Appendix IV

Project Review Information for the Department of Fisheries and Oceans Canada

Project Review Information on the Clean Up of the DYE-M (Cape Dyer) DEW Line Site

For Submission to the Department of Fisheries and Oceans

Prepared for:
Defence Construction Canada

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ENVIRONMENTAL SERVICES

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2. PROJECT LOCATION

The DYE-M, Cape Dyer Distant Early Warning (DEW) Line site is one of the 21 Department of National Defence (DND) DEW Line sites to be cleaned up as part of the DEW Line Clean Up Project. DYE-M (66° 39' N, 61° 21' W) is located on the easternmost point of Baffin Island of the Nunavut Territory. The site is currently remotely operated by the Canadian DND as part of the North Warning System as a Long Range Radar site. The radar station of the DEW line system is situated on a DND reserve on Crown Lands.

The station is about 15 km inland from the Sunneshine Fiord shore. The main site facilities are located atop a summit, approximately 20 km east-northeast of the Airstrip and Lower Camp Area. The main DEW site is connected by road to the lower camp, where petroleum, oil and lubricant (POL) storage, vehicle maintenance, and airstrip facilities were located. The Beach Area facilities consist of POL storage facilities, and open storage areas.

Selected drawings showing the project location are in Appendix I.

3. PROJECT DESCRIPTION

3.1 Background

The DYE-M site was constructed in 1958 as part of the Distant Early Warning (DEW) Line and operated until the early 1990's. The site was decommissioned in the fall of 1992 following construction of a Long Range Radar (LRR) site. As one of the "main" sites in the distance early warning radar line, the extent of site activities, contaminant releases, and materials disposal at DYE-M was much greater than at adjacent "auxiliary" sites such as the Broughton Island (FOX-5) DEW Line site.

Site investigations were carried out at DYE-M in 1990 as part of a preliminary assessment of the environmental status of DEW Line installations (ESG, 1991). Several areas were found to be contaminated with PCBs, nickel, lead, chromium and/or zinc. Many of these areas, however, were sufficiently removed from Davis Strait or Sunneshine Fiord that migration of contaminants to the sea would be unlikely. A large, partially buried and eroding dump, the Lower Camp Landfill – West, located in a ravine near the DYE-M lower site was situated in a runoff area subjected to high seasonal flows. Soil samples taken from the dump were contaminated with PCBs, copper, lead and zinc. The potential for contaminant migration into Sunneshine Fjord was demonstrated by the presence of detectable PCB levels (0.37 ppb, or µg/L) in a water sample collected downstream from the Lower Camp Landfill - West, and immediately adjacent to Sunneshine Fiord.

In 1993 and 1994, studies were undertaken to assess the environmental consequences of possible debris disposal in the marine environment (refer to Appendix II). The 1993 study focussed on Cambridge Bay, while the 1994 study focussed on former military sites along the eastern coast of Baffin Island, including Resolution Island, Iqaluit, Cape Dyer, and Kivitoo. Therefore, good information exists on the marine habitat in Exeter Bay, adjacent to the DYE-M lower camp and shorefront areas requiring remediation.

In 1992, the DEW Line Clean Up Protocol was developed by the Environmental Sciences Group (ESG) of the Royal Military College of Canada and reviewed and approved by federal and territorial environmental officials. The protocol includes procedures for dealing with contaminated soil, waste oil, landfills, wastewater, debris and hazardous materials. In 1998, the Environmental Provisions of the Cooperation Agreement between DND and Nunavut Tunngavik Inc. (NTI) were implemented to provide the approach necessary to restore the DEW Line sites to an environmentally safe condition and prevent the migration of contaminants into the Arctic food chain.

In 1997-1998, and 2000-2002, a detailed site investigation was completed on behalf of the Distant Early Warning (DEW) Line Clean Up Project Management Office to provide sufficient data for the design and development of construction specifications required for the environmental clean up of the DYE-M site.

There are no ecological sanctuaries identified in the immediate vicinity of the site.

