11.2 Physiography and Bedrock Geology

11.2.1 Onshore

The proposed Chevron Ellice and Mallik winter seismic program lies within the Tuktoyaktuk Coastal Plain Ecoregion of the Southern Arctic Ecozone. The Ellice Island block lies just north of the Mackenzie Delta Ecoregion of the Taiga Plains Ecozone. The program area will also extend onto the landfast ice to the north of Ellice, Langley, and Richards Islands. The geology of the region is variable due to differences in the extent of glaciation events.

There are two main landscape types within the Tuktoyaktuk Coastal Plain Ecoregion. The first type is associated with the active delta plain, and consists of low-lying (*i.e.* elevations of less than 4 m above sea level) deltaic sediments incised by a network of meandering channels and delta lakes (Todd and Dallimore 1998). These landforms include wetlands, active alluvial channels and estuarine deposits. Characteristic wetlands, which cover 25-50% of the area, are lowland polygon fens, both the low- and high-centre varieties (ESWG 1995). The second landscape type consists of broadly rolling uplands rising up to 30 m above sea level, the surfaces of which have been modified by glacial and periglacial processes (Todd and Dallimore 1998). Discontinuous morainal deposits mantle much of the area, except near the coast where fine-textured marine sediments cover the surface. Occurring less frequently are outwash aprons of crudely-sorted sand and gravel, and raised beach ridges along the shores of preglacial lakes. The resulting undulating terrain is studded with innumerable lakes and ponds.

The Mackenzie Delta ecoregion is a complex area of peat-covered deltas and fluvial marine deposits. The present delta is unique for its multitude of lakes and channels. Wetlands extend over 50% of the ecoregion, and are characteristically polygonal peat plateau bogs with ribbed fens (ESWG 1995).

The Quaternary surficial geology of the outer Mackenzie Delta is well documented as consisting of Holocene deltaic and floodplain sediments from the modern surface of the Mackenzie Delta, typically composed of interbedded silts and silty sands, and often ice-rich in the upper 30 m (Todd and Dallimore 1998). The surficial geology of the Tuktoyaktuk Coastal Plain reflects the fact that the most recent glaciation did not extend over much of the northernmost part of the area, with older Wisconsinan deposits dominating, and some younger Holocene lacustrine deposits occurring mainly in thermokarst basins (Taylor et al. 1996). Sediments in the Tuktoyaktuk Coastal Plain are predominantly composed of late glacial till or glaciofluvial sand and gravel (Todd and Dallimore 1998).

The hydrocarbon-bearing sequence straddling the outer Mackenzie Delta and Tuktoyaktuk Peninsula has been identified as an upper sequence of weakly consolidated to unconsolidated sandstone and conglomerate, and includes the uppermost Quaternary sediments of the area. Underlying this is a sequence of primarily fine-grained siltstone and shale. The boundary between the two sequences marks a widespread regional unconformity (Todd and Dallimore 1998).

11.2.2 Near-shore

The Mackenzie Delta coastline is very low (often less than 1 m) with delta channels, tidal flats and coastal wetlands (Hequette and Barnes 1990). The Pleistocene Coastlands include the coast of Richards Island and the Tuktoyaktuk Peninsula as well as the outlying islands in Mackenzie Bay (Percy 1975). They form part of a sand and gravel delta that was laid down by an ancient river (Percy 1975).

The coast in this area is undergoing regional retreat, with a mean coastline recession rate of greater than 1 m per year, increasing to over 10 m per year in some locations (Hequette and Barnes 1990). This retreat is occurring at rapid rates even though the Canadian Beaufort Sea is ice-free for 3 months of the year, and wave energy is restricted by the pack ice (Hequette and Barnes 1990). Several factors have been identified as contributors to the regional coastal retreat, including storm-produced wave action, sea-ice processes such as gouging, ice-enhanced current scour, piling, ride-up and sediment entrainment within the ice, and degradation of ground ice in the cliff sediment (Dallimore et al. 1996, Hequette and Barnes 1990).

An extensive, relatively shallow continental shelf underlies the southern portion of the Beaufort Sea. Major tectonic activity towards the end of Middle Devonian time produced land areas in what is now the Beaufort Shelf (Dixon 1982 *in* Pelletier 1987). The Shelf is composed of Fluvio-deltaic clastic rocks deposited during various periods (Yorath et al. 1980 *in* Pelletier, 1987). The relative depression of the continental shelf is a result of differential uplift in the northern part of the Richardson Fault array during mid-Tertiary and later times (Norris 1972 *in* Pelletier 1987). The continental shelf extends out to the 100 m isobath in the southeast Beaufort Sea and can extend up to 150 km from the shoreline (Dome et al. 1982a). The near-shore portion of the shelf is defined by the coastline and the 10 m isobath, and can extend up to 40 km off the Tuktoyaktuk Peninsula (Dome et al. 1982a). The continental shelf in this region generally has a gentle slope of 0.03° to 0.06°.

11.2.3 Landfast Ice

Three ice zones are found within the Southern Beaufort Sea: landfast zone, seasonal ice/transition zone and polar pack zone (Dome et al. 1982a). Landfast ice is found near the coast and can be further divided into three zones: a bottom-fast ice zone extends to a depth of approximately 2 m, a floating ice sheet continues from the edge of landfast ice to the 13 m isobath, and a grounded ice zone of heavily ridged ice occurs beyond the floating ice zone (Dome et al. 1982a).

From late September to October, the ice builds from the shoreline to approximately the 20 m-depth contour over the Continental Shelf (Dome et al. 1982a). Ice begins to form along the edge of the pack ice and in sheltered coastal waters, expanding to bridge the gap between two advancing ice fronts. New ice forms first in areas with low surface salinities caused by discharge from the Mackenzie River (Markham 1975 *in* Dome et al. 1982a). The Beaufort Sea becomes ice covered approximately two weeks after the first ice begins to form. By mid-November, the landfast ice in this area has reached the 5 m isobath and is 30 to 60 cm thick (Dome et al. 1982a). A maximum ice thickness of roughly 2 m is achieved by late April (Dome et al. 1982a).

Over the course of the winter, the landfast ice undergoes sporadic movements in response to storms and thermal effects. Near-shore landfast ice displacements on the order of metres are common, while polar and seasonal pack ice have typical displacements of tens of kilometres.

Break-up and clearance of the landfast ice begins in May with an ice-free water corridor present from July to October (Dome et al. 1982a). The extent of open water is variable from year to year. In spring, the Mackenzie River floods the delta and the adjacent sea ice. This initiates sea ice melting directly, by heat transfer from the warmer fresh water, and indirectly, by lowering the sea ice albedo and thus increasing solar radiation absorption (Dean et al. 1994). The melted areas of sea ice eventually merge to form a shallow body of fresh, warm water that is sediment and nutrient rich (Dome et al. 1982a).

11.3 Soils

Soils found in the proposed Chevron Ellice and Mallik winter seismic program area have resulted from prolonged cryoturbation, low temperatures and low permeabilities in the mostly fine-textured soils (Timoney et al. 1992). Regosolic Static and Gleysolic Static Cryosols with Organic Cryosols developed on level fluvioglacial, organic and marine deposits are the dominant soils of the Mackenzie Delta Ecoregion. An extensive layer of discontinuous permafrost underlies these soils. The soils of the Mackenzie Delta are relatively infertile and macronutrients may be largely unavailable to most plants (Pearce et al. 1988). The dominant soils of the Tuktoyaktuk Coastal Plain Ecoregion are Organic and Turbic Cryosols on level to rolling organic, morainal, alluvial, fluvioglacial and marine deposits (ESWG 1995). These soils are underlain by a continuous layer of permafrost and are often water-logged due to impeded drainage. The organic soils found in the eskers of this ecoregion are generally shallow, highly acidic and nutrient-poor. The mineral soils are also poorly developed and often frozen (ESWG 1995).

The depth of the active layer (*i.e.* the portion of soil that thaws seasonally) varies greatly with the angle of exposure to the sun, the degree of shading, the soil texture and the water content of the soil (Mackay 1995). In well-drained sand or gravel, the seasonal thaw may be relatively deep, whereas in wet peaty soils the summer thaw penetrates only a short distance (Porsild and Cody 1980). Poorly-drained soils over ice wedges are associated with unique physical processes, such as active frost churning that modifies both soil and parent material, and vertical cracking of the soil, resulting in the inflow and subsequent freezing of water fingers, providing added moisture source to the soil (Brown 1967).

Hummocks are the most abundant soil microrelief feature of the Tuktoyaktuk Coastal Plain and Mackenzie Delta Ecoregions (Mackay 1995). In this region, hummocks are generally composed of fine-grained frost-susceptible soils that have been upwardly displaced, and range from those that are completely vegetated (earth hummocks) to those with bare centres (mud hummocks) (Mackay 1980).

11.4 Climate

The Tuktoyaktuk Coastal Plain and Mackenzie Delta Ecoregions are classified as having a low arctic ecoclimate. The mean annual temperature for the Tuktoyaktuk Coastal Plain and Mackenzie Delta Ecoregions is –11.5°C and –9.5°C, with mean summer temperatures of 4.5°C and 8.5°C and mean winter temperatures of –24°C and –26.5°C, respectively (ESWG 1995). The mean winter temperature in the coastal Beaufort Sea region in the winter is –30°C (Dome et al. 1982a).

During the roughly two-month period when the sun does not rise above the horizon, very cold conditions prevail and may last for several weeks at a time. Snow and freshwater ice persist for six to eight months. When the sun begins to rise above the horizon (January), increasing temperatures begin to dissipate the typical winter high-pressure centres and storms prevail. By June most of the snow has melted, though lake ice may persist until July. The mean annual number of frost-free days varies from approximately 12 to 15 days on the coast, compared to about 50 days at Inuvik (Dome et al. 1982a).

The mean annual precipitation for the Tuktoyaktuk Coastal Plain and Mackenzie Delta ecoregions ranges from 125-200 mm to 200-275 mm to respectively (ESWG 1995). Areas modified by open water tend to receive most precipitation during summer and autumn before freeze-up, while areas further inland such as Inuvik are seen to have a higher frequency of precipitation during autumn and winter. The contribution of snowfall to total annual precipitation increases with increasing latitude and higher elevations, and can be greater than 60% in some northerly coastal locations (Dome et al. 1982a). Data from onshore meteorological stations indicate that the annual snowfall varies from a low of 40 cm per year at Nicholson Peninsula to 80 cm per year at Shingle Point. The lowest precipitation is generally recorded in January and February.

Winds are westerly in the summer and northwesterly in winter, with potentially severe weather resulting from deviations in this pattern (Dome et al. 1982a). Local topography and vegetation cover can vary considerably, especially between coastal and inland areas, affecting wind regimes. Generally, the wind strength and duration decreases from the coast southwards. Low-pressure systems moving across the Beaufort Sea mainly in January and March produce blizzard conditions along the coast and within the Mackenzie Delta while high-pressure centres are dominant. Spring reaches the Mackenzie Delta in late April or early May, progressing gradually from south to north with a distinctive eastward movement of the dominant pressure system. Arctic air masses generated from the ice pack are moderated during transit across open water, and further warming occurs as the air travels across the Mackenzie Delta, resulting in increased precipitation in this area. In autumn the dominant airflow shifts to a westward direction, and temperatures fall with freeze-up and the advance of arctic air (Dome et al. 1982a).

11.5 Permafrost

Permafrost is defined as sediments that remain below 0°C for two or more years (Taylor et al. 1996). Permafrost occurs beneath all terrestrial and many subaqueous areas of both the Mackenzie Delta and Tuktoyaktuk Coastal Plain. The permafrost layer often lies just a few centimetres below the surface preventing the downward flow of water. Consequently, the soils are often waterlogged or frozen, even though there is little precipitation.

In the Holocene Mackenzie Delta, maximum permafrost thickness is less than 100 m, increasing to maximums of 500 m and 750 m in the Big Lake Delta Plain and the Pleistocene Tuktoyaktuk Coastal Plain, respectively (Taylor et al. 1996, Todd and Dallimore 1998). In the Southern Arctic Ecozone, permafrost thickness increases rapidly from the delta to the Tuktoyaktuk coastlands, with thickness increasing from 50 m to 500 m over just a few kilometres (Todd and Dallimore 1998).

In all areas where permafrost is prevalent, permafrost-related processes such as solifluction and soil creep, ice wedge formation, frost shattering of boulders, pingo formation and the heaving of areas formerly covered by water bodies, have a major effect on shaping the landscape (Rampton and Bouchard 1975). Repeated freezing and thawing of these soils creates features on the surface that include cell-like polygons, bulging hummocks, and bare mud boils where the soil is so active that no plants can take root.

11.6 Hydrology

11.6.1 Terrestrial

The Tuktoyaktuk Coastal Plain is characterized by a large number of isolated and interconnected lakes that drain into the southern Beaufort Sea via small ephemeral streams that freeze entirely in winter. These lakes, known as thermokarst lakes, were predominantly formed through local melting of the uppermost part of the underlying permafrost layer, and subsequent settling of the ground (Dome et al. 1982a). Few lakes in this area were formed by glacial action.

Lakes on the Tuktoyaktuk Coastal Plain tend to remain ice-covered for around 250 days a year, with freeze-up generally occurring in September or October and break-up occurring in late June (Bond and Erickson 1985, Bigras 1990). Break-up on the peninsula is caused by melting, as opposed to flooding of the ice by a warmer water body, as in the case in the Mackenzie Delta break-up. The slower process of ice melting and the lack of a flood regime on the Tuktoyaktuk coastal and tundra lakes contribute to greater year-to-year variability in measured physical properties as compared to lakes of the Mackenzie Delta (Fee et al. 1988). Lakes on the Tuktoyaktuk Peninsula differ from those on the Delta with respect to ice-covered period, maximum mid-summer temperature, water level, and transparency (Chang-Kue and Jessop 1992). The poorly formed levees of the estuarine Mackenzie Delta were formed largely from sediments transported by the Mackenzie River over the last 13,000 years. The southwest sector of the delta also receives sediment from the Peel and Rat Rivers. The delta is active and builds forward into the Beaufort Sea during the open water season from June to October (Bigras 1990).

The Mackenzie Delta is a dynamic complex of lakes and ponds, islands and tidal flats, braided channels and oxbows. The Mackenzie River is the main driving force, introducing large amounts of water, sediment and energy to the delta. The major channels appear largely unchanged in the last century, with the Middle, East, and West channels primarily controlling the hydrologic regime of the delta lakes (MRBC 1981). However, the main channel water level regimes vary significantly over the north-south and east-west extent of the delta due to changes in levee heights, ice jamming and inflow to the delta (Marsh and Hey 1989). The hydrologic regime is the primary factor controlling vegetation and wildlife habitat in the area (MRBC 1981) and the productivity of the delta ecosystem (Marsh and Hey 1989). Flooding of the Mackenzie River, precipitation, and evaporation control the water levels of approximately 25,000 delta lakes. Changes in these controlling factors particularly affect sensitive high elevation lakes. Without flooding, these lakes would dry up rapidly. Spring flooding of the delta adds sediments and nutrients to the lakes (Marsh and Lesack 1996). While these lakes are generally shallow (few exceeding 3 m in depth), they play a significant role in the ecology of the delta, affecting the distribution of permafrost, supporting populations of fish, waterfowl and mammals, and providing storage for water, sediment and pollutants (RWED 1999).

