POLARIS MINE

DECOMMISSIONING AND RECLAMATION PLAN

VOLUME 2 OF 4

SUPPORTING DOCUMENTATION

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POLARIS MINE
DECOMMISSIONING AND RECLAMATION PLAN

Volume 2 of 4
Supporting Documentation

1. Report on Barge Reclamation Options, Gartner Lee Limited, March, 2001.
2. Polaris Landfill Closure Report, Gartner Lee Limited, March, 2001.
3. Garrow Lake, Effect of Removal on Lake Stability and Outflow Water Quality, Axys Environmental Consulting Ltd., March 12, 2001.
4. Garrow Lake Dam Decommissioning, EBA Engineering Consultants Ltd., March, 2001.
5. Decommissioning of Dock at Polaris Mine, Westmar Consultants Inc., March, 2001.
6. Human Health and Ecological Risk Assessment of Cominco's Polaris Mine on Little Cornwallis Island: Derivation of Soil Quality Remediation Objectives, Cantox Environmental Inc., March 12, 2001

Prepared for
Cominco Ltd.

Prepared by:
Gartner Lee Limited

March 2001

Distribution:
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Polaris Mine
Report on Barge Reclamation Options

Prepared for

Cominco Ltd.

Prepared by:

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GLL 20-936

March 2001

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Executive Summary

The development of the Polaris mine in 1981 was highlighted by the construction of the process plant and related facilities on a barge in southern Canada and its subsequent transportation to the site, towed 4,800 km, by tugs. The barge was then beached at the site for use as the main plant building. Cominco Ltd. had always felt that the barge design would allow the barge to be re-floated and used at another Arctic mining project, or returned to southern Canada for sale at the end of its Arctic use.

The Polaris Mine will be closing in 2002. Cominco tried to extend the life of the operation by development of other ore sources in the area but after extensive exploration no economic deposits have been discovered. Cominco Ltd. is currently developing a detailed Closure Plan based on the assumption that all facilities and installations that comprise the Polaris Operations will ultimately be decommissioned, removed or reclaimed. The Closure Plan is based on the concepts that contaminated soils will be disposed in the underground mine and that all non-hazardous demolition materials from the surface buildings will be buried in the Little Red Dog quarry. The quarry will be covered with natural materials designed to provide a frozen, impermeable cover.

Previous Closure Plans have only considered the option of removing the barge from the site by re-floating and towing to a southern location for disposal or re-fitting for another project.

In 1999, an Environmental Site Assessment was conducted to assist in developing an updated decommissioning and reclamation plan. The assessment concluded that the industrial activities conducted in the vicinity of the barge have resulted in significant impacts to the active layer of the permafrost surrounding the barge.

The feasibility of re-floating the barge had not been examined in any detail until recently, when it became clear that the concept of re-floating and towing south may be risky from environmental, operational and cost perspectives.

This report reviews two options for reclamation and disposal of the barge, including the risks associated with each option.

- Option 1: Re-floating of the barge and towing to southern Canada for ultimate disposal.
- Option 2: Dismantling and/or demolition of the barge and disposal at the mine site.

Option 1

Option 1 is essentially a reverse of the barge towing and berthing of 1981. Preliminary assessments of seaworthiness have been positive, with no obvious defects that would prevent permitting for marine transport. Review of the procedures required to render the barge seaworthy and consideration of

environmental and regulatory issues related to the cleaning of the barge and excavation of a lagoon to re-float the barge have identified several concerns.

Re-establishing the correct weight and ballasting for the voyage is complicated by the extra concrete, equipment and service lines installed during operations. These items will have to be removed to provide sufficient freeboard for sailing and not all of the installations have been documented. Final adjustments cannot be made until the barge is floating, which may result in delays. Significant delays could jeopardize the voyage.

The dust accumulations on the interior of the barge must be removed prior to the voyage. This will be accomplished by high pressure water washing. The wash water will be discharged to Garrow Lake. Other preparations required for the voyage have been identified by marine consultants and can be completed prior to sailing. These would include examination of the barge bottom, which can not be completed until the barge has been re-floated and is in deep water.

The lagoon for floating the barge will be a similar size to that used in 1981. However, metal and oil contamination in the fill and ground water around the barge may necessitate some minor adjustments in size. The contaminated fill will be disposed in the underground mine. The best time to excavate the lagoon will be in the winter prior to the voyage. Provisions will have to be made to handle any spring runoff entering the excavation prior to flooding with seawater, this runoff would likely require disposal in Garrow Lake.

The contamination under the barge can not be removed until the barge is moved. It will, therefore, be very difficult to prevent mobilization of sediments and contaminants into the seawater as seawater enters the lagoon. Discharge of these contaminants into the ocean would be in contravention of the Fisheries Act and the Arctic Waters Pollution Prevention Act.

If the barge voyage to southern Canada begins at the optimum time, the third week in August, the ice conditions should allow easy sailing out through Lancaster Sound. The September weather in the Labrador Sea may be difficult with a higher frequency of storms, high winds and waves. However, if it is a “bad ice” year, the passage through to Lancaster Sound may also be difficult or impossible, resulting in delays at a minimum and cancellation or over wintering as the worst case.

Option 2.

Option 2 requires dismantling/demolition of the barge superstructure and recovery of saleable equipment, followed by demolition of the barge hull. All demolition materials would be buried on site in the Little Red Dog quarry pit. Information provided by Cominco Ltd. indicates that the volume of quarry pit is more than adequate to accommodate the barge, as well as materials from other demolition on site.

Option 2 fits into the same concept as the current Closure Plan and as a result will require no special approvals other than those required for the Plan itself.

The contaminated fill under the barge can be dealt with in an environmentally sound manner, without concerns for release or mobilizing the contaminants. Following shut down of the mill site, alternate methods of management and treatment of potentially contaminated spring runoff in the lagoon area will be required. However, this is a concern common to both options being considered.

In summary, Option 2 is recommended as the preferable option to reclaim the barge. It provides one major advantage, every aspect is under control. Option #1 involves too many potential risks or unknowns, such as floating the barge, the potential for mobilizing contaminants and /or sediments and extremes in the weather and ice conditions. In addition, the cost of disposal on site in Option #2 is estimated to be similar to the cost of towing to the south and southern disposal.

1. Introduction

The development of the Polaris Mine was highlighted by the construction of the process plant and related facilities on a barge in southern Canada and its subsequent voyage to the site towed by tugs. Prior to beaching the barge at Polaris a lagoon was excavated to provide access and a berthing base for the barge. A cofferdam was installed and the berthing lagoon was pumped out and backfilled.

With most of the service facilities located on the process barge, the Polaris mine became one of the most compact mining operations in Canada. In addition to the process plant (or the concentrator) the barge contains the powerhouse, maintenance shops, warehouse, offices and change rooms. The bottom and side tanks of the barge hull were also designed to provide a large part of the diesel fuel storage for the site (10.6 million litres). The only other major buildings on site are the accommodation building and the concentrate storage building.

The Polaris Mine will be closing in 2002 and Cominco Ltd. is developing a Closure Plan to address contamination issues and the decommissioning and disposal of plant and buildings. The general objectives of the Polaris Closure Plan are:

- To ensure that the site returns to a condition such that public health and safety, and the environment are protected.
- To provide a working document to address the concerns and requirements of all stakeholders during the consultation and implementation stages of the Polaris Closure Plan.
- To ensure that the planned closure activities are such that the requirements for long term maintenance and care are minimized or eliminated.
- To identify those activities required to return the site to an aesthetically acceptable condition.

To assist in developing the scope of work, an environmental assessment of the leased lands and adjacent areas was carried out during the 1999 and 2000 field seasons to determine the environmental impacts of the Polaris mine operations.

Working in the Arctic presents many unique challenges. This is especially true with the remote location and harsh environment at the Polaris Mine site. These challenges are at the forefront of the planning process for completion of mining, decommissioning and reclamation at the Polaris mine site. The decommissioning and reclamation activities are being planned to take advantage of the frozen winter conditions, the permafrost environment and the short summer shipping season. Currently, the mine is scheduled to complete operations and close in 2002.

Although the original concept of using the barge process plant was developed to reduce time and costs for the mine development and construction project, Cominco had always felt that the barge design would allow the barge to be re-floated and used at another Arctic mining project, or returned to southern Canada for sale at the end of its Arctic use. Considerable mineral exploration by Cominco and others in the region has not resulted in another project that could utilize the barge and Cominco has been unable to find a buyer for the barge process plant.

Previous Polaris Mine Closure Plans have specified removal of the barge by re-floating and towing to a southern location for disposal or re-fitting for another project. However, in early Closure Plans submitted to the NWT Water Board, there was no detailed examination of the risks associated with re-floating the barge.

An Environmental Site Assessment (ESA) to support the Closure Plan was conducted in 1999 and 2000. This ESA has shown metal (Pb, Zn) and hydrocarbon (diesel fuel) contamination in the fill and groundwater around the barge. The 1999 Draft Closure Plan was the first to examine decommissioning and disposal of the plant and buildings in detail, identifying some of the problems associated with re-floating the barge and towing to southern Canada for demolition and disposal.

Cominco has commissioned Gartner Lee to review the options for disposal of the barge as part of the Polaris Closure Plan.

This review considers two options:

- Option 1, removing the barge from the mine site by re-floating and towing to southern Canada, with demolition and disposal of the demolition materials and equipment in a southern landfill.
- Option 2, disposal of the barge on site by dismantling and/or demolition with disposal of the demolition materials on site.

The following review includes details of the original barge voyage to be sure that all aspects of these two options are put into perspective.

2. Background Information

2.1 Barge Construction

The barge is 31m wide, 122m long and 18m high, above a 4.3m deep hull. The completed barge, superstructure and original contained equipment weighed approximately 11,250 tonnes. The superstructure is a custom engineered frame building with ribbed, insulated sandwich panel exterior siding and roofing. The barge hull was constructed of welded mild steel with an ice strengthened shell framing (Lloyd's Grade E steel), the same steel used for icebreaker construction. The bow and sides were protected with heavier than normal shell plating 1" thick.

The hull is divided into five separate watertight compartments with full double bottom tanks. The barge was constructed to survive the flooding of any two adjacent compartments. The bow was raked and the stern partly raked for the voyage to the mine site. There were plans to strengthen the superstructure to six feet above the hull to withstand wave action and impact from collisions with free ice (no details on whether this was actually carried out). The barge was not classed by any Ship Classification Society but was built to standards of good shipbuilding practice.

A protective epoxy coating was applied to the bottom and two feet up the sides of the barge hull as an anti-corrosion measure. The coating consisted of two layers of Inerta 160 (no details). At the time of construction, this product was quoted by Bechtel as being the best coating available. It was also being used on icebreaker hulls as a protection against abrasion in the ice breaking operation. The sides of the hull were treated with three layers of cold tar epoxy.