4. PROJECT ACTIVITIES

The overall intent of the proposed clean up is to provide a remedy for previous activities that occurred as a result of the operation of the former DEW Line Site and associated facilities, specifically with regard to the release of physical debris and/or contaminants into the environment, including the adjacent marine and freshwater environment. The existing site conditions are a result of historical and cumulative operational activities over several decades.

Details of the construction activities are provided on the drawings in Appendix I. In general, during the construction phase of the clean up, existing facilities no longer required for the operation of the North Warning System will be demolished. The demolition wastes will be segregated into hazardous and non-hazardous materials and disposed of appropriately. Contaminated soils identified during the previous site investigations will be excavated and properly disposed of in on-site engineered landfills or at off-site facilities. Scattered surface and partially buried debris on the site will also be collected and disposed of. New engineered landfills will be constructed to contain the non-hazardous contaminated soil and demolition waste generated during the clean up. Existing landfills within the site will be remediated, as required. Disturbed areas will be physically restored to a stable condition shaped to match the existing terrain.

The specific work activities detailed in this report that are directly related to the project review for compliance with the Fisheries Act are the remediation of the Beach Landfill–North and associated debris areas; the Construction Camp Debris Area – South; and the Lower Camp Landfill – West. These landfills and debris areas are located directly adjacent to either marine or freshwater environments. In the case of the Construction Camp Debris Area – South, the toe of the debris area is in the intertidal zone of Sunnshine Fiord. A description of each area is provided in Section 5.

Photographs of the above-noted landfills and debris areas are presented in Appendix III.

Ancillary work activities that will be undertaken concurrently with those mentioned above, but not directly related to compliance with the *Fisheries Act*, include the following:

- Excavation, treatment and/or disposal of soil impacted with organic (i.e., petroleum hydrocarbons, PCBs) and inorganic contaminants;
- Construction and engineered closure of two Tier II Soil Disposal Facilities for disposal and encapsulation of soil containing elevated contaminants;
- Construction and engineered closure of two Non-Hazardous Waste Landfills for disposal of non-hazardous demolition debris and soil containing low-level contaminants;
- Construction, operation and closure of two Hydrocarbon Treatment Areas (i.e., Landfarms) for soils impacted with hydrocarbons (primarily diesel-type hydrocarbons);
- Containerization and off-site disposal of hazardous waste materials;
- Demolition of structures, including removal of asbestos material, creosote-treated poles, related utilities, communication equipment and other ancillary facilities;
- Collection and disposal of site debris;
- Excavation of 8 existing landfills;
- Closure and grading of 10 landfills; and,
- Removal of water from the water supply lake for camp supply and construction activities.

5. CONSTRUCTION PLANS

5.1 Project Scheduling

Clean up activities at the DYE-M site are scheduled to commence in July 2004 and will be completed in October 2011. The majority of work activity on site will occur during the summer months of July through to September.

The remediation activities are contingent on construction of the Tier II, Non-Hazardous, and Landfarm facilities.

All landfill and remedial excavations not completed during the work season will be closed and temporary containment structures will be removed each season prior to suspending work for the winter.

5.2 Landfill Descriptions

The following sections include details regarding the existing conditions of the work sites.

5.2.1 Beach Landfill – North

The Beach Landfill North is located at the northern end of the beach landing area, adjacent to an un-named stream (see Drawings 102, 104, and 115). The landfill area has a well-defined crest on its north and west edges. A large pile of surface debris is located at the landfill crest. The topography generally slopes down to the southwest towards Exeter Bay. The surface area of the landfill is approximately 3000 m^2. There was no contaminated surface soils identified; however, there was evidence of leachate from the landfill. The cover of the landfill consists of highly erodible, fine-grained materials. Exposed, partially buried debris is present over 50% of the landfill surface. The

landfill grade is greater than 40% and is located immediately adjacent to a stream and is likely eroded by this stream during spring freshet. The stream drains overland approximately 10 to 20 m directly into Sunneshine Fiord.