Water levels in the Mackenzie River and adjoining channels vary dramatically with climatic changes and ice regimes. Spring break-up in the delta is the most dynamic and important hydrological event of the year, dominating the hydrologic regime of delta lakes (Bigras 1990). A short-term rise in water level occurs with initial freeze-up, followed by low levels persisting for the remainder of winter. The water levels then rise rapidly due to snow-melt in the southern part of the delta and from ice jams in the main channels of the delta (Marsh and Hey 1989). Depending on the strength of local ice jams during the spring break-up period the peak water levels can last from 3 to 45 hours (Bigras 1990). Once the ice jams fail there is a downstream surge of floodwater, and lake levels begin to drop rapidly (Bigras 1990). The Mackenzie Delta lakes store large volumes of water during the spring break-up period (Marsh and Hey 1989). The magnitude of the spring flood varies greatly from year to year, and as a result, not all lakes are flooded annually (Marsh and Hey 1989).

The spring break-up period is dominated by snow-melt runoff and ice jamming, while the summer period is mainly controlled by rainfall runoff (Marsh and Hey 1989). During summer, water levels may rise in response to rainstorms upstream and along the delta, and some lakes may be flooded again during these rain-induced peaks (Marsh and Hey 1989). Some lakes lose more water to summer evaporation than is received through precipitation, causing them to have a negative annual water balance until flooding occurs (Bigras 1990). Water levels in the northern portion of the delta may also change due to tidal activity and storm surges of the Beaufort Sea (RWED 1999). The largest storm surges occur during the open water season, but surges have also been observed during the ice-covered period (Marsh and Schmidt 1993).

Lakes of the delta can be considered connected or perched, depending on their geomorphic or hydrologic characteristics (Bigras 1990). Connected lakes have a well-defined, water-filled channel that connects them to the main delta channel from break-up to freeze-up. These lakes are constantly interchanging water with delta channels. Lake levels are similar to the distributary channel throughout the open water period. Perched lakes are not directly connected by a channel, but are isolated atop levees, and are cut off from other lakes and channels except during flooding (Bigras 1990). The hydrologic regime of connected lakes is more complex than perched lakes due to the connection to the main delta channels. Discharge through distributary channels is responsible for the majority of the annual water loss rather than evaporation (Bigras 1990). Due to present climatic and hydrologic conditions most perched lakes are flooded with a frequency of between 2 and 10 years and only have a slightly negative water balance between floods (Marsh and Lesack 1996). Connected lakes do experience occasional summer flooding as a result of high flow events or storm surges (Bigras 1990).

11.6.2 Marine

Runoff and sea ice melt comprise the main sources of fresh water to the Mackenzie estuary (Macdonald et al. 1995). The freshwater discharge from the Mackenzie River reduces coastal salinities in the Southern Beaufort Sea (Thomson et al. 1986, Dome et al. 1982a). The discharge creates plumes of warm, nutrient-rich water in the summer and local wind patterns create longshore currents that push these waters westerly along the coast (Howland et al. 2000, Dome et al. 1982a). As a result, the inshore coastal environment experiences fluctuations in temperature, turbidity and salinity (Dome et al. 1982a). The temperature of some protected surface water layers ranges from 0°C to 5°C in the spring and reaches temperatures up to

16°C in mid August (Dome et al. 1982a). A narrow zone of brackish water that persists throughout the year is created by the plume extension along the coastline, behind the barrier islands, and in lagoons and embayments (Howland et al. 2000, Dome et al. 1982a). A study by Macdonald et al. (1995) showed that most of the winter discharge from the Mackenzie River remains trapped as liquid under the landfast ice zone, continuing to exert its near-shore effects throughout the winter, while approximately 15% of it becomes incorporated into the ice. High salinity (>20 ppt) and low temperatures (0°C) are characteristic of near shore marine overwintering habitat around Richards Island. Water quality is good to excellent and the near shore marine environment is well connected to other water bodies.

The weak tidal currents of the Beaufort Sea prevent sufficient mixing from occurring, giving rise to a highly stratified salt wedge estuary (Dyer 1986, Dome et al. 1982a). The fresh water flows over the surface of the seawater, forming a very stable upper layer, while the salt water rests on the bottom in an almost motionless salt wedge (Dyer 1986). The salt wedge tapers off toward the head of the estuary. While the two layers generally remain separate and stable, some upward mixing may occur from entrainment or internal wave action along the halocline, resulting in a gradual loss of salt into the surface layer (Dyer 1986).

During the winter, surface waters cool and increase in salinity due to ice formation, resulting in mixing of the layers and a homogeneous brackish near-shore environment (Craig and Haldorson 1980 *in* Dome et al. 1982a). Both the mixed waters and the stratified waters are generally found within approximately 10 km of the coastline (Dome et al. 1982a). Farther offshore, the cold marine water mass remains stable throughout the year (Dome et al. 1982a).

During prolonged westerly wind conditions, the freshwater plume is contained close inshore off of Tuktoyaktuk Peninsula, while the water near Richards Island is under oceanic influence (Thomson et al. 1986). Under prolonged easterly wind conditions, the freshwater plume extends north of Richards Island and its influence continues west of Herschel Island (Thomson et al. 1986). However, wind conditions alone cannot be used to predict the location of the freshwater plume. Under both easterly and westerly wind conditions, the intense freshwater plume extends farthest from the shoreline off Shallow and Kugmallit Bays (Thomson et al. 1986). Data from the 1980s indicates that a diffuse plume can extend well north of 70° N from Mackenzie Bay to Kugmallit Bay (Thomson et al. 1986).

11.7 Vegetation

Permafrost limits soil productivity by cooling the soil and creating waterlogged conditions in the thawed active layer near the soil surface (Stonehouse 1999). Plant communities in the arctic are therefore relatively simple and dominated by a few species that are well adapted to poor soil conditions and the harsh climate.

No distinct succession of plant species is observed on the tundra of the Tuktoyaktuk Coastal Plains, due to the relatively infrequent occurrence of natural disturbances, like fire (Wein 1976). Germination from seeds or vegetative growth is minimal and depends heavily on both site-specific and temporal characteristics (Bell and Bliss 1980, Hobbie and Chapin 1998). Therefore, plant recruitment becomes an opportunistic process (Svoboda and Henry 1987).

The major community on the tundra is dwarf shrub-heath, which covers 77% of the vegetated surface, while tussock tundra covers 14%, sedge meadows 6%, and lake-edge communities only 3% (Hernandez 1973). The dwarf shrub-heath community is dominated by dwarf birch (*Betula nana*) smooth willow (*Salix glauca*), crowberry (*Empetrum nigrum*), lingonberry (*Vaccinium vitis-idaea*), northern Labrador tea (*Ledum palustre decombens*), mosses and lichens. Sedge meadows are dominated by *Carex* spp., mosses, and lake-edge communities.

Where raised centre polygons occur, moist conditions in the depressions between polygons result in vegetation that is generally richer than that of the well-drained areas, especially when there is standing water in the depressions (Corns 1974). The depressions are dominated by alpine bearberry (*Vaccinium uliginosum*), leatherleaf (*Chamaedaphne calyculata*), stiff sedge (*Carex bigelowii*), dwarf bog rosemary (*Andromeda polifolia*) and a carpet of sphagnum moss. In very wet depressions, species such as pendent grass (*Actophila fulva*), water sedge (*Carex aquatilis*) and tall cotton grass (*Eriophorum angustifolium*) are found. Dwarf birch, cloudberry (*Rubus chamaemorus*), Labrador tea (*Ledum palustre*) and lingonberry grow primarily on the high points of land.

In both upland and lowland tundra communities soil moisture is the most important environmental influence on vegetation (Sheard and Geale 1983). Plants typically establish in openings on moss or lichen mats, or in desiccation cracks where moisture levels are most constant (Bell and Bliss 1980). Soil characteristics related to depth of the permafrost layer are the second most important influence on vegetation (Sheard and Geale 1983).

Although it is in the continuous permafrost zone, the Mackenzie Delta has a relatively complex flora. It is a northward extension of the boreal forest due to the warming influence of the Mackenzie River (Gill 1973). There is a distinct succession of plant species that result on the Delta, which is initiated by flooding. Floods deposit sediments, and levees are gradually formed through alluviation.

Gill (1973) describes five successional stages on the Delta. They reflect a transition moving away from the shore of main river channels, distributaries, and tributaries. The first stage, which is closest to the water, occurs when water horsetail (*Equisetum fluviatile*) colonizes freshly deposited sediments. It is replaced further inland by a *Salix-Equisetum* association, in which felt-leaf willow (*Salix alaxensis*) forms the canopy and common horsetail (*Equisetum arvense*) makes up the understorey. These early stages of succession are maintained by frequent flooding. The vegetation pattern observed in these early successional stages exists as the Mackenzie Delta empties into the Beaufort Sea (Pearce et al. 1988). Flooding becomes more prevalent closer to the sea, and consequently the vegetation rarely reaches late successional stages. The outer delta and seaward alluvial islands are home to hardier, flood resistant plants.

Six plant species of national significance are found in the Mackenzie Delta region (McJannet et al. 1995), and may occur in the Ellice, Langley and Mallik blocks (Table 8).

TABLE 8

VEGETATIVE SPECIES OF SIGNIFICANCE FOUND IN THE VICINITY OF THE PROPOSED PROJECT

Common Name	Latin Name	Phytogeography	Habitat	NCR[1]
Pussytoes	*Antennaria friesiana*	Arctic-alpine	Alpine ridges and snowbeds.	N3T1
Mustard	*Braya pilosa*	Arctic	Sandy seashores.	NX
Pondweed	*Potamogeton subsibiricus*	Aquatic	Still waters.	N2
Goose grass	*Puccinellia poacea*	Arctic	Riverbanks, flood plains and tidal flats.	N1
Buttercup	*Ranunculu*	Arctic-alpine	Coasts and estuaries	N2
Willow	*Salix ovali*		s and terraces.	N2T2

1772
Ellice & Mallik
Winter
2001-2002

Notes:
1. The Nature Conservancy F
   - Canada Rank (N): na
   - Taxon Subrank (T): a
2. The degree to which a spe ly rare to abundant), with X indicating the species is extirpated o

11.8 Wildlife

Chevron's Ellice, Langl f terrestrial mammals including Arctic fox, caribou, griz Portions of the proposed program also extend into marine Bay, containing marine mammal habitat. Polar bear and f the proposed program area. A number of these species are important to local subsiste s as well as recreational users. Inuvialuit Wildlife and Environmental Monitors will be present during the program to help manage potential wildlife conflicts as the program progresses. Mammal species of concern are listed in Table 9 because of their sensitivity or importance for subsistence.

Caribou (*Rangifer* spp.)

Three subspecies of caribou are found in the ISR: barren ground caribou (*Rangifer tarandus groenlandicus*), Grant's caribou (*R. t. granti*), and Peary caribou (*R. t. pearyi*). Barren ground caribou are the most abundant of these subspecies, and three distinct populations have been identified based on the location of their calving grounds: Bluenose-East, Bluenose-West, and Cape Bathurst. The proposed program coincides with the home range of the Bluenose-West herd (TCCP 2000).

The Bluenose-West herd range reaches its westernmost extent slightly east of Campbell Lake (southeast of Inuvik), its northernmost point at the North Head of Richards Island, its easternmost point slightly east of the boundary between the ISR and the Territory of Nunavut, and its southernmost extent slightly south of Colville Lake in the Sahtu Settlement Area (RWED 1999). The combined population of the Cape Bathhurst-Bluenose West herds was estimated at 88,000 to 106,000 individuals in 1992 (AICCP, IICCP, and TCCP 2000).

Caribou are highly migratory, and migration patterns are well established. In spring, cows lead the herds northward from wintering habitat in the boreal forest to calving grounds and summer ranges on the coastal tundra (Dome et al. 1982b). The migration tends to follow frozen lakes and rivers, as well as open, snow-free uplands and eskers (CWS 2000a). Important calving areas include the Brock, Hornaday, and Horton rivers (AICCP, IICCP, and TCCP 2000), located to the east and outside the proposed program area. Calves are born between late May and early June. Intensive grazing starts shortly after calving and continues throughout the summer. Herds move to mating grounds in October. These herds overwinter north, east, and southeast of Inuvik (AICCP, IICCP, and TCCP 2000).

RWED has initiated a Bluenose-West/Cape Bathurst caribou herd satellite tagging program. The study will provide information on caribou locations during the winter months to better understand habitat use and assess effects of exploration activities on the herd.

Grizzly Bear (*Ursus arctos*)
There are three distinct populations of grizzly bears in the ISR: arctic coastal, arctic mountain, and barren ground. Both arctic coastal and barren ground grizzlies are found in the vicinity of the proposed program, residing there year round, albeit in low densities. Particularly important habitat for these populations includes Richards Island (TCCP 2000), where the Mallik program is proposed. The proposed program area also falls within critical denning habitat of the Richards Island-Tuktoyaktuk Peninsula range (TCCP 2000) (see Table 5, Section 8.0, Traditional and Other Land Uses). The Ellice and Langley blocks fall within the Inuvik Grizzly Bear Management Area, while the Mallik block is located within both the Inuvik and Tuktoyaktuk management areas (TCCP 2000).

Grizzly bears require large areas for feeding (Knight 1977). Grizzly bears are omnivorous, primarily feeding on vegetation but taking advantage of higher energy food sources when available (AICCP, IICCP, and TCCP 2000). Habitat structure is very important for territory selection. In all parts of their range, grizzlies prefer open or semi-open forests (Dome et al. 1982a). In contrast, dens are found in association with thick vegetative cover, particularly willow and alder. This likely provides structural stability to the soil and aids in snow accumulation above the den (Harding 1976, Martell 1984). Denning areas are quite specific and are usually found on banks of lakes, creeks, or rivers (Harding 1976, Martell 1984), and occasionally in pingos or snowdrifts (Harding 1976). Grizzly bears typically den from October to May (AICCP, IICCP, and TCCP 2000). They breed in June and July, and females have a pair of cubs every four to five years (AICCP, IICCP, TCCP 2000).

Arctic Fox (*Alopex lagopus*)
Arctic fox are widespread in northern Canada and are commonly found above tree line in tundra, forest-tundra, and often near coastal areas (Martell et al. 1984). Throughout most of their range, Arctic fox are terrestrial animals. However, foxes from Arctic coastal populations generally move onto the near-shore landfast ice during winter (Dome et al. 1982a). In the Mackenzie Delta region, Arctic fox are associated with coastal areas from Herschel Island to Shallow Bay, Kendall and Hooper Islands, parts of the Tuktoyaktuk Peninsula and from Cape Dalhousie to Bathurst Peninsula (Martell et al. 1984). During spring and summer they occupy areas near terrestrial denning sites, remaining there during the relatively snow-free period from May until August (Dome et al. 1982a). Den construction occurs in areas of early snow melt where soils are well drained and stable (Martell et al. 1984). Important known denning sites in the coastal Mackenzie Delta region includes the coast of Richards Island (Dome et al. 1982a).