Captain T.C. Pullen in his report "A Route Examination for the Barge Tow to Little Cornwallis Island, N.W.T. 1981" states that "Construction of the barge, and of its superstructures will be such as to provide a seaworthy and ice-worthy tow for the conditions to be expected in August and the first week in September." A report by Marine Engineering Consultants, Noble Denton in September 1980 confirms Captain Pullen's observations and indicates that the barge was not designed to withstand severe weather (see Section 2.3).

A requirement prior to the voyage was to install a considerable amount of steel bracing and supports to provide structural strength and bracing to the barge interior and equipment. This requirement was to provide stability during the crossing of the Labrador Sea.

2.2 Barge Towing to Polaris

There are few records documenting the actual voyage from Trois Rivieres, Quebec to Polaris Mine on Little Cornwallis Island (LCI). The Cominco Library Archives contain telexes of the daily position of the barge and weather conditions encountered, these have been summarized in Appendix A.

The tow was performed by Atlantic Towing Limited (St John, New Brunswick) using three tugs from Trois Rivieres to the Strait of Belle Isle and then continuing with two tugs to Polaris.

The barge left Trois Rivieres, Quebec on July 24, 1981 and arrived at LCI on August 13, 1981. The 5,038 km voyage was completed in 19 days, 9 days less than the plan. There were no recorded problems during the voyage. Weather and ice conditions were almost perfect, which is considered to be very unusual in Arctic Canada during the first half of August. There was no damage to the barge or superstructure. The only maintenance necessary during the voyage was to repair leaks in the roof of the superstructure which were detected during routine inspections by the towing crews.

The voyage was split into six segments. (Figure 1):

- Segment One (288nm) - Trois Rivieres to Pointe des Monts in the estuary of the Gulf of St Lawrence.
- Segment Two (590nm) - Pointe des Monts to Belle Isle Strait.
- Segment Three (730nm) - Belle Isle Strait to the vicinity of Godhaab, Greenland (Nuuk)
- Segment Four (1,000nm) - Davis Strait and Baffin Bay.
- Segment Five (216nm) - Lancaster Sound
- Segment Six (112nm) - Barrow Strait, via McDougall Sound to Crozier Strait and Polaris Mine.

The total distance was 5,038 km (2,936 nautical miles).

The route selected provided the following:

- Minimal exposure to the North Atlantic sea and swell conditions.
- Avoided East/West traffic area in the Atlantic off Newfoundland.
- Avoided southerly currents along the Newfoundland coast.
- Advantage of the north flowing current on the West Coast of Greenland.
- Avoided potential pack ice in Baffin Bay off the Canadian Coast.
- Minimal exposure to ice on the North side of Lancaster Sound.

2.3 Voyage Risks and Situations

The timing of the voyage was critical. Prior to 1981 the best ice conditions for vessel movement in and out of Little Cornwallis Island had been between August 15 and September 7. The voyage segments were assessed for risk in the following order (Figure 1):

Most Risk	Segment Three	Labrador Sea (Heavy seas and storms)
	Segment Six	McDougall Sound (Ice conditions)
	Segment One	St Lawrence River (Heavy river traffic, currents and tides)
	Segment Four	Baffin Bay
	Segment Two	Gulf of St Lawrence
Least Risk	Segment Five	Lancaster Sound

Two documents provide an overview of the voyage risks considered prior to sailing.

- "A report on situations which could arise during the tow to Little Cornwallis Island from Trois Rivieres during August 1981, and the steps that should be taken to cope with them", by Captain T. C. Pullen
- "A Review of Risks Arising From the Voyage of Arvik II To The Polaris Site", by the Polaris Risk Audit Committee, Cominco Ltd., Vancouver, B.C. May 1981.

The Pullen document concentrates on the practical situations or crises that may have arisen during the voyage. The Cominco document deals with insurance and legal aspects of the voyage, including applicable regulations and voyage permitting requirements.

The situations (risks) as described by Pullen are summarized below. His lengthy recommendations to cope with these risks have not been included :

Segment One - St Lawrence River

- High wind conditions and poor visibility
- Loss of tow control
- River traffic and fishermen
- Unfavourable tide conditions in some sections

Segment Two – Gulf of St Lawrence

- Fishermen and other traffic
- Fog and icebergs in the Strait of Belle Isle
- Loss of tow control

Segment Three – Belle Isle to Davis Strait

- Wind, sea and swell conditions in the Labrador Sea
- Loss of tow control due to weather or ice damage
- Icebergs, Bergy bits, growlers
- Fishing vessels.

Segment Four – Davis Strait and Baffin Bay

- Fog and ice
- Collision with ice
- Pack ice
- Loss of tow control

Segment Five – Lancaster Sound

- Worse than average ice conditions
- Icebergs
- Fog
- Gales and loss of tow control

Segment Six – Barrow Strait to LCI

- Ice stops passage
- Towline parts in ice
- Tug services are lost
- Ice jam on arrival at LCI
- Ice breaker damage to barge
- Grounding
- Refusal to continue
- Loss of tow control
- Unexpected storms

2.4 Barge Excavation and Berthing

The berthing of the barge entailed construction of an approach basin and a berthing pad behind a closed dyke (Figure 2). The approach basin was excavated to a depth of about 4m to provide 0.6m clearance under the barge at low tide. The excavation was carried out in winter in early 1981. The permafrost was broken by drilling and blasting and removed by front-end loaders and trucks. The dyke was constructed with loose material from the barge excavation and allowed to freeze in place to keep out the sea water.

The barge berthing pad was prepared at an elevation to accommodate the barge draft at the predicted high tide during the time of the berthing operation. The pad was constructed by filling the excavation with a granular material and graded carefully. Cement is reported to have been added to the granular material, but this has not been confirmed in discussion with those on site at the time.

Because the dyke material was placed above the excavation grade, some sub-grade excavation was required when the dyke was opened to permit entry of the barge.

It is reported that spring runoff water was not a problem in the excavation. The small amount of the water entering was handled easily by a Wilden pump.

The barge was expected to arrive at LCI around August 28, 1981. Tide studies indicated that the most favourable high tide conditions for berthing would occur on August 30, September 1, 15, 16 and 17. However, as discussed, in Section 2.2 the barge arrived on August 13 at 3.45 am and was berthed by 2.00 p.m. on the same day. Interestingly, according to the 1981 tide tables, high tide at 1.00 p.m. on the 13th was probably the "lowest" high tide of the month and 20cm lower than high tide on August 30. Discussion with J. Gowans indicates there was a large safety factor built into the estimates.

The barge was floated into place over the prepared berthing pad using a combination of tugs and cables attached to land based bollards and heavy mobile equipment. Once the barge was in place and secured against the timber bumpers on shore the dyke was re-constructed across the entrance to the basin, then a second dyke was constructed adjacent to the barge (Figure 2). After removal of the internal bulkheads, ballasting of the barge to ensure firm and level beaching, was carried out by pumping 4,000 tons of fuel oil from the tank farm into the barge tanks.

The plan was then to pump the seawater out of the lagoons to allow backfilling to take place. However, it is reported that it was difficult to empty the large lagoon (Figure 2) completely and backfilling began with water in the lagoon (no details on how much water). While the lagoon was open to the ocean a number of pieces of ice floated in also, these required removal with a backhoe prior to backfilling the lagoon. The backfilling material was obtained from the excavation for the concentrate storage building and raised beach material from south of the plant area. J. Gowans believes no mine waste was used as backfill around the barge.

2.5 Voyage Permitting

The voyage fell within the scope of federal legislation; designed to ensure the safety of Canadian vessels and their crews and intended to prevent pollution of Canada's coastal and marine areas.

The two main statutes that regulated the voyage of the barge were the Canada Shipping Act and the Arctic Waters Pollution Prevention Act (AWPPA), as well, several sets of regulations made under these Acts. The "AWPPA" effectively replaces the Canada Shipping Act north of 60° for pollution prevention. The "AWPPA" applies to all waters within 100 nautical miles of the nearest Canadian land.

The barge was unmanned during the voyage. An inspection crew, based on one of the tugs, went aboard the barge occasionally to check conditions and possible wave damage. The barge would not have complied with all of the applicable regulations which were required for a manned voyage.

By regulations made under the AWPPA, a series of "shipping safety control zones" was established. The barge voyage crossed Zone 13, which includes all of Lancaster Sound and entered Zone 6 which includes Little Cornwallis Island. Navigation was allowed in Zone 13 before August 15 only with the aid of a duly qualified ice navigator. Between August 15 and September 20, an ice navigator was not required. However an ice navigator was required at all times in Zone 6. (See Section 4.3.1 for current "ice regime" regulations).

The barge required compliance with other formalities prior to sailing including:

- Registration as a ship
- Clearance certificate from the Manager of the Port of Trois Rivieres indicating all fees have been paid and the barge was not subject to any liens.
- Permission of St Lawrence pilotage authorities.
- Certificate from Health and Welfare Canada which states the barge is free of rodents and other vermin, in order to gain entry to West Greenland ports, if necessary.

- Compliance with the Collision Regulations.

2.6 Mine Operations, 1981 to 2000

The barge has been the centre of operations throughout the mine life. As a result, considerable mining related activity has occurred around the barge. The barge was designed to prevent process discharges (liquids and solids) from the concentrator other than into the barge sumps (below ground level) or into the tailings line. The only process discharges in the barge area have been airborne, including exhausts from the crusher and assay lab dust collection systems and from the scrubbers on the lead and zinc concentrate dryer exhausts. Much of the activity within the barge area revolved around the maintenance, re-fuelling and movement of surface and underground mobile equipment.

Other specific mining related activities within the barge area and potential contaminant sources have included:

- Fuel transfer, ship to barge and tank farm to barge (potential for spills from barge tank vents).
- Construction of the Cat generator building and operation of the two Cat diesels adjacent to the process barge (potential for spills).
- Construction of the Benthorn crude oil building adjacent to the barge and operating one diesel with Benthorn crude oil (potential for spills from the conditioning and day tanks).
- Mobile equipment steam cleaning in the building adjacent to the north end of the barge.
- Tire repair shop adjacent to the steam bay
- Discharge from the lead and zinc concentrate scrubbers on the dryers at the south end of the barge (dust contamination).
- Spring runoff water collection and pumping from a sump at the NE corner of the barge .
- Movement of core and ore samples in and out of the geology core trailer, adjacent to the west wall of the barge.
- Movement of mill chemicals into the SW barge door and disposal of cleaned chemical containers from a temporary garbage dump at the south end of the barge.

All of these activities over 20 years have contributed to the metal and hydrocarbon contamination of the fill around the barge area (Figure 5). An Environmental Site Assessment study in 1999 and 2000 has identified the nature and extent of the contaminants in the rockfill surrounding the barge and is summarized in Section 3.