5.2.2 Construction Camp Debris Area – South

The Construction Camp Debris Area - South is a small (~225 m^2) mounded area located along the access road to the original beach landing area, more than 2 km south of the existing beach landing area (Drawings 102 and 107). The area was likely associated with the original staging area for the site construction. No contaminated surface soil and no leachate were identified; however, approximately 40% of the surface area is covered with debris. The grade is 20%, and the area drains overland and over a 5 m cliff directly into Sunneshine Fiord. It is subject to wave action at high tide over approximately 20% of the area. Cover materials at the debris area consist of sandy gravel materials with moderate evidence of erosion of 35% of the area. There is also moderate (40%) vegetative cover.

5.2.3 Lower Camp Landfill – West

The Lower Camp Landfill West is located adjacent to the south side of the un-named stream (Drawings 103, 111 and 119-120). The landfill consists of three lobes that extend parallel to the riverbank over a distance of approximately 300 m. The total surface area of the landfill is approximately 12,000 m^2. Contaminated soil has been identified and the landfill is known to be leaching. There is very little cover material and extensive debris is visible at surface. There is localized evidence of erosion along the toe of the landfill, with coarser grained materials and steeper slopes at periods of high runoff. There is evidence of surface water drainage through the landfill. The landfill drains directly to a stream, which discharges to Sunneshine Fiord, approximately 7 km downstream. The landfill has approximately 20% vegetative cover.

5.3 Construction Method

The remediation of the Beach Landfill – North, the Construction Camp Debris Area – South and the Lower Camp Landfill - West will consist of excavating all debris and impacted soils. The final depth of excavation along the shore will be determined, in part, by the occurrence of frozen ground and/or bedrock. The debris and impacted soils will be disposed of in on-site constructed landfills, remediated in an on-site landfarm treatment area or, when necessary, transported off-site for disposal.

The excavations will be backfilled with granular material obtained from local borrow sources. The granular fill will consist of suitably sized material with a minimum content of fine particles. The disturbed area will be graded to a stable contoured condition with positive surface drainage. A detailed description of the remediation activity at DYE-M is contained in the NIRB submission for the project (UMA 2003).

Tracked excavators will excavate the debris material and impacted soils. Tandem trucks will transport the excavated and granular fill material. Tracked excavators and small crawler tractors will be used to move and place granular fill material during site restoration activities.

Additional work associated with the excavation and removal of contaminated soils and debris within these areas will include the following:

- Deployment of floating silt curtains and absorbent booms, as necessary, along the water side perimeter of the work area prior to any excavation activities. These measures will be removed upon completion of each season of the work activity;
- Installation of silt fences to control erosion and sedimentation prior to excavation in upland areas;
- Collection of phase separated petroleum product, if encountered during excavation;

- Removal and treatment of hydrocarbon impacted water, if encountered, if dewatering of excavations is required. Discharge of treated groundwater shall comply with all project, Federal and Territorial guidelines and permits;
- Backfill excavations with granular fill to design grade elevation consisting of stable slopes and positive drainage; and
- Removal of all equipment and materials associated with the remedial activity at the end of each work season.

Explosives will not be used for site remediation activities at DYE-M.

6. NAVIGATION

During site remedial activities conducted in shore and near-shore areas, temporary containment structures including floating silt curtains and hydrocarbon booms will be installed at various locations adjacent to the work sites. Suitable identification markings and buoys will be installed as necessary, to provide advance warning of the temporary obstructions for any watercraft in the immediate area. The containment structures and warning devices at the work sites will be promptly removed each season following the completion of the related work activities.

The near shore areas adjacent to the work area are not ordinarily used for local traditional activities such as hunting and fishing or transportation. The impact of the temporary containment structures on navigation will be localized, short term and negligible.

The Department of Fisheries and Oceans – Canadian Coast Guard, in accordance with the Navigable Waters Protection Act (NWPA) will be requested to review the project regarding navigability concerns.

