

3.0 BIOPHYSICAL ENVIRONMENT

3.1 CLIMATE

The Shepherd Bay DEW Station site is located 10 km inland from Shepherd Bay on the west shore of Boothia peninsula approximately 50 m above sea level. Table 3.1 presents climate normals for CAM-3 Shepherd Bay.

3.1.1 PRECIPITATION

Every year approximately 79.9 mm of rain and 64.6 cm of snow falls at this site. In total, approximately 144.5 mm of precipitation occurs per annum, during 59 days of measurable precipitation. The maximum recorded amount of rain and snow received in 24 hours is 23.6 mm in August and 17.8 cm in April, respectively. July through October is the wettest time of year.

3.1.2 TEMPERATURE

Mean daily temperature ranges from 7.5°C in July to -36.6°C in February, averaging -16.1°C annually. Extreme maximum and minimum temperatures are 32.2°C in October and -57.8°C in February.

3.1.3 WIND AND FOG

Winds are primarily from the northwest. Wind speed is fairly steady throughout the year averaging 16.1 km/hr. Mean annual vector speed is 3.6 km/hr, ranging from 1.3 km/hr in April and November to 6.3 km/hr in July. Information on fog and cloud cover was not available.

3.2 GEOLOGY

3.2.1 OVERVIEW

Regionally the landscape is characterized by a surficial veneer or blanket of glacial drift subsequently reworked by marine waters. The terrain is mostly part low-lying and subdued; however, a comparatively high flat-topped plateau occupies the eastern part of the map sheet. Numerous water ponds or thaw lakes occur throughout. The ponds are generally small and are irregular to subcircular in outline and of shallow depth. Isolated raised beach ridges, mostly obliterated by the active frost processes are scattered throughout the landscape. Drainage channels and patterns are poorly developed throughout the area with drainage directed for the most part westward toward the ocean.

Surface materials consist mostly of sand-, gravel-, and cobble-sized rubble with a variable silt and clay content. The surface materials are derived largely from the underlying bedrock which consists mostly of dolostone. The surface materials are often veneered by organic-rich muds or silts particularly within areas of standing water or water saturated surface materials. The coastal area and specifically the active beach region is comprised of well sorted gravel and cobble-sized fragments with variable sand and silt content.

General considerations for development of a landfill in permafrost areas were summarized in Section 6.3.3 of Volume 2. The availability of the capping materials required to insulate the landfill contents and prevent frost heaving of debris from the landfill is discussed in Section 3.2.3 of this volume.

TABLE 3.1 CLIMATE NORMALS FOR CAM-3, SHEPHERD BAY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation													
Mean Rainfall	0.0	0.0	0.0	0.0	0.2	8.0	22.4	35.1	13.6	0.6	0.0	0.0	79.9
Mean Snowfall	3.4	4.2	2.7	6.8	6.2	2.3	0.3	2.2	8.5	15.6	7.3	5.1	64.6
Mean Total	3.4	4.2	2.7	6.8	6.4	10.3	22.7	37.3	22.1	16.2	7.3	5.1	144.5
1 No. Days w/meas rain	0	0	0	0	*	2	7	9	4	*	0	0	22
No. Days w/meas snow	2	2	2	4	4	2	0	1	5	8	4	3	37
No. Days w/meas precip	2	2	2	4	4	4	7	10	9	8	4	3	59
Greatest rain in 24 hrs	T	0.0	0.0	T	1.3	21.3	21.6	23.6	21.8	8.1	0.0	T	23.6
Greatest snow in 24 hrs	11.7	11.4	6.1	17.8	5.3	7.6	4.4	13.2	12.7	11.4	9.4	6.4	17.8
Greatest precip in 24 hrs	11.7	11.4	6.1	17.8	5.3	21.3	21.6	23.6	21.8	11.4	9.4	6.4	23.6
Temperature (C)													
Mean Daily Max	-31.5	-32.5	-27.8	-17.3	-5.7	3.5	11.6	9.7	1.2	-8.4	-19.9	-27.2	-12.0
Mean Daily Min	-40.0	-40.7	-37.7	-28.5	-14.3	-2.6	3.4	2.7	-3.4	-15.8	-29.0	-35.6	-20.1
Mean Daily	-35.8	-36.6	-32.8	-22.9	-10.0	0.5	7.5	6.2	-1.1	-12.1	-24.5	-31.4	-16.1
Extreme Max	-3.3	-5.5	-7.7	2.2	6.7	19.4	23.9	24.4	14.4	32.2	-0.6	-3.3	32.2
Extreme Min	-54.4	-57.8	-55.6	-46.7	-31.7	-18.9	-6.7	-5.6	-16.1	-46.1	-47.2	-50.6	-57.8
Wind													
Mean Wind Speed (km/hr)	13.0	13.4	13.8	18.1	18.1	18.5	18.6	16.5	17.9	17.1	15.2	13.0	16.1
and prevailing direction	SW	SE	W	SW	NW	NW	NW	NW	NW	NW	SE	SE	NW
Mean Vector Speed (km/hr)	3.6	3.0	3.9	4.4	1.3	2.1	6.3	4.1	6.4	3.4	1.3	3.0	3.6
and direction	23.0	16.0	29.0	19.0	19.0	1.0	35.0	33.0	33.0	2.0	17.0	18.0	20.4

