in extreme situations where very large areas are affected or where species are close to the limits of their geographic range and re-colonisation proves to be slow.” (Dicks, 1999).

“If sediments are penetrated by the oil, then considerable quantities may be held and the likelihood of long term retention and longer-term impacts is greatly increased. However the more viscous nature of weathered oils may result in reduced penetration compared to fresh, less viscous crudes.” (Dicks, 1999).

“Fine sediments (fine sands and mud) are usually found in more sheltered areas, and tend to be highly productive, particularly in estuaries. They support large populations of migrating birds as well as shell fisheries, and also function as nursery areas for some species. Whilst oil can exert immediate toxic and smothering effects, penetration of the oil to deeper layers is rare, especially if sediments remain waterlogged during low tide. However there have been cases of oil penetrating into animal burrows, and once oil is incorporated within the sediment it can delay natural recovery.” (Dicks, 1999).

“In fine sediment areas the upper shore fringe is often dominated by salt marsh which, although generally only temporarily harmed by single oiling, can take more than 10 years to recover if damaged through repeated oiling. However long-term damage is more usually the result of using inappropriate clean-up techniques than as a direct consequence of oiling.” (Dicks, 1999).

Time of year / season

“According to season, vulnerable groups of birds or mammals may be congregated (perhaps with young ones) at breeding colonies, and fish and shellfish may be spawning in shallow near-shore waters. Winter months may see large groups of migratory waders and sea ducks feeding in estuaries and coastal areas. At such times the effects of a spill can be considerably increased.” (Dicks, 1999).

“The effects of a spill may vary markedly between winter and summer. Winter oiling of a salt marsh may have little effect on the above-ground parts of plants as many naturally die-back at that time of year. However oil can affect over-wintering seeds and reduce germination in the spring. In spring or summer oil can damage new growth and may cause a marked reduction in flowering if plants are oiled when the flower buds are developing. Even though there may be good vegetative recovery, there is loss of seed production for that year.” (Dicks, 1999).

Clean-up

Oil spill countermeasures can increase or decrease damage. The advantages and disadvantages of each clean-up method must be analyzed in the context of local environmental conditions with the objective of achieving net environmental benefit. These will be considered further during NLRC’s contingency planning process in light of recent thinking.

"In many cases, the predicted natural cleaning times may be acceptable, either because they are short, or because, even if long, no net environmental benefit can be predicted by human intervention." (Dicks, 1999).

Recovery

"Given the difficulties of knowing exactly what pre-spill conditions were, and how to interpret them in the face of natural ecological fluctuations and trends, it is unrealistic to define recovery as a return to pre-spill conditions." (Dicks, 1999).

"Recovery is marked by the re-establishment of a healthy biological community in which the plants and animals characteristic of that community are present and functioning normally. It may not have the same composition or age structure as that which was present before the damage, and will continue to show further change and development. It is impossible to say whether an ecosystem that has recovered from an oil spill is the same as, or different from, that which would have persisted in the absence of the spill." (Dicks, 1999).

"Recovery depends upon both the removal of oil which is toxic or physically smothering, and biological processes such as the settlement of larvae and growth of seedlings. Whilst clean-up is normally the first step in the recovery process, complete removal of all oil is not necessary – there are many examples of recovery progressing in the presence of weathered oil residues." (Dicks, 1999).

"Whatever the extent of damage, the reproductive success of the survivors, as well as the influx of eggs, juveniles or adults from unaffected areas underpins the recovery process. Many marine species produce vast numbers of eggs and larvae which are widely distributed in the plankton by currents. This is a strategy to overcome high rates of natural mortality. The number of eggs and larvae which survive and eventually develop into adults is therefore normally low, but this over-production strategy ensures that there is a considerable reservoir for the colonization of new areas and the replacement of adults which have been killed as a result of short-term unfavourable conditions." (Dicks, 1999).

"On the other hand, species which are long-lived, slow to breed and which produce few offspring may take many years to recover from the effects of a short-term adverse change in their environment. Some may have built-in compensatory mechanisms such as maturing earlier and having extra broods after a period of population decline. For short-lived species, migration of adults and juveniles from neighbouring areas which have escaped the unfavourable conditions frequently enhance the recovery process." (Dicks, 1999).

Spilled Oil Drift

Oil spill drift modeling has not yet been done by NLRC for the oils to be handled by the Refinery. An assessment of the properties of the Arabian crude oils found that these oils have properties similar to those of Hibernia and Terra Nova crudes (NLRC, 2007). For this reason the oil drift modeling done in 1997 for the oils being handled by NTL (NTL, 1997) is considered to be valid for the Arabian crudes.

What has been prepared for this environmental assessment is a map (Figure 7.3) showing extrapolated probability contours for hypothetical oil contact on the sea surface in the marine area surrounding the Refinery from hypothetical spills from the Refinery.

The extrapolated probability contours were derived from the probability maps made for simulated spills from the existing transshipment terminal (NTL, 1997). To prepare the maps, an oceanographic contractor was engaged to forecast the drift of a large number of hypothetical spills released at the transshipment terminal jetty. Their computerized "stochastic modeling" was used to produce one probability map for each month of the year. The methodology used is described in detail in NTL (1997).

NLRC redrew the twelve NTL monthly maps using a GIS system and overlaid all twelve to construct a new composite map showing the greatest extent of each contour line indicating probability of oil contact on the sea surface. From the composite map, NLRC extrapolated a similar map for its own Refinery facility located a short distance away. The composite map for the NLRC Refinery is Figure 6.3.

Similarly, Figures 7.6, 7.7 and 7.8 are probability maps for sea surface contact by oil after a hypothetical spill at two locations along the existing tanker routes into and from Placentia Bay. These probability maps give the reader a sense of the likely extent and consequences of a hypothetical oil spill at two locations along the tanker route. A tanker spill could in fact occur anywhere along the tanker routes in and out of Canadian waters.

All three probability maps described above were derived from the hypothetical spill forecasting done by NTL as part of their submission for the Termpol Review conducted with Transport Canada and other agencies in 1997. The Termpol Review was conducted to examine the hazards associated with the tanker operations involved in their project.

As indicated earlier, NLRC will participate in a similar Termpol Review of the tanker operations associated with its Refinery project. As part of the necessary preparation work, NLRC will do stochastic modeling for hypothetical spills from its Refinery site. At this moment NLRC intends to use the ASA OilMap computer software to do its stochastic modeling work.

A reliable hydrodynamic model for Placentia Bay is needed before the OilMap oil drift forecast software can produce reliable results. Oceanographic data has been collected in the past by the Department of Physics and Physical Oceanography at Memorial University of Newfoundland (MUN) in 1998 and 1999, and Bedford Institute of Oceanography (BIO) in 1998. This data is discussed in Section 3.5.4. At the time of this writing, NLRC is collecting ocean current information at two locations in the inner part of Placentia Bay near Come By Chance Point. As part of its data collection NLRC is supporting the SmartBay program for marine weather and oceanographic data collection led by the Canadian Centre for Marine Communications (the SmartBay website is at www.smartbay.ca).

The following information is being collected by a SmartBay weather buoy positioned at Latitude: 47° 47.3667' N and Longitude: 054° 02.7000' W in the Port of Come By Chance very near the NLRC Refinery site. The data are available on the SmartBay website:

- Average Wind Speed: 4 knots
- Peak Wind Speed: 5 knots
- Wind From: SSE
- Air Temperature: 8.9 ° C
- Dew Point: 8.1 ° C
- Barometric Pressure: 102 kPa   Trend: UP
- Sea Surface Temperature: 8.8 ° C
- Current Velocity: 0.15 knots
- Current Direction: 153 ° True
- Significant Wave Height: 0.2 m (0.7 ft)
- Maximum Wave Height: 0.4 m (1.2 ft)
- Waves From: 179 ° True

The ocean current model(s) for Placentia Bay have not been examined by NLRC. It is hoped that the additional ocean current, salinity, water temperature and wind data will add value to the hydrodynamic modeling. The oil drift forecast simulations will only be as good as the accuracy of the ocean current and wind forces used in the modeling.