TABLE 9

MAMMAL SPECIES OF CONCERN POTENTIALLY FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species [1]	Habitat	Program Interaction	COSEWIC [1]
TERRESTRIAL MAMMALS			
Arctic fox[2] (*Alopex lagopus*)	Widespread above treeline and coastal areas. Herschel Island to Shallow Bay, Kendall and Hooper Islands, parts of the Tuktoyaktuk Peninsula, and from Cape Dalhousie to Bathurst Peninsula.	All blocks overlay potential habitat, including winter habitat on near-shore ice and denning habitat on the Richards Island coast.	Not listed
Caribou[2] (*Rangifer tarandus*)	Hornaday, Brock and Horton Rivers area for calving, winter habitat northeast of Inuvik. Upland habitats with abundant lichen cover.	Mallik block overlap with Bluenose-West range.	Not listed
Grizzly bear (*Ursus arctos*)	Prefers open areas of alpine tundra, subalpine mountains or subarctic tundra. Richards Island, Kugaluk River, delta.	Critical denning habitat near southern Mallik block.	Special Concern
Muskrat[2] (*Ondatra zibethicus spatulatus*)	Mackenzie Delta, Mackenzie River Valley, coastal Beaufort region. Lakes and ponds with aquatic vegetation where water does not freeze to the ground.	Potential habitat in terrestrial areas of all blocks.	Not listed
Wolf[2] (*Canis lupus arctos*)	Treeline-tundra transition zone. Bluenose caribou wintering range. Caribou Hills.	Variable and infrequent.	Data deficient
Wolverine (*Gulo gulo*)	On tundra between treeline and arctic coasts. North Slope, Cache Creek, Sheep Creek, Big Fish River, Foothills west of Aklavik. Relatively few in delta.	Infrequent, natal dens in rocky scree slopes or large snowdrifts in all blocks.	Special Concern
Moose[2] (*Alces alces andersoni*)	Husky Lakes, Sitidgi Lake, Miner River	Riparian/floodplain areas of all blocks.	Not listed
MARINE MAMMALS			
Polar bear (*Ursus maritimus*)	Southern broken edge of the arctic ice pack. Less use of delta region during summer and fall.	Landfast ice extent of blocks as well as denning habitat within vicinity of Mallik block, and infrequent denning habitat in other blocks.	Special Concern
Ringed seal[2] (*Phoca hispida*)	Widespread across Beaufort Sea. Winter in large bays off Amundsen Gulf and inshore Tuktoyaktuk Peninsula and Banks Island.	Inshore landfast ice areas near northern extent of all blocks.	Not listed
Beluga whale (*Delphinapterus leucas*)	Subarctic and Arctic waters. Winter in the Bering Sea. Summer in eastern Beaufort Sea, Amundsen Gulf, and Mackenzie estuary.	Limited by winter timing of program.	Not listed

Notes:

1. Committee on the Status of Endangered Wildlife in Canada 2000.
   Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural events.
   Data deficient = A species for which there is insufficient scientific data to support status designation.
   Not listed = A species which does not appear in COSEWIC documentation.
2. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.

Movements and fluctuations of coastal populations are related to the availability and abundance of prey species and appropriate denning sites (Macpherson 1969, Banfield 1974, Dickinson and Herman 1979 *all in* Dome et al. 1982a). Arctic fox may move great distances over the course of the year in response to low food supplies in customary hunting areas. In the southern Beaufort Sea region a regular migration occurs from Banks 1sland out to the sea ice in winter. Similar migrations occur off the outer Mackenzie Delta and Tuktoyaktuk Peninsula, at times in mass movements (Martell et al. 1984).

Arctic fox are mainly solitary until they form breeding pairs in mid February to late April (Dome et al. 1982a). As landfast ice is at or near its maximum winter extent during this time, it can be assumed that courtship and mating often occurs offshore on landfast ice. Mating pairs then move onshore to occupy dens often excavated the previous summer. Dens are generally found in light, stable, sandy soils in river banks, eskers or small hillocks (Banfield 1974). Litters of+ 8 to 20 young are born between mid May and mid June (TCCP 2000). In years of low prey abundance, the breeding season may be late or missed entirely (Banfield 1974).

Arctic foxes are highly opportunistic and are known to scavenge on the sea ice on the remains of seal carcasses killed by polar bears (Dome et al. 1982a, Banfield 1974). While lemmings, Arctic hares, and ptarmigans are also available to hunt during the winter season, carrion plays a more important role in their diet. Foxes inhabiting coastal regions also hunt for fish, including burbot, Arctic cod, salmon, and char, as well as small marine animals and birds.

Moose (*Alces alces andersoni*)

Moose are generally solitary. They commonly range throughout the boreal forest and occasionally the forest-tundra transition zone or tundra areas (Kelsall 1972 *in* Dome et al. 1982a). The western limit of moose range extends into the proposed program area (TCCP 2000).

Winter habitat is extremely important for moose (Gasaway and Coady 1974 *in* Dome et al. 1982a). Early successional-stage vegetation, which is found in riparian areas or recently burned areas (willows, birch, alder), provides good quality winter moose habitat (Dome et al. 1982a). The fast-flowing braided streams and rivers on the west side of the Mackenzie River provide optimum winter habitat because the annual torrents of meltwater and ice scour the banks and floodplains which keep the riparian vegetation at an early successional stage (Watson et al. 1973).

Muskrat (*Ondatra zibethicus spatulatus*)

In the 1SR, muskrats occur in particular concentrations in the Mackenzie Delta and coastal Beaufort region (Dome et al. 1982a, 1982b, TCCP 2000). This species is likely most abundant in standing water habitats of the upper Mackenzie Delta and adjacent areas (Dome et al. 1982a, Martell et al. 1984).

Muskrats burrow into the banks of lakes and streams in areas where aquatic plants are accessible for food and building materials (Dome et al. 1982a, 1982b, Jelinski 1989). Severe climate in the arctic restricts the number of waterbodies suitable for muskrats (Dome et al. 1982a). The optimum depth of water required to support muskrat in winter is between 1.2 m and 3 m (Hawley 1974 *in* Dome et al. 1982a). Prior to the onset of winter, muskrats relocate to areas of deeper water, and burrow in higher, steeper banks (Dome et al. 1982a). This shift appears to maintain the accessibility of food, and allows muskrats to forage on high-energy roots and rhizomes of submerged aquatic vegetation, thereby increasing overwinter survival. Muskrats are able to swim considerable distances under the ice to reach foraging areas. The winter range is often extended by the construction of pushups, which are small mounds of vegetation and mud built over holes in the ice that provide cover for feeding (Dome et al. 1982a, 1982b, Martell et al. 1984). An intermediate number of muskrat pushups on Richards Island have been recorded (Slaney 1974a *in* Dome et al. 1982a).

Wolverine (*Gulo gulo*)
The distribution of wolverines is circumpolar in tundra and tundra-taiga zones (Landa et al. 1998). The species is a solitary resident of tundra, boreal forest and mountainous regions (Banci and Harestad 1990). In the ISR, wolverines are found at low population densities throughout the tundra (Martell et al. 1984, Wilson et al. 2000). Wolverines are also found throughout the year in the forests of the Mackenzie Delta region (Martell et al. 1984).

While not considered migratory, the wolverine may roam large areas in search of food (Wilson et al. 2000), and has been known to travel up to 45 km per day through dispersal corridors (TCCP 2000). Although wolverines are highly mobile and maintain large home ranges, most individuals exhibit fidelity to discrete areas, particularly their natal site (Wilson et al. 2000). Movement patterns, home range size, and density estimates have not yet been made for the wolverine populations in the ISR (TCCP 2000).

Wolf (*Canis lupus*)
In the ISR, wolves occur in forested and tundra habitats and are closely associated with various species of ungulates, including caribou, moose, muskoxen and sheep (Banfield 1974). A wolf research program undertaken by RWED in the Western Arctic from 1987-1993 indicated that wolves also commonly occur in the Caribou Hills (Clarkson and Liepins 1989), located to the southeast of the proposed program area.

Wolf packs establish well-defined territories when the predominant prey species is non-migratory (Mech 1970, Peters and Mech 1975 *both in* Dome et al. 1982). During the winter, packs often hunt over long distances along ridges, trails, seismic lines, lakeshores, and frozen lakes and rivers (Mech 1970, Peters and Mech 1975 *both in* Dome et al. 1982a). Wolves that live within migratory caribou ranges prey primarily on caribou and do not appear to be territorial, moving as required to remain with the caribou herds (Heard and Williams 1992). Studies in northern areas have indicated that other prey items include beaver, small mammals, snowshoe hares, birds, and vegetation (Theberge and Cottrell 1977, Stephenson 1978 *both in* Dome et al. 1982a).

Polar Bear (*Ursus maritimus*)
The polar bear is circumpolar in distribution and ranges in Canada from the pack ice of the Arctic Ocean and High Arctic Islands to southern James Bay (Stirling et al. *in* Olson et al. 1984, Dome et al. 1982a). In the Canadian Beaufort-Amundsen Gulf region there are two relatively discrete polar bear populations; one associated with the west coast of Banks Island and the other with the mainland coast (Dome et al. 1982a). From freeze-up in the fall to break-up in the spring, polar bears are generally restricted to areas with sea ice, although they prefer areas with suitable combinations of pack ice (preferably relatively free of snow cover), open water and land (CWS 1992). Following break-up, the distribution of polar bears is often governed by prevailing winds causing drifting of the ice (Martell et al. 1984). Bears concentrate along offshore ice adjacent to series of leads and on unstable ice (Martell et al. 1984). A study looking at Canadian Beaufort data from 1971 to 1979 showed that during the winter and spring, most adult males, non-breeding females, females with yearlings and two year olds, and subadults preferred the ice floe edge and areas of moving ice with $7/8^{th}$ or more ice cover (Stirling et al. 1975, Stirling et al. 1981b *both in*

Dome et al. 1982a). This is likely due to the accessibility of seals in these areas. In contrast, adult females with cubs-of-the-year preferred stable landfast ice with deep snow drifts along the pressure ridges (Stirling et al. 1981b *in* Dome et al. 1982a).

Pregnant females use coastal lands in the winter for denning sites. Primary denning areas in the Canadian Beaufort Sea include coastline from Kay Point to Kugmallit Bay (TCCP 2000), the west and south coasts of Banks Island, and to a lesser extent, the west coast of Victoria Island, while the coastal mainland is used infrequently (Stirling et al. 1975, 1981b *in* Dome et al. 1982a). A study by Stirling et al. (1981b *in* Dome et al. 1982a) identified a maternity den on the ice offshore of Richards Island. The Mallik block of the proposed program area overlaps the near shore denning habitat that includes parts of Richards Island and the Big Lake Delta Plain. Denning on pack ice is known to occur in the Alaskan part of the Beaufort Sea (Martell et al. 1984, Lentfer 1975 *in* Dome et al. 1982a). During late March or early April, females and their new cubs are found on landfast ice, preying on ringed seals (Dome et al. 1982a).

Mating occurs during April to May, and at times in June, when polar bears are out on the pack ice hunting seals (CWS 1992). The reproductive potential of bears in the Delta region varies with nutritional state. Maternal dens are usually excavated in snow banks on coastal hillsides or, less commonly, on the sides of pressure ridges of ice, and occupied by pregnant females for 160 to 170 days from early November through to late March or early April (Dome et al. 1982a, Banfield 1974). Cubs are born in December and January, emerging from the den in the spring, and usually remain with their mothers for 1 to 2 years. Starting in mid November, non-breeding females and adult males spend 115 to 125 days and 50 to 60 days respectively in hibernation (Banfield 1974).

Ringed Seal (Phoca hispida)
Ringed seals in the Mackenzie Delta region maintain a highly variable population, with approximately 37,000 animals (Martell et al. 1984). Each winter, a portion of this population remains offshore from the Mackenzie Delta and concentrates wherever breathing holes may be maintained near landfast ice (Martell et al. 1984). During winter, breeding adults are known to occupy to a lesser extent, the inshore landfast ice areas of Tuktoyaktuk Peninsula. Subadults and non-breeding adults typically concentrate in open leads and areas of thin ice in the transition zone during winter and spring (Stirling et al. 1977 *in* Dome et al. 1982a). Pupping occurs from late March to early May in snow lairs on landfast ice, with secondary pupping habitat in the waters extending approximately 145 km north of the proposed program area. The ringed seal is an important element of the arctic marine ecosystem, both as a main prey of polar bears and as a major consumer of marine fish and invertebrates (TCCP 2000, Lowry et al. 1980, Smith 1987).

Beluga Whales (*Delphinapterus leucas*)
Beluga whales typically begin arriving in the Canadian Beaufort Sea in mid May (Fraker 1977c, 1979, Braham et al. 1977 *all in* Dome *et al.* 1982a). The spring migration occurs through offshore leads similar to those used by bowhead whales. A portion of the Beaufort Sea seasonal population concentrates in the Mackenzie River estuary during July and August but most of the population remains in offshore waters of the Beaufort Sea and Amundsen Gulf (Davis and Evans 1982, Richard et al. 1997). The migration of belugas into the Mackenzie Bay region is typically along the remaining landfast ice edge off the Tuktoyaktuk Peninsula, across northern Kugmallit Bay, and along the northeast and north coasts of Richards Island (FJMC 1998; Fraker 1977c *in* Dome et al. 1982a). The Ellice program is located 2.5 km from the Mackenzie Bay Beluga 1A Management Zone at its closest point, and operations do not coincide with the presence of beluga.

11.9 Birds

Very few species of birds are adapted to overwinter in the Mackenzie Delta Region. The vast majority migrate into or through the area to nest, raise young, molt, and accumulate fat reserves, before returning south in the fall to overwinter in other regions (Martell et al. 1984). The Mallik and Langley blocks of the proposed Chevron program are in the vicinity of the Kendall Island Bird Sanctuary. It is an area of high use for breeding by geese and other waterfowl during the spring and summer. Migrating species are not likely to be found in the program area when activities are occurring, as they move south for winter by early September and do not generally arrive in spring until mid May. Birds that may overwinter in the area include the snowy owl and gyrfalcon, as well as both species of ptarmigan found in the ISR. Table 10 shows bird species of concern, because of their sensitivity or importance for subsistence, with habitat or populations that may be found within the vicinity of the proposed program.

11.9.1 Migratory Birds

Various species of waterfowl, raptors and shorebirds utilize the Mackenzie Delta and environs as migratory staging and nesting grounds. Waterfowl migrating into the Mackenzie Delta region use staging areas in the spring for resting and feeding. Depending on the location of their overwintering areas, waterfowl may reach the Delta area by inland or coastal migratory routes. Most species of waterfowl and raptors arrive at their nesting grounds by early June (Johnson and Herter 1989). Tundra swans (*Cygnus columbianus*) arrive on nesting grounds in mid-May (Stewart and Bernier 1989). Mallards (*Anas platyrhynchos*) arrive in the area from mid to late May (Johnson and Herter 1989). Loons (*Gavia* spp.) and White-fronted geese (*Anser albifrons frontalis*) arrive in late May and early June (Dome et al. 1982a, Bailey et al. 1933 *in* Johnson and Herter 1989). Some migratory raptors may move into the area relatively early in the season, including Red-tailed hawk (*Buteo jamaicensis*) in early April and migratory golden eagles (*Aquila chrysaeto*) in mid-March (Savage 1985).