1. measurable rain > 0.2 mm

measurable snow > 0.2 cm

measurable precipitation > 0.2 mm water equivalent

rainfall in mm

snowfall in cm

total precip in mm water equivalent

T = trace

M = missing data

* less than 0.5 greater than 0.0

3.2.2 TERRAIN UNITS

Five terrain units can be delineated within the CAM-3 area as shown in Figure 3.1, and are described in the following sections.

3.2.2.1 Terrain Unit 1

The main or upper DEW station facilities are included within Terrain Unit 1. The terrain is extensively disturbed and forms a U-shape in plan view. Surface materials consist of graded and packed sands, gravels, and silts. The terrain is bounded along its perimeter by steeply inclined (5 to 25 m high) slopes - perhaps bedrock controlled. The surface of the plateau is inclined gently towards the north. The sands, gravels, and silts are highly pervious and the terrain is well drained. Drainage channels and patterns are not well developed, however, most surface drainage appears to collect within the central part of the unit.

3.2.2.2 Terrain Unit 2

Terrain Unit 2 comprises a nearly flat-lying terrain. Surface materials are likely typical of the region consisting mostly of sands and gravels with variable silt and clay fractions. The terrain is moderately well to poorly drained with large isolated elongate ponds throughout. Drainage from unit 1 collects in the extreme southwestern portion of the unit.

3.2.2.3 Terrain Unit 3

Terrain Unit 3 includes the majority of the landscape surrounding the CAM-3 facilities. The surface materials consist mostly of sands and gravels which are often veneered by organic-rich silts or muds. The terrain is low-lying and characterized by extensive thaw ponds which are predominantly irregular in outline and very shallow. The terrain is poorly drained and drainage channels and patterns are poorly developed. Three units designated 3a, 3b, and 3c (Figure 3.1) are delineated. Units 3a and 3b differ only in the degree of development of frost induced features. Unit 3a is characterized by extensive polygonally patterned ground whereas unit 3b is not. Unit 3c includes developed terrain adjacent the sea (i.e. airstrip and lower base facilities).

3.2.2.4 Terrain Unit 4

Terrain Unit 4 includes raised beach ridges and interrridge swales. The beach ridges are comprised of comparatively well sorted, angular to subangular gravel, sand, and cobble-sized material. Interridge swales are comparatively finer grained and are often veneered by organic-rich material. The ridge terrain occurs sporadically throughout the region. Most of the ridges have been obliterated by frost processes. Remnants consist of gently curved elongate linear ridges. The ridges are typically well drained; however, the interrridge swales or depressions are often water ponded. This terrain is removed from direct influence of the base operations.

Two units designated 4a and 4b are delineated. Unit 4a includes a better developed perimeter of the base. Unit 4b includes isolated poorly developed ridges scattered throughout the terrain.

3.2.2.5 Terrain Unit 5

Terrain Unit 5 includes the active beach area. The terrain is characterized by a lack of vegetation and granular surface materials consisting of comparatively well sorted sands and gravels. The terrain is low-lying and elevations rarely exceed a few metres above sea level. The surface materials are pervious and few areas of standing water occur on the terrain surface. The water table is probably very shallow.

3.2.3 POTENTIAL BORROW SOURCES

Eight borrow areas were identified at this site and are delineated on Figure 3.1. The majority of these sources are located in the vicinity of the main camp facilities within Terrain Unit 2. The soils encountered are typically coarse grained, ranging from sand to cobble sizes.

The beach area has not been extensively exploited for granular material.

The majority of this site is covered by poorly drained low-lying terrain between the main camp and the beach. Surficial sediments include a veneer of organic rich material overlying coarse grained soils. If required, intermittent ancient beach ridges located across this area would provide additional granular sources.