7. FISH AND FISH HABITAT

7.1 Background

This section discusses aspects of the supratidal, intertidal and subtidal zones of Sunneshine Fjord adjacent to areas identified for remediation at DYE-M Lower Site and Beach Areas, with a focus on the protection and enhancement of fish habitat during and after site remediation activities as summarized in Sections 4 and 5.

In addition, one aspect of the site remediation that is atypical relative to many other Canadian DEW Line sites is the presence of a watercourse that cuts through one major and one slightly less extensive landfill area, both of which would be disturbed during remediation activities. This seasonally active watercourse flows into Sunneshine Fjord at a point where the Beach Landfill - North is located. The major debris area targeted for remediation within and adjacent to the stream channel is located inland at an elevation of about 268 to 284 m ASL. The second less extensive area (Debris area No. 6/Beach Landfill North) is located at the mouth of the stream, extending into the intertidal zone, and primarily south of the active channel. The affected estuarine and freshwater area merit a separate discussion as estuarine and freshwater fisheries habitat.

7.2 Biophysical Attributes of Intertidal and Subtidal Areas Adjacent to DYE-M

Sheer cliffs line the coast near the summit, where the DYE-M Upper Site is located, some rising to over 600 m in height. The area is underlain by granite gneiss, granite and migmatite. Small pockets of soil are present in some areas of the site, allowing for minimal vegetation growth, primarily drought tolerant species such as *Dryas* sp. and *Saxifraga* sp. The shear slope of the supralittoral, littoral, and sublittoral zones has precluded the accumulation of substantive contaminated soil masses and physical debris, and remediation works are not currently proposed for the nearshore areas adjacent to DYE-M Upper Site in 2004.

The beaching and airstrip area of the DYE-M site is adjacent to the relatively protected confines of Sunneshine Fiord. Cliffs rise up out the fjord to heights of more than 600 m and plunge to depths of 160 m below sea level at some locations along the fiord. The slope from the shoreline is about 100 m per kilometre or 6 degrees on average perpendicular to the sides of the fiord. There is only limited productive benthic habitat within the photic zone, which is confined to narrow shelves that do not tend to accumulate sediments.

Seals and walrus are hunted in the fiords around DYE-M by residents of Qikiqtarjuaq. There are polar bear dens in the vicinity. Other marine mammals known to frequent the area includes migrating bowhead and beluga whales, and narwhals.

According to the 1994 historical ocean disposal report (Bright *et al*, 1995), the investigation of DYE-M and Sunneshine Fiord revealed the following:

> "The seabed close to shore is composed of relatively coarse materials similar to the debris on the subaerial slopes. Numerous boulders litter the sea floor and the area is surprisingly heavily ice-gouged at water depths less than 100 m. During a two-day wind storm which made side-scan operations impossible, many small icebergs were seen being driven down the fiord by winds, frequently grounding on the seabed near the shoreline. The icebergs presumably were calved off the glacier at the head of the fiord. These bergs were certainly the source of many of the small scours seen on the seabed…. Large scours… …are probably produced by occasional icebergs being carried into the fjord with pack ice under favourable wind conditions. Diver and Remote Operated Vehicle observations confirm that the seabed at depths less than 50 m is relatively mobile and consists of sand and gravel with boulders, cobbles and associated kelp… . Cores and grabs in water depths greater than 100 m retrieved only soft mud. A large gravel barrier beach oriented towards the fjord head

> provides evidence that relatively large swells can enter the mouth of the fiord and propagate headward, despite the relatively protected nature of the site."

Syvitski et al. (1989) conducted a study of the bottom-dwelling macrobenthos of Sunneshine Fjord and nine other arctic fiords. According to these authors –

> "Cluster analysis of the benthos from ten Baffin Island fjords defines six faunal associations. The macrotidal Sunneshine Fiord has a shallow kelp-related Isopod Association. Cambridge Fiord supports a shallow Onuphid Association controlled by gravel from dropstones. A widespread Portlandia Association typified the shallow zones of more recently glaciated fiords where sedimentation rates are high. An Ophiuroid-Anemone Association was defined from current-affected submarine channel environments. A Maldanid Association covered the greatest area in all fiords and passed into an Elasipod Association in the deepest water in Cambridge Fiord. Fiord-head faunas are used to model ecological changes accompanying glacier retreat, from monospecific Portlandia, through mature Portlandia Association to Onuphid Association accompanied by diverse filter feeders and herbivores."