NLRC will engage a meteorological and oceanographic services company to evaluate the data needs for its oil spill drift forecasting. NLRC together with its contractor will consult with Environment Canada before proceeding with the modeling work.

It is anticipated that the NLRC Refinery will be classified as a Level 4 oil handling facility (OHF) based on a maximum oil transfer rate greater than 2000 cubic metres per hour. The criteria appear in the Canada Shipping Act (CSA), Oil Handling Facility Standards – 1995 (TP 12402). To comply with the CSA regulations and standards, NLRC will be required to develop an Oil Pollution Emergency Plan and in it describe the response needed for a 50 m^3 spill for each of the oil products it will handle.

To comply with the CSA, the proposed scenarios for spill modeling and for response analysis and description include:

- A 50 m^3 spill of gasoline at the Refinery jetty;

- A 50 m^3 spill of jet fuel/kerosene at the Refinery jetty;
- A 50 m^3 spill of low sulphur diesel at the Refinery jetty;
- A 50 m^3 spill of Arabian crude oil at the Refinery jetty (the two Arabian crudes are sufficiently similar to model only one of the two); and
- A 50 m^3 spill of No. 6 Fuel Oil at the Refinery jetty.

The Newfoundland and Labrador Department of Environment and Conservation regulations require NLRC to have an approved contingency plan for its storage tank system with planned procedures for reporting, containing, removing and cleaning up after a spill or leak.

In addition to CSA requirements, credible worst-case spill scenarios should also be modeled, analysed and included in the Refinery's contingency plan. In the unlikely event that a Refinery tank should lose its contents, it is very unlikely that oil will reach the sea because each tank will have secondary containment (set-backs, dikes, liners and impounding basin). These installations will be constructed in full compliance with Newfoundland and Labrador Department of Environment and Conservation regulations.

It is proposed that a credible worst-case scenario for spilled oil reaching the marine environment would be from a break in the 42-inch pipeline used for oil transfers between the jetty and the tanks. This line does not have secondary containment but it does have features to minimize the volume of a spill (and the consequences). These spill reduction features are a leak detection system and an automatic shutdown system that will be part of the pipeline design. With these systems in place, the oil release period after a pipeline break would be 60 seconds (or less) as the automatic shutdown system closes the valves along the pipeline.

For oil drift modeling and contingency planning purposes, the hypothetical release would be at the full oil transfer pumping rate of 100,000 barrels per hour for the full 60 seconds giving a release volume of 1667 barrels or 256.5 m^3. This is the worst-case spill to the sea that is proposed for stochastic modeling and analysis.

Sensitivities to Oil Spills

NLRC has begun to develop a GIS folio of maps and drawings relevant to understanding and managing the potential effects of the project on the marine environment. The maps will show environmental sensitivities relevant to the Refinery development, its operations and decommissioning. A hard copy of the folio is an appendix to the NLRC Oil Pollution Emergency Plan (OPEP). The folio will be developed further throughout the Refinery project. At the time of this writing, some of the maps and drawings being produced are:

- Fish harvesting maps for Placentia Bay
- Map of aquaculture sites on Placentia Bay
- Map showing protected areas, parks, resorts and human use activities for the area around the Refinery and Placentia Bay

- High resolution shoreline segmentation maps between North Harbour and Arnold's Cove for shorelines on either side of the Refinery site within the Port of Come By Chance (McNeil, 2007)
- Oil Residence Index maps for shoreline segments between North Harbour and Arnold's Cove (McNeil, 2007)
- Shoreline segmentation maps by geomorphology type from Environment Canada's E-Map website located at http://www.e-map.gc.ca/
- Other sensitivity maps from the Environment Canada E-Map website
- Tanker route maps – for international and Canadian waters
- Map of NAFO divisions, VTS Zones, Placentia Bay tanker traffic lanes, boundary of the port of Come By Chance, oil handling facility locations
- Probability contour maps for oil contact on the sea surface from hypothetical oil spills released at the Refinery site
- Sea surface current maps
- Bathymetry maps for the entire Placentia Bay
- Drawing of the Refinery jetty layout

When NLRC has completed its oil spill drift forecast work (stochastic modeling), these probability maps will be added to the folio for reference during actual spills and spill response training.

Other sensitivities for the Refinery and Placentia Bay areas are described in the ecological component studies undertaken for NLRC. Maps developed for these studies relevant to oil spill preparedness and response will be added to the map folio.

During an actual spill of any size in Newfoundland waters, the Environment Canada E-Map system and the ECRC sensitivity mapping system will be used by the spill management team for sensitivity identification and response planning.

7.2.5 Potential Effects on Placentia Bay

Owens Coastal Consulting (OCC) has written a definitive work on the potential effects of oil spills on the south east-coast of Newfoundland including Placentia Bay. This paper is very relevant to the NLRC oil spill situation and will be an important reference in NLRC planning for oil spill prevention, preparedness and response. For Placenta Bay, the shoreline types are as follows (OCC, 1997):

Table 7.11 Shoreline Description for Placentia Bay

Shoreline Type (Upper intertidal zone)	km	%
Bedrock	1026.5	73.7
Mixed coarse beach	196.8	14.5
Boulder beach	141.7	10.2
Man-made solid	14.1	1.0
Salt marsh	7.4	0.5
Sand tidal flat	5.3	0.4
Sand beach	0.3	0.1
Total coast length in the PAR areas	1392.1	
Impermeable bedrock shore type	1026.5	73.7
Cliff backshore	1222.3	88
Exposed coast	1320	95
Sheltered coast	70	5
Shoreline accessible by road - estimated	120	8.5

"Three-quarters of the coastline in Placentia Bay is bedrock that either is exposed in the shore zone or is overlain with a veneer of coarse sediments (pebbles, cobbles, and boulders). There is some variability within the region and, in Placentia Bay, beaches are more common (i.e., make up 50% or more of the shoreline type) along the coast northwest from Long Harbour around the head of the Bay to Ile Valen in the northwest. The most common sediment type is the coarse fraction (cobbles and boulders) and sand or sandy gravels account for less than 1% of the total coastline analyzed by the most recent study (OCC, 1996). Salt marshes occur in only a few (12) small areas and a few tidal flats with marshes are found in the southwest Burin Peninsula." (OCC, 1997)

"Almost 90% of the coastal zone is described as cliff shoreline. This means that there is a steep or vertical outcrop at the shore or that there is high backshore relief. Offshore rock outcrops are common and approximately one-third of the coastline has been identified as having rock or boulders in the near shore environment." (OCC, 1997)

"In terms of the distribution of oil on the shore, the predominance of bedrock shore types means that (i) on exposed coast, wave reflection likely would prevent oil from stranding, and (ii) in sheltered areas or under conditions where oil could strand, the oiling would not be heavy due to the impermeable nature of bedrock shore types. Where oil does reach the shore, it is more likely to strand in bays and coves, which often have beach deposits." (OCC, 1997)

"The coast is a high-energy storm-wave environment and stranded oil is likely to be physically abraded and removed within a short period – days to a few months at most. Actual persistence of stranded oil would be a function of the timing of the oiling. Oil stranded on exposed coasts in late summer, autumn or winter months is not likely to remain for more than a period of days or weeks. Oil stranded in the spring or summer may persist for several months until the onset of winter-storm-wave action." (OCC, 1997)

"The only conditions under which oil would be expected to persist for more than several months would be if that oil were stranded above the normal limit of wave action, during periods of the highest spring tides and/or a storm surge, or stranded in one of the relatively few sheltered, low wave energy environments. Oil stranded in these locations likely would weather into an asphalt pavement and, in this stable form, residual oil likely would not pose a significant threat to wildlife or fisheries. Any penetrated or buried subsurface oil, because of its weathered state, would not be expected to leach oil into the nearshore, although sheen may be produced during periods of wave action." (OCC, 1997)