3.3 HYDROLOGY

Terrain in the vicinity of the CAM-3 station is undulating to nearly flat. The area is characterized by beaded drainage which features shallow circular to semi-circular lakes, pools and bogs connected by short, poorly defined drainage lines. A variety of isolated water bodies and bogs are also scattered throughout the poorly drained, low lying areas.

The CAM-3 site sits on a ridge approximately 10 km east-northeast of Shepherd Bay. Surface drainage around the station flows outward to the west, south and east in a semi-radial pattern. Surface water drains in short, poorly-defined channels which connect many of the ponds or have breached the ridges.

The summer water supply comes from an interior lake located approximately 2.4 km north-northeast of the station, while the winter water supply lake is approximately 5.2 km east-northeast of the station.

The current landfill (Landfill B) is adjacent to the road to the beach cargo area, about 0.5 km north of the station. It drains to the southeast into a small pond immediately west of the station. Landfill C (abandoned), situated in the southwest corner of the site drains west towards the same small lake as Landfill B. Landfill A (abandoned) is located near the winter water supply lake and drains northward. Landfill D is in the beach cargo area immediately adjacent to the shores of Shepherd Bay, which it drains into directly.

3.4 FLORA

This area is typical of low-Arctic tundra and is characterized by a nearly continuous cover of vegetation (less than 20 cm tall), consisting of willow (*Salix arctica*), sedge (*Carex spp.*), mountain avens (*Dryas octopetala*), saxifrage (*Saxifraga spp.*), Arctic poppy (*Papaver radicum*), lousewort (*Pedicularis spp.*), and polar grass (*Arctagrostis latifolia*) on drier, upland sites. Cotton grass (*Eriophorum spp.*), willow (*Salix spp.*), sedges, grasses, and mosses are commonly associated with moist sites. *Senecio congestus* was found around the sewage outfall and at brackish sites near the abandoned village which is its typical habitat across the Arctic (Porsild and Cody 1980). Vegetation was relatively green and lush at the sewage outfall characterized by *Senecio spp.*, grasses, and sedges. On dry, upland sites that had previously been disturbed, such as landfills and roads, *Oxytropus spp.*, willows, grasses, and Arctic poppy were found.

3.5 FAUNA

3.5.1 LARGE MAMMALS

In a review of previous studies in the Chesterfield Inlet North area, Urquhart (1982) reported that muskoxen (*Ovibos moschatus*) had not been seen in the Pelly Bay area for the previous 30 years. A reconnaissance survey of suitable habitat in the area during 1980 also found no muskoxen.

Barren-ground caribou (*Rangifer tarandus greonlandicus*) in this region belong to the Wager Herd which was estimated at 15,200 in 1983 (Heard *et al.* 1986). Calving occurs in early June in an area north of Wager Bay which has been recognized as an area of special significance (Ferguson 1987). Approximately 30 caribou were within 1 km of the station during the site visit. The majority of these animals were males and no calves were observed. Caribou seemed attracted to the sewage outfall area where they were usually found feeding on the relatively lush vegetation.

Polar bears (*Ursus maritimus*) in this area are within Management Zone E and are part of a sub-population in Victoria Strait and the south end of McClintock Channel, which was estimated at 305 animals in the late seventies (Schweinsburg *et al.* 1981). Denning areas for polar bears of the region are found along the north coast of King William Island (Urquhart and Schweinsburg 1984). During winter bears in this region are found on land-fast ice along the Franklin Strait and Bellot Strait. Polar bears have been reported at this station but this is apparently rare and not as common as at the eastern sites (Stenhouse *et al.* 1988).

The grizzly bear (*U. arctos horribilis*) is known to exist in this region (Jonkel 1987) but there were no reports of sightings at Shepherd Bay.

3.5.2 OTHER TERRESTRIAL MAMMALS

An Arctic fox (*Alopex lagopus*) den with at least two young was located approximately 1 km west of the station near the road to the beach. The site was beneath a pile of boulders and was typical of fox dens in coastal areas (Review by Garrot and Eberhardt 1987, Smits *et al.* 1988). An adult was observed carrying a ptarmigan-sized bird to the site and several brown lemmings (*Lemmus sibiricus*) were found dead in the area. Other abandoned dens were found northwest of the airstrip. These animals were probably attracted initially by artificial food sources (landfill and litter), as foraging around construction camps is common (Eberhardt *et al.* 1982). Home range size with territories overlapping petroleum development facilities have been reported as 20.8 km² and 3.7 km², for adults and juveniles respectively (Eberhardt *et al.* 1982). Several fox traps were found discarded in the vicinity of the station.