3. Environmental Quality in the Barge Area

An assessment of rockfill and groundwater quality was conducted in the area surrounding the barge in 1999 to identify potential impacts resulting from the industrial activities in this portion of the mine site (section 2.6). The field investigations consisted of borehole drilling, test pit excavation and the installation of groundwater monitors to characterize the subsurface conditions and collect rockfill and groundwater samples for chemical analysis. Based on the type and nature of industrial activities conducted in the barge area, the soil and groundwater samples were analyzed to determine concentrations of petroleum hydrocarbons and metals.

3.1 Physical Characteristics

Observations during test pit excavation within the process barge rockfill area showed that the thickness of the active layer generally varied from 1 to 2 m. The thickness of the active layer is influenced by the presence of heat sources, such as the barge. Observations during field investigations showed that the thickness of the active layer adjacent to the barge wall was over 3m. The cross-section of the barge area (Figure 4) illustrates the influence of this heat source on the thickness of the active layer.

Water level measurements in the monitors installed in the vicinity of the barge showed that a thin layer of groundwater accumulates above the permafrost and within the active layer, during the summer season. There is, however, no potential for large-scale groundwater movement due to factors such as restricted recharge, the low temperature of the groundwater and the limited thickness of the saturated zone. The groundwater flow system is therefore very localized and is influenced by local conditions such as differential melting due to the presence of heat sources, soil permeability and sump pumping. Groundwater quality also strongly reflects the local soil quality characteristics. Figure 4, shows a cross-section of the barge area, and illustrates the occurrence of groundwater in relation to the measured thickness of the active layer. The measured depth to groundwater in monitors installed in test pits excavated in the barge area varied from 0.4 m in a monitor located closest to the dock, to 2.1 m in a monitor located adjacent to the east wall of the barge.

3.2 Contaminant Occurrence and Distribution

The results of sampling and analysis of rockfill and groundwater samples collected from test hole locations excavated in the vicinity of the process barge identified the presence of elevated concentrations of lead and zinc, and petroleum hydrocarbons.

Rockfill samples collected within the barge area contained elevated lead and zinc concentrations to a depth of 1.5 m. Observations during test pit excavation and the results of soil sample analysis indicated that petroleum hydrocarbon contamination was restricted to the active layer, measured to be approximately 1.1

to 1.5 metres below ground level in the area surrounding the process barge in July 1999. Analysis of soil samples collected from boreholes drilled in the vicinity of the process barge at depths below the maximum thickness of the active layer indicate that the presence of permafrost restricts the downward movement of contamination.

Due to differential heating of the permafrost adjacent to the barge walls, the thickness of the active zone and therefore the zone of metal and petroleum hydrocarbon contamination in the rockfill and seepage water increased to over 3 metres at test hole locations directly adjacent to the barge walls. Figure 5 illustrates the approximate areal extent of the elevated levels of metals and petroleum hydrocarbons in rockfill and groundwater surrounding the process barge.

On the basis of the industrial activities in the vicinity of the barge, two major sources of metal contamination to the subsurface were identified: concentrates from dryer emissions, spillage, vehicle tracking, and conveyor transfer; and, mineralized rockfill which have resulted in the occurrence of elevated metal concentrations at depth.

The hydrocarbon contamination found in the rockfill is attributed to fuel transfer activities associated with diesel fuel storage and use in the vicinity of the barge and dock. Diesel is stored in tanks within the barge hull, an above-ground tank used for vehicle fuelling, and a day tank located on the west side of the barge. Frequent small volume spillage of diesel during vehicle fuelling and accidental releases through the ventilation ports during filling of the under-barge tank have contributed to contamination of the rockfill in the vicinity of the barge.

The results of groundwater analysis indicate that due to the limited thickness of the saturated zone, the concentrations of petroleum hydrocarbons and lead and zinc tend to correlate closely with the soil contaminant levels. Accordingly, dissolved zinc and petroleum hydrocarbon concentrations exceeded the CCME water quality guideline and Territorial standards in a majority of the groundwater samples collected in the vicinity of the barge. Ammonia and nitrite concentrations in water sampled from a water level control sump installed at the northwest corner of the barge also exceeded the federal water quality guidelines for the protection of aquatic life.

Differential heating of the subsurface in the vicinity of the barge has resulted in a thicker active layer immediately adjacent to the barge that extends beneath the structure. Observations recorded during the field program conducted in 1999 and 2000 indicate that due to the increasing thickness of the active layer from areas around the barge to the zone beneath, a gradient has been established that provides a pathway for the migration of metal and petroleum hydrocarbon contaminated seasonal groundwater. The area beneath the barge therefore serves as a sink for the dissolved contaminants in the surrounding area. As a result, the zone of hydrocarbon and metal contamination extends to the rockfill beneath the barge. In addition, water quality within the active zone beneath the barge has been impacted and will require cleanup during decommissioning.

3.3 Management of Contaminated Rockfill and Groundwater in the Barge Area

Subsurface assessment studies to determine the quality of rockfill in the vicinity of the barge have identified the upper 1 to 2 metres of the fill (active layer) as well as the rockfill beneath the barge to be contaminated with petroleum hydrocarbon residuals and metals.

The proposed remediation method for areas containing elevated concentrations of metals and petroleum hydrocarbons will involve excavation and disposal of the contaminated soil to the underground mine. Excavated areas may require filling and re-grading. Water in the excavation must be controlled to prevent discharge into the ocean for both barge reclamation options.

The final schedule and procedures for the management of contaminated groundwater and excavation of the rockfill will be determined on the basis of the final decommissioning option chosen.

4. Option #1 - Barge Removal

This option is essentially a reverse of the 1981 barge voyage. Re-floating the barge and towing to southern Canada had previously been considered a simple operation. Preparation of the 1999 Draft Closure Plan necessitated a detailed examination of how the barge would be prepared for the voyage, re-floated and towed to the south and the risks associated with such a plan.

4.1 Engineering and Construction Requirements

4.1.1 Seaworthiness Assessment

Cominco engaged two consultants to determine the seaworthiness of the barge and to determine the preparations required for the sea voyage. In 1996, Noble Denton & Associates Inc. (Marine Engineering Consultants) were on site and carried out a detailed preliminary inspection. In 1997 CANSPEC performed tests to determine hull plate thicknesses and in 1998 Noble Denton reviewed the CANSPEC report and provided Preliminary Towage Preparation Recommendations. Noble Denton were consultants to Bechtel and Cominco for the 1981 voyage.

The CANSPEC study examined the hull plate thickness throughout the sides of the barge hull. Excavation of the fill surrounding the barge at a number of points on the hull exterior provided access for thickness measuring and a visual inspection. The results of this study were assessed by Noble Denton who determined that the hull appeared to be in excellent condition and suitable for the proposed voyage to the mainland. They also concluded that the barge would not noticeably deteriorate by the proposed date of departure, unless the hull sustained physical damage. No assessment has been possible for the hull bottom, no access is possible from the interior while the fuel tanks are in use.

RISK
There is a small risk that the hull bottom may have sustained damage during the beaching procedure or that it may have corroded during the 20+ years it will have sat at Polaris. This cannot be determined until the barge is re-floated and inspected by divers. While it may be possible to carry out any hull repairs required from the barge interior, serious delays may jeopardize the voyage by missing the best weather window.

4.1.2 Preparation for the Voyage

Noble Denton carried out a detailed inspection of the barge exterior and interior and prepared a report which provides the following recommendations:

- for the temporary bracing required within the barge interior prior to towing;
- towing arrangements for the voyage to the St. Lawrence River and
- for the items to be removed prior to the voyage.

Approximately 80% of the original bracing installed for the 1981 voyage was removed to facilitate operation of the concentrator and workshops. By reviewing the “as built” drawings the consultant was able to calculate the exact amount and type of steel which will be required for replacement. The consultant has estimated that 66 tons of bracing and 40 tons of bracing connections will be required to be shipped to the site in the summer shipping season prior to installation. The consultant also noted that the internal temperature of the barge should be maintained at a temperature appropriate for welding procedures. Under the current schedule, this would mean either installing the temporary bracing prior to the winter of 2002/2003 or keeping the barge heated until installation takes place in spring 2003.

The following original towing equipment needs to be checked and/or re-installed on the barge prior to the voyage:

- Chain towing bridle (still in place, but condition unknown)
- Emergency towing pennant
- Stern notch for use by a pushing tug
- Anchors stowed on ramps at the port and starboard bows

Noble Denton have recommended that the barge be unmanned during the voyage, but adequate provision should be made for personnel involved with the tow to board the barge for inspection and/or maintenance during the voyage. They have also provided a list of other general items of preparation for the voyage, including a list of loose items and additional weighty items which will require removal from the barge and disposal as part of the Polaris Closure Plan. Items to be removed include:

- all portable equipment, tools, spare parts and warehouse supplies;
- office and laboratory supplies;
- various items installed on the barge exterior since arriving at site e.g. ventilation stacks, conveyor belts, access bridge, etc.;
- grinding media and process chemicals;
- fuels and lube oils contained in the internal barge tanks; these would be discharged to land based storage tanks;
- stationary equipment (such as the tower mill) and wiring added at the site would also be removed.

Noble Denton estimated that approximately 450 tons of concrete have been added to the barge since 1981, 290 tons in the upper warehouse and 150 tons in the maintenance shops. On the 1981 voyage the barge was bow heavy and to compensate, about 150 tons of grinding balls was used as ballast in the shop area at the stern. There was no ballast such as water or fuel in the barge bottom and side tanks. Thus for the return voyage the warehouse concrete requires removal. (Note: when the barge is in the floating mode, 450 tons will reduce the freeboard by 4 to 7 inches depending on the weight of the concrete). However, discussion with J. Gowans indicates that concrete was also placed in other areas including under the thickeners and in several pump sumps. These extra items are not documented and information required to determine the full extent of modifications will have to be obtained by interviews with previous employees.

Noble Denton also noted that approximately 100 tons of loose dust attached to stairwells, bulkheads, braces, etc. will have to be removed prior to the voyage. This dust will be either ore dust or lead/zinc concentrate dust depending on the location. Their concern is barge stability, but there will also be an environmental concern for the voyage. Prior to the voyage, the barge would require cleaning to comply with the Arctic Waters Pollution prevention Act

RISK
If all of the additional weight installed at site is not identified and removed, adjustments will have to be made once the barge is floating. This may cause serious delays, especially if the facilities are not available to quickly make adjustments and provide correct ballasting for the voyage.

4.2 Barge Lagoon Excavation and Flooding

It has been assumed for the purposes of this study, that the excavation required to re-float and remove the barge will be approximately the same size and in the same location as that required to berth and beach the barge (Figures 3 and 4).