"Existing protection and treatment or cleanup methods can mitigate potential adverse impacts in locations where either the threat of oiling, or the persistence of stranded oil, poses an unacceptable risk. Response activities would be constrained by the lack of (road) access in most locations and/or the presence of cliffs in the backshore, so that water based operations would be required in most areas. Planning and feasibility studies would emphasize in situ treatment methods and the minimization of waste generation." (OCC, 1997)

Based on the Owens Coastal Consultants (1997) description, 1320 km or 95% of the Placentia Bay shoreline is exposed coast. It follows that essentially all of the outer reaches of Placentia Bay is exposed coast. This is supported by a comparison of wave statistics presented in the table below for Outer Placentia Bay and for Whiffen Head and Come By Chance (two locations in the inner portion of Placentia Bay):

Table 7.12 Wave heights for Locations on Placentia Bay

	Outer Placentia Bay[1]	Whiffen Head[2]	Come By Chance[2]
Significant wave height			
Mean (m)	1.2	0.33	0.22
Median (m)	1.1	0.20	0.10
Standard deviation (m)	0.97	0.30	0.24
67% upper limit (m)	2.2	0.63	0.46
95% upper limit (m)	3.09	0.90	0.80
Maximum (m)	9.5	3.00	3.04
Percent exceeding 0.5m	80	24	12.4
Percent exceeding 1.0m	68	3.15	1.78
Percent exceeding 1.5m	40	0.40	0.20

	Outer Placentia Bay[1]	Whiffen Head[2]	Come By Chance[2]
Percent exceeding 2.0m	26	0.06	0.02
Percent exceeding 3.0m	9	0	0
Percent exceeding 4.0m	3	0	0
Combined wave height (wind wave and swell)			
Mean (m)	1.4		
Median m)	1.2		
Maximum (m)	9.5		
Percent exceeding 0.5m	85		
Percent exceeding 1m	72		
Percent exceeding 1.5m			
Percent exceeding 2m	30		
Percent exceeding 3m	10		
Percent exceeding 4m	2.6		
Percent exceeding 5m	1.0		
Percent exceeding 6m	0.5		
Percent exceeding 7m	0.15		
Percent exceeding 8m	0.13		
Percent exceeding 9m	0.02		

1 Information source: Environment Canada marine statistics (MAST) data from 1886 to 1989 for the area of Placentia Bay bounded by 46.7N, 47.5N, 60.0W and 58.0W

2 Source: BAE Newplan – SNC Lavalin, 1996

From the Placentia Bay wave information above one can see that the wave energy is highest for the outer Placentia Bay area and decreases dramatically as one moves in to Whiffen Head and Come By Chance at the head of the bay. One can also see that the wave heights at Come By Chance are less than those at Whiffen Head. This can be attributed to greater sheltering (clockwise from WSW to SE) of Come By Chance Arm by the landmass surrounding it. Because the prevailing winds are from the SW and fetch distances from this direction are shorter, it is expected that the wave heights along the west side of Southern Head will lie somewhere between the wave heights observed at Come By Chance and at Whiffen Head. The different magnitude of wave energies will determine the speed of natural cleaning of stranded oil from shorelines along the length of the bay.

As indicated in OCC (1997) only about 8.5 per cent of the Placentia Bay shoreline is accessible by road. That means that about 91.5 per cent of the shoreline is only accessible by floating platforms that will conduct oil recovery operations against shorelines and shoreline treatment operations. The wave height limit for such shoreline operations is about 0.5m. Waves against a shoreline can be confused when reflected waves combine with incoming wind wave and one or more swell waves. The waves may, however, be dampening by floating oil accumulated against a lee shore, which may increase the shore access opportunity.

The wave height limit will also vary with the size and stability of boats and platforms used to conduct the work. The table below shows an estimate of the time when waves are less than 0.5m and when shoreline response operations can be conducted for the different Placentia Bay locations. Wave information for Come By Chance and Whiffen Head appear in the following two tables below.

Table 7.13 Estimated percent of the time that countermeasures are possible against shorelines using vessels for shoreline access

Location on Placentia Bay	% Of Wave height Observations less than 0.5m	Estimated % of the time shoreline treatment and countermeasures are possible
Outer Placentia Bay (exposed coast)	15 to 20	15 to 20
Whiffen Head (sheltered waters)	76	76
For Come By Chance (sheltered waters)	87	87

1 From Environment Canada Marine Statistics (MAST)

2 From BAE Newplan (1996)

From the table above, one can see that the low-wave time opportunity for oil recovery against shorelines and for shore landings to conduct shoreline treatment, is far greater in the more sheltered areas of inner Placentia Bay and specifically in the vicinity of the proposed NLRC Refinery.

On-water containment and recovery operations also have wave height limits. Smaller vessels and barges such as the sheltered waters craft owned by the Response Organization (RO) certified for this area; fishing vessels under 65-ft; and the tugs and barges chartered by the RO for oil spill countermeasures, each have an operating wave height limit in the range of 0.5m to 1m for their operations. Larger tug boats and offshore supply vessels that use deck tanks or internal tanks for storage of recovered oil may have an operating limit in the range of 1 to 2 metres for effective oil containment and recovery operations.

An estimate of the time that on-water containment and recovery is possible considering the wave height limit only is shown in the table below. This time estimate will be reduced during years when sea ice forms on Placentia Bay and by hours of darkness.

Table 7.14 Estimated percent of the time that on-water containment and recovery is possible using the vessel types indicated

Location on Placentia Bay	% Of the time waves are 0.5m or less	% Of the time waves are 1m or less	Estimated % of the time waves are 1.5m or less
Outer Placentia Bay	15 to 20	32	60
Whiffen Head	76	96	99.6
Come By Chance	87	98	99.8
Vessels used for on-water containment and recovery	Sheltered waters craft	Terminal Tugs and fishing vessels up to 65-ft	Open ocean oil recovery vessels

It should be noted that the Response Organization has vessels and barges in its inventory that are suitable for on-water containment and recovery in sheltered waters. For operations in unsheltered waters the RO will charter vessels of opportunity.

Table 7.15 Significant Wave Height at Come By Chance and Whiffen Head, Newfoundland.

	Mean (m)	Std Dev (m)	Median (m)	Max (m)	Min (m)	Upper 95% (m)	Most Frequent Direction From	Num Obs
Significant wave height - Come-By-Chance (m)	0.22	0.24	0.10	3.04	0.00	0.80	W	86751
Significant wave height - Whiffen Head (m)	0.33	0.30	0.20	3.00	0.00	0.90	W	86751

Source: BAE Newplan – SNC Lavalin, (1996)

Table 7.16 Percentage Frequency of Occurrence of Significant Wave Height by Direction, for Come By Chance Based on 30-Year Hindcast (1966 – 1995).

	Direction – Coming From									
Height Range (m)	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**All Dirs**	**Num Obs**
0.00 (calm)	-	-	-	-	-	-	-	-	4.5	3932
>0.00 - <0.25	8.4	7.7	8.4	7.1	6.2	3.1	20.5	9.8	71.1	61651
0.25 - <0.50	1.3	0.3	0.1	0.1	1.7	5.6	2.5	0.4	12.0	10372
0.50 - <0.75	0.0	-	-	-	1.5	5.8	0.0		7.3	6328
0.75 - <1.00	-	-	-	-	0.5	2.9	0.0		3.3	2902
1.00 - <1.25	-	-	-	-	0.1	1.1	-		1.2	1010
1.25 - <1.50	-	-	-	-	0.0	0.4	-		0.4	382
1.50 - <1.75	-	-	-	-	0.0	0.1	-		0.1	122
1.75 - <2.00	-	-	-	-	-	0.0	-		0.0	29
2.00 - <2.25	-	-	-	-	-	0.0	-		0.0	12

	Direction – Coming From									
Height Range (m)	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**All Dirs**	**Num Obs**
2.25 - <2.50	-	-	-	-	-	0.0	-		0.0	4
2.50 - <2.75	-	-	-	-	-	0.0	-		0.0	2
2.75 - <3.00	-	-	-	-	-	0.0	-		0.0	4
3.00 +	-	-	-	-	-	0.0	-		0.0	1
TOTAL	9.7	8.0	8.6	7.1	9.9	19.0	23.0	10.2	100.0	86751

Source: BAE Newplan – SNC Lavalin, (1996)

The prevailing winds on Placentia Bay are westerly and south-westerly. The residual sea surface currents move into Placentia Bay on the east side and out of the bay on the west side. Under these forces, spilled oil is expected to generally migrate northward along the east side of the bay and southward along the west side. The sea surface current at the centre of the bay is tidal.