Many species of shorebirds migrate through the Mackenzie Delta and Beaufort Sea regions during spring and fall. Concentrations of several species feed together in coastal bays, estuaries and in the nearshore Beaufort Sea in late summer prior to southward migration (Hawkings 1987, Alexander et al. 1988, 1991, Johnson and Herter 1989). The Eskimo curlew (*Numenuis borealis*) has been designated as 'endangered' by COSEWIC and has been unofficially sighted only occasionally in recent years in the woodland zones of the Mackenzie Delta (COSEWIC 2000).

Waterfowl start to move to staging areas in preparation for fall migration by about mid-August (Martell et al. 1984). Some migratory bird species do not leave the area until most waterbodies are frozen in late September (Johnson and Herter 1989). The migration of White-fronted geese from the area is gradual, beginning possibly as early as mid-August and continuing until late September or early October (Barry 1967 *in* Dome et al. 1982a). Greater scaup (*Aythya marila*) may be present in the area until late September (Johnson and Herter 1989). All of these species will have left the proposed area of operations prior to program commencement.

TABLE 10

BIRD SPECIES OF CONCERN FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species	Habitat	Program Interaction	COSEWIC [1]
WATERFOWL AND SHOREBIRDS			
Long-tailed duck[2] (*Clangula hyemalis*)	Coastal and tundra ponds during summer; large lakes, bays, estuaries, and ocean during migration.	Limited to transient periods of migration and impacts to habitat.	Not listed
Eskimo curlew (*Numenuis borealis*)	Formerly bred in the tundra and woodland transition zones of the Mackenzie District.	Low potential though generally unknown.	Endangered
Lesser snow goose[2] (*Chen caerulescens caerulescens*)	Kendall Island during nesting, bays, estuaries, and ocean during migration	Limited to transient periods of migration and impacts to habitat.	Not listed
White-fronted goose[2] (*Anser albifrons frontalis*)	Polynas and leads on open water in the Mackenzie Delta, limited to the transient periods of spring and fall migration	Limited to transient periods of migration and impacts to habitat.	Not listed
Red-throated loon[2] (*Gavia stellata*)	Coastal and tundra ponds during summer; large lakes, bays, estuaries, and ocean during migration.	Limited to transient periods of migration and effects to habitat.	Not listed
Yellow billed loon[2] (*Gavia adamsii*)	Arctic tundra on large lakes or in backwater areas of flooded rivers. Winter in the Gulf of Alaska.	Limited to transient periods of migration and impacts to habitat.	Not at risk
Shorebirds (*Phalaropus spp., Calidris spp.*)	Coastal and tundra marshes during summer, bays, estuaries, and ocean during migration	Limited to transient periods of migration and impacts to habitat.	Not listed
Tundra swan[2] (*Cygnus columbianus columbianus*)	Coastal and tundra marshes during summer, bays, estuaries, and ocean during migration	Limited to transient periods of migration and impacts to habitat	Not listed
RAPTORS			
Golden eagle[2] (*Aquila chrysaetos*)	Mountain forests and open grasslands; can be found in any habitat during migration. Willow River, Fish Creek, First Creek, Mackenzie delta.	Limited to transient periods of migration and impacts to habitat.	Not listed
Gyrfalcon[2] (*Falco rusticolus*)	Arctic tundra and rocky cliffs near water, nests in cliffs and occasionally trees. Richardson Mountains.	Aircraft use or other disturbance near any rocky outcrops or other suitable nesting areas.	Not at risk
Peregrine falcon (*Falco peregrinus tundrius*)	Coastal areas, nests on cliffs and occasionally trees, hunts over open tundra habitats. Richardson Mountains.	Limited to transient periods of migration and impacts to habitat.	Special Concern
Rough-legged hawk[2] (*Buteo lagopus*)	Coastal areas with suitable cliff nesting habitat. Richardson Mountains and Herschel Island.	Limited to transient periods of migration and impacts to habitat.	Not listed
Short-eared owl (*Asio flammeus*)	Open habitat in the winter, prairies, grassy plains or tundra in the summer.	Limited to transient periods of migration and impacts to habitat.	Special Concern
Snowy owl[2] (*Nyctea scandiaca*)	Coastal areas. Open tundra during breeding. Prefers to nest on elevated ground.	Open tundra near high points of land, erratics or rock promontories within any block.	Not listed
GROUND BIRDS			
Rock and Willow ptarmigan[2] (*Lagopus mutus and lagopus*)	Rock ptarmigan found in coastal areas and open tundra, forested areas east of the Anderson River in winter. Willow ptarmigan widely distributed throughout forest and tundra areas. Remain in burrows in snow during winter, emerging mid-day to feed	Limited to areas of tall shrubs and forest, not commonly found in any of the blocks.	Not listed

Notes:

1. Committee on the Status of Endangered Wildlife in Canada 2000.
   - Endangered = A species facing imminent extirpation or extinction.
   - Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural events.
   - Not listed = A species which does not appear in COSEWIC documentation.
   - Not at risk = A species that has been evaluated and determined to be not at risk.
2. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.

11.9.2 Overwintering Birds

A few bird species remain in northern areas throughout the winter, often moving locally in response to availability and abundance of food (Dome et al. 1982a). Raptors of concern that remain in the ISR year-round include the gyrfalcon and snowy owl (Fleck 1981, Savage 1985, Martell et al. 1984). Groundbirds that overwinter in the area include both species of ptarmigan found in the region.

Gyrfalcon (*Falco rusticolus*)
The chosen symbol of the Inuvialuit people and the world's largest falcon, the gyrfalcon resides in the ISR year-round and its breeding range includes the northern Mackenzie District, Banks Island, Prince Patrick and Ellesmere Island (AOU 1983 *in* Johnson and Herter 1989). Gyrfalcons are known to nest on the North Slope of the Yukon and Northwest Territories, and in the British and Richardson Mountains (Platt 1975 *in* Dome et al. 1982a).

Gyrfalcons nest much earlier than most other raptor species. Pair formation may occur as early as February or March (Platt 1976b, Roseneau et al. 1981 *both in* Dome et al. 1982a). The species nests primarily on cliffs, bluffs and outcrops, but they will occasionally nest in trees (Cade 1960, White and Roseneau 1970, White and Cade1971, Kuyt 1980 *all in* Dome et al. 1982a and 1982b). Some adults will remain near their nests all winter (Platt 1976b, Roseneau et al 1981 *both in* Dome et al. 1982a). The winter range of the gyrfalcon in North America includes the majority of its breeding range, especially for adult birds and during years of abundant prey (AOU 1983, Palmer 1988 *in* Johnson and Herter 1989).

Snowy Owl (*Nyctea scandiaca*)
The most numerous of the arctic owls, this species was at one time harvested by the Inuvialuit for food (TCCP 2000). The snowy owl's wintering range extends from the northern extremities of the contiguous 50 states to the Arctic Archipelago. The snowy owl winters in all types of habitats, but prefers open rangeland, prairie or tundra environments, and therefore may be observed in the vicinity of the program area. During breeding, snowy owls are found on the open tundra (Parmelee 1972). Individuals who do not spend the entire winter in the tundra begin the northward migration to the arctic breeding grounds in February and March (CWS 1991).

11.10 Fish

Many fish species occur in the freshwater and marine environments of the mainland western Arctic. Fish species of concern, because of their sensitivity or importance for subsistence, that are found within the vicinity of the proposed program are listed in Table 11. Species discussed include those with known overwintering habitat within the vicinity of the proposed program.

Fish populations are most sensitive to environmental disturbance during spawning, incubation, emergence, rearing, overwintering and migration (Dome et al. 1982a). Overwintering success of any fish species in the arctic is influenced primarily by the amount of overwintering habitat available and the quality of the habitat in terms of its ability to support fish. Many of the water bodies in the arctic coastal plain are too shallow to support fish during the winter when ice depth can approach 2 m. Fish that remain in water that is less than 2 m deep after ice formation will likely perish (Reynolds 1997 *in* Truett and

TABLE 11

FISH SPECIES OF CONCERN FOUND IN THE VICINITY OF THE PROPOSED PROGRAM

Species	Habitat	Spawning Period	COSEWIC [1]
FRESHWATER			
Arctic cisco[2] (*Coregonus autumnalis*)	Mackenzie River and estuary, tributaries to the Mackenzie (spawning habitat - inland lakes).	Fall	Not listed
Arctic grayling[2] (*Thymallus arcticus*)	Kugalak River, coastal rivers of North Slope. Occasionally Richards Island.	Spring	Not listed
Broad whitefish[2] (*Coregonus nasus*)	Several overwintering areas in East Channel and Whitefish Bay. Tuktoyaktuk Harbour, Mason Bay, Mallik Bay, Shallow Bay, streams of Tuktoyaktuk Peninsula, spawning throughout the Mackenzie system.	October, November	Not listed
Burbot[2] (*Lota lota*)	Mouths of creeks. Winter and spring may be abundant in fresh or brackish waters of Kugmallit Bay's coastal embayment.	January – March	Not listed
Deepwater sculpin (*Myoxocephalus thompsoni*)	Habitat preferences are not known. Spawning areas are not known.	May and June	Threatened
Inconnu[2] (*Stenodus leucichthys*)	Mackenzie River and estuary (rearing habitat). Turbid lakes on Richard Island throughout summer, Mallik and Mason Bays.	Late September – early October	Not listed
Lake trout[2] (*Salvelinus namaycush*)	Outer delta lakes (including minor channels) with high oxygen levels, a good connection to adjacent water bodies, small to moderate volumes available and poor to moderate water quality.	Fall	Not listed
Lake whitefish[2] (*Coregonus clupeaformis*)	Lakes and large rivers, brackish coastal waters	Late September	Not listed
Least cisco[2] (*Coregonus sardinella*)	Mackenzie River and estuary, tributaries to the Mackenzie (spawning habitat), inland lakes. Inner Shallow Bay / Niakunak Bay and Kugmallit Bay are important overwintering and nursery areas.	Early October	Not listed
Northern pike[2] (*Esox lucius*)	Tributaries, creeks and shallow lakes in Mackenzie delta.	Early spring	Not listed
SALTWATER			
Blue herring[2] (*Clupea spp.*)	Mackenzie River and estuary, tributaries to the Mackenzie, inland lakes.	Late June	Not listed
Dolly Varden[2, 3] (*Salvelinus malma*)	Fish Hole, Rat River, Big Fish River, Fish Creek, Babbage River, Peel River, Shingle Point, occasionally travel the Mackenzie near Inuvik and Aklavik. Travel from stream to stream along the Beaufort Coast.	August, early September	Not listed
Fourhorn sculpin (*Myoxocephalus quadricornis*)	Lakes and streams of the Arctic archipelago.	May and June	Special Concern

Notes:
1. Committee on the Status of Endangered Wildlife in Canada 2000.
   Threatened = A species likely to become endangered if limiting factors are not reversed.
   Special Concern = A vulnerable species because of characteristics that make it particularly sensitive to human activities or natural event
   Not listed = A species which does not appear in COSEWIC documentation.
2. Species are included due to their listing in Community Conservation Plans as species of interest or declining in population.
3. Historically, fish of the genus Salvelinus caught along the Beaufort Sea coast have been identified as Arctic char (Salvelinus alpinus). Haas and McPhail (1991) note that Dolly Varden char (*Salvelinus malma*) are formally separated from the Arctic char complex.

Johnson 2000). Increased survival rates are seen in species that feed in warm, shallow water during the summer and overwinter in deeper water (Truett and Johnson 2000). Within the proposed program area there are some lakes with the potential to overwinter fish, particularly within the Mallik block located on Richards Island. Near-shore and estuarine areas, such as Mallik Bay, also provide important overwintering habitat for some species (Sekerak et al. 1992).

Several studies have been conducted on fish and fish habitat within the Mackenzie River Delta. Research indicates the Delta provides overwintering habitat for a variety of fish species. Large deep lakes with connections to river channels are used more extensively for wintering than are small channels. Overwintering data is found primarily in research conducted by Mann (1975) during three winter surveys in October and November 1974 and April 1975 at locations between Moose Channel and Shallow Bay. Fisheries resource information from scientific reports and land use map data were compiled by Sekerak et al. (1992) in order to describe overwintering habitats and to note the occurrence of each of the major fish species in different habitat types of the near-shore Beaufort Sea and Mackenzie River delta area.

In the context of this section, the term "anadromous" refers to fish that either spend most of their lives in the sea and migrate to freshwater to spawn (i.e. salmon and Arctic cisco) or to fish that migrate from freshwater to the sea, or vice versa, at some definite stage in their life cycle for purposes other than spawning (i.e. Dolly Varden and least cisco).

Northern Pike *(Esox lucius)*

The northern pike is primarily a freshwater fish, found in the warm waters of shallow lakes and bays or quiet rivers. Northern pike are found throughout the Mackenzie Drainage area and likely most of the Eastern Coastal Drainage area. In addition, pike frequent the brackish coastal waters near the mouths of rivers off Tuktoyaktuk Peninsula and Richards Island (Martell et al. 1984).

Northern pike spawn following ice melt in the spring (mid-June to early July). Spawning mainly occurs in heavily vegetated marshes, lakes and river floodplains (Scott and Crossman 1973). Following spawning, pike generally remain in shallow, warm waters for the duration of summer. Mature pike feed mainly on small fish, including small pike, and on small mammals and invertebrates. Pike move out of shallow waters to wintering habitats between mid-August and freeze-up. They often concentrate at the mouths of creeks in November and December. They require deep channels and lakes for overwintering (Martell et al. 1984), of which there are a limited number within the vicinity of the proposed program area. Identified overwintering lakes in the region include lakes located on Richards Island (Sekerak et al. 1992), including lakes within the Mallik program area.

Broad Whitefish *(Coregonus nasus)*

Broad whitefish are commonly found in coastal habitats that have an extensive freshwater influence (Percy 1975, Bond 1982, Lawrence et al. 1984, Bond and Erickson 1991, 1992). The life-history of broad whitefish in this area is dominated by the fact that the Mackenzie River is the only river that flows into the Beaufort Sea year round (Bond 1982, Lawrence et al. 1984). This continuous flow allows young-of-the-year broad whitefish to move in late winter within the freshwater plume under the landfast ice, eastward along the Tuktoyaktuk Peninsula, arriving at mouths of freshwater streams along the Tuktoyaktuk Peninsula during breakup (Bond 1982, Lawrence et al. 1984, LGL 1990). These yearlings then enter freshwater lakes along the peninsula where they spend 3 to 4 years before beginning a lifelong cycle of moving to coastal waters for summer feeding, and returning to overwintering sites in the Mackenzie Delta (Bond 1982, Lawrence et al. 1984). Coastal areas and bays along the Tuktoyaktuk Peninsula, as well as Mackenzie Bay, Mallik Bay, and the south coast of Kugmallit Bay, are important rearing areas for older juvenile and both spawning and non-spawning adult broad whitefish (Percy 1975, Kendel et al. 1975 *in* Dome et al. 1982a, Lawrence et al. 1984, LGL 1990). In August and September, the spawning portion of the population moves into the Mackenzie Delta prior to migrating to spawning habitat in October (Dome et al. 1982a). Broad whitefish mainly overwinter in lower Mackenzie drainage areas and along the Tuktoyaktuk Peninsula (Dome et al. 1982a, Sekerak et al. 1992). Within the vicinity of the proposed program area are several lakes on Richards Island that may provide suitable overwintering habitat for broad whitefish (Sekerak et al. 1992).