Overall, Sunneshine Fiord is at an early successional stage with regard to glacial retreat.

Bright et al. (1995) briefly describes attempts by divers to capture shallow water macrobenthic species in Sunneshine Fiord and elsewhere, in order to obtain samples of the analysis of contaminant bioaccumulation (e.g. PCBs). Biota collected in 1994 from Sunneshine Fiord, adjacent to DYE-M Lower Site included –

- Short-horn sculpins *(Myoxocepahlus scorpius)*, by gill net;
- Fish doctor (*Gymnelus viridis*), by SCUBA;
- Isopods *(Saduria entomon)*, by SCUBA;
- Brittle stars (ophiuroids), by SCUBA; and

- Gastropods (2 spp. of neogastropods), by SCUBA.

Bivalve populations, including *Mya truncate, Arctica islandica* and *Hiatella arctica* were not located at Sunneshine Fjord during the historical ocean disposal study, but were sampled in Frobisher Bay and off Kivitoo. Also, gill net sets at other east Baffin locations produced catches of Arctic char (*Salvelinus alpinus*), Greenland cod *(Gadus ogac),* Arctic cod (*Boreagadus saida*), and/or Arctic sculpin *Myoxocephalus scorpioides.* Net sets in Sunneshine Fiord resulted in catches of only short-horn sculpins. There were no arctic char gillnetted or observed by divers or ROV in Sunneshine Fiord.

A search of existing historical literature did not provide any additional biophysical information on the aquatic environment at or near DYE-M. There is nonetheless a reasonable understanding of characteristics of arctic benthic and epibenthic community structure and associated governing processes in nearshore coastal areas, based on a combination of peer-reviewed scientific studies and other observations.

Research studies by Aitken and Fournier (1993), Carey (1991), Conlan *et al.* (1998), Curtis (1972), Dunton *et al.* (1989), Kvitek *et al.* (1998), Mikhail and Welch (1989), Percy (1983), Schewe (2001) and Starmans *et al.* (1999) offer useful information on the structure and function of coastal marine communities within the Canadian Arctic in general.

Many of the aspects of especially physical processes that have been demonstrated to shape benthic macroinvertebrate, macroalgal, and fish community structure and productivity in other areas of the Canadian and international arctic are expected to be relevant for Sunneshine Fiord, adjacent to the DYE-M lower camp. According to Aitken and Fournier (1993), who studied the macrobenthos of Cambridge, McBeth and Itirbilung Fiords, Baffin Island –

> "Macrobenthic associations recorded in the fiords are comparable, both with respect to species composition and habitat, to benthic invertebrate associations occurring on

> the Baffin Island continental shelf and in east Greenland fiords, reflecting the broad environmental tolerances of the organisms constituting the benthic associations. Deposit-feeding organisms dominate the fiord macrobenthos, notably nuculanid bivalves, ophiuroid echinoderms and elasipod holothurians."

A major controlling factor for viable fish, other faunal and macroalgal habitat in the coastal zone is expected to be the presence of sea ice, which is present most of the year. Annual marginal sea ice exerts a very direct influence on arctic intertidal and shallow subtidal communities by virtue of the extreme physical scouring that it causes. Such scouring may be further exacerbated in areas with higher maximum tidal amplitudes such as occur along the southeast coast of Baffin Island; for example, Frobisher Bay. In areas such as Sunneshine Fjord with a moderate tidal amplitude, the scouring and physical exclusion of sessile and infaunal macrofauna as well as macroalgal species is often extreme at vertical zones influenced by scouring from annual ice of up to 2 m thickness or more. Wind-generated waves further tend to increase extent of the zone of ice scour. Another phenomenon that limits the biological value of intertidal and shallow subtidal habitat is the tendency of nearshore ice to extend into cobble to silt sediments through the freezing of sediment interstitial water (formation of anchor ice), followed by bulk removal of sediments during break-up periods when rafted ice is blown offshore.