If the seas become rough, which is more likely in outer Placentia Bay, the heavy oils (i.e., the emulsified Arabian crudes and No. 6 fuel oil) are expected to be reduced in one week to approximately half of the original volume (ITOPF, 1987). The refined products (gasoline, kerosene and diesel fuels) will dissipate much more quickly because of much higher evaporation rates.

Because of the relatively short distance for spilled oil to drift to shore within Placentia Bay the time to shore is expected to be in tens of hours for a spill along the tanker lanes through Placentia Bay. The expected time to shore can be confirmed for different hypothetical spill scenarios by computer modeling during the detailed design stage of the project.

To minimize the impact on shorelines and other sensitive areas, on-water containment and recovery should be deployed as soon as possible after a spill if wave heights below the required operating limits allow. On-water containment and recovery should be considered for the more persistent oils (crude oils and No. 6 fuel oil) if wave heights are sufficiently low.

Evaporation and dissolution are important processes in removing oil from an oil slick. The dissolved fraction is a function of the percent dispersed into the water column. A comparison of the evaporation and dispersion after 120 hours for the oils handled by NLRC has been made for inner Placentia Bay (the Refinery marine area) and outer Placentia Bay using the oil weathering computer model ADIOS2. Average wind, temperature and wave conditions were assumed for each location. The results appear in the table below:

Table 7.17 Comparison of Evaporation and Dispersion at Refinery Site and Outer Placentia Bay.

	Refinery Site	Refinery site	Refinery site	Outer Placentia Bay	Outer Placentia Bay	Outer Placentia Bay
Oil Type	% Evaporated after 120 hrs	% Dispersed after 120 hrs	% Remaining after 120 hrs	% Evaporated after 120 hrs	% Dispersed after 120 hrs	% Remaining after 120 hrs
Fuel Oil No. 6	7	0.1	93	5.7	2.8	92
Arabian Medium Crude	30	0.04	70	23.6	0.77	76
Arabian Heavy Crude	30	0.01	70	27.5	0.2	72
Diesel Fuel Oil	46	25	29	16	84	0
Jet Fuel / Kerosene	94	4.8	1.2	41	59	0
Gasoline	100	0.03	0	99	1.08	0

Table 7.18 Comparison of Evaporation and Dispersion at Refinery Site and Outer Placentia Bay.

	Refinery Site	Refinery site	Refinery site	Outer Placentia Bay	Outer Placentia Bay	Outer Placentia Bay
Oil Type	% Evaporated after 120 hrs	% Dispersed after 120 hrs	% Remaining after 120 hrs	% Evaporated after 120 hrs	% Dispersed after 120 hrs	% Remaining after 120 hrs
Fuel Oil No. 6	7	0.1	93	5.7	2.8	92
Arabian Medium Crude	30	0.04	70	23.6	0.77	76
Arabian Heavy Crude	30	0.01	70	27.5	0.2	72
Diesel Fuel Oil	46	25	29	16	84	0
Jet Fuel / Kerosene	94	4.8	1.2	41	59	0
Gasoline	100	0.03	0	99	1.08	0

Source NLRC (2007)

Under average wind, temperature and sea conditions for Outer Placentia Bay, it is expected that for spills of diesel, kerosene or gasoline, little or no oil will be remaining on the sea surface after 120 hours due to evaporation and natural dispersion.

Because of the high volatility of kerosene and gasoline, on-water containment and recovery is not possible for these oils for reasons of responder safety. For a diesel spill there is usually a very short time period where on-water containment and recovery can remove a meaningful volume of oil. Conditions needed include having:

- Suitable low wave heights;
- Suitable vessels available and mobilized for work in unsheltered waters;
- Sufficient tanks for temporary oil storage; and
- Sufficient oil thickness and oil encounter rate before the spilled oil spreads to a thickness that is too thin to achieve significant oil recovery volumes.

The No. 6 fuel oil and Arabian crude oils are far more persistent than the three refined products. They will each attain high viscosity within 24 hours or less after being spilled. There may be opportunity to remove a significant volume of oil from the sea surface if:

- Wave heights are sufficiently low to allow on-water containment and recovery operations;
- The equipment is quickly mobilized on suitable boats and moved to the spill site;
- The oil recovery equipment is able to collect very high viscosity oils from the water surface; and
- The oil recovery equipment is able to pump and transfer very high viscosity oils after recovery.

On-water containment and recovery should cease as soon as the oil recovery rate becomes insufficient to justify the effort. At that point resources should be reallocated to other response tasks.

If the drifting oil reaches a shoreline, a portion of it will become stranded with varying levels of loading depending on the permeability of the shoreline material. The remaining floating oil together with any remobilized oil will continue to migrate along the shoreline to strand on adjacent shores.

Once the oil is against the shoreline it may no longer be accessible to the on-water containment and recovery vessels because of near-shore rocks and shallow waters. Accessibility will also depend on the underwater draught of the vessels being used.

For Outer Placentia Bay the protection methods are limited to mobile on-water recovery operations using ships to tow oil containment booms. The seas are potentially too rough for effective deployment of anchored boom along shorelines or for the use of the on-water containment and recovery equipment close to the shore.

When waves are very low, bulk oil removal, and the burning of oiled debris such as driftwood and flotsam will be considered on accessible shorelines. Bioremediation will be considered only for those beaches that are unlikely to be cleaned naturally by wave action and that have an expected oil residency in years.

For Outer Placentia Bay, safe shore landings for shoreline treatment and oil recovery work along the shorelines will be entirely subject to the wind and wave conditions as well as the near shore character (rocks, shoals local wind and wave conditions). Safety of responders will be the highest priority. Because the average wave conditions for Outer Placentia Bay are well above the safe operating limits for shore landings, it is expected that natural recovery through wave forces will be the dominant shoreline cleaning process.

For the Refinery area (inner Placentia Bay), the opportunity window for deployment of on-water containment and recovery resources is expected to be much greater than for outer Placentia Bay due to the likelihood of lower wave heights; less natural dispersion and correspondingly more oil remaining on the water surface. The generally lower wave heights will allow such on-water operations more often.

For a spill from the Refinery site, if uncontained, the oil drift time to shore is expected to be in hours to tens of hours. As floating oil approaches shorelines or shallow waters, on-water containment and recovery may no longer be possible with deeper draft vessels.