Arctic Cisco (*Coregonis autumnalis*)
Arctic cisco are already in coastal waters at the time of breakup and disperse both east and west of the Mackenzie Delta (Bond and Erickson 1987, 1989, 1991, 1992, LGL 1990). They are found up to 200 km eastward past the Tuktoyaktuk Peninsula in the Anderson River area (Bond and Erickson 1991, 1992, 1993) and westward at least as far as Demarcation Bay (Bond and Erickson 1987, 1989, LGL 1990, Griffiths et al. 1975). Some portion of Mackenzie Delta young-of-the-year Arctic cisco are carried to the west by easterly wind driven currents into the central Alaskan Beaufort Sea as far west as the Colville River (Fechhelm and Griffiths 1990, Fechhelm and Fissel 1988, Gallaway et al. 1983). These fish take up residence in the Colville River and remain in the central Alaskan Beaufort until they reach sexual maturity at ages 7 to 9 at which time they return to the Mackenzie River to spawn (Fechhelm and Griffiths 1990, Fechhelm and Fissel 1988, Gallaway et al. 1983).

The coastal waters are used primarily for feeding and prey items include benthic crustacea, amphipods, mysids, and small fish (TCCP 2000, Craig and Haldorson 1980 *in* Dome et al. 1982a). Although the coastal population includes both mature spawners and non-spawners the majority of Arctic cisco dispersed along the Beaufort Sea coast throughout the summer are juveniles (Bond and Erickson 1991, 1992, Griffiths et al. 1975, Craig and Haldorson 1980 *in* Dome et al. 1982a). The spawners tend to return to freshwater earlier in the summer than the rest of the population (Bond and Erickson, 1987, 1989, 1991, 1992, Dome et al. 1982a). Migration of mature males and females into tributaries of the Mackenzie River occurs during late July and early to mid September, apparently in two spawning runs (Dillinger et al. 1992). This behaviour may serve to spread any risk associated with migration, or may result from groups of differentially maturing fish (Dillinger et al. 1992). Once finished spawning in the fall, they return downstream to overwinter in the lower areas of the river delta (Dome et al. 1982a). However, there have been observations of immature fish and non-spawners wintering under the ice in areas such as Mallik Bay and Kugmallit Bay (Percy 1975) and in marine waters in Tuktoyaktuk Harbour (TCCP 2000, Lawrence et al. 1984, Bond 1982).

Least Cisco (*Coregonus sardinella*)
The least cisco is commonly known as 'big-eyed herring' (TCCP 2000). Some populations are anadromous, spawning in fresh water and spending the remainder of their life in marine environments, while others remain in freshwater lakes all year. The freshwater least cicso occurs in offshore waters, coastal regions, lakes, and rivers. This population spawns from mid-September to after freeze-up (Martell

et al. 1984). Areas of important overwintering habitat for the least cisco include Inner Shallow Bay and Kugmallit Bay (TCCP 2000). Mallik Bay has also been identified as Least cisco overwintering habitat (Sekerak et al. 1992).

Burbot (*Lota lota*)
Commonly known as 'loche', burbot is a freshwater species also found in brackish coastal waters, ranging from Herschel Island to Atkinson Point, with concentrations in the Kendall Island area (Percy 1975, Martell et al. 1984). This species generally prefers deep lakes (Martell et al. 1984). They are bottom-feeding predators, consuming sculpins, other burbot, smelt, and mysids on the coast (Percy 1975). The burbot spawns in late fall and early winter under the ice of lakes and rivers (Martell et al. 1984, TCCP 2000). In addition, estuarine coastal and nearshore marine areas, including Mallik Bay, have been identified as burbot overwintering habitat (Sekerak et al. 1992). In late winter and early spring, burbot move into tributary rivers before continuing on to deeper water in the summer, including the fresh or brackish waters of Kugmallit Bay (TCCP 2000).

Inconnu (*Stenodus leucichthys*)
Inconnu, commonly known as 'coney', are the largest member of the whitefish family. The species is often anadromous, making long migrations between freshwater and coastal areas, however exclusively freshwater populations do reside in some lakes (TCCP 2000). The preferred spawning habitat is characterized by gravel substrate in relatively shallow, fast-flowing, and clear water. Spawning usually occurs in late September, approximately 2-3 weeks prior to the average date of first ice formation. Important wintering habitat for both immature and mature inconnu in the lower Mackenzie Delta area includes the main channels and deeper parts of the outer delta, coastal embayments, and larger lakes of the inner delta. Mallik Bay has been identified as inconnu overwintering habitat (Sekerak et al. 1992). It is unclear if inconnu also overwinter in rivers (Howland et al. 2000).

The Mackenzie Delta Project Team compiled an Aquatic Resources Plan to address the concerns raised by DFO about the appropriate mitigation of impacts on fish and fish habitat. This Plan is attached in Appendix A, where proposed aquatic studies are outlined, as is proposed monitoring techniques for overpressure and various other hydrological parameters.

11.11 Cultural and Historic Resources

Cultural and historic resources include the physical traces of culture and societies from the past, as well as resources currently utilized by local people. Heritage sites recognized by Federal agencies are considered and these sites include: archaeological sites, historic structure sites, traditional trails, campsites, berry picking areas, sacred or medicinal plant picking areas, burial sites, ceremonial sites, traditional hunting grounds, and places associated with traditional names or legends.

11.11.1 Methods

Baseline information provided in this report was synthesized from existing archival records, maps, and air photos held in databases at the Prince of Wales Northern Heritage Centre. Records of known, mapped heritage resource sites on file at the Canadian Museum of Civilization were searched to identify sites within the project area.

In the summer of 2001, a heritage resource inventory was conducted to confirm the locations and extent of known archaeological sites. Field reconnaissance included aerial surveys and ground inspections. Potential impacts of the proposed program on archaeological and cultural resources are described in Section 12.0, Proposed Mitigation and Anticipated Environmental Impacts. located just outside of the project area.

11.11.2 Known Archaeological and Cultural Resources

Ellice and Langley

The programs are situated in the lowland delta environment of the Mackenzie Delta. Hydrological processes including fluvial erosion from changing water levels and stream flows significantly disrupt vegetation cover and lead to extensive landscape modification. The changing landscape decreases the likelihood of finding existing long-term heritage resources and tends to decrease their visibility. No new cultural or archaeological sites were recorded through field-testing in the summer of 2001 on Ellice Island. No field testing was completed on Langley because of the low potential for locating sites in the region, as well as the low potential for impacting any unknown sites.

Mallik

This program extends from the Mackenzie Delta lowlands to the upland tundra environment of Richards Island. The upland environment, in offering a well-drained ground cover with exposed sandy and gravel ridges, also offers moderate to high potential for the presence of heritage sites. Five archaeological sites having Borden designations NiTu-1, NiTu-2, NhTr-7, NiTt-1, and NiTt-2 are all located just outside of the project area. Five archaeological sites having Borden designations: NiTu-1, NiTu-2, NhTr-7, NiTt-1, and NiTt-2 are all located from 0.25 – 4.0 km (see Figure 5).

NiTu-1

NiTu-1 is located just south of Big Horn Point on north-central Richards Island. The site consists of two sharpened stakes of wood possibly used as tent pegs or hide stakes. Chevron's proposed program is located approximately ¼ km north of this site.

NiTu-2

NiTu-2 consists of two driftwood log structures. The first is a partially collapsed Mackenzie Eskimo grave or cairn. The second is a collapsed and dispersed log structure, which may have been a grave. The 3D seismic program proposed by Chevron is located approximately 2 km to the northeast of this site.

NhTr-7

NhTr-7 is a contemporary site with a relatively recent period of occupation of the last 50 years. It consists of three clusters of supplies (lumber, galvanized steel cable, and a bag of mixing cement) related to the construction of nearby navigation beacons. Chevron's proposed 3D seismic program is located approximately 2 km to the east of this site.

NiTt-1

NiTt-1 is a scatter feature or cultural-activity area consisting of fire-cracked rock, caribou and bird bones as well as evidence of tool making with the presence of chert flakes. The site is located in a sand blowout on the northeastern end of an unnamed lake. The 3D seismic program proposed by Chevron is located approximately 4 km at its closest point to the southwest of this site.

NiTt-2

NiTt-2 consists of a surface scatter of cultural activity consisting of bird, mammal and fish bone along with stone artifacts or tools evidenced by quartzite and chert flakes, a chert burin spall and a chert biface or bifacially-worked hand axe. The site is situated on the west side of an unnamed lake with the identifying coordinates delineating a triangular area. Chevron's proposed program is located approximately 2 km at its closest point southwest of this site.

TABLE 12

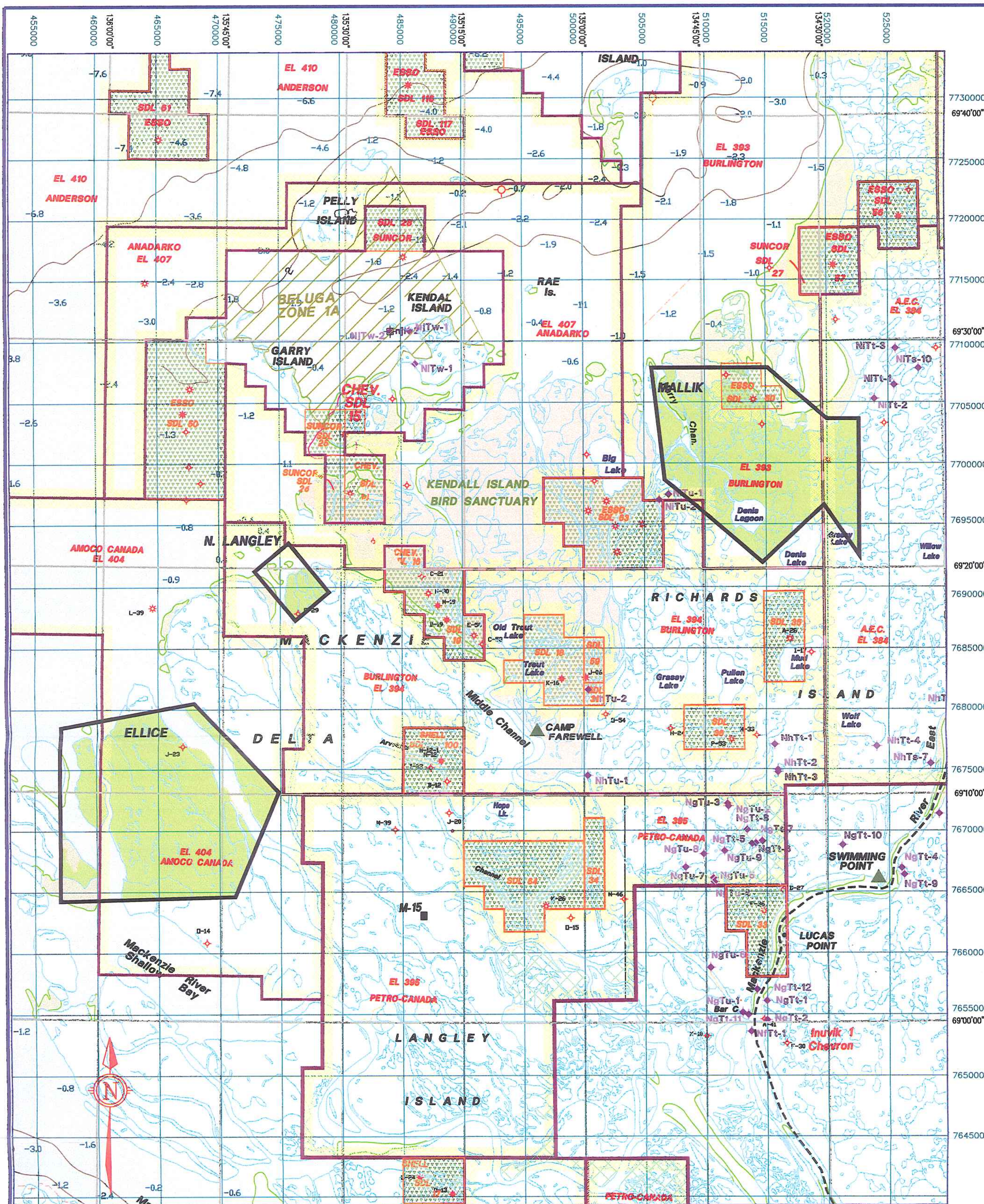
PREVIOUSLY RECORDED HISTORICAL SITES IN THE VICINITY OF THE PROPOSED SEISMIC PROGRAM

Site	Type	Coordinates	Location	Association	Distance To Project (Km)
NiTu-1	Isolated find	69°23'20"N 134°49'18"W	Located near a pingo just south of Big Horn Point on north central Richards Island.	Undetermined	~ ¼ km
NiTu-2	Burial	69°23'06"N 134°50'29"W	Located on a pingo on Richards Island about 1.5 km south of Big Horn Point	Indigenous historic	~ 2 km
Ni Tt-1	Surface scatter	69°19'49"N 133°47'41"W	Located in a sand blowout at northeastern end of unnamed lake.	Undetermined	~ 4 km
NiTt-2	Surface scatter	69°27'22"N 134°23'35"W 69°27'17"N 134°23'45"W 69°27'22"N 134°23'47"W	Located on the west side of an unnamed lake.	Prehistoric	~ 2 km
NhTr-7	Depot	69°19'49"N 133°47'41"W	About 80 m inland from eroding bank.	Contemporary	~ 2 km

Plate 2: NiTt-2: View northwest.

Plate 3: NiTt-1: View northeast.

Plate 4: NiTu-2: Log cairn atop pingo, log grave lower right.



LEGEND

PROPOSED 3D PROGRAM	
ARCHAEOLOGICAL SITES SHOWN THUS	◆
EXPLORATION LEASE (EL) BOUNDARY	
BASE CAMP SHOWN THUS	▲
EXISTING WELLSITE SHOWN THUS	
IKHIL GAS PIPELINE	

CHEVRON CANADA RESOURCES

FIGURE 5

ARCHAEOLOGICAL AND CULTURAL SITES VICINITY OF THE PROPOSED PROJECT

MACKENZIE DELTA, N.W.T.

SCALE : 1 : 300 000

Inuvialuit Environmental & Geotechnical Inc.

INUKSHUK Geomatics Inc.

DRAWN : B.T.	JOB NO. : 00–12115–MAP CHEV2001–PROJECT1–FIG5	
DATE : AUG. 16, 2001	REV NO: 0	

11.12 Field Reconnaissance

A field reconnaissance was undertaken of the proposed Ellice, Mallik and North Langley 3D seismic blocks on July 27 and 29, 2001 by Cynthia Pyć on behalf of the Mackenzie Delta Joint Project Team. The North Langley 3D block is located just north of the area where the South Langley 3D program was conducted during winter 2001. This area contains lowland delta vegetation exposed to annual spring flooding. Many areas are essentially mud-flats with very little vegetation present. During the aerial reconnaissance of the new proposed areas, an inspection of the South Langley 3D was conducted. Impacts from this program are negligible. From the air, lines are discernible in some locations as a line of darker vegetation. This can be attributed to the darker colour of new vegetation. When ground assessments were conducted, the lines were usually undetectable (Plate 5).