The best time to carry out the excavation would be during the winter, when the fill around the barge would be frozen. The fill would be removed by drilling and blasting and hauling the broken material by truck for disposal. Fill contaminated with hydrocarbons and metals would be disposed in the underground mine.

Carrying out the excavation in the winter will ensure easy management of the frozen groundwater, which is contaminated with hydrocarbons and metals. This water would be mobile in the summer. Winter would also be the best time to remove other contaminated fill around the area, most of this is within 1.5 m of the surface. In order to reduce the risks associated with hydrocarbon contamination, de-watering of the rockfill during the preceding summer should be examined. (Figures 3, 5 and 6 provide approximate outlines of the groundwater, soil hydrocarbons and metals contamination and the relationship to the proposed excavation).

A cofferdam would be left in place to prevent the entry of seawater (Figure 3). Testing confirms that the fill close to the shoreline is frozen and competent. However, a geotechnical inspection will be required to assess the permafrost conditions and strength of any proposed coffer dam.

The excavation would then be left empty until summer. During the summer runoff period, a pump(s) would be required to remove any water entering the excavation (Figure 3). Previous experience around the barge, especially in recent years with more winter snowfall, indicates that a considerable amount of water would enter the excavation. This water will likely be contaminated with metals from the areas around the excavation and will require disposal to Garrow Lake. Another alternative may be to set up a temporary water treatment plant with disposal into the ocean. This alternative would require permitting and would likely be too problematic and costly to deal with both hydrocarbons and metals.

Flooding of the excavation would be accomplished by removal of the coffer dam (Figure 3). It may be prudent to initially remove only sufficient material to allow seawater to enter the lagoon, in order to prevent any local ice from entering, to reduce wave action in case of high winds and to allow easy closure in the event of problems.

Although as much of the contaminated soils as possible will have been removed during the lagoon excavation, it is quite possible that some contamination will remain and be mobilized by the seawater (Figure 3). The ESA has shown at least two areas on the fringe (walls) of the proposed excavation location with metal contamination down to 3 m. Loose soils and sediments will also be picked up by the seawater and any wave action on the sides of the excavation will increase the sediment load.

The ESA has also shown that hydrocarbon contamination exists underneath the barge but the amounts are unknown. This contamination would be mobilized as soon as the lagoon is flooded. It has been suggested that hydrocarbon contamination getting into the seawater may be removed by using booms and a skimmer. However, the practicality of this solution is uncertain considering the potential for wave and ice conditions. Metal concentrations in the excavation are difficult to predict and it may not be acceptable to discharge this water to the ocean.

RISKS

- ***There is a small risk that fill conditions adjacent to the shoreline will not be suitable for an impermeable coffer dam.***
- ***It is likely that some metal and hydrocarbon contamination in the fill under the barge will not be removed from the excavation and will be mobilized when flooding with seawater takes place.***
- ***Some hydrocarbon contamination under the barge will be mobilized with the introduction of seawater.***
- ***Potential for sediment loading of the seawater in the lagoon.***
- ***Once the mill has been shutdown for a winter and site reclamation has begun, pumping contaminated surface drainage water to Garrow Lake would be difficult.***
- ***If ice conditions are poor and winds are from the west, ice may enter the lagoon when the coffer dam is removed. It will be very difficult to remove the ice once it is in the lagoon.***

After removal of the barge the excavation will be filled and contoured.

4.2.1 Regulatory Issues

As discussed in Sections 2.5 and 4.3, the main regulation dealing with shipping "North of 60" is the Arctic Waters Pollution Prevention Act (AWPPA). Transport Canada can trigger a CEAA review under AWPPA "if the construction, alteration or extension of a project is likely to result in the deposit of waste of any type into Arctic Waters".

The excavation, flooding and reclaiming of the barge excavation and channel may require a CEAA review by DFO.

RISKS

- ***The regulatory issue is unclear, however if a CEAA review is triggered, the process will become longer and more complicated.***

4.3 Barge Towing

The Noble Denton report provides two alternatives for towing: wet towing and dry towing. Wet towing is the conventional method using tugs, whereas dry towing would use a heavy lift carrier or a submersible barge. The Noble Denton report recommends the dry towing alternative as a means of reducing delays if adverse weather or ice conditions delay the barge crossing of the Labrador Sea, where the worst weather will be encountered. The dry tow has not been considered in this report as it is not viewed as a practical option from a cost perspective.

Noble Denton recommended a towing configuration similar to the 1981 voyage consisting of ocean going tugs with a lead tug of minimum 70 tonnes bollard pull and 40 tonnes bollard pull assisting tug. Ice breaking assistance will also be required during the first leg of the voyage from LCI through Lancaster Sound.

RISKS

- ***Weather and ice conditions prevent the tugs arriving at LCI.***
- ***If tugs get to LCI then weather and ice conditions on the return route may cause delays or over wintering on route.***

4.3.1 Permitting

Permitting for the voyage will be very similar to that required for the 1981 voyage (Section 2.5). The Arctic Waters Pollution Act is still the prime regulatory instrument for shipping “North of 60”. However there have been some changes to the ice regime in the last few years, the old Ice Zone System is not being used. Now there is a calculation, based on the type of vessel, experience and ice conditions. If the calculation is positive then the voyage can take place, if negative then the vessel cannot enter/leave the area. However, for a voyage such as towing the barge, taking place between August 15 and September 15, it is likely the Coast Guard will require an experienced Ice Master and ice breaker support for the voyage segment from LCI to the eastern entrance of Lancaster Sound.

A more detailed study will be required closer to the time of the voyage, to enable certification requirements for the sea voyage. The study will include the following:

- routing recommendations
- towing arrangements
- general items for preparation
- recommended criteria for longitudinal strength and motions
- stability and damage stability review

- seafastening review
- emergency measures and contingency planning

The above information will need to be discussed with the Coast Guard approximately one year prior to the voyage date, in order to obtain necessary approvals.

Consultations with communities along the route would also be required to ensure potential impacts to them are considered.

<u>RISKS</u>

- ***Any permitting is risky these days, the proponent usually has very little control over the time taken to review permit applications and often no control over the eventual scope covered by the regulatory agencies. Any permitting in Nunavut has the added risk of being the first to go through this process, the guidelines are still somewhat unclear.***

4.3.2 Barge Floating and Removal

While no detailed plan has been prepared for the barge floating and removal from the lagoon, Noble Denton, as expected, have confirmed that the berthing operation in reverse is the most likely scenario (Figure 3).

When the barge was berthed in 1981, a number of temporary bumpers, dolphins, bollards and mooring posts were installed to assist in the berthing process, some of the bollards are still in place. Also, two D9 Cat Dozers and one D8 were required to handle mooring lines and walk (tow) the barge into place. There was also a small tug available to work inside the lagoon. Similar arrangements and equipment will be required to move the barge to the entrance of the lagoon once it has been re-floated (Figure 3). A small tug would have to be shipped to the site in the summer of 2003.

Development of a detailed plan for the refloating and towing of the barge will be required closer to the time of the voyage, to enable certification for the sea voyage. This study will be required for regulatory approval and will include the following:

- unberthing procedures and equipment requirements
- routing recommendations
- towing arrangements
- general items for preparation
- recommended criteria for longitudinal strength and motions
- stability review
- seafastening review

Re-floating will be carried out when tides are suitable. While no tide charts have been consulted for August/September 2003, based on previous years, there should be at least four occasions when the tides are of sufficient height. Once the barge is afloat, prior to the tow commencing, an underwater hull inspection by divers would be required. It would also be preferable to move the barge out of the lagoon on high tide as soon as possible after re-floating to prevent the potential for grounding on subsequent lower tides.

One item to note, if the barge sits unheated over the winter of 2002/3, there is potential for the permafrost to re-establish around the barge and the barge to freeze in place. If the freezing continued into summer it may be more difficult to break the barge free in the re-floating process.

<u>RISKS</u>

- ***If problems are encountered with damage to the hull, barge ballasting, or ice, wind (waves) preventing or delaying departure, the sailing window may be missed.***
- ***Re-floating will be done when the tides are suitable, delays in the lagoon coinciding with lower tides may result in grounding within the lagoon if the bottom clearance is less than forecast due to excess weight in the barge.***
- ***If the barge is unheated through the winter of 2002/3 it may be difficult to break the ice bond in the re-floating process.***

4.3.3 Voyage Routing

The best voyage route would be the reverse of the voyage taken in 1981 (Figure 1). This has been confirmed by Noble Denton in their 1998 report. See Section 2 for details.

<u>RISKS</u>

- ***Ice conditions in Crozier Strait and McDougall Sound***
- ***Ice and fog in Lancaster Sound***
- ***Icebergs in Davis Strait***
- ***Storms, high winds and waves in the Labrador Sea***
- ***Traffic, tides and currents in St. Lawrence River***

Weather and Ice Conditions

There is a feeling that summer ice conditions have generally been improving over the last 10 years or so. Polaris has been able to begin shipping concentrates earlier than was expected in the mine feasibility studies. Experience and better ships may have contributed to this fact. However, the ice and weather situation in the Arctic should never be underestimated, any year can be a bad ice year. Every project should always include contingencies for the bad years.

Recent discussions with Fednav, a company with 20 years of experience in arctic shipping, indicate that the optimum time for a barge voyage out of LCI is August 20. Enfotec Technical Services, a subsidiary of Fednav, has provided an analysis of ice conditions for the period mid-August to mid-September for thirty years from 1969 to 1998 (Appendix B). The Enfotek analysis also provides weekly ice charts

The 30-year median of ice concentration indicates the following conditions:

- August 13 - Little Cornwallis Island Ice concentration 4 to 8 tenths: Lancaster Sound West, Ice concentration 1 to 6 tenths

- August 20 – Little Cornwallis Island 1 to 3 tenths: Lancaster Sound West >1 to 3 tenths
- August 27 to September 10 – Little Cornwallis Island 1 to 3 tenths: Lancaster Sound, West >1 to 3 tenths
- September 17 – Little Cornwallis Island 4 to 6 tenths: Lancaster Sound West 1 to 6 tenths

If the barge leaves LCI on August 20, then it will enter the Labrador Sea in the first or second week of September. Weather conditions here in September worsen and the frequency of storms increases, with corresponding increases in waves and swells. The risks will be greater than those for the 1981 voyage when the Labrador sea was crossed in late July and early August.

In planning the voyage it will be necessary to consider safe havens in case of bad weather or ice conditions. This will require discussions with communities along the route in Canada and Greenland and with the Greenland Government. Once again posing a risk of increased public exposure and potential for rejection. Pullen's routing report provides considerable detail on potential havens.

RISKS

- ***Ice and weather may be unsuitable for a safe voyage.***
- ***The Labrador Sea will provide difficult weather conditions.***
- ***Negotiating for safe havens present problems.***
- ***Severe weather or ice conditions in any segment may create delays and in the extreme, over wintering on route.***

4.3.4 Communities and Consultation

Cominco would consult with communities "along the route". These communities could include Resolute, Pond Inlet, Pangnirtung and Iqaluit at a minimum, but consultation with other communities along the Baffin coast may be required by the regulators. These other communities could include Clyde River and Broughton Island.