For the Refinery area protection objectives for sensitivities include:

- Oil containment booming around the spill source if the boom can be secured or anchored
- Containment and recovery on the water surface to prevent floating oil from contacting shorelines
- Oil exclusion booming along shorelines
    - Where there are sensitive shoreline segments such as those where oil can penetrate the sediments and the oil residency index is high
    - to prevent oil from stranding on large expanses of tidal flats
    - to prevent oil from entering a lagoon area such as the estuaries at the head of small bays and inlets (such as Come By Chance River gut and the barachois at Arnold's Cove)
    - to prevent oil from entering a channel
    - To keep oil from contacting human use sensitivities
    - Other oil handling facilities
    - Rip rap shorelines and breakwaters
    - Harbours, wharfs, marinas and boats
    - Aquaculture sites
    - Lobster holding pounds
    - Fish plant seawater intakes
    - Populated shorelines
    - Amenity beaches, parks and protected areas

  - At the outer edge of very shallow waters on which response vessels may become grounded
  - Along shorelines with outcropping rock or boulders dangerous to vessel operations
- In each case the water depth must be shallow enough that the boom can be anchored
- Deflection of floating oil past sensitive shoreline segments (requires current)
- Containment of oil accumulated against shorelines
  - For oil recovery purposes
  - To prevent further migration of stranded oil to adjacent shoreline areas

Shoreline response in the outer reaches of Placentia Bay will likely be very difficult for a number of reasons:

- Only 15% to 20% of the time wave heights are low enough to conduct countermeasures operations against a shoreline.
- The work time available is reduced by hours of darkness and hours at high tide when the shoreline is no longer exposed.
- Offshore rock outcrops are common and approximately one-third of the coastline has been identified as having rock or boulders in the near shore environment (OCC, 1997).
- Almost 90% of the coastal zone is described as cliff shoreline where the bedrock forms a steep or vertical outcrop at the shore or there is a high backshore relief (OCC, 1997).
- Only about 120 km (8.5%) of the 1392 km of shoreline in Placentia Bay is accessible by road (OCC, 1997).
- The transit time by boat from staging areas on shore to shoreline treatment sites may be quite long and use up much of a work day in travel time.
- If shoreline workers are to have a productive work shift each day and be able to take advantage of low wind and wave conditions as soon as they occur, the response teams will need to be housed on ships or barges certified to Transport Canada standards and will require extensive logistics support and resupply.
- There are safety risks associated with personnel working on narrow exposed beaches during increasing wind speed, wave height and rising tide with a cliff in the backshore, therefore excellent weather observation and forecasting services will be required along with diligent safety officers to ensure safety.

About 1026 km (73.7%) of the Placentia Bay shoreline is bedrock (OCC, 1997). However, beaches make up 50 per cent of the shoreline type along the coast northeast from Long Harbour around the head of the bay to Ile Valen in the northwest (OCC, 1997). For this reason, outer Placentia Bay should then have a percentage of bedrock shorelines even greater than 73.7 per cent.

Bedrock is impermeable to oil penetration and much of the bedrock is vertical cliff, which, together with reflected waves, is expected to reduce oil loading on bedrock to a low level in comparison to the permeable sediments found in the less frequent sheltered coves and inlets.

It has been shown earlier that higher energy waves are more frequent in outer Placentia Bay than for inner Placentia Bay. If oil is stranded in the normal wave action zone, natural wave forces will be a very effective oil removal mechanism. The expected persistence of that oil is in the order of days to weeks (OCC, 1997)

If oil is stranded above the normal wave action zone, on a storm surge or spring tide, in a sheltered bay or cove where wave energy is low, the same oil may persist for months to years (OCC, 1997). For these areas, shoreline treatment will be considered along with the expected natural removal by waves during the next winter storm months.

7.2.6 Types of Possible Spills

Oil Spills

NLRC will develop a well-considered oil spill prevention program for its operations as part of its environmental and operational management systems and procedures including the development of Refinery Regulations for tanker operations associated with its project. NLRC will develop a process to screen the tankers it engages to transport oils. NLRC will also participate in a Termpol Review of the tanker operations associated with its project with the primary objective of reducing risks of tanker incidents and associated spills.

NLRC will develop an oil spill response capability. It will be focused on developing the following:

- A well set-up Emergency Operations Centre and spill management system;
- A well-trained spill management team from Refinery staff;
- A core team of highly-trained field responders comprised of Refinery staff and contractor personnel;
- A clear chain of command during response operations;
- Good communications equipment infrastructure with training;
- A well-considered safety program focused on oil product safety, safety of environmental conditions and oil spill response operations;
- A capability for oil containment at the marine spill source (the Refinery jetty area) using anchored boom;
- A capability to deploy and anchor oil exclusion boom in the marine areas surrounding the Refinery;
- An oil recovery capability for the oil products handled. Product properties and behaviour will be considered in its development;
- A service provision agreement with the Response Organization;

- A close working relationship with the Response Organization (RO);
- A close working relationship with neighbouring oil handling facilities;
- An open relationship with interested citizens in the local communities around the Refinery to understand the environmental aspects they value;
- A close working relationship with government agencies from Newfoundland and Labrador and Canada that have jurisdiction over aspects of land and marine oil spill response;
- A well-considered plan for the segregation, storage and disposal of oily wastes;
- An inventory of oil spill response equipment that is fit for purpose;
- Response vessels that meet Transport Canada standards for safety and stability;
- A training program to develop the needed skills; and
- An exercise program to demonstrate capability.

NLRC will direct a high level of attention to spill prevention and preparedness for response. As part of its preparedness, NLRC has already prepared a draft Oil Pollution Emergency Plan (OPEP) along with an assessment of the properties and behaviour of the oils that it will handle as well as a folio of maps and drawings relevant to oil spill planning and response preparedness. These documents will be further developed after staff has been hired and trained and response equipment acquired. These documents will be submitted in final form to the governments of Newfoundland and Labrador and Canada before Refinery start-up.

NLRC will maintain an information base including maps and drawings relevant to oil spill response preparedness for use in the Emergency Operations Centre and to support field operations where relevant.

As part of its sensitivity information development NLRC has supported a shoreline geo-morphologist from Memorial University of Newfoundland in developing high resolution shoreline segmentation maps for the area between Arnold's Cove and North Harbour (McNeil, 2007). McNeil has also developed an oil residency index (ORI) for each shoreline segment as a measure of relative sensitivity and produced oil residency index maps. Examples of the two map types appear in Figures 7-10 and 7-11. A series of higher resolution maps showing shoreline classification and ORI are presented in the Map Folio. NLRC will use the shoreline maps in training and exercises to demonstrate areas of relative sensitivity around the Refinery marine area and to develop protection strategies and field methods.

Figure 7.10 Shoreline Mapping

Figure 7.11 ORI index

NLRC will execute a contract agreement with Eastern Canada Response Corporation (ECRC) for spill response services to meet Canada Shipping Act requirements. The ECRC contract will be activated by NLRC to respond to all spills over 50 cubic metres and for spills under 50 m at the discretion of NLRC. It is expected that the ECRC contract will be activated for almost every spill to ensure the best containment effort possible, especially in the area of the spill source.

NLRC will work with ECRC and the existing oil handling facilities in the Port of Come By Chance to develop and improve field response strategies to protect sensitive areas in the marine areas around the Refinery. These strategies will be tested in the field during training and exercises and incorporated in the NLRC Oil Pollution Emergency Plan (OPEP).

Eastern Canada Response Corporation Ltd. (ECRC) is the Response Organization (RO) certified under the Canada Shipping Act to provide oil spill response services to oil handling facilities such as the NLRC Refinery and to tanker operating companies in Canadian Waters for 99% of the marine areas on the east coast of Canada. There are two other ROs, one in Nova Scotia and one in New Brunswick with very small defined service areas.

ECRC was first certified by the Government of Canada in 1995 and has been certified every three years since (1995, 1998, 2001 and 2004). ECRC is presently seeking to obtain its re-certification effective November 1, 2007. Having been certified for four occasions, it is assumed by NLRC that ECRC meets all requirements of the Canada Shipping Act with respect to response capabilities, equipment, trained personnel, response preparedness and delivering their required levels of response within the expected time frame.

ECRC has five response centres: Mount Pearl, Newfoundland; Dartmouth, Nova Scotia; Sept Iles and Montreal, Quebec and Sarnia, Ontario. ECRC is certified as having an overall 10,000-tonne response capability with a 2500-tonne response capability located at each of its response centres so that it can meet the response time standards in the Canada Shipping Act.

The CSA requires Response Organizations (RO) such as ECRC to deliver their response capability within specified time increments. The time increments (presented in the Table below) are a planning standard assuming average weather conditions.