The net result of the extreme ice-related physical disturbance in the intertidal zone and shallow subtidal zone is that there are few, if any, permanent or multi-year resident species, including otherwise hardy macroalgal species such as *Fucus* or laminarians. The area can be used transiently by some marine animals, especially during the brief summer period, but there is a very low productivity of this zone in most coastal areas, given a very limited primary productivity or presence of substrates that might accumulate organic carbon in support of various types of secondary productivity. A limited number of coastal embayments and estuaries provide an exception to this rule, since the conditions exist for localized eutrophication based on terrigenous runoff (Weslawski *et al.*, 1999); for example, from bird colonies or riverine inputs. Countering this effect, however, and influencing

shallow zones in general are low salinities associated with seasonal ice melt that tend to eliminate all but the most euryhaline species. The DYE-M shoreline would not be expected to exhibit atypically high seasonal activity in the intertidal or shallow subtidal zone.

Habitats at depths greater than approximately 3 - 5 m relative to the mean lower tide level nonetheless offer viable habitat for fish, macroinvertebrates, and macroalgae; less so along the sides of steep-walled fjords than in embayments and coastal areas with a broader shelf area. At depths where there is a diminished magnitude of physical disturbance, softer sediments with a higher surface area to volume ratio may accumulate depending on the local bathymetric and physical oceanographic conditions. Finer sediments are accompanied in general by the potential to contain higher levels of detrital organic matter and bacterial biomass. This component can be a major contributor to benthic community productivity on shelf areas in general.

Even in areas removed from the immediate effects of seasonal ice scour, grounding and dragging of multiyear ice can have profound influences on benthic community structure. Conlan *et al.* (1998) for example noted effects on bottom communities in Barrow Strait at depths of up to 30 m from ice keel scouring. Conlan *et al* (1998) observed that both the high frequency shallow depth scours and deeper ice-keel scours were dominated by the same disturbance-associated fauna, which was distinctive from the benthos outside the scour. The disturbance-associated fauna included scavenging amphipods, and carnivorous gastropods in scours occupied by bivalves displaced from higher topographic areas of the surrounding seabed. Kvitek *et al.* (1998) noted that scours in less than 10 m depth waters of Resolute Bay covered approximately 14% of the seabed. These scours were observed to create pockets of seasonal anoxia, however, containing dark coloured, sulfide-rich waters, as well as abundant dead epibenthos (shrimps, amphipods, mysids, bivalves, gastropods, sea cucumbers, and fishes). Their observations compelled them to describe such scours as transient death traps.

Common to virtually all available studies except one (Feder *et al*, 1994), the abundance and diversity of benthic invertebrates and fish has been observed to increase from shallower to deeper depths on the continental shelf, and from areas of freshwater and glacial sediment release to areas farther removed, in a pattern that is often correlated with sediment particle size sorting during deposition (higher to lower energy environments) (Aitken and Fournier, 1993; Denisenko *et al.*, 1999; Jùrgensen *et al.*, 1999; Starmans *et al.*, 1999; Weslawski *al.*, 1999). According to Feder *et al.*, observed differences in diversity between shallow and deeper areas in the Chukchi Sea were not related to differences in sediment sorting. Instead, regional diversity differences were deemed to be related to greater environmental stresses (e.g. ice gouging, wave-current action, marine-mammal feeding activities) inshore than offshore.

In general, the Canadian Arctic is typified by very few marine fauna that are endemic species, with the majority of fauna being circumpolar or Atlantic and Pacific taxa that also occur in the arctic.