Plate 5: South Langley 3D with lines from 2001 visible on light green vegetation.

It is anticipated that the impacts on vegetation that may result from the North Langley and Ellice 3D blocks would be similar to those observed on the South Langley 3D, since the vegetation communities in these areas are similar, and because the same technology for conducting seismic is planned for this area.

The Mallik block located on Richards Island has vegetation communities similar to that found on the North Langley and Ellice blocks in lowland areas, particularly those in proximity to Beluga and Mallik Bay. Inland from the coastal portion of the Mallik block, vegetation communities of the upland delta are present. It is anticipated that the impacts on vegetation in this area will be similar to those observed during the Burlington 2D program, as the 3D block is situated to overlay this area, and the same equipment and seismic technology are planned for use in this area. Impacts on vegetation communities resulting from the Burlington 2D were observed as minimal and restricted to above-ground crushing of woody vegetation during inspection.

12.0 PROPOSED MITIGATION AND ANTICIPATED ENVIRONMENTAL IMPACTS

Chevron's proposed seismic program has been designed to acquire geophysical data, while mitigating impacts to the environment and land users. Without adequate mitigation, potential environmental impacts resulting from the winter seismic program may include temporary disturbance to terrain, soils, permafrost, vegetation, terrestrial wildlife, aquatic resources and other land uses. The following section and Table 13 identify how potential environmental and socio-economic impacts could arise during the seismic program. They also present recommended mitigative measures to avoid the potential impacts and the significance of the residual impacts. The assessment criteria and definitions used in assessing the significance of each potential impact are provided below.

The proposed mitigative measures to be used by Chevron and Veri Illuq should ensure no significant residual impacts will occur as a result of the project. General seismic activities will follow INAC *Environmental Guidelines: Northern Seismic Operations.* Best management practices that have been adopted by the seismic industry since publication of that document, and build on the experiences of the winter 2001 seismic work and July 2001 field inspections of the results.

12.1 Methodology

As detailed in Section 11.0 (Environmental Overview), determining environmental concerns, which may be encountered during the course of this project, included reviewing existing literature and maps, consulting with communities, conducting field reconnaissance and communicating with people knowledgeable about the area.

12.2 Implementation of Mitigation Measures

The goal of this section is to provide guidance for recommended environmental mitigation measures. It is important that the mitigation measures outlined in the project description are adhered to by the operator, the contractors, and the subcontractors.

12.2.1 Role of the Environmental Monitor and Wildlife Monitor

A qualified Inuvialuit Environmental Monitor and Wildlife Monitor will be utilized to provide supervision to ensure mitigation measures are implemented and environmental and wildlife concerns are addressed as encountered. The Environmental Monitor will take an active role in daily crew meetings, providing guidance and inspiring an environmentally-responsible work ethic. Daily meetings will provide an opportunity for the monitors to communicate concerns about observations in the field and to provide positive feedback about practices that are successful in mitigating impacts.

The program supervisor will be in daily or twice daily contact with the Environmental Monitor to ensure that the Monitor is aware of the status of operations and to assist the Monitor in acquiring knowledge about all phases of seismic operations. An established relationship between the Monitor and operational staff will facilitate communications in the event of an environmental incident. The Environmental Monitor will inform the Party Manager of incidents, which she/he deems to have the potential to cause unnecessary impact. The Environmental Monitor will prioritize her/his supervisory activities to reflect the potential significance of adverse impacts. It will also be the Environmental Monitor's responsibility to document relevant information for INAC and Chevron.

An Inuvialuit Wildlife Monitor will be employed for the duration of the program to mitigate impacts to wildlife in the vicinity of the program and to handle interactions between wildlife and crews or equipment. The Wildlife Monitor will have knowledge of the local area and experience handling firearms. The Wildlife Monitor will attend daily crew meetings and communicate wildlife sightings or environmental concerns to the Environmental Monitor.

12.2.2 Identification of Areas of Environmental Concern

Daily crew meetings are held in the field where environmental concerns that may be encountered during upcoming tasks and areas where improvement can be made are discussed. The Monitor will flag areas where environmental concerns warrant avoidance (for instance, where the permafrost is deemed to be particularly sensitive, areas where wildlife habitat is of concern and areas where vegetation should not be disturbed). The flagging will be a different colour than that used for program and ROW boundaries, and will be made known to all crew members during start-up meetings and subsequent tailgate meetings. Areas where heritage resources have been identified will be staked or flagged if located in close proximity to the program area.

Maps and/or diagrams indicating areas of environmental concern will be posted in a visible and accessible location within the seismic camp. Warning signs will be posted as indicated in Table 13 where traplines are present. Hunters and trappers will be notified of the proposed project and its progress by communication with the HTCs.

12.2.3 Permafrost and Soils

A continuous layer of permafrost underlies soils in the proposed project area. Biological processes and organic accumulation are slow in cold, shallow soils (Stonehouse 1999). Resistance, resilience, and recovery of vegetation depends on the presence of organic matter (Stonehouse 1999). The vegetation cover determines the thermal regimes within the soil (Stonehouse 1999). If vegetation is removed, the soil becomes warmer, the permafrost may melt and the ground may subside. Subsidence is non-reversible.

In order to minimize impact to permafrost and soils, line width will be limited to approximately 4 m, or as required to accommodate equipment and ensure safe working conditions (program details are provided in Section 4.0). Access and line preparation will be conducted under the guidance of the Environmental Monitor and will take place only under frozen ground conditions in order to limit soil disturbance

Overland access and line preparation will entail compaction of snow. A minimum of 15 cm of snow cover will be left on all access routes and a minimum of 15 cm on seismic lines to ensure the organic layer is not disturbed by the activities. Surface preparation for lines and access over frozen lakes and river channels will involve clearing snow from the ice and thickening of ice as required.

12.2.4 Vegetation

Few studies of human disturbance in the Arctic have documented long-term impacts to tundra vegetation from winter disturbance. In general, the highest recovery of vegetation following disturbance occurs on sites that are initially minimally impacted (Emers et al. 1995). The most visible impacts to vegetation communities result from changes to the physical environment (e.g. exposed soil and increased thaw depth).

The seismic lines are situated in areas of sparse vegetation, dominated by grasses, forbs (particularly horsetail (*Equisetum* spp.)), sedges and dwarf shrubs. The area is generally flat with visible patches of sediment often occurring between plants. It is expected that there will be no need for line clearing. Vegetation will be walked down along lines or access roads. A tracked unit will be used to lay cable along the line.

In tundra areas where dwarf shrub species, forbs and graminoids are covered by the snow pack, the disturbance by seismic lines is generally low. While compression of the above-ground plant material is likely to occur, the frozen ground and snow cover prevents root compression from occurring. Wetter vegetation types are often more heavily impacted because of less resistance of the substrate to equipment. However, these communities often recover faster, partly due to increased soil temperatures (Ignatenko and Pavlov 1988, Harper and Kershaw 1996), the mechanism of vegetative regrowth and the release of nutrients from increased decomposition immediately following disturbance (Emers et al. 1995). This is observed in the rapid recovery of cotton grass (*Eriophorum* spp.) in areas with initial minimal impact (Emers et al. 1995).

Frozen ground conditions, snow cover and the use of tracked vehicles will minimize impacts to vegetation communities. The number of passes made along the line will be kept to a minimum. In addition, overland travel of personnel and transport of equipment will be restricted to ice access and seismic lines.

12.2.5 Wildlife

Caribou

Caribou are sensitive to aircraft disturbance and typically respond to overflights by running (Maier et al. 1991, Harrington and Veitch 1991, 1992). However, their response is generally of short duration, often lasting only seconds (Maier et al. 1991, Harrington and Veitch 1991). Caribou are least disturbed by overflights during winter (Maier et al. 1991, Harrington and Veitch 1992). They are most easily disturbed during calving periods in spring and during peak insect abundance in summer (Maier et al. 1991, Harrington and Veitch 1992), and overflights at these times adversely affect calf survival (Harrington and Veitch 1992).

The type of aircraft also has significant effect on the magnitude of disturbance to wildlife. High-noise aircraft have a greater effect than low-noise aircraft and the response to helicopters is greater than to fixed-wing aircraft (Miller 1994, Ward et al. 1999). Wildlife may habituate to aircraft over time depending on the frequency and predictability of overflights.

As the program is occurring in the winter and only a small area of the program overlaps with caribou overwintering areas, the impacts are expected to be negligible. To be cautious however, aircraft will maintain a ceiling of 500 m whenever possible.

Grizzly and Polar Bears

As grizzly and polar bears both den within the vicinity of the proposed program, disturbance to denning bears is possible, but is expected to be minimal. All known grizzly denning sites will be avoided. RWED is conducting research using satellite collars on grizzlies to track their movements and locate dens. Grizzly dens are difficult to identify without the assistance of telemetry data (Ross, Pers. Comm., Branigan, Pers. Comm). The telemetry data will be used to identify dens. Any dens located during the program activities will be avoided.

Research conducted on denning polar bears has shown they are not adversely affected by sound from the use of vibroseis at distances as close as 100 m. Polar bears are more sensitive to noise as winter progresses due to decreasing fat reserves. Disturbance therefore, is more likely to have an adverse effect as winter progresses (Amstrup 1993). Noise sensitivities may also apply to grizzly bears. Chevron will endeavour to complete the program expeditiously in order to minimize impacts. Because waste is incinerated daily, any bears that may be active during the program, should not be attracted to waste produced on site.

Muskrat

As the proposed project may impact muskrat pushups, all water bodies with visible lodges and pushups will be avoided.

Arctic Fox

Since Arctic fox give birth between April and July, their denning and reproductive activities may coincide with the proposed program. Because impacts on the prey of Arctic fox are expected to be negligible and Arctic fox are not greatly affected by sensory disturbance, the impacts on the fox population are also expected to be negligible.

Moose

In the project area, moose are rare and habitat productivity is low. Given measures described above to mitigate impacts on permafrost, soils and vegetation, the impact on moose and moose habitat are expected to be negligible.

Wolf and Wolverine

Wolves and wolverines occur at very low densities in the project area. Direct interactions with the program are therefore unlikely. Because impacts on their main prey base is anticipated to be negligible, the overall impacts on wolves and wolverine are also expected to be negligible.

Ringed Seal

When the program is active, most ringed seals will be in offshore areas. Some breeding adults may occupy the inshore landfast ice, but the numbers occupying the inshore area are expected to be very low. Any interaction with ringed seals is likely to be an isolated event and the overall impact on the population will be negligible.

Beluga Whale

Beluga will not be in the project area during operations, so there will be no direct interaction. No lasting impacts on their habitat are expected, and the overall impact therefore should be negligible.

12.2.6 *Birds*

The program is located in the vicinity of the Kendall Island Bird Sanctuary, which offers critical waterfowl nesting, staging and rearing habitat. Measures taken to minimize impacts on water quality, quantity and vegetation will also minimize any potential impact on waterfowl habitat. As the program should be complete by mid-April, before migratory waterfowl return to the area, noise disturbance from activities are unlikely to influence nesting and staging locations.

Impacts to raptors are varied on both temporal and spatial scales. Injury or death can be attributed to collision and entanglement with industrial equipment. Collision of raptors with ground vehicles and aircraft are major causes of death in raptors (Osborne 1994). Gyrfalcons have been observed attacking fixed-wing aircraft (Clum and Cade 1995). A 500 m flight ceiling will be maintained wherever possible to avoid negative interactions.

Habitat quality is an important factor in determining survival rates in raptors. In the ISR, ground-nesting raptors are at a higher risk for nesting habitat destruction, than are other raptors. Linear disturbance such as the construction of access routes, or the running of seismic lines may degrade habitat for ground nesters such as snowy owls and may also displace important prey species for certain raptors. By minimizing line widths, maintaining the vegetative cover below the snow pack and operating only under frozen conditions, the impacts to habitat and breeding success will be negligible.

12.2.7 *Fish*

Extensive measures will be taken to mitigate potential impacts on fish habitat. Shallow waters near stream banks, which often provide spawning habitat, will be protected from erosion and sedimentation by following guidelines for mitigating impacts on permafrost and soils. Potential impacts to water quality will be avoided by allowing no waste water to be discharged. Water withdrawal will only be done from the Mackenzie River where drawdown will be imperceptible. All intake lines will be fitted with 2.54 mm mesh screens, in accordance with DFO's Freshwater Intake End-of-Pipe Fish Screen Guideline, to avoid the impingement of fish. Dangerous materials will be stored at least 30 m from waterbodies, where possible and all fuel will be stored on secondary containment equipment. Further, any dynamite use in waterbodies with fish-bearing potential will be strictly monitored to ensure compliance with DFO guidelines (Refer to Section 4.2.5.4 for further details).

12.2.8 *Cultural Resources*

Based on data accumulated from archival records and maps, combined with a thorough field examination completed in the summer of 2001, potential impacts to archaeological sites within the proposed Ellice and North Langley areas is low. However, should an archaeological site be discovered during seismic operations, the site will be flagged and the appropriate agencies notified.

Several archaeological sites exist in the vicinity of the proposed Mallik program area. Though the program will not directly impact any of the known sites, the area has traditionally offered rich natural resources and the potential for additional heritage sites to be located within this area is high. Should additional sites be discovered during seismic operations, the sites will be flagged and the appropriate agencies notified.

Mitigative measures for archaeological sites are determined by the viability of the site, in the context of the development project. Mitigation strategies include avoiding sites by a minimum 30 m buffer zone, protecting the resource by constructing physical facilities or investigating and recovering information through excavation. Chevron will avoid all known sites by a minimum of 30 m.

SIGNIFICANCE CRITERIA

AREAL EXTENT

Local:	Impacts are limited to the seismic rights-of-way and camp.
Subregional:	Impacts may extend beyond the limits of the rights-of-way and camp, but are limited to within 1 to 50 km of the rights-of-way and camp.
Regional:	Impacts may extend beyond 50 km from the rights-of-way and camp to the entire region.

MAGNITUDE

Negligible:	Impacts that are judged by experts to result in negligible or non-measurable effects on species population levels and/or habitat carrying capacity.
Low:	Impacts would be restricted to a few individuals or only slightly affect the resource or parties involved; factors related to species' population levels would not be affected.
Moderate:	Impacts would affect many individuals or noticeably affect the resource or parties involved; factors related to a species' population levels would be affected to a degree that a change within natural limits of variability will occur; impacts would be socially tolerated.
High:	Impacts would affect numerous individuals or affect the resources or parties involved in a significant manner; factors affecting species' population levels would be altered to a degree that a change beyond natural limits of variability will occur or the viability of a population would be altered.

DURATION

Immediate:	Impact duration is limited to less than two days.
Short-term:	Impact duration is longer than two days but less than one year.
Medium-term:	Impact duration is at least one year but less than ten years.
Long-term:	Impact duration extends ten years or longer.

FREQUENCY OF OCCURRENCE

Isolated:	Occurrence confined to single incident.
Accidental:	Occurs rarely over assessment period (*i.e.*, life of the project).
Occasional:	Occurs intermittently and sporadically.
Periodic:	Occurs intermittently but repeatedly.
Continuous:	Occurs continually.