Table 7.19 Response Time Planning Standards for Response Organizations

Capability to be delivered by RO	Time Increment
150-tonne response	Within 6 hours
1000-tonne response	Within 12 hours
2500-tonne response	Within 24-hours
10,000 tonne response	Within 72-hours

Capability up to a 2500-tonne response level can be delivered from one ECRC response centre. Further capability to meet a 10,000 tonne response requirement would be delivered to Newfoundland from other ECRC response centres in Nova Scotia and Quebec.

ECRC has developed a world-class spill response operations centre (analogous to an emergency operations centre or 'command centre') at its Newfoundland response centre at Mount Pearl, NL. ECRC uses a spill management system similar to the incident command system which was developed specifically for managing oil spill responses. The operations centre can accommodate the oil spill response manager and advisors from the Responsible Party (RP) (i.e., the polluter) working in concert with ECRC experts in Operations, Logistics, Finance, Planning, Health and Safety. As an integrated spill management team, ECRC works with the RP to arrange a variety of surveillance and investigations with continuous situation analysis to define the oil spill problem and sub-problems which include:

- The oil product(s) spilled;
- The weather and ocean conditions (wind, waves, sea surface currents, ice);
- The likely drift of the oil;
- The health and safety issues associated with the product spilled; the physical environment around the spill location and equipment staging and deployment areas;
- The resources at risk of being affected by the spilled oil (environmental, biological and human use resources);
- Public and community concerns; and
- Government concerns.

ECRC develops proposed daily action plans for approval by the RP:

- For surveillance, investigation and monitoring activities;
- For on-water containment and recovery;
- For boom deployment for oil containment, exclusion, deflection, diversion in order to protect sensitive shorelines or other identified sensitivities;
- For oil recovery operations;
- For shoreline protection; and
- For shoreline treatment.

ECRC also develops proposed long term plans (7-day or longer) based on a long-term weather forecast, a long term oil spill drift forecast and other assumptions. The long term plan describes "what" will be done, the assumed level of effort and cost. The long term plan is approved by the RP giving ECRC a general mandate for the next seven days and authorization for expenditure.

The daily action plans implement the long term plan through a series of daily work tasks (referred to by ECRC as field missions and support assignments). Work tasks can be added or removed each day to adjust to the actual spill situation. Variances are documented by ECRC for approval by the RP.

In addition to developing proposed daily action plans, ECRC prepares progress reports daily for the RP, documenting the evolution of the spill and the actions that are being taken each day. During the early hours of a spill the reports may be as frequently as hourly to provide sufficient information for decision makers and those seeking response resources until the problems have been defined, analysed and mitigation planned.

During an actual spill of any size in Newfoundland waters, the Environment Canada E-Map system and the ECRC sensitivity mapping system will both be available for use by the spill management team for shoreline and other sensitivity identification and response planning. The system also has information available for recommended shoreline treatments for each shoreline segment of Placentia Bay. ECRC's GIS system is used to produce maps and drawings for use in action plans, field instructions, progress reports and briefings.

ECRC in Newfoundland maintains over 100 trained spill responders and about 20 consultants as specialist advisors for work with the spill management team on an availability basis. ECRC also has a full time staff of 35 most of which are available for technical and management roles in the spill operations management centre.

Although not part of their Canada Shipping Act requirements, ECRC will assist the RP with its responsibilities for public relations, wildlife response (capture, cleaning, rehabilitation and release) and disposal of waste materials generated by the spill response. ECRC will place recovered oil and oily debris in secure temporary storage. Oily waste materials are typically segregated and stored in secure containers until quotations for disposal can be obtained.

ECRC has equipment suitable for response in sheltered waters (boats, booms, oil recovery devices and a variety of tanks). ECRC also has the response equipment for response in unsheltered waters within their inventory but do not have the boats for unsheltered waters work.

Under Canada Shipping Act rules, boats for response in unsheltered waters can be chartered at the time of the spill by the responding RO.

NLRC is aware that the RO has undertaken a program to upgrade its oil recovery systems to handle high viscosity oils. NLRC will work with the RO to ensure that the RO will have sufficient capacity to recover, pump and transfer emulsified Arabian crude and No 6 fuel oil from the sea surface through the various storage devices and transport to disposal during winter temperature conditions.

NLRC has consulted with the RO with respect to the facilities it would like to see installed at the Refinery. NLRC will be building a wharf to accommodate response vessels and will provide a 4-inch steam line to the wharf for heating barge cargoes. NLRC would like to see the RO further develop its equipment and personnel resources for heating recovered oils in its barge tanks using steam coils as well as to process recovered oil by breaking water-in-oil emulsions; then separating oil, water, debris and sediment to a level sufficient to meet specifications for disposal facilities.

NLRC recognizes that if it has a spill, NLRC as the RP and its oil spill response service provider ECRC will need to closely work with the Canadian Coast Guard and the Regional Environmental Emergency Team (REET) during a spill response in order to address numerous response issues. The REET is comprised of representatives from the Canadian Coast Guard, Environment Canada departments (weather services, environmental emergencies, fisheries and oceans, wildlife) and the Government of Newfoundland and Labrador departments (such as Environment and Conservation). NLRC also recognizes its responsibilities to deal effectively with public concerns.

For further information, the ECRC website is www.ecrc.ca . The ECRC facility and equipment can be viewed by organized groups through special application by NLRC.

Chemical Spills

NLRC will store and handle a number of chemicals as part of its refining operations. Chemical storage facilities are described in Volume 2 Project Description.

Some of the types of chemicals required for normal refinery operations are:

- Alumina absorbents
- Ammonium polysulphide
- Anitfoam
- Antioxidant
- Biocide
- Boiler feed water treating chemicals
- Caustic 50 Baume
- Cooling water treatment chemicals
- Corrosion inhibitor
- Demulsifier
- Refinery distillate and gasoline additives
- Filming amine
- Glycol
- Hydrogen sulphide scavengers
- Methanol

- Neutralizing amine
- Organic chloride
- Potable water treating chemicals
- Scale inhibitor
- Sodium hypochloride
- Waste water treatment chemicals
- Soda ash
- Activated carbon

NLRC will comply with the Canadian Environmental Protection Act, 1999 and will provide appropriate notices and develop Environmental Emergency (E2) Plans for those chemicals listed under the Act in the quantities specified. At this point the only chemical known to be listed under CEPA is gasoline. At this point it is not yet known if their will be other listed chemicals.

NLRC will develop site specific procedures and training for the safe storage, handling, use and disposal of chemicals stored and used on site. NLRC will implement a WHIMIS program with a method to ensure that a Material Safety Data Sheet (MSDS) for each of the chemicals it acquires will be readily available to all Refinery workers. NLRC will provide the necessary WHMIS awareness training as well as site specific training. NLRC will also provide workers with the appropriate protective equipment to handle each chemical and will train its workers in its safe use.

NLRC will also develop a team of trained responders to respond to chemical spills. These persons will be provided with the appropriate training as well as personal protective equipment and training in its safe use. A disciplined approach, safety, hazard identification, risk assessment and risk reduction will be a major focus of the training.

NLRC will also obtain and distribute copies of the latest version of the CANUTEC Transport Canada Emergency Response Guidebook (latest version ERG2004) to its staff and train them in its use. The Guidebook is a guide for first responders during the initial phase of a transportation incident involving dangerous goods/hazardous materials. The guide is a reference book organized to enable first responders to quickly identify the specific or generic hazards of a material involved in an incident and the steps necessary to secure a spill scene and protect the individual on-scene and others in the vicinity. The guide provides a table of initial isolation distances in all directions and protective action distances intended to protect the public or persons downwind during day and night conditions for both small and large spills. The guidebook is intended for the "initial response phase" following arrival at the scene of an incident during which the identification of dangerous goods is confirmed, protective actions and measures to secure the scene are initiated, and the assistance of qualified personnel is requested. The guidebook does not provide information on the physical or chemical properties of dangerous goods.