Few fish species are expected to utilize the shallow subtidal area in the vicinity of DYE-M as brooding or nursery areas. Such species may utilize especially deeper subtidal areas for foraging on scavenging and predatory amphipods, mysids, shrimp, errantiate and sedentariate polychaete worms such as *Pectinaria*, soft-shell clam siphons, sea butterflies (*Clione* and *Limacina*), and a range of other invertebrates. The deeper subtidal community is also likely to be occupied by other invertebrate filter feeders such as sea cucumbers, ophiuroids, and bivalves such as *Mytilus edulis*, *Hiatella arctica*, and *Mya truncata*. In deeper more uniform areas, and over soft silt-clay sediments, brittle stars often comprise the major portion of macrofaunal biomass- and this is certainly true for Sunneshine Fjord.

7.3 Biophysical Attributes of Freshwater and Estuarine Environments at DYE-M

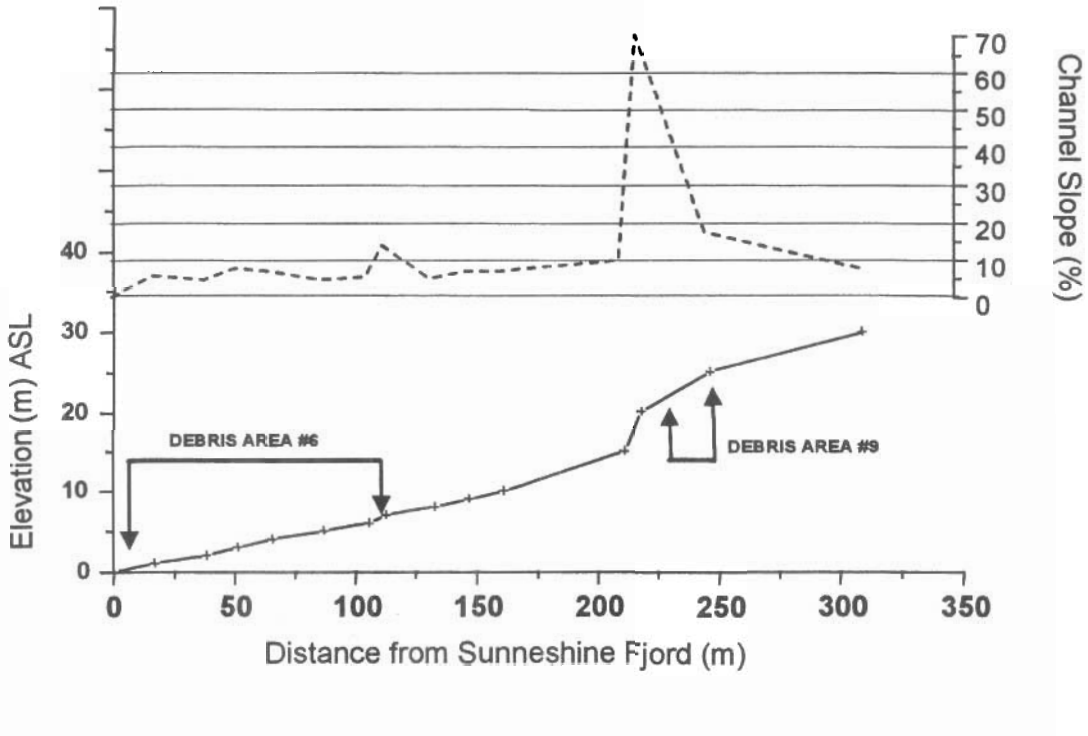
Detailed assessments of the estuarine habitat at the mouth of the "Ravine Watercourse" have not been completed, although informal observations of this area were completed during the 1994

historical ocean disposal investigation. The area was not deemed to be remarkable relative to adjacent intertidal and subtidal areas in Sunneshine Fjord.