Consultation would require community meetings and presentation of the proposed project. The presentation would necessarily focus on safeguards to prevent accidents during the voyage.

It may also be necessary to inform the Greenland government and West Greenland communities about the voyage, especially if Greenland ports or harbours could be used as safe havens in case of voyage delays due to bad weather or unusual ice conditions.

RISKS

- ***Community consultations and increased publicity could result in a negative response to the proposed plan.***
- ***The Greenland Government may deny access to their harbours for safe havens without some guarantees.***

4.3.5 Final Destination and Disposal

Cominco has not been able to find a purchaser for the process barge. As a result, if the barge is towed south, it is planned to return to the original construction dry dock on the St. Lawrence River in Quebec for dismantling and demolition (pers.comm. R.M.Jacko). No detailed review of alternate destinations has been carried out. Other potential destinations may include Newfoundland or Nova Scotia; both Provinces with a shipbuilding history and a number of dry docks.

Saleable equipment would likely be disposed through a used equipment dealer; the remainder of the plant and facilities would be demolished and transported to suitable landfill sites.

It is possible the barge hull could be sold if a buyer could be found, but indications are that the hull has little commercial value.

RISKS

- ***Despite being cleaned prior to shipping, metal contamination levels on the interior of the barge may be potentially too high for disposal in landfill sites and will require disposal in hazardous waste sites.***
- ***Regulators may designate oil/grease contaminated metal as hazardous wastes under Quebec regulations, requiring disposal in hazardous waste sites at a higher cost.***

5. Option #2, Disposal of Barge on Site

5.1 Dismantle and /or Demolish and Disposal

In this option the barge will remain on site for demolition of the barge superstructure, removable of saleable equipment and then demolition of the hull. It is proposed to use the Little Red Dog Quarry for disposal of all demolition material. All saleable equipment would be shipped south.

5.1.1 Dismantling, Demolition and Disposal Methods

Immediately following the cessation of ore processing, the interior of the barge would be cleaned to remove the obvious accumulations of ore, concentrates, dusts and solidified process slurries. The cleaning will be carried out by a combination of washing with hoses and manual methods.

Dismantling and demolition of the barge superstructure would begin in the fall of 2002. The side cladding would be removed and cut into sections suitable to transport to the LRD quarry. The structural steel would be cut into pieces by hydraulic shears. Barge stationary equipment would be removed during the demolition process. Equipment destined for sale would be prepared for shipment to the south, other equipment would be disposed into the LRD quarry.

The barge hull would be cut (by burning) into pieces suitable for disposal into the LRD quarry. A review of LRD quarry confirms there is more than adequate capacity. In order to provide easy access for cutting the hull, the fill adjacent to the barge will require removal. Most of this fill is contaminated with hydrocarbons and metals and would require excavation and disposal as described in the Closure Plan. Access ramps would be constructed into the excavation to enable use of mobile equipment for transporting the demolition materials.

Prior to excavating the fill, the hydrocarbon contaminated groundwater (Figure 5) would require pumping and treatment using a mobile treatment system to remove hydrocarbons, prior to discharge. Environmental testing of the discharge water will be conducted to ensure that water discharged meets required standards.

Once demolition is complete any hydrocarbon and metal contaminated fill or gravel from under the barge will be removed for disposal in the mine. The excavation will require backfilling and contouring. This work will be carried out along with the final contouring following dock removal.

The additional material being placed in LRD quarry will aid in filling more of the void left by mining and aid in restoring the visual appearance of the final quarry outline.

As most of this work will be by contractor, Cominco will require high levels of safety, environmental management from the contractors. Cominco will ensure site specific environmental training is given to contractors.

RISKS

- ***Management and monitoring of wash water quality and site ground water will be required during the demolition and cleanup of the contaminated fill.***

5.1.2 Cleaning and Disposal of Barge Fuel Tanks

The fuel inventory at the Polaris mine site will be carefully controlled during the final year of operation and through the reclamation period to ensure a minimum volume remains for transport off-site following mine closure. It was originally planned that the barge fuel tanks would be the final diesel storage unit to be used at the mine site. This will have to be reviewed in light of the change in closure timing to spring 2002 and the fact that the barge demolition will begin in fall 2002. It is unlikely demolition and dismantling of the barge can begin with fuel remaining in the barge tanks. If demolition did not begin until 2003, presumably the barge will be unheated through the winter of 2002/3, making it more difficult to clean the tanks with "cold" fuel present. It is recommended that the barge tanks be cleaned and purged of explosive vapours during the summer immediately following closure and while the barge is warm. Bottom tank sludge and oil from the oil/water separator would be incinerated. Residual oily water would be collected and treated in a mobile treatment plant erected at the site for the reclamation program. Sufficient openings should be cut into the tanks to allow safe access for demolition. Gas free certificates will be required and "hot work" permits issued prior to any burning or cutting in and around the barge tanks.

RISKS

- ***Fluids from the cleaning the barge tanks must be collected, treated and disposed according to correct protocols and must not be allowed to further contaminate to fill around the barge.***

5.2 Regulatory Issues

There are no discharges to the ocean and no interference with the shoreline with this option. The regulatory issues should be no different than those for the overall Closure Plan. This option follows the same concepts as have already been presented in the 1999 Draft Closure Plan

The approvals for the on site disposal of the barge will be achieved through the Decommissioning and Reclamation Plan for Polaris Mine. No other approvals will be required.

5.3 Community Consultations

Community consultations for this option would form part of the regular consultations to be held with Resolute and Grise Fiord. Although this consultation may be mandated by the Regulators, Cominco has already initiated discussions with the Resolute Hamlet Council and with Grise Fiord and will continue the dialogue as closure planning proceeds. At these meetings, Cominco clearly stated its intentions to demolish and dispose of the barge in the LRD quarry. There have been no concerns raised about this proposal to date from either community.

The communities have confidence in the manner in which Cominco conducts its operations on site. Cominco must continue to keep the communities informed and demonstrate its commitment to decommission the site in an environmentally sound manner. If Cominco fails to demonstrate this, opposition to demolition and disposal of facilities on site will be substantial.

6. Benefit and Cost Comparison of the Options

The benefits and costs of demolishing the barge on site compared to re-floating and towing to the south for demolition were examined.

Option #1.
To re-float, tow and demolish the barge in the south would require the following design, approval processes and work:

- More detailed engineering review of the barge stability and seaworthiness.
- Routing studies, detailed towing plans and weather and ice studies.
- Regulatory approvals for seaworthiness and routes. Consultations with potentially affected communities would be required.
- The barge would require extensive preparation including reducing and re-distributing weight as well as extensive strengthening (60 tons of steel identified to date).
- A thorough cleaning job to remove metal and hydrocarbon contamination from the barge. Removal of all other process chemicals and/or hazardous materials prior to being re-floated.
- Excavation of approximately 60,000 cubic metres to construct a channel to the ocean.
- Elaborate clean up of hydrocarbon contamination surrounding and beneath the barge hull in its present location. This must be done prior to opening the channel to the ocean.
- Re-floating the barge and towing south. (Towing costs will include substantial insurance costs).
- Backfilling the channel and berthing location.
- Placing the barge in a large dry dock in southern Canada.
- Recovery and sales of the major equipment from the barge.
- Demolition of the barge in dry dock and removal of demolition material from the site.
- Disposal of demolition material. Significant quantities of steel would be salvaged as scrap and other materials would require tipping fees for burial.

Option #2.
To demolish the barge on site, the following would be required:

- Demolition would be done on a more flexible schedule which would not require major engineering design or reviews completed prior to carrying out the work. Apart from regulatory approvals and community consultations that will be required for the Decommissioning and Reclamation Plan, no special authorization is required.
- Clean up of contaminated fill around the barge can be completed as demolition proceeds. There are no complex processes required as the site will not be flooded by the ocean.
- Most of the major equipment required for the demolition is owned by Cominco and already on site i.e. minimum cost.
- The labour and project overhead costs will be higher due to the northern location. Productivity, once the outer shell of the barge has been removed, will be lower due to the weather.

- Some major equipment from the barge will be removed and shipped south for re-use by Cominco or will be sold.
- The barge will require a thorough cleaning to remove metal and hydrocarbon contamination, the same as if it were to be towed to southern Canada. All other process chemicals and/or hazardous materials will be removed prior to burial.
- Demolition of the barge and removal of the materials to the LRD quarry for burial.
- Final clean up of any metals and hydrocarbon contaminated material from beneath the barge hull location.
- Backfilling and re-contouring of the hull excavation area.

The cost review of the two options was conducted by:

- Using existing detailed construction drawings to establish the labour and equipment required to demolish the barge.
- Updated expected towing costs, through discussions with arctic towing companies.
- Reviewing Canada wide construction labour rates. The work will be contracted for both options.
- Reviewing expected on site overhead costs for employing and housing workers.

The cost for demolishing the barge in the south (including towing costs) was estimated to be similar to demolition at the site. The higher overhead costs and increased labour costs due to working in the northern climate, along with the use of Cominco owned equipment (low cost) was found to offset the advantages of doing work in a southern climate combined with the towing costs to the south. The relatively low salvage value for scrap steel did not provide sufficient additional gains to make the southern option attractive. The value for salvaging major equipment from the barge would be equal for either option (except for the shipping cost in Option #2). Thus equipment salvage values were not taken into account.

The local communities of Resolute and Grise Fiord, consulted through community meetings, have stated that they want to benefit from the closure process through economic opportunities and access to surplus facilities/materials and/or equipment that would otherwise be disposed on site or shipped south.

Option #2 provides for:

- Increased opportunities for employment for Nunavut residents due to the increased labour requirements to demolish the barge on site (relative to Option #1).
- Increased level of support services in Resolute due to the increased activities on site while the barge is being demolished (relative to Option #1).

When the cost and benefits analysis is considered along with the operational and environmental risks, Option #2 becomes recommended as the preferable option to reclaim the barge. Option #2 provides complete control over all aspects of the demolition and reclamation (i.e. reduction of environmental risks) and provides more potential for community benefits without increasing the overall cost for barge reclamation.

7. References

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5. A Report On Situations Which Could Arise During The Tow To Little Cornwallis Island From Trois Rivieres During August 1981, And The Steps That Should Be Taken To Cope With Them. Prepared by Captain T.C. Pullen, Figure 1981.

6. Preliminary Towage Preparation Recommendations from Little Cornwallis Island, Northwest Territories to Trois Rivieres, Canada (Report No. H4363/NDAI/MAT). Prepared by Noble Denton and Associates Inc. December 4, 1997.