The initial response is followed by a proactive program with a plan for the containment, stabilization or neutralization of the hazardous material, removal, packaging, transport and disposal using trained personnel under the direction of a trained supervisor. All hazards and risks will be reviewed for each step of each work task before it is executed and measures will be taken to eliminate or reduce risks to as low as possible.

7.2.7 Spill Prevention

A general philosophy is that investment is better spent on prevention than on mitigation.

Tanker Hazards and Risks in Newfoundland

As part of its risk reduction strategies, NLRC will implement a process for tanker vetting or screening based on tracking measures of tanker performance on a computer database by a service provider. By screening its tankers to demanding criteria NLRC will allow tankers of higher quality and better performance record to berth at its facility and to load or offload oil cargoes. This vetting process in itself is a significant measure in reducing the risk of tanker incidents and associated spills.

NLRC will also participate in the Termpol Review Process (Transport Canada, 2001) led by Transport Canada to identify and consider the hazards and risks associated with the NLRC marine tanker operations while at sea on route to and from the Refinery and while at the Refinery's marine terminal.

NLRC's objective in participating in the Termpol Review is simply to prevent marine incidents and associated marine pollution. NLRC supports a systematic approach to considering hazards and risks and where necessary to introduce measures to further reduce risks of tanker incidents. One of the risk reduction measures that will be implemented by NLRC is Refinery Regulations that will be developed in consultation with Transport Canada to govern the interactions between the Refinery and its associated tankers.

NLRC recognizes that considerable risk reduction measures have already been implemented by Transport Canada through:

- Its regulations
- Ship safety and inspection systems
- Navigation aids
- Notices to mariners and shipping
- Weather services for shipping
- Ship identification systems and tracking radars
- Existing vessel traffic management system

- Communications systems
- Segregated tanker lanes in Placentia Bay
- Modifications to marine charts
- Pilot system
- Tanker escort and vessel support systems
- Aerial surveillance with radar to detect ice and other floating hazards along tanker routes
- Previous Termpol Reviews
- Operating committees to review issues and improve the system

NLRC believes that these existing prevention measures are reflected in a good track record for the safe shipping of oil cargoes into and from Placentia Bay. Having the present level of experience to draw from, NLRC expects that the Termpol Review for its project will produce sound analysis and well considered results.

Some of the risk areas that will be examined will include potential tanker hull damage, grounding, collision, fire and explosion and the tanker interactions with the marine terminal.

Grounding risks include rocks and shoals along the tanker routes. Collision risks include other vessels and floating objects such as icebergs, multi-year ice and man-made objects.

Tanker interactions with the marine terminal will be studied along with the management framework, communications and Refinery regulations that will govern the preparedness and safety aspects of oil transfers between the refinery and marine tankers.

The Termpol review will examine each component of the tanker traffic management system. The system includes: traffic lanes, traffic density, convergence and separation, anchorages, potential traffic conflict and risk areas, navigation aids, pilotage and tanker escort, traffic services, communications, ship detection, tracking and identification systems, tanker requirements and operating procedures.

The probability and consequences of marine pollution incidents will also be considered by the Termpol Review, some of which have been described in this report section. Given the known wind and wave limits for spill response on-water and along exposed shorelines, spill prevention must be a priority focus for the Termpol panel and participants.

It is expected that the Environmental Oil Spill Risk Assessment Study for the Southwest Coast of Newfoundland commissioned by Transport Canada will be released to the public by the end of 2007. The results should be a valuable input into the Termpol Review Process. When the theoretical hazards to tanker operations are examined from a Newfoundland perspective the measures that can be taken to reduce risk will undoubtedly become evident.

The Termpol Review will examine causes of spills. Statistics for the causes of actual oil spills have been kept on a database by ITOPF since 1974. Based on analysis by ITOPF:

“Most incidents result from a combination of actions and circumstances, all of which contribute to the final outcome in varying degrees. The causes of intermediate spills in the 7-700 tonnes category for the period 1974-2006 can be seen in Figure 7.12 below. In this category accidents were the main cause, with groundings and collisions accounting for 63% of the total during that period. Other significant causes included hull failures and fire/explosion. Some 34% of spills in the 7 to 700 tonne spill category occurred during routine operations, most during loading or discharging (27%). The causes of large spills greater than 700 tonnes is shown in Figure 7.13 for the 1974 – 2006 period. (ITOPF, 2007)

From the ITOPF figures below a world-wide trend of fewer spills and less volume spilled can clearly be seen since 1995.

A list of the standard surveys and studies that are part of a Termpol Review can be found in the Transport Canada document TP743E entitled Termpol Review Process- 2001.

For the refinery operations, the spill prevention measures are embedded in the design of the refinery components, and the integrity testing measures conducted before, during and after construction. Quality assurance measures on the procurement of materials, the corrosion prevention coatings specified for materials, the x-ray testing of welds, hydrostatic testing of tanks, pressure testing of piping systems are all measures that contribute to spill prevention.

NLRC will pressure test its tanker loading and discharge pipelines and loading arms to ensure their integrity.

The tanker loading and discharge pipeline system will be designed and built with a leak detection system as well as an automatic shutdown system to close valves in the pipeline within 60 seconds of a leak being detected.

Oil storage tank installations will be built to Government of Newfoundland standards. Tanks will have secondary containment with sufficient storage capacity for the tank contents either inside a lined dike built around the tank or an impounding basin for a series of tanks.

Spill prevention measures are also imbedded in the operations, maintenance, environment and safety management systems and procedures. Operations procedures contain spill prevention measures including monitoring of operations involving the transfer of hydrocarbons.

The Refinery preventative maintenance program will be an important spill prevention measure. Pipelines will periodically be tested for evidence of corrosion, pitting, stress fracturing or shape distortion. Various steel installations will have metal thickness measurements taken on a periodic basis to ensure that any thickness loss to corrosion is within acceptable standards to maintain the required operational integrity.

Storage and handling for smaller quantities of fuels, lubricants and chemicals to support refinery operations will meet or exceed government standards and good industry practice. These products will be stored in areas with secondary containment with oversize drums and spill response materials on site.