The estuarine and freshwater ecosystems of the high arctic potentially provide habitat and transportation corridors for anadromous populations of arctic char, depending on local conditions. In fact, arctic char would be the only species of freshwater or anadromous fish expected at the latitude occupied by DYE-M. The realized habitat potential of any particular water course depends on a number of partially interrelated factors, including –

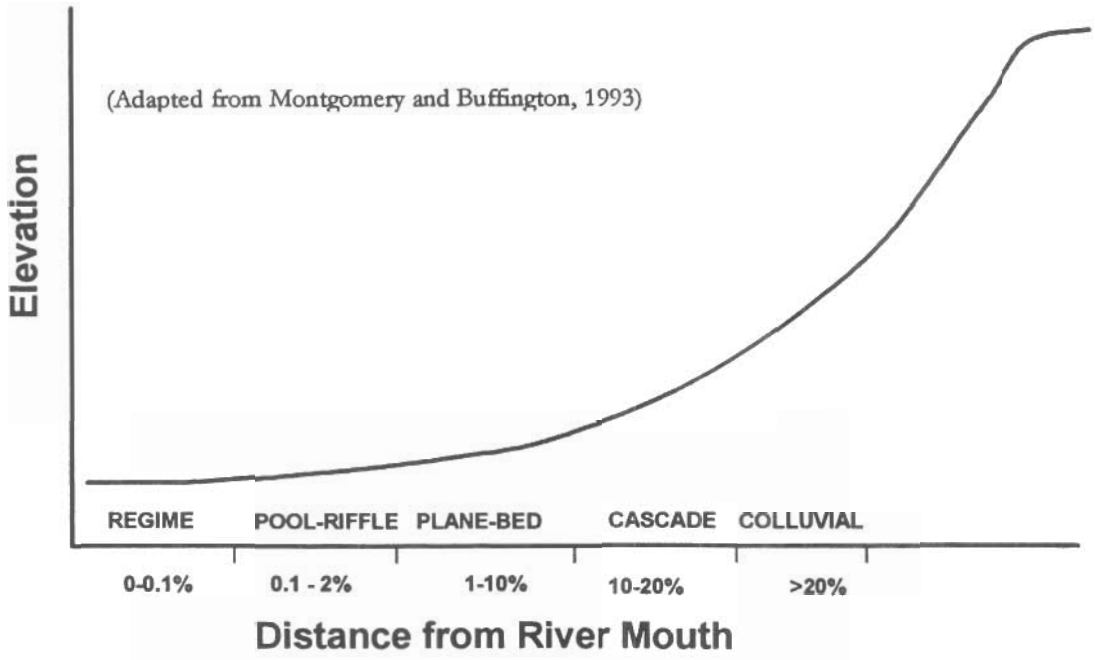
- Average and seasonally variable stream volumes, as indicated by hydrographs or minimum stream levels;
- Gradient of the stream channel, including maximum steepness and combined effects of steepness and length of higher gradient reaches;
- Presence of ice, waterfall, or other obstructions to upstream movement; and
- Presence of viable spawning habitat within the creek or – more typically – within small to medium-sized lakes farther up the watershed.

The gradient of the lower ca. 0.3 km of the stream channel is shown below:



The extreme slopes of the streambed (>20% rise over run) at a distance approximately 200 m inland likely preclude the upstream migration of arctic char. For any particular stream reach, the streambed slope is expected to exert significant control over the hydraulic and biological characteristics (Montgomery and Buffington, 1993). For a temperate environment, Montgomery and Buffington (1993) noted the following slope – stream channel correspondence:

- Gradient less than 2%: conditions favouring formation of pool riffle channels;
- Gradient 1 to 3%: formation of plane bed channels;
- Gradient 3 to 8%: conditions favouring formation of step pool channels;
- Gradient 8 to 30%: conditions correlated with cascade channels; and
- Gradients > 20%: colluvial channel formation.



Conditions conducive to salmonids spawning and juvenile survival, as well as those favouring the presence of benthic invertebrate communities are typically associated with pool riffle and plane bed channels. The presence of productive fisheries habitat in the majority of the ravine watercourse, therefore, is very unlikely, even in the absence of highly variable seasonal flows and a very contracted running water period during late June to early September of each year.

7.3.1 Hunters and Trappers Association

The Qikiqtarjuaq Hunters and Trappers Association (HTA) were contacted for information regarding the local fisheries and fisheries concerns associated with the project. The response received is presented in Appendix IV.