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8. A Review of Risks Arising from the Voyage of "Arvik II" To The Polaris Operations Site Prepared by Cominco Ltd., May 1981.

9. Personal communication with J.K. Gowans P.Eng, President Placer Dome Canada. Formerly Mill Superintendent, Polaris Mine 1980 to 1984.

10. Transcript of Public Hearing on the Polaris Project, Resolute NWT, May 23, 1980.

11. Government of Quebec. Ministry of Environment and Wildlife. 1999. Regulation respecting hazardous materials and amending various regulatory provisions. Environment Quality Act.

LEGEND

- PROPOSED BARGE TOWING ROUTE (1981)
- 4 — SEGMENT OF BARGE TOWING ROUTE
- (540 km) — LENGTH OF SEGMENT
- ACTUAL BARGE TOWING ROUTE
- DAY 1 JULY 25 — ACTUAL LOCATION OF BARGE ON DATE GIVEN

SOURCE OF DRAWING:
GSC MAP D1880A (1996) CD DIGITAL MAP
PROJECTION:
LAMBERT CONIC CONFORMAL
NAD 27
UNITS METRES

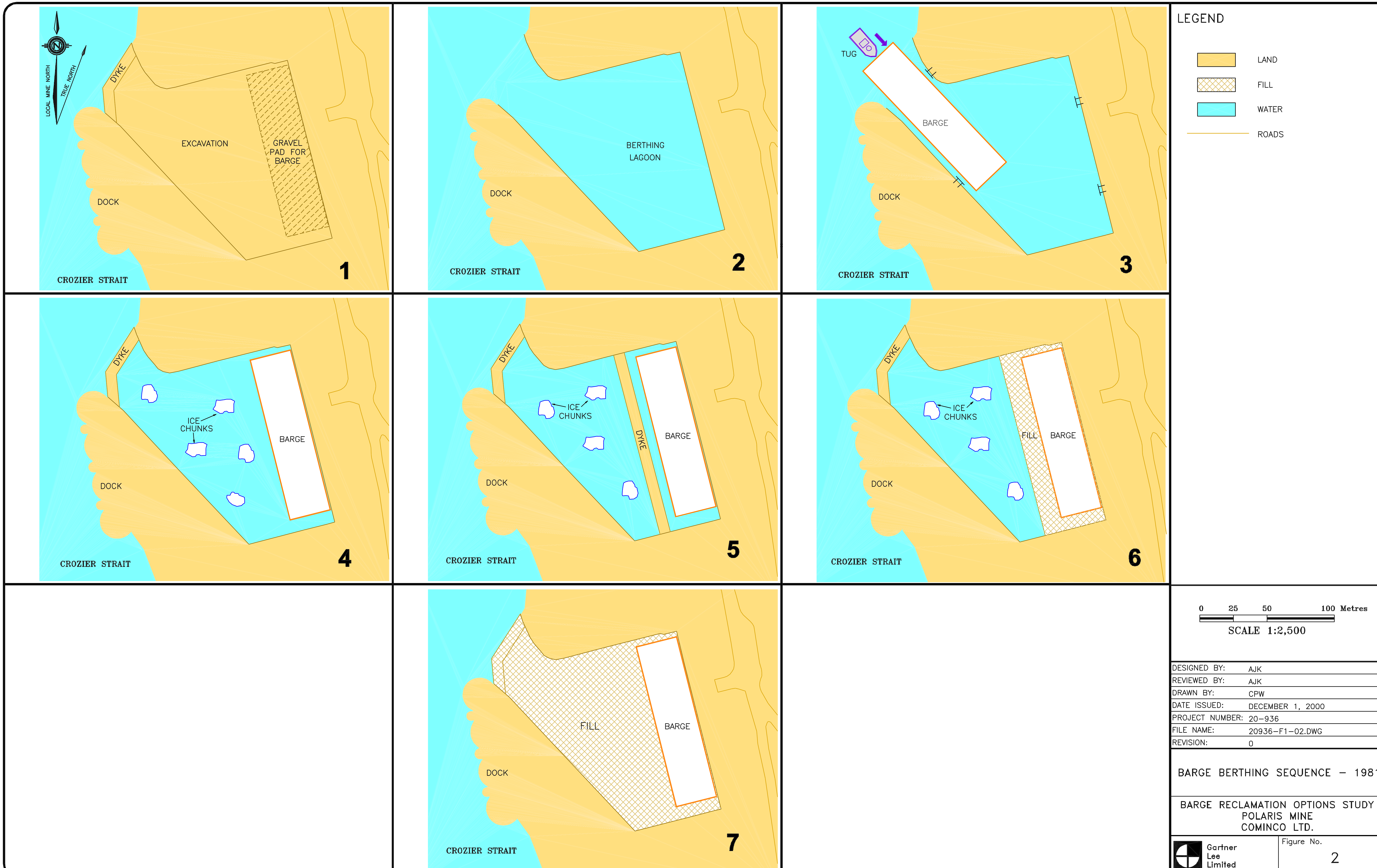
DRAWING INFORMATION:	
DESIGNED BY:	AJK
REVIEWED BY:	AJK
DRAWN BY:	CPW
DATE ISSUED:	DECEMBER 1, 2000
PROJECT NUMBER:	20-936
FILE NAME:	20936-F1-01.DWG
REVISION:	0

BARGE TOWING ROUTE – 1981

BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

Gartner Lee Limited

Figure No. 1



0 25 50 100 Metres

SCALE 1:2,500

DESIGNED BY:	AJK
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PROJECT NUMBER:	20-936
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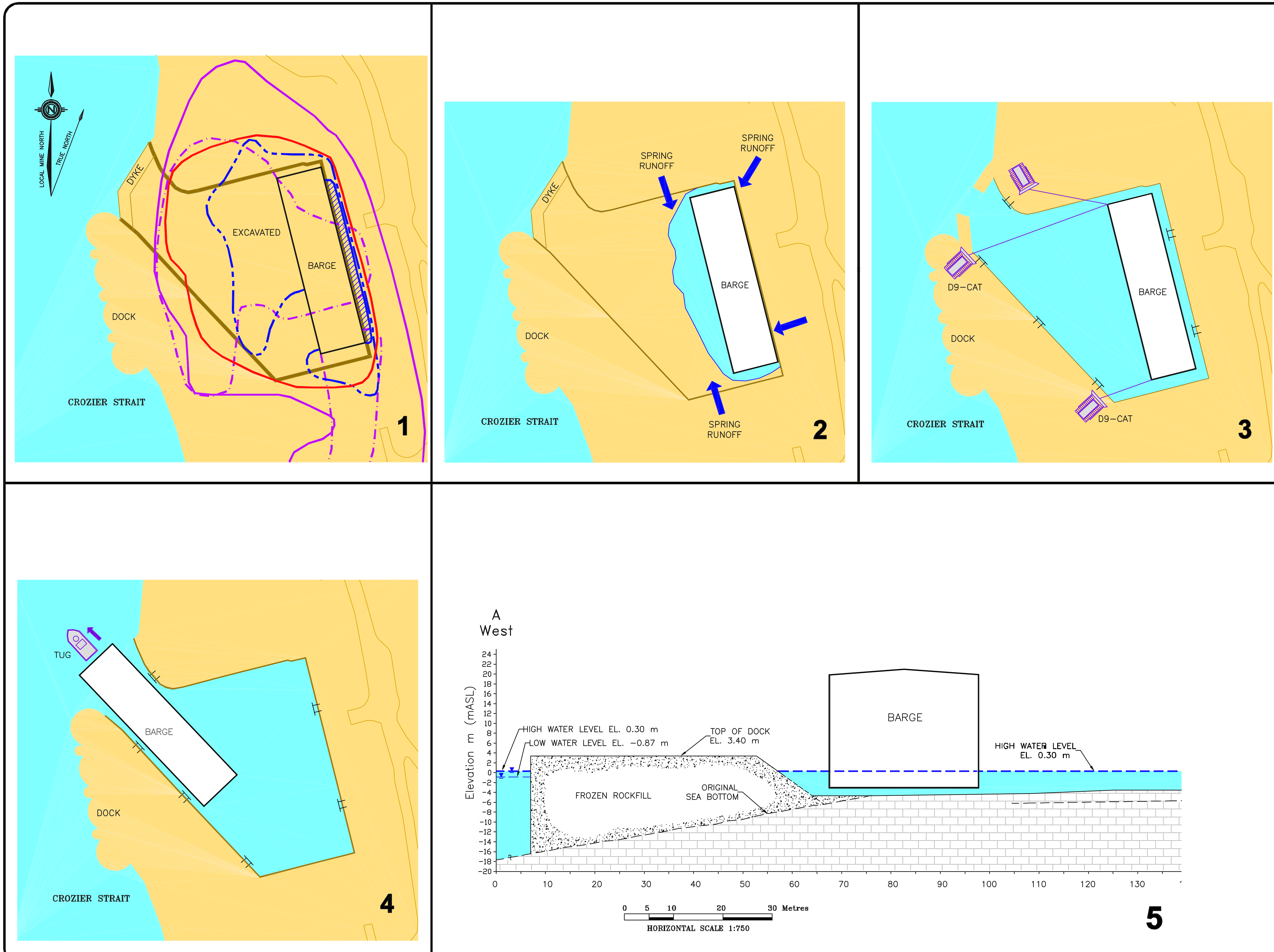
REVISION:	0