Observations or reports of other furbearers at CAM-3 were not evident although wolves (*Canis lupus*) and the short-tailed weasel (*Mustela erminea*) probably occur (Carbyn 1987, Fagerstone 1987).

Arctic hare (*Lepus arcticus andersoni*) droppings were found at the site but no individuals were observed. An Arctic ground squirrel (*Spermophilus parryii*) was found in a den along the road to the beach. The abundance of Snowy Owls (*Nyctea scandiaca*) and dead carcasses of brown lemmings found at the fox den indicated that small mammals were abundant. Collared lemming (*Dicrostonyx torquatus kilangmiutak*) may also exist at the site (Banfield 1974).

3.5.3 MARINE MAMMALS

Beluga whales (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) whales migrate westward through Lancaster Sound into Parry Channel from Baffin Bay after ice-break-up in the spring (June-July) (Read and Stephansson 1976). At this time, most marine mammals concentrate in the main channel of Lancaster Sound with diminished numbers migrating to Barrow Strait and few or none penetrating into Viscount Melville Sound. It has been estimated that 10000 beluga migrate into west Lancaster Sound, Barrow Strait and Prince Regent Inlet each spring (Sergeant and Brodie 1975) and leave in September following a route along the south coast of Devon Island (Arctic Pilot Project 1979). Narwhals have a similar summer migration route although they may enter Lancaster Sound somewhat later in the spring (Sergeant and Hay 1978). Population estimates of narwhals entering Lancaster sound in May are placed between 20000 and 30000 (Davis *et al.* 1977).

Preferred summer habitats and areas of major concentrations of beluga and narwhal are north of the study area, adjacent to Prince of Wales and Somerset Islands. Any sightings of belugas or narwhals in the vicinity of Shepherd Bay would probably represent strays from the Franklin Strait migration route (Arctic Pilot Project 1979, Spencer 1983).

The endangered bowhead whale (*Balaena mysticetus*) migrates into Lancaster Sound in June and July. It is unlikely to be encountered in the study area, preferring, like the narwhal, the fiords of northern Baffin Island during the summer (Arctic Pilot Project 1979).

During the open water season (summer) walrus (*Odobenus rosmarus*) concentrate in Lancaster Sound in the vicinity of southwest Devon Island in numbers of less than 400 animals (Sergeant and Hay 1978). Walrus are unlikely to be seen in and around Shepherd Bay since only periodic migrations are made south of Somerset Island (Read and Stephansson 1976). In general, the main range of the Atlantic subspecies of walrus is to the north and east of the Boothia Peninsula (Dahlke 1984). Walrus haul-out sites are found on the eastern sides of Somerset Island and the Boothia Peninsula (Read and Stephansson 1976).

Due to annual ice conditions in the central arctic, most marine mammals either do not penetrate into or migrate from Lancaster Sound prior to winter freeze-up (September). An exception are the seals which occur year-round in the region although, depending on the species, there are shifts in distribution in relation to preferred ice habitats. The two most common seal species, bearded (*Erignathus barbatus*) and ringed (*Phoca hispida*) seals, extend southward into Queen Maud Gulf (Read and Stephansson 1976). The least common of these, the bearded seal, is known to summer around Jenny Lind Island and the Royal Geographical Society Islands (Read and Stephansson 1976). Both bearded and ringed seals have been reported occurring in the pack-ice west of the King William Island in August (Stewart and Bernier 1983). A ringed seal was observed in the open water lead at the beach area during the site visit.

In contrast to bearded seals which prefer offshore areas of shifting pack-ice, ringed seals are likely to be encountered near shore in areas of fast, first-year ice (Arctic Pilot Project 1979). Ringed seals summer throughout the central Arctic including Victoria Strait and Queen Maud Gulf (Read and Stephansson 1976). Coastal densities of 0.69 ringed seals per km² have been recorded in the central arctic (Smith *et al.* 1979). Ringed seals are also common throughout the open water areas of Victoria Strait throughout the winter.

It has been estimated that as many as 130,000 harp seals (*Phoca groenlandica*) enter Lancaster Sound during June and July (Read and Stephansson 1976). Migration routes and summering areas of harp seals are similar to those of narwhal and, therefore, it is unlikely that significant numbers of harp seals would be seen in the vicinity of Shepherd Bay.