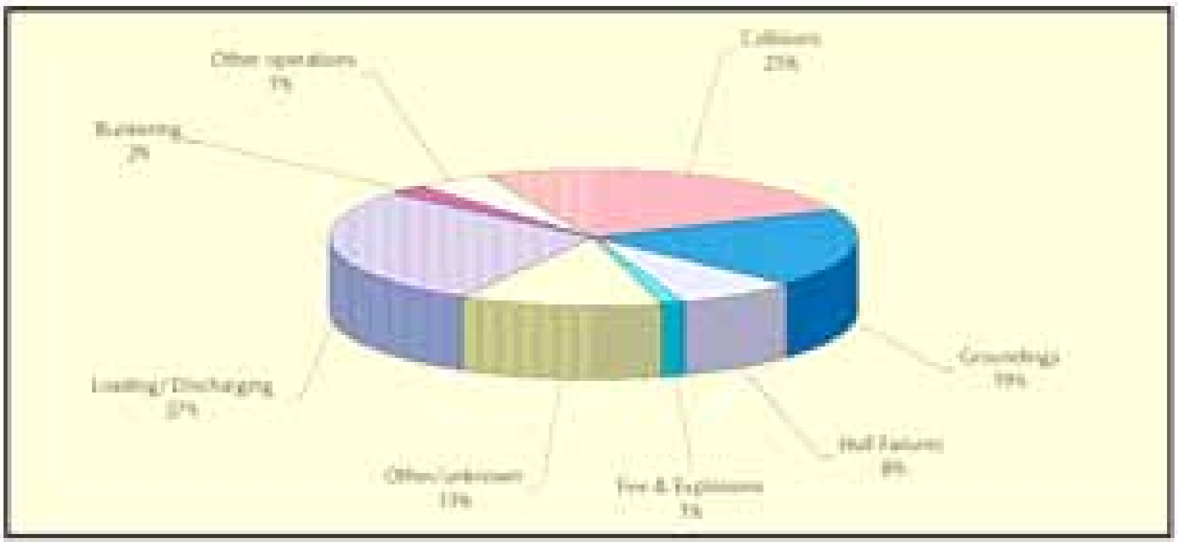

Figure 7.12 Causes of intermediate spills (7-700 tonnes), 1974-2006

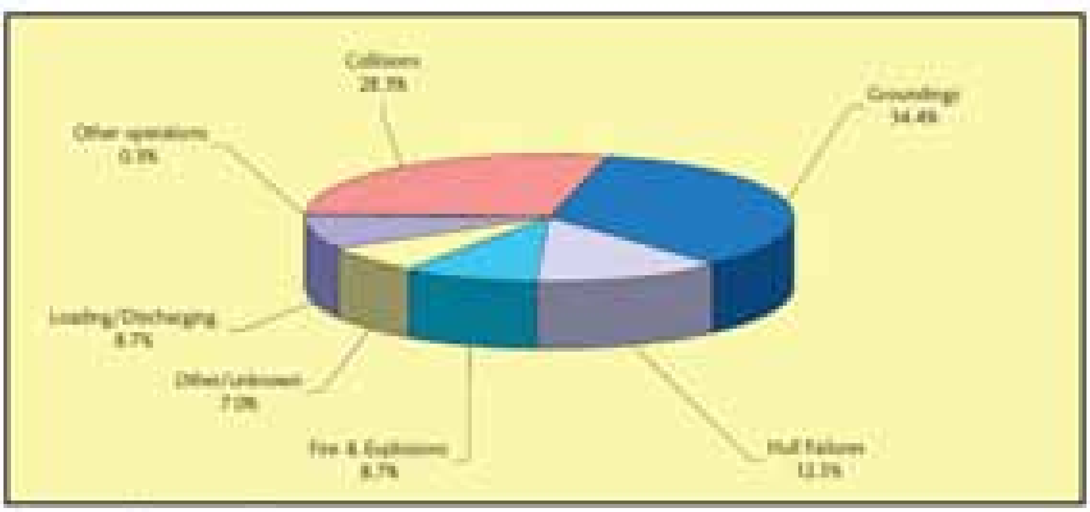

Figure 7.13 Causes of large spills (>700 tonnes), 1974 – 2006

The Refinery Regulations developed by NLRC in consultation with Transport Canada will govern the interactions between the tankers and the Refinery with respect to arrival, tug escort, berthing, line handling; preparations before the transfer of oil cargoes; communications protocols, oil transfer procedures, post-transfer procedures and unberthing operations. Safety, incident prevention and spill prevention measures comprise the majority of the Refinery Regulations document.

In anticipation of new changes to the regulations for oil handling facilities under the Canada Shipping Act, NLRC has prepared a draft Oil Pollution Prevention Plan. This document has been included as an appendix to the draft Oil Pollution Emergency Plan (OPEP) that NLRC has also prepared.

NLRC will submit the Oil Pollution Emergency Plan OPEP in final form to Transport Canada and the Government of Newfoundland and Labrador before commissioning its Refinery. At that point staff will be hired; telephones installed and spill response staff assigned to spill response roles and response equipment delivered so that the appropriate contact and organizational information can be included in the Plan.

7.2.8 Spill Response

NLRC will take a systematic approach to managing health and safety related to response to oil and chemical spills. It is recognized that there will be a large number of safety issues associated with such operations. The generic approach to safety management will include:

- Training response personnel to take a systematic and disciplined approach to every situation
- Hazard recognition, situation analysis, assessment of hazards and risks, measures needed to eliminate or reduce risks
- Conducting job task safety analysis for each work task to Identify the hazards, risks and risk reduction measures
- Conducting “Tool box safety talks” or “tail-gate safety meetings” before every job
- Examining the safety issues around the product spilled
    - Hazard to human health
    - Risk of fire and/or explosion
    - Air monitoring for different parameters
    - Eliminating potential ignition sources
- Examining the safety issues around the physical work environment
    - Review existing and forecast weather conditions to identify potential hazards from wind, waves, temperature, visibility, freezing rain, storms and ice in relation to each planned work operation
    - Assessment of work site conditions

Some of the oil products that NLRC will handle contain benzene and trace levels of hydrogen sulphide, which, depending on circumstances, present varying level of risks that must be managed.

On Placentia Bay the sea wave heights may be near or above operating limits for the types of vessels used. NLRC and its spill response contractors will use boats of different sizes and designs for oil spill response operations. NLRC will comply with Transport Canada vessel stability regulations (tp7301e) to eliminate risk of capsize.

The stability of oil recovery vessels under Placentia Bay wave conditions when lifting oil recovery devices over the ships side during equipment deployment and recovery operations is a safety issue that will be considered. The marine area around the Refinery generally has much lower wave conditions that outer Placentia Bay but wave heights as high as 3m can occur. NLRC response vessels will be operated in a safe manner.

Placentia Bay has 120 km (8.5%) of shoreline that is accessible by road; 1272 km of shoreline is accessible only by water. One-third of the coast has rocks or boulders in the nearshore environment and 1222 km (73.7%) of shoreline with cliff backshore. (OCC, 1997). The character of the shorelines gives rise to a number of safety issues in regard to working on or near shorelines in the event of a tanker spill. It is recognized that there are hazards and risks that must be managed.

Safety training is described in considerable detail in the draft Oil Pollution Emergency Plan (OPEP) prepared by NLRC.

8.0 EMERGENCY RESPONSE PLANS

The NLRC oil refinery will be designed and operated in a manner such that accidents and malfunctions will be prevented or avoided. Despite risk reduction measures, accidents can still occur.

NLRC is an organization that may be affected by natural, technological, and human events that could have a detrimental impact on the following:

9. The health and safety of persons in the affected areas;
10. The health and safety of persons responding to incidents;
11. Continuity of business operations;
12. Property, facilities, and infrastructure;
13. Delivery of services;
14. Environmental conditions;
15. Economic and financial conditions;
16. Regulatory and contractual obligations; and
17. Organizational reputation.

The Canadian Standards Association standard CAN/CSA-Z731-03 Emergency Preparedness and Response will be used to guide NLRC's response planning process. The Standard provides advice on planning, administration, training, resource utilization, auditing, and other aspects of emergency preparedness and response.

The NLRC Refinery will have an umbrella emergency response plan with sub-plans for each type of emergency. Contingency plans will be designed to deal with events such as:

- Power failure
- Computer Control System Failure
- Refinery fire and/or explosion in various refinery facilities
- Accidental release of a substance on land at the Refinery site
- Accidental release of a substance to the sea from the Refinery site
- Chemical spill on refinery site
- Gas release (hydrocarbon, LPG, benzene, H2S)
- Pipeline rupture
- Jetty loading arm rupture
- Support vessel Incident (tugs, line handling boats, oil spill response vessels)

- Tanker incident at Jetty
- Man overboard from a wharf, jetty or ship berthed at Refinery
- Injury to a person or persons
- Loss of life
- Heavy snowfall and freezing rain
- Contamination of potable water supply
- Vehicle incident with death or injury
- Vehicle in the water
- Journey management overdue report
- Confined space entry incident – one or more persons
- Security Breach
- Bomb threat or sabotage
- Forest Fire
- Hurricane
- Earthquake
- Tsunami

Tanker related incidents will be the responsibility of the tanker operator and owner. Numerous resources are available in Newfoundland and Labrador to assist a tanker in distress in Canadian waters. Depending on the incident situation and location, NLRC will provide assistance when requested to do so by the tanker operator.

8.1 Organizational Structure for Emergency Response

The NLRC Refinery operations will use an Incident Command System (ICS) structure to organize the response to each emergency situation. For each emergency event, an incident management team will be activated along with an Emergency Operations Centre (or command centre). The ICS structure is further described below.

The organizational structure will include an incident management team to address the different operational components of the incident:

1. Emergency operations
2. Core-Business operations
3. Pollution Response operations
4. External Affairs activities
5. Internal Affairs activities
6. Health and Safety operations