BARGE BERTHING SEQUENCE – 1981

BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

Gartner Lee Limited

Figure No. 2



LEGEND

LAND

FILL

WATER

ROADS

PB & ZN CONCENTRATIONS IN SOIL > 1000 PPM AT DEPTHS FROM 0 – 0.6 m

PB & ZN CONCENTRATIONS IN SOIL > 1000 PPM AT DEPTHS FROM 0.6 – 1.5 m

HYDROCARBON CONCENTRATION IN GROUNDWATER

LEPH 1 – >15 mg/L

HYDROCARBON CONCENTRATION IN SOIL

AT DEPTH 0–1.5m LEPH > INDUSTRIAL STANDARD

AT DEPTH 1.5–3.0 m LEPH > INDUSTRIAL STANDARD

0 25 50 100 Metres

SCALE 1:2,500

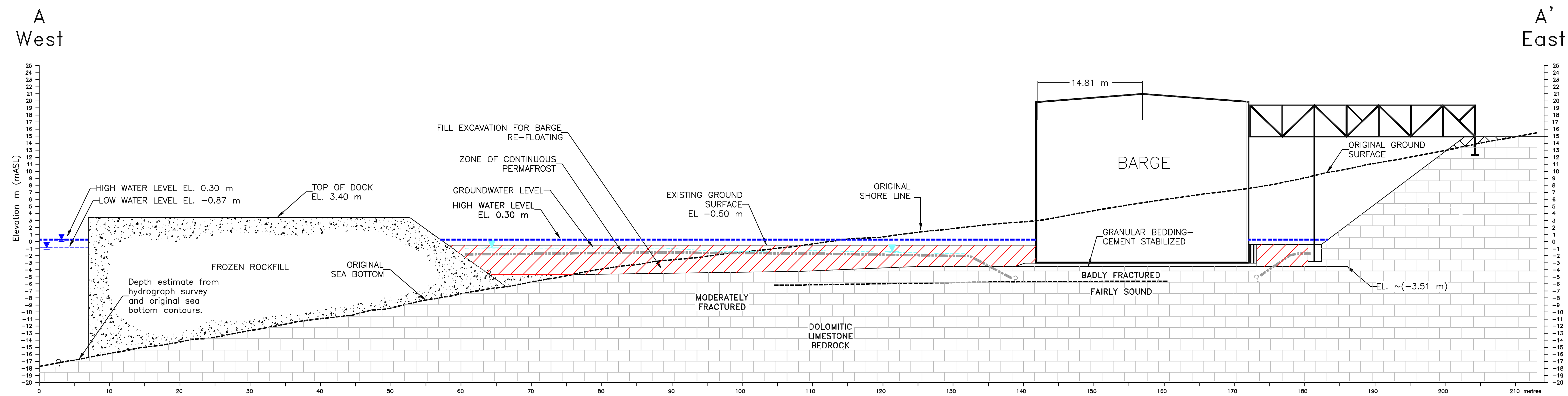
DESIGNED BY:	AJK
REVIEWED BY:	AJK
DRAWN BY:	CPW
DATE ISSUED:	DECEMBER 1, 2000
PROJECT NUMBER:	20–936
FILE NAME:	20936-F1-04.DWG
REVISION:	0

OPTION 1 – BARGE REFLOATING

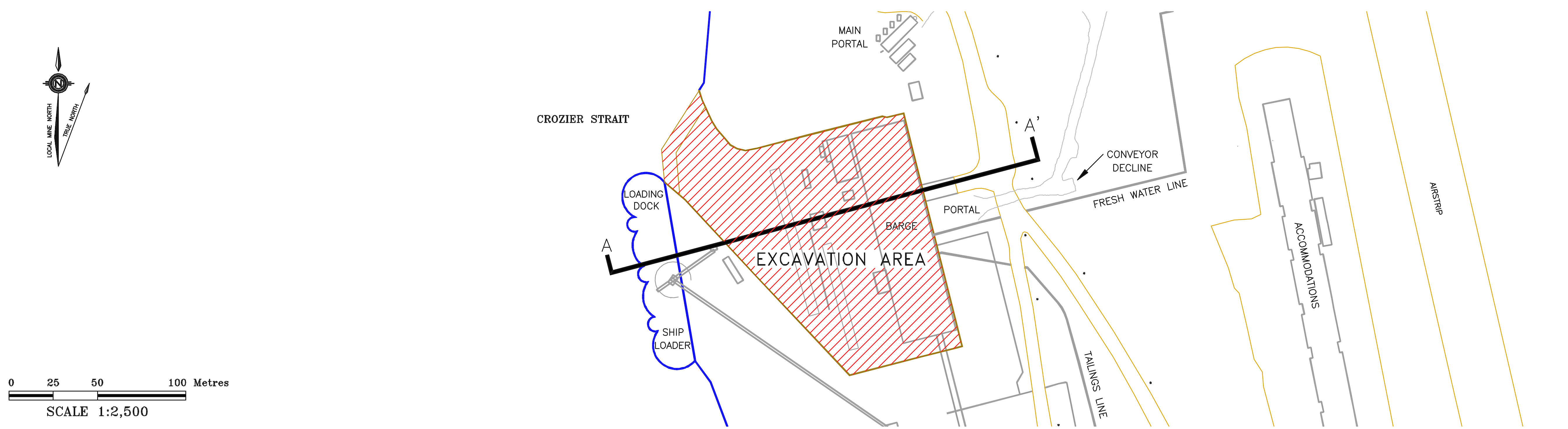
BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

Gartner Lee Limited

Figure No. 3



Scale 1:550 (approximate)



NOTES:
1. Cross–section produced from drawing 110–C–116, Bechtel Canada Ltd., Cominco Ltd.
2. Boreholes and test pits are projected along cross section line.
3. Elevations are in metres, mean above sea level (mASL).
4. Stratigraphic information adapted from Figure 8 Concentrator–Section, Golder 1980.

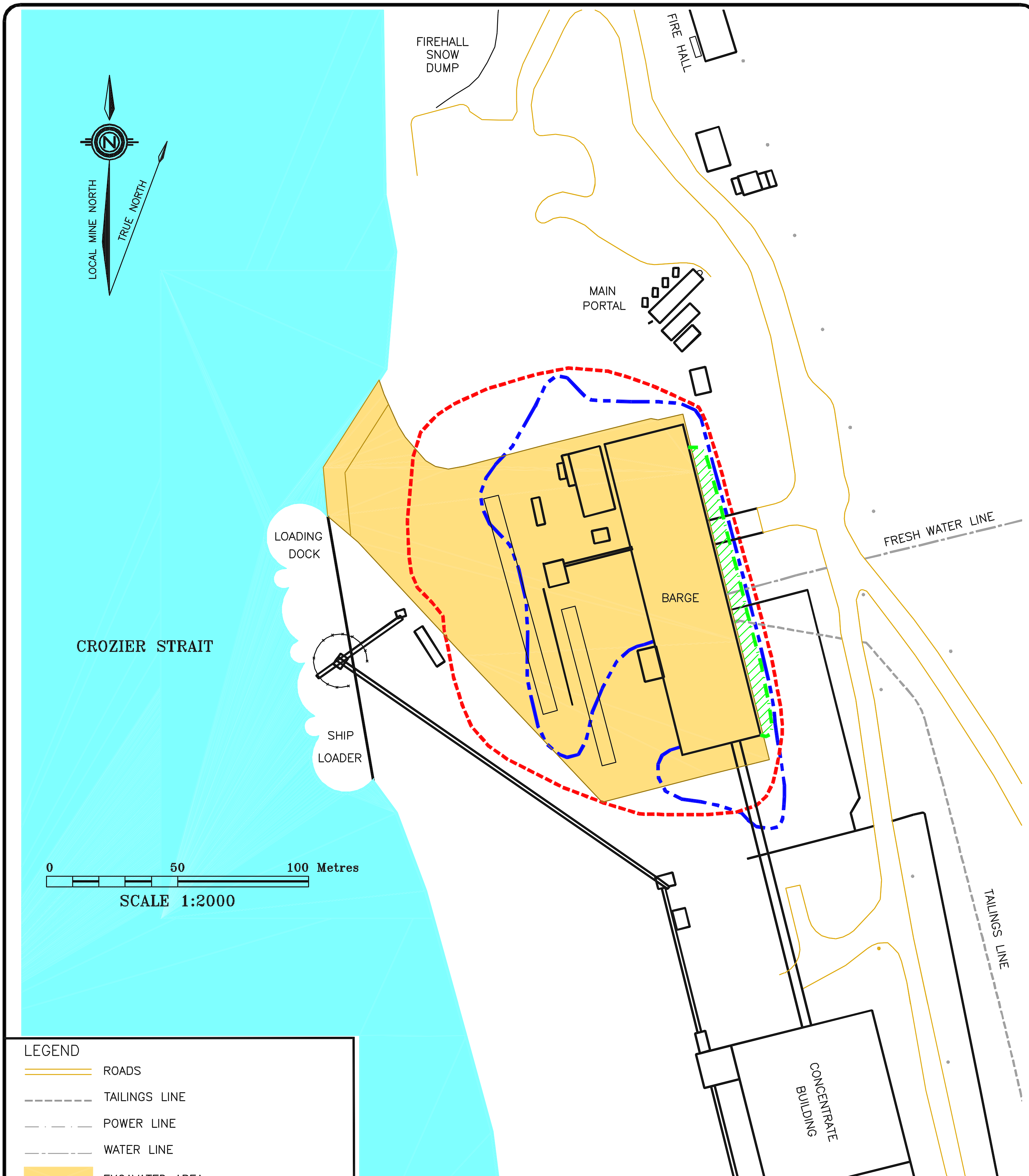
DRAWING INFORMATION:	
DESIGNED BY:	AJK
REVIEWED BY:	AJK
DRAWN BY:	CPW
DATE ISSUED:	DECEMBER 1, 2000
PROJECT NUMBER:	20–936
FILE NAME:	20936–F1–03.DWG
REVISION:	0

BARGE REMOVAL EXCAVATION

BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

Gartner Lee Limited

Figure No. 4



SUBSURFACE HYDROCARBON CONCENTRATIONS

BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

DESIGNED BY:	AJK
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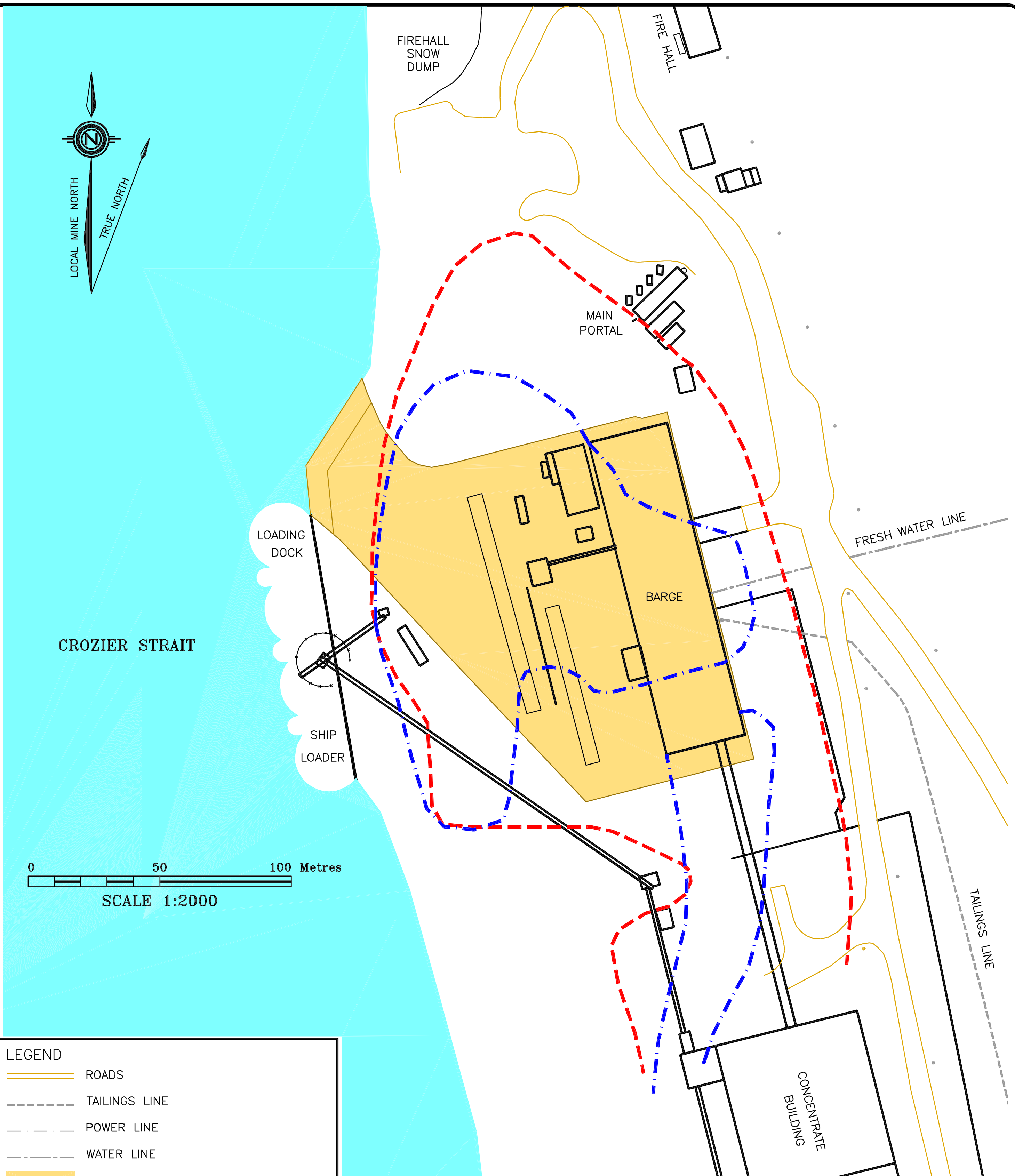
Figure No. 5