PROBABILITY OF OCCURRENCE

Low:	Unlikely.
High:	Likely.

LEVEL OF CONFIDENCE

Low:	Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to project area.
Moderate:	Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationships using data pertinent to project area.
High:	Based on good understanding of cause-effect relationships and data pertinent to project area.

PERMANENCE OR REVERSABILITY

Reversible in short-term:	Impact can be reversed in less than one year.
Reversible in medium-term:	Impact can be reversed in 1 year or more, but less than 10 years.
Reversible in long-term:	Impact can be reversed in 10 years or more.
Irreversible:	Impact is permanent.

RESIDUAL IMPACT BALANCE

Positive:	Net benefit or gain to the resource or affected party.
Neutral:	Neither a positive nor negative impact; or positive and negative impacts are balanced.
Negative:	Net loss to the resource or detriment to the affected party.

RESIDUAL IMPACT SIGNIFICANCE

Significant Adverse Effect:	High probability of permanent or long-term residual effect of high magnitude on ecological, social, or economic sustainability that cannot be technically or economically mitigated or compensated.
Significant Positive Effect:	High probability of permanent or long-term positive residual effect of high magnitude on ecological, biological, social, or economic sustainability.
Unknown:	Potential significance cannot be defined with existing information or knowledge.
Not Significant Adverse Effect:	All other negative effects.
Not Significant Positive Effect:	All other positive effects.

TABLE 13

POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS, MITIGATION AND RESIDUAL IMPACTS

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
1. Permafrost and Permafrost Features										
1.1 Disturbance of permafrost	.1 A minimum of 15 cm of snow will be left on all access trails and 15 cm on all seismic lines. Low ground pressure vehicles (tracks) will be used to mitigate permafrost disturbance. .2 The project will be completed under frozen ground conditions. .3 Vehicle movement will be restricted in the event of thaw or soft ground conditions. .4 An Environmental Monitor will be present to identify sensitive areas and assist in mitigation. .5 Line locations will avoid environmentally sensitive areas in keeping with all regulations.	Local	Low	Short-term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
1.2 Pingos	.1 All pingos will be avoided by a minimum of 150 m.	Local	Low	N/A	N/A	N/A	High	N/A	Neutral	Not significant
2. Terrain and Soils										
2.1 Disturbance to the soil profile (*i.e.* soil loss, compaction, admixing)	.1 Program will be completed under frozen ground conditions limiting soil disturbance caused by uprooting. .2 Any inadvertent surface disturbance will be repaired immediately. .3 Blasting will be restricted to isolated areas (shot holes) and will be conducted in accordance with all relevant regulations and safety guidelines. All explosive detonations will be confined and contained underground. .4 Access routes and trails will be limited to seismic rights-of-way and ice access routes wherever possible. .5 Any soil or organic material displaced during operations will be replaced and compacted. .6 Tracked and low-pressure tire vehicles will be used to minimize surface disturbance. .7 Equipment turnarounds will be restricted to designated locations. Turnarounds on ice roads or waterbodies will be utilized as often as possible.	Local	Low	Medium Term	Accidental	Low	High	Reversible in medium-term	Neutral	Not significant

TABLE 13 Cont'd

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
2.2 Disturbance to erosion prone banks and slopes.	.1 Snow/ice ramps will be constructed on riverbank slopes to prevent equipment disturbance and erosion. .2 Sensitive areas will be avoided by using detours. .3 Equipment operators will be instructed to not disturb the organic mat, and all access will be clearly marked to reduce the possibility of inadvertent surface disturbance. .4 If surfaces are disturbed in an area where drainage or erosion is a possibility, such as channels, lakes or oxbows, erosion control measures will be employed.	Local	Low	Short-term	Occasional	Low	High	Reversible in short-term	Neutral	Not significant
2.3 Disturbance to drainage	.1 Snow bridges or ice roads will be constructed across drainages or waterbodies. Only clean snow and/or ice will be used for drainage crossings. .2 Drainages will be left free of debris. .3 V-notching of snow bridges will be performed upon completion.	Local	Low	Short-term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
3. Vegetation										
3.1 Loss of vegetation communities	.1 Shrubby vegetation will be rolled over on seismic lines rather than cleared to accommodate natural regeneration. .2 Right-of-way widths will be restricted to 6 m for both source and receiver lines. .3 Disturbed areas will be stabilized to promote natural revegetation. .4 Tracked and low-pressure tire vehicles will be used to minimize disturbance to vegetation root zones.	Local	Low	Medium Term	Occasional	Low	High	Reversible in medium term	Neutral	Not significant
3.2 Potential disturbance to rare, sensitive or unique plant species or vegetation communities	.1 Seismic operations will occur in winter, coinciding with the dormant period for herbaceous plants. .2 Natural re-vegetation of rights-of-way will be promoted by avoiding disturbance of root zone.	Local	Low	Medium Term	Accidental	Low	High	Reversible in medium term	Neutral	Not significant
4. Wildlife										
4.1 Disturbance to wildlife	.1 Regular (daily) garbage patrols will be undertaken to remove materials (*i.e.* metals, plastics) that may be potentially harmful to wildlife.	Local	Low	Immediate to Short term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant

TABLE 13 Cont'd

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.2 All activity will be restricted to access routes, camp and seismic rights-of-way. .3 Inuvialuit Environmental/Wildlife Monitors will be employed to assess potential wildlife conflicts in the area of operations. .4 Aircraft will maintain a ceiling of 500 m in areas of wildlife concentration.									
4.2 Disturbance of wildlife migration	.1 Seismic operations will be completed prior to the arrival of and initiated after the departure of the majority of migratory bird species (mid-May) and after mating of caribou. Caribou calving occurs outside the program area. .2 Seismic operations will be completed expeditiously to minimize impacts to resident wildlife. .3 Inuvialuit Environmental/Wildlife Monitors will be employed to assess potential wildlife conflicts in the area of operations. .4 Any windrows created by snow removal on the lines will be interrupted every 500 m to provide unimpeded wildlife movement.	Sub-Regional	Low	Immediate to Short term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
4.3 Attraction of nuisance animals	.1 Kitchen wastes will be incinerated. .2 Camp wastes will be incinerated daily. .3 Wildlife will not be harassed or fed.	Local	Low	Immediate to Short term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
4.4 Encroachment on endangered species or important wildlife habitats	.1 Environmental/Wildlife Monitors will scout ahead of equipment in order to avoid potential conflicts with denning bears. Local RWED biologists and officers will be notified if a bear is encountered. Lines will avoid bear dens.	Local	Low	Immediate to Short term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
5. Aquatic Resources										
5.1 Erosion of stream banks and destabilization of slopes	.1 Snow ramps will be designed to minimize erosion and/or destabilization of slopes. .2 Detours will be utilized to avoid any steep slopes where activity may increase the erosion potential. .3 Blades of tracked units and dozers will be equipped with mushroom shoes to reduce the possibility of surface disturbance. .4 Clean ice bridges will be constructed if ice thickness tests reveal that ice cannot support equipment loads.	Local	Low	Short-term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant

TABLE 13 Cont'd

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.5 If the surface is disturbed in an area such as channels or lakes where drainage or erosion is a possibility, control measures may include using earth breaks or cross ditches. .6 Channel crossings will be made at a level location wherever possible. Crossings will be scouted in advance and will be constructed at 90 degree angles. .7 When access routes parallel lakes or streams, the access will be more than 30 m from a waterbody, where feasible.									
5.2 Disturbance to Fish or Fish Habitat	.1 Waste materials and debris will not be disposed of in or on waterbodies. .2 No hazardous materials will be stored on any ice surface of a waterbody or within 30 m of such a waterbody. .3 Water intake from waterbodies will utilize 2.54 mm mesh screens on intake hoses to prevent disturbance to stream or lake bottoms and to prevent the entrainment of fish. .4 Because water will be drawn from the channels of the Mackenzie, water sources and fisheries will not be affected by drawdown. .5 Dynamite shot holes on land will not be initiated within DFO setback distances and where possible 30 m of any waterbody not frozen to bottom. .6 Charges will be set to a minimum depth below lakebed and sea floor as recommended by DFO (Wright and Hopky 1998). .7 Drill cuttings will be disposed of in drill holes or a minimum of 30 m away from waterbodies. .8 Disturbance to creek banks will be minimized. The right-of-way width may be decreased at stream crossings to preserve riparian habitat.	Local	Low	Immediate	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
5.3 Introduction of oil, fuel or other pollutant to waterbody	.1 Liquid fuels and oils will be stored in a closed system during transportation. .2 Fuel storage will include secondary containment. .3 Refueling hoses will use Spill-Proof fuelling mechanisms to prevent fuel leakage and spill during transfer.	Regional	Moderate	Immediate to Medium term	Isolated	Low	High	Reversible in medium-term	Neutral	Not significant
	.4 Access routes will be on ice channels and down the lines. When access routes parallel lakes or streams, the access will be more than 30 m from the waterbody to prevent deleterious material from entering the waterbody and to prevent disturbance of banks that can result in sedimentation.									

TABLE 13 Cont'd

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
	.5 Any deleterious material that accidentally falls into a waterbody will be removed. .6 In the event of a spill, the Fuel Spill Contingency Plan will be followed (Appendix B). .7 Spills will immediately be reported to Chevron's Environmental, Health and Safety Coordinator, ILA and INAC. All accidental spills will be reported to the NWT Emergency Spill Response Line (867-920-8130), ILA, INAC and to John Korec, the Environmental Assessment Officer with the National Energy Board (403-292-6614). .9 Personnel will be trained in spill response procedures and equipment use.									
5.4 Snow fills/ ramps/ bridges can act as dams during break-up resulting in impacts to channels and banks	.1 Snow fills/ramps/ice bridges will be removed by V-notching upon completion of seismic operations and prior to break-up.	Local	Low	Short term	Accidental	Low	High	Reversible in short-term	Neutral	Not significant
6. Interference with Other <u>Land Uses</u>										
6.1 Possible conflict with wildlife harvesting in the area	.1 Public consultation with all local communities is ongoing to notify communities of seismic operations and timing.	Local	Low	Short term	Isolated	Low	High	Reversible in short-term	Neutral	Not significant
6.2 Trapline Operators	.1 Local trappers will be notified of seismic operations and timing. .2 Coloured lath will be present along seismic routes.	Local	Low	Short term	Isolated	Low	High	N/A	Neutral	Not significant
6.3 Traffic accident on winter access	.1 Only identified access routes will be used and traffic safety will be implemented.	Local	Low	Short term	Isolated	Low	High	N/A	Neutral	Not significant
6.4 Disturbance to snowmobile trails	.1 When an access route or seismic line crosses snowmobile trails utilized by community members, any debris from the seismic operation will be removed and the trail left clean and open.	Local	Low	Short term	Accidental	Low	High	N/A	Neutral	Not significant
6.5 Loss or damage to existing cabins	.1 Chevron will discuss appropriate site-specific mitigation measures with cabin owners in the vicinity of the proposed project. Seismic operations will be set back 180 m from cabins.	Local	N/A	Short term	Isolated	Low	High	N/A	Neutral	Not significant

TABLE 13 Cont'd

Concern/Impact	Mitigative Measures	Areal Extent	Magnitude	Duration	Frequency	Probability	Confidence	Reversibility	Residual Impact Balance	Residual Impact Significance
7. Future Land Use										
	.1 The project is not anticipated to affect future land use by local and/or recreational users of the region.	Local	Negligible	Short term	Isolated	Low	High	N/A	Neutral	Not significant
8. Archaeological, Historical or Palaeontological Sites										
	.1 Should any archaeological or palaeontological sites be discovered during construction or operations, work will be re-routed around that location. Notification of site discovery shall be provided in writing within 2 days to Inuvialuit organizations and the Prince of Wales Northern Heritage Centre. .2 A 30 m buffer between camp facilities, access routes and seismic lines, and archaeologically or culturally important sites will be maintained.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Neutral	Not significant
9. Health or Environmental Threatening Emergency										
	.1 In the event of an emergency, Veri Illuq's Emergency Response Plan will be implemented (Appendix B).	N/A	N/A	N/A	Isolated	Low	High	N/A	Neutral	N/A
10. Abandonment and Restoration										
	.1 All equipment and materials will be removed from area immediately following project completion. .2 Equipment will be removed before spring break up to prevent permafrost and organic mat disturbance. .3 All garbage will be incinerated or transported to an approved waste management facility. No waste will be left at a campsite. .4 Line inspections will be conducted in July or August 2002 to ensure proper clean-up and restoration is undertaken where needed.	Local	Low	Short term	Isolated	Low	High	Reversible in short-term	Neutral	Not significant

13.0 EMERGENCY RESPONSE PLANS

In the event of an emergency, Veri-Illuq's Emergency Response Plan will be followed (Appendix B) and Indian and Northern Affairs Canada, the Inuvialuit Land Administration, and the National Energy Board will be contacted immediately. In the event of a spill, the Fuel and Oil Spill Contingency Plan will be followed (Appendix B) and the INAC, the ILA, the NEB, and the NWT Spill Response Line will be contacted immediately.

14.0 CLEANUP, RECLAMATION, DISPOSAL, AND/OR DECOMMISSIONING PLAN

Once recording is complete in one portion of the program, cable and geophones will be picked up and transported to a subsequent portion of the program. Wooden lath and flagging will be retrieved as portions of the program are completed. All lath and flagging will be retrieved at the end of operations and will be incinerated or disposed of in the Inuvik landfill. Snow fills and ramps used for waterbody crossings will be V-notched upon completion of the program, allowing flowing water to remove fill during spring break-up, while preventing overflow onto the banks.

Equipment, materials, and any other debris that cannot be incinerated will be removed from the project area prior to spring break-up and taken to an approved landfill. Any waste fluids and excess fuel or fuel containers (*e.g.* drums, propane bullets, fuel tanks, or sloops) will be removed from the project area and disposed of appropriately. Any hazardous waste will be documented in waste manifests.

Program inspections will occur during the summer (July or August timing). Materials still remaining on line will be collected at this time. Inspections will also note locations where additional reclamation or restoration is needed.

15.0 OTHER ENVIRONMENTAL ASSESSMENT

IEG prepared previous environmental assessments for the Chevron Canada Resources Langley South 3D Seismic Program, the Burlington Resources Canada Energy Ltd. Mackenzie Delta Winter 2000/2001 Seismic Program and the ExplorData Mackenzie River Delta Winter 2001 Regional Seismic Acquisition Program in the area of the current proposed programs. The Project Descriptions are on file with the EISC and the NEB. A number of assessments written for proposed developments within the vicinity of the project area have also been approved or submitted for approval by IEG. Additional studies utilized in the preparation for this Project Description are listed in the References section.

16.0 COMMUNITY CONSULTATION

Chevron initiated public consultation with the communities and regional organizations potentially affected by the proposed exploratory seismic program in June 2001. Consultation meetings provided the opportunity for Chevron, and their joint venture partners, BP and Burlington, to present the program to various stakeholders, obtain information on the area from local residents and hear concerns raised about the proposed project, in addition to the operations carried out during 2000/2001.