3.5.4 RAPTORS

There were at least three pairs of Snowy Owls observed within the station and beach area. A confirmed nest with three young was found, but not approached, north of the road to the beach. Other possible nest sites were northeast and south of the station. An adult Peregrine falcon (*Falco peregrinus*) was seen one morning perched on a shack at the beach area. This bird may have been nesting in the area although it was not seen again after repeat visits. No other raptor species were observed but Gyrfalcon (*Falco rusticolus*), Rough-legged Hawk (*Buteo lagopus*), and Golden Eagle (*Aquila chrysaetos*) are known to occur in this region. Seaducks were commonly observed flying along the open water between the pack ice in the bay.

3.5.5 WATERFOWL

A pair of Pacific loons (*Gavia pacifica*) were probably nesting on a lake northeast of the airstrip and other single individuals were observed on lakes around the station. The red-throated loon (*G. stellata*) was more common but was only observed in the open water leads of the bay. Yellow-billed loons (*G. adamsii*) were not observed during the site visit.

Station personnel reported that Shepherd Bay is an important area for staging Canada Geese (*Branta canadensis hutchinsii*) but nesting density appeared to be low. During the site visit only three Canada Geese were found and these appeared to be moulting as they were reluctant to fly. Six female King Eider (*Somateria spectabilis*) were on small ponds surrounding the facilities and at the sewage outlet. One of these females was incubating a clutch of eggs 200 m from the garage throughout the site visit. Oldsquaw (*Clangula hyemalis*) were seen on several occasions in flocks of 3-20 birds flying along the coast at the beach area. The bay was still covered in pack ice except for a narrow lead near shore. Tundra Swans (*Cygnus columbianus*) were also found at this location and appeared to be nesting further inland. Three broods of White-fronted Goose (*Anser albifrons*) with broods were found on and near the water supply lake northeast of the site.

3.5.6 OTHER AVIFAUNA

The more common shorebirds at Shepherd Bay included Semipalmated Sandpiper (*Calidris pusilla*), Baird's Sandpiper (*C. bairdii*), and Lapland Longspur (*Calcarius lapponicus*). Lesser Golden Plover (*Pluvialis dominica*), Semipalmated Plover (*Charadrius semipalmatus*), Ruddy Turnstone (*Arenaria interpres*), and Red Phalarope (*Phalaropus fulicarius*) were also frequently encountered. Snow Buntings (*Plectrophenax nivalis*) were found in disturbed areas around the station and appeared to be nesting beneath the trains.

Rock Ptarmigan (*Lagopus mutus*) and sign were common throughout this site. Five sightings of 1-3 birds and two broods 6 were reported during the site visit.

Glaucous gulls (*Larus hyperboreus*) were common and were frequently observed along the beach and at the landfill with Ravens (*Corvus corax*). The rare Ivory gull (*Pagophila eburnea*) is not known to nest on Boothia Peninsula (Thomas and MacDonald 1987). All three species of jaeger, Parasitic (*Stercorarius parasiticus*), Pomarine (*S. pomarinus*), and Long-tailed (*S. longicaudus*) were found at the site and were relatively common. Caribou were being almost constantly harassed by defensive nesting pairs of jaegers during the site visit.

3.5.7 FISH

The domestic, commercial and sport fishing activity of western Boothia Peninsula has been reviewed by Stewart and Bernier (1983). Anadromous arctic char (*Salvelinus Alpinus*) are an important food for residents of the Spence Bay who range as far south as Shepherd Bay to fish. Most of the fish is caught in July-August by Inuit domestic fishermen for consumption by their families. Anadromous arctic char, Arctic cisco (*Coregonos Autumnalis*) and Arctic Cod are the main species caught. In late August and early September, anadromous Arctic char are netted at river mouths as they return upstream to overwinter in freshwater. Limited recreational fishing is being done by station personnel in the area.

3.6 HERITAGE RESOURCES

No previously recorded sites occur within the area of the CAM-3 station. Three prehistoric sites were identified during the field reconnaissance. All of the sites, containing tent rings and caches, appear to be of Thule age. One of the sites has been disturbed severely by gravel extraction and probably looting activities. The remaining two are located in close proximity to existing roads and may be impacted by continued use of these communication routes. These sites are shown on Figure 3.2.

The area of Shepherd Bay contains significant archaeological remains. The general region is considered to be of high archaeological potential. In light of the proposed conversion of CAM-3 to a NWS site, it is recommended that additional archaeological studies be conducted in the area of the station and associated facilities to ensure that all sites are identified and assessed, and clearly mapped for current and future avoidance by station activities.

3.7 LAND USE

The waters adjacent to this site are major seal and bird hunting areas during the spring and summer for Inuit from Gjoa Haven, located 100 km west, across Rae Strait. Arctic fox are also trapped in the vicinity of the Shepherd Bay site.