Government representatives were informed of the proposed project, and consultation was initiated early on where specific issues required further discussion. Extensive consultation was conducted with DFO regarding fisheries issues. Joint Project Team representative Cynthia Pyć met with DFO, and Environment Canada in May 2001. Consultation with DFO has been ongoing.

On August I, 2001, Chevron sent an initial project notification along with a request for comments to all pertinent Territorial, Federal and Inuvialuit agencies with jurisdiction in the project area. The purpose of the notification was to provide agency representatives with an overview of the project prior to consultation meetings with representatives of the Joint Project Team, and to offer the opportunity for early comments or identification of concerns.

Formal consultation was conducted from August 14-17, 2001 in Aklavik, Inuvik and Tuktoyaktuk to discuss issues of concern and proposed mitigative measures. In response to feedback from community members and leaders regarding the need for operators to co-ordinate consultations in order to minimize the number of meetings, the consultation meetings were held in conjunction with Petro-Canada. Communities, local organizations and government agencies were notified of the proposed project, exploration schedule, and where warranted, the technical details of the proposed seismic program. In addition, the public meetings were advertised on local community television stations, in the Inuvik Drum and News North newspapers, in ads posted on community bulletin boards and an announcement was made during bingo in Tuktoyaktuk.

Chevron seismic operations personnel, the Joint Project Team's Environmental Specialist and Land and Regulatory Affairs Co-ordinator, together with representatives from the seismic contractors were present at the meetings. Project information was presented to the various individuals and groups, and input related to issues, concerns or questions was invited. A schedule of meetings is provided in Table 14. The issues raised during community consultation meetings are listed in Table 15.

TABLE 14

COMMUNITY CONSULTATION MEETINGS

Date	Consultation Group	Location
June 18, 2001	Public Meeting in Aklavik – cancelled owing to funeral	David Storr Building, Aklavik
June 21, 2001	Inuvik Community Corporation (Inuvik HTC also invited but unable to attend)	IRC Building, Inuvik
June 22, 2001	Tuktoyaktuk Hunters' and Trappers' Committee	HTC Office, Tuktoyaktuk
August 14, 2001	Indian and Northern Affairs	INAC Office, Inuvik
August 14, 2001	Public Meeting in Aklavik - 22 people attended	David Storr Building, Aklavik
August 15, 2001	Inuvik Community Corporation & Inuvik Hunters' and Trappers' Committee	IRC Building, Inuvik
August 15, 2001	Ed McLean, Fisheries Joint Management Committee Katherine Theisenhausen, Inuvialuit Game Council Linda Graf, Environmental Impact Screening Committee Brian Johnston, Wildlife Management Advisory Council (NWT)	Joint Secretariat Offices, Inuvik
August 15, 2001	Inuvialuit Land Administration (Felix Horne)	IRC Building, Inuvik
August 15, 2001	Public Meeting in Inuvik – 11 people attended	Ingamo Hall, Inuvik
August 16, 2001	Tuktoyaktuk Hunters' and Trappers' Committee	HTC Office, Tuktoyaktuk
August 16, 2001	Public Meeting in Tuktoyaktuk – 13 people attended	Hamlet Office, Tuktoyaktuk

TABLE 15

COMMUNITY CONSULTATION ISSUES AND RESPONSES

Issue	Response
Will you do a fish habitat study?	We would like to. A fish habitat study was developed in consultation with DFO and a proposal has been submitted to the various regulators. The proposal is currently being reviewed by the Environmental Impact Screening Committee. If approved, the work will take place in early September. An overview of the proposed study was provided (please refer to Appendix A).
Can the information from the fisheries studies and bathymetric profiler be shared with the co-management bodies?	Yes, we can share the information we the co-management boards.
Will seismic be conducted on lakes? If so, what measures will be taken to protect fish?	Small water bodies can often be avoided by re-routing the lines around the perimeter. In order to prevent large gaps in seismic data quality, however, it is necessary to conduct seismic over large water bodies. In all cases, DFO regulations will be strictly followed. The methods to be used (as outlined in Article 10.0 of this report) were explained.
How do you determine which waters are considered to be fish-bearing (eg. do you develop a profile of each water body to determine the likelihood that it contains fish)?	We are required by DFO to drill holes to determine ice thickness before we move equipment onto a water body. If there is any free (non-frozen) water, the water body is automatically considered to be fish-bearing. For instance, a water body with one inch of open water at depth would be considered to be potentially capable of having fish. It would be considered fish bearing and all of the DFO guidelines for protecting fish and fish habitat would be followed.
What are the differences between the way seismic was conducted on water bodies last year and what you are proposing?	We used the same technology – a cased drill rig – last season. Some of the other operators used different technologies. To the best of our knowledge there were only four cased drill rigs in the region last season and they were all working on our program. The cased drill rig is different from other methods because the hole is cased all the way to the bottom. With some other methods, the hole is cased only to the bottom of the water body (eg. lake bottom). Last season, this technology helped successfully load charges to the right depth and allowed us to operate in accordance with DFO regulations. As additional safeguards for the 2001/2002 season we plan to: conduct tests of the technology early in the season in conjunction with DFO; measure the length of the leads throughout the program (to ensure charges are at depth); and employ periodic pressure monitoring.
Are shot holes cased in fish bearing waters?	Yes, the drill rigs we are proposing to use on fish-bearing waters are cased. In accordance with DFO regulations, it is mandatory to use technology in water bodies that will prevent harm to fish. We believe that the cased drill rigs we are proposing to use, together with our plans for testing, periodic monitoring and measuring lead lengths will prevent harm to fish and fish habitat.
Too many vehicles went through the ice last season. Part of the problem was that Southern contractors didn't have enough local people working for them. Our people know the land and the ice conditions.	We used local people on our operations last season. They were a critical part of our ice monitoring program and provided valuable information. We plan to use local people again for the upcoming season.
The number of vehicles that went through the ice last season may have an environmental impact if there is leakage from the equipment into the water. Is there a way to measure the environmental impact(s)?	Ice thickness was a very serious concern last season. Fortunately, Chevron did not drop any equipment through the ice. We agree that having vehicles go through the ice is both a serious safety hazard and an environmental concern. It would be difficult to measure the impacts of this issue. We plan to focus our efforts on improving ice profiling and ice checking to help prevent any incidents.

Table 15 Cont'd

Issue	Response
The quick-locks and automatic shut-off valves on the fuel pumps did not work last season.	The quick-locks and fuel shut-off valves have been identified as a problem. It appears that the problem was that the high-pressure systems were designed for fueling large vehicles and did not function properly when fueling small vehicles (eg. Pick-ups). A problem with the springs in the nozzles was identified. The manufacturer has re-engineered the nozzles to ensure that they will shut off at lower pressures, thereby reducing the probability of spillage.
There should be one person responsible for fueling.	We are looking into the possibility of having only certain people responsible for refueling.
Are fuel spills reported?	Fuel spills are taken very seriously. All spills greater than one litre are required to be reported and cleaned up.
All cats should all have mushroom shoes on them and be raised to a certain height.	The regulators require that all cats have mushroom shoes.
Environmental monitors should have more influence over the way things are done. For example, they should be responsible for ensuring that debris gets picked up. They should not be paid to sit and watch television.	We recognize the need for the environmental monitors to have more training. At the annual review meetings held in Inuvik in June 2001, we recommended to both ILA & IRC that the training for environmental monitors be improved. We advised that we would be willing to participant in the review of the training program for the upcoming season. ILA held a meeting today (August 14, 2001) with industry representatives to review the proposed outline for the training program and receive feedback.
Reporting relationships for both environmental monitors and wildlife monitors are very important. Do both kinds of monitors issue daily reports?	The environmental monitors' reports are issued daily to the ILA and the wildlife monitors' reports are issued to the local HTC. Copies of both reports are to be issued to the operator. Last season we received reports on a semi-regular basis. We are hoping to work together with the ILA and the Hunters' and Trappers' Committees to improve communication for the upcoming season.
Communication is lacking. After the approvals are issued, communities do not know where industry is in the field – we hear about things third or fourth hand. There should be some way to better disseminate information about what is going on in the field.	We will make a commitment to meet with communities on a more regular basis to provide updates on the status of our operations. We will also take a look at other ways to communicate more effectively.
Is there a list of studies (eg. environmental, habitat, wildlife) that measure the impact of oil and gas activity?	Project Descriptions containing an environmental impact assessment and lists of studies and literature reviews are submitted to the Environmental Impact Screening Committee for each proposed project.
Last year, ruts were created while trying to tow tracked vehicles. Is it mandatory to use winches to tow equipment?	Other operators may have used this practice, we are not aware of our crews doing so. The regulations clearly indicate that we are not allowed to rut the ground and we will only use tow/winch practices that do not cause rutting.
Will bear denning be studied?	BP, Burlington & Chevron are contributing to a grizzly collaring study by Resources, Wildlife and Economic Development. Ten female grizzlies will be collared. The collars will allow us to locate the dens, in order to stay away from them.
How is kitchen garbage from the camps handled?	Garbage is incinerated on site at the camps, or contained and trucked out to Inuvik.
How many camps will there be?	There will be two camps supporting the Northern programs and one supporting the Southern programs. The camps supporting the Northern programs will move at least once during the winter. Two proposed camp locations are identified on the consultation map. The Southern camp will likely stay in the same place throughout the season.
Which camps will you be using?	We will be using the same camps we used last season. One is a sleigh camp that was used in the Southern Delta by WesternGeco. In the North, Veritas will once again have two camps. One will be for advance operations and will sit on the ground. The other is for the recording crew and is sleigh mounted.

Table 15 Cont'd

Issue	Response
How will sewage be treated? Do you have a back-up plan?	Veritas camp: Sewage will be treated by incinolet toilets and grey water will be steamed off and/or trucked to an approved facility. More toilets and related facilities have been added to this camp. WesternGeco camp: A water treatment system will be utilized allowing grey water to be returned to source and black water to be trucked to an approved facility. This camp will have new washroom and kitchen facilities this year. We recognize that there were capacity problems with the incinolet toilets and grey water holding and steaming systems in both camps last year. We have addressed these problems and have back-up systems in place for our 2001/2002 operations.
Were any local people taken to the programs for the summer inspections? We would like to go and see the programs for ourselves.	The HTC's were invited to participate in the inspections and a Wildlife monitor did participate in the Inuvik Blocks 1 & 2 - 2D inspection. We can arrange to take a local person on a future trip (eg. HTC or Community Corporation representative).
Was any seeding done on last season's programs. If so, was the seed native to the area?	Seeding was not required on our operations. Veritas seeded some other program(s), where required, with an approved seed.
What will determine how much seismic gets shot out of your total application?	The key factors are money, weather and time. We probably will not shoot all of the seismic that we are submitting for approval. Once our budget cycle is complete late in the Fall we will have a much better idea how much money we have to spend on the programs and may need to scale back the operations accordingly.
Do you use slashers or machines to cut the willows?	We use both. We tried hand-cutting willows in the Southern Delta for a short time last year. The crew reported serious safety concerns because of the density of the willows. The progress was extremely slow and the work was difficult. As a result, we started using a combination of the hydro-axe machine and cats to help make working conditions safer. Hand-cutting is still done in cases where machine access is not feasible or permitted.
People complain that the willows are cut too high. Once the snow melts, the willows stick out of the ground several inches and make travel down the lines difficult and potentially dangerous.	It is challenging to balance environmental concerns with the desire by some community members to have access to areas via the seismic lines. ILA requires that willows be left at a certain height in order to promote quicker re-growth. The willows are therefore cut off only to the top of the snow cover in order to accelerate re-growth in the spring and summer. In recent inspections, we were quite pleased at the rate of re-growth already this year. We expect that the willows should reach their full height in approximately five to ten years.
Are trees cut down to make room for the seismic lines?	We are committed to low impact seismic. It is important to keep in mind, however, that low impact is not zero impact. We try to avoid cutting down trees, wherever possible, by moving the lines around them though it is sometimes necessary to cut down trees.
When trees are cut down, are they cut to the ground?	Yes, when we need to cut down trees, they are cut right down to the ground and we try not to disturb the ground and root system. In response to requests from community members at last year's consultation meetings, the trees are cut into smaller pieces and may be picked up by local cabin owners to be used for fire wood.
Have you considered replanting trees to replace the ones that need to be cut down?	We have not considered this. It is something we can take a look at. One of the challenges may be the logistics of getting to some of the program areas during the summer, however, the idea is worth exploring.
It is difficult for trappers to cross seismic lines where their trap lines intersect with seismic lines, because ridges are built up on both sides of the seismic line that make it difficult to cross.	Thank you for bringing this to our attention. We can create breaks if we know where the crossings are located.
Cabin owners (in the area of the proposed seismic programs) should be notified.	Absolutely. If you are aware of the names and/or cabin locations, it would be very helpful if you could share that information with us.
Are people allowed to harvest while they are working?	No. The crews are not allowed to hunt or trap while they are in camp.

Table 15 Cont'd

Issue	Response
Why were tracks everywhere (eg. in several different directions, overlapping, and/or in circles) on some of the programs?	We inspected our programs and found no evidence that this type of tracking occurred on a Chevron operated program. Supervision at various levels is key to reducing this type of impact. We will continue to have committed supervisors and ongoing enforcement of our line travel policy. All vehicle operators are made aware of line travel policies and reminded of them regularly.
What is the difference between a blow-out and a crater?	It is important to distinguish between a blow-out and a crater. A blow-out occurs when the contents of the hole – gas, sand and/or drill cuttings – blow back up. A crater, on the other hand, is created when the surrounding land is affected. When a crater occurs, a piece of soil is actually disrupted and moved. Craters are more environmentally damaging than blow-outs and occur far less frequently. When craters occur, our operating procedures are reviewed to determine if we need to take measures to decrease the likelihood of re-occurrence. In response to a few craters on our programs last year, the charge size was decreased. This helped address the problem. It is also worth noting that when we returned to some of the crater sites during summer inspections there were already signs of re-vegetation and in several cases they were virtually undetectable from the rest of the landscape.
When craters occur the dirt should be placed back in the hole right away.	Agreed. When craters occur our crews are directed to put the soil back in the hole as soon as it is safe to do so, to minimize any further damage.
Why do blow-outs occur? Is it because there isn't enough soil placed back in the hole?	Blow-outs occur for one of three reasons: (1) there may be gas going back up the hole; (2) gas and sand blowing back up the hole; or, (3) cuttings blowing back up the hole. Each time a hole is drilled, the drill cuttings (eg. soil) is placed back in the hole and tamped. In most cases, the hole re-freezes and blow-outs are prevented. Sometimes, however, a blow-out will occur for one of the three reasons indicated.
Local people see debris from the operations out on the land. The crews should take more time to pick things up.	Immediately after the work is done, a crew follows behind to pick-up everything they can see. One of the challenges is that during the winter, debris can get blown under the snow and may not be visible when the crew comes by. Additional clean-up is conducted in the spring and summer to collect any remaining debris. It is always our intent to leave nothing behind.

17.0 PERSONAL COMMUNICATIONS

Chernoff, Eric. EIRB Secretary, Joint Secretariat – Inuvialuit Renewable Resources Committees, Inuvik, NT.

Slack, Todd. GIS Specialist, Joint Secretariat, Inuvik, NT.