LEGEND

- ROADS
- TAILINGS LINE
- POWER LINE
- WATER LINE
- EXCAVATED AREA
- PB & ZN CONCENTRATIONS IN SOIL > 1000 PPM AT DEPTHS FROM 0 – 0.6 m
- PB & ZN CONCENTRATIONS IN SOIL > 1000 PPM AT DEPTHS FROM 0.6 – 1.5 m

DESIGNED BY:	AJK
REVIEWED BY:	AJK
DRAWN BY:	CPW
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METAL CONCENTRATIONS IN SOIL

BARGE RECLAMATION OPTIONS STUDY
POLARIS MINE
COMINCO LTD.

Gartner Lee Limited

Figure No. 6

Appendices

Appendix A

Summary of 1981 Barge Voyage Progress and Weather Details

Cominco Ltd. Polaris Mine

Barge Reclamation Options Study

Barge Voyage From Trois Rivieres To Polaris, 1981

Date 1981	Position N	Position W	Speed Knots	Estimated Distance	Wind Direction/Knots	Wave Height Metres	Ice Conditions
24-Jul	***Departed***						
25-Jul	4765	6945	6.5		S 10	0.0	
26-Jul	?	?	?		?	?	
27-Jul	?	?	?		?	?	
28-Jul	4953	5938	6.0		NW 18	2.5	
29-Jul	5124	5642	6.1		NW 8	1.0	
30-Jul	5150	5516	2.5		NW 20	2.0	One iceberg
31-Jul	5314	5323	5.5		N 12	1.5	Iceberg scatter
1-Aug	5435	5235	4.0		W 18	0.8	
2-Aug	5646	5130	6.0		NNW 15	1.5	
3-Aug	5836	5056	6.0		W 10	1.5	
4-Aug	6170	5229	5.6		W 15	1.8	
5-Aug	6329	5318	7.0		NW 8	?	Strays of multi year ice and small icebergs
6-Aug	6616	5540	6.0		Calm	0.0	
7-Aug	6851	5749	5.0		NW 12	0.8	A few icebergs
8-Aug	7107	6014	5.9		N 6	0.3	A few icebergs
9-Aug	7330	6220	6.5		S 12	0.8	Icebergs
10-Aug	7410	7958	6.0		?	?	?
11-Aug	7426	8440	6.0		?	?	Ice pack
12-Aug	7435	9437	?		?	?	Heavy loose ice, tugs following ice breaker
13-Aug	***Arrived 3.45 EDT***						

Appendix B

Enfotek 30 Year Ice Summary

Summary of Ice Conditions in the Eastern Parry Channel
Mid-August to Mid-September

1.0 Introduction

The purpose of this document is to provide a brief summary of the range of ice conditions that have occurred in the access to the Polaris Mine in the period from mid-August to mid-September. This time period represents the minimum ice conditions found in the Eastern Parry Channel. Section 3 provides weekly summaries for this period based on the median ice concentration for the thirty year period from 1969 to 1998.

2.0 Description of Ice Conditions

The break-up of the Eastern Parry Channel region is usually complete by the beginning of August with a typical ice condition of open water in Barrow Strait and Lancaster Sound but with high ice concentrations to the west of Resolute. Ice reduction in the central Parry Channel is largely by *in situ* melt with minor amount of ice subject to a slow eastward drift and export during the summer and early fall. A narrow stream of ice will begin to drift eastward from the high concentrations west of Griffith Island across the northern entrance to Peel Sound and will continue along the north coast of Somerset Island. Rapid *in situ* melt occurs with this ice such that little ice survives to reach Prince Leopold Island and exit Barrow Strait into the Prince Regent gyre of western Lancaster Sound. Only small amounts of this ice in most years survives long enough to enter central Lancaster Sound during the summer ablation period.

Ice reduction is slow during the month of August in western Barrow Strait. A narrow lead will develop along the south coast of Bathurst Island by mid-August but this can be highly variable between late July and early September. The ice in western Barrow Strait tends to clear much more slowly during the month of August than the ice in central Viscount Melville Sound. This delayed ice reduction may be due to the prevention of south and eastward drift of ice by Prince of Wales Island and the Islands of central Barrow Strait.

The typical pattern in most years was for Lancaster Sound and eastern Barrow Strait to completely clear of ice by late July. This is followed by an early formation of and widening of the lead in Barrow Strait extending into McDougall Sound. Throughout the remainder of August the ice of western Barrow Strait and Viscount Melville Sound undergo a rapid *in situ* melt. However, break-up is so extensive in these years that high concentrations of old ice move south from Byam Martin Channel in to eastern Viscount Melville Sound and western Barrow Strait during the months of September and October. Nevertheless, little ice remains in Barrow Strait by the end of the melt season resulting in little movement of old ice eastward into Lancaster Sound in the fall and winter.

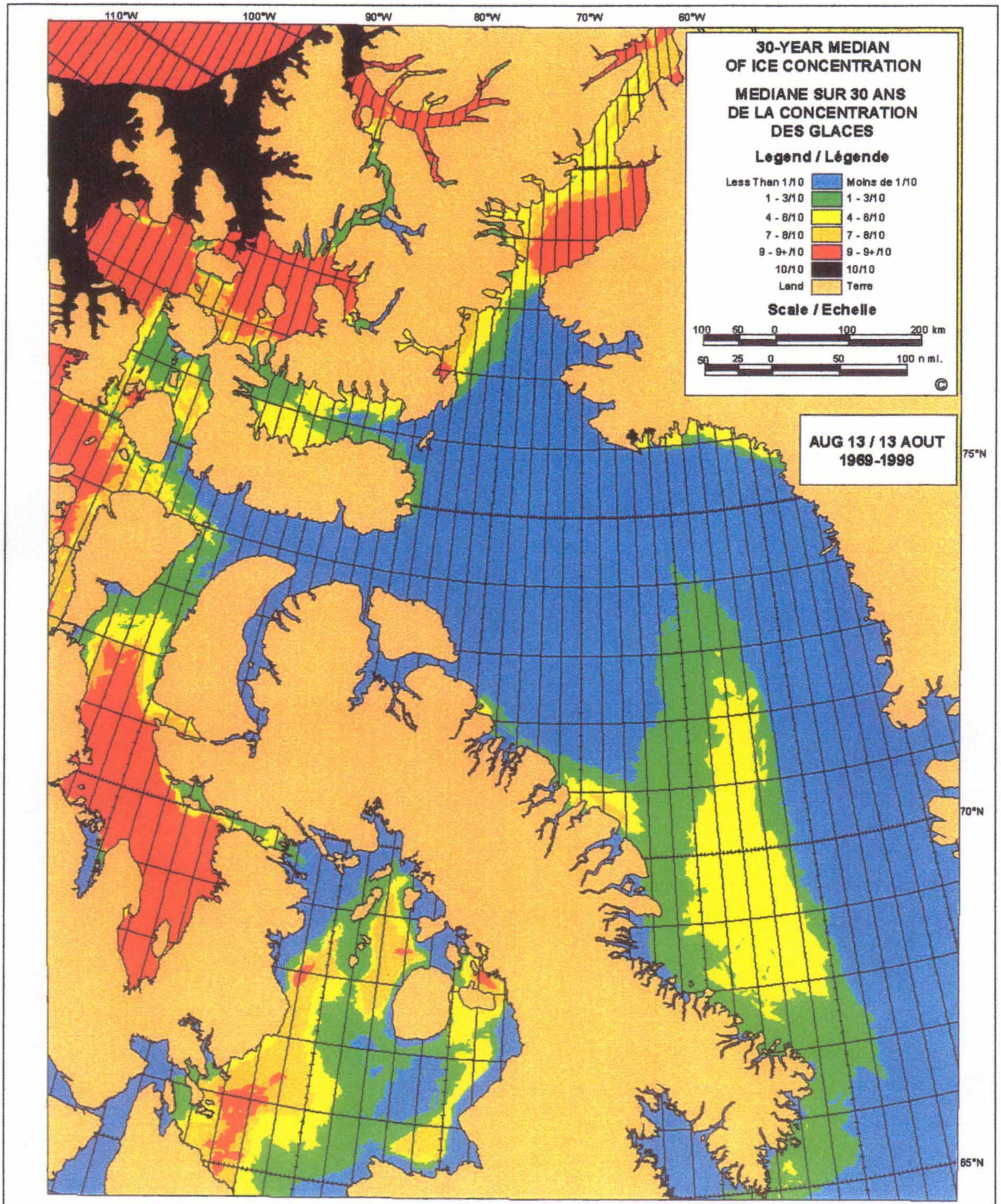
In years of later than average break-up there can be very limited open water development in Barrow Strait. Years when break-up was not complete until mid-August were followed by the development of a narrow open water lead across southern Bathurst Island. The Byam Martin Channel ice bridge does not fracture leaving open water conditions across northern Barrow Strait. However, a high concentration of first year and old ice remain throughout Barrow Strait resulting in the extensive movement of old ice into Lancaster Sound in the fall and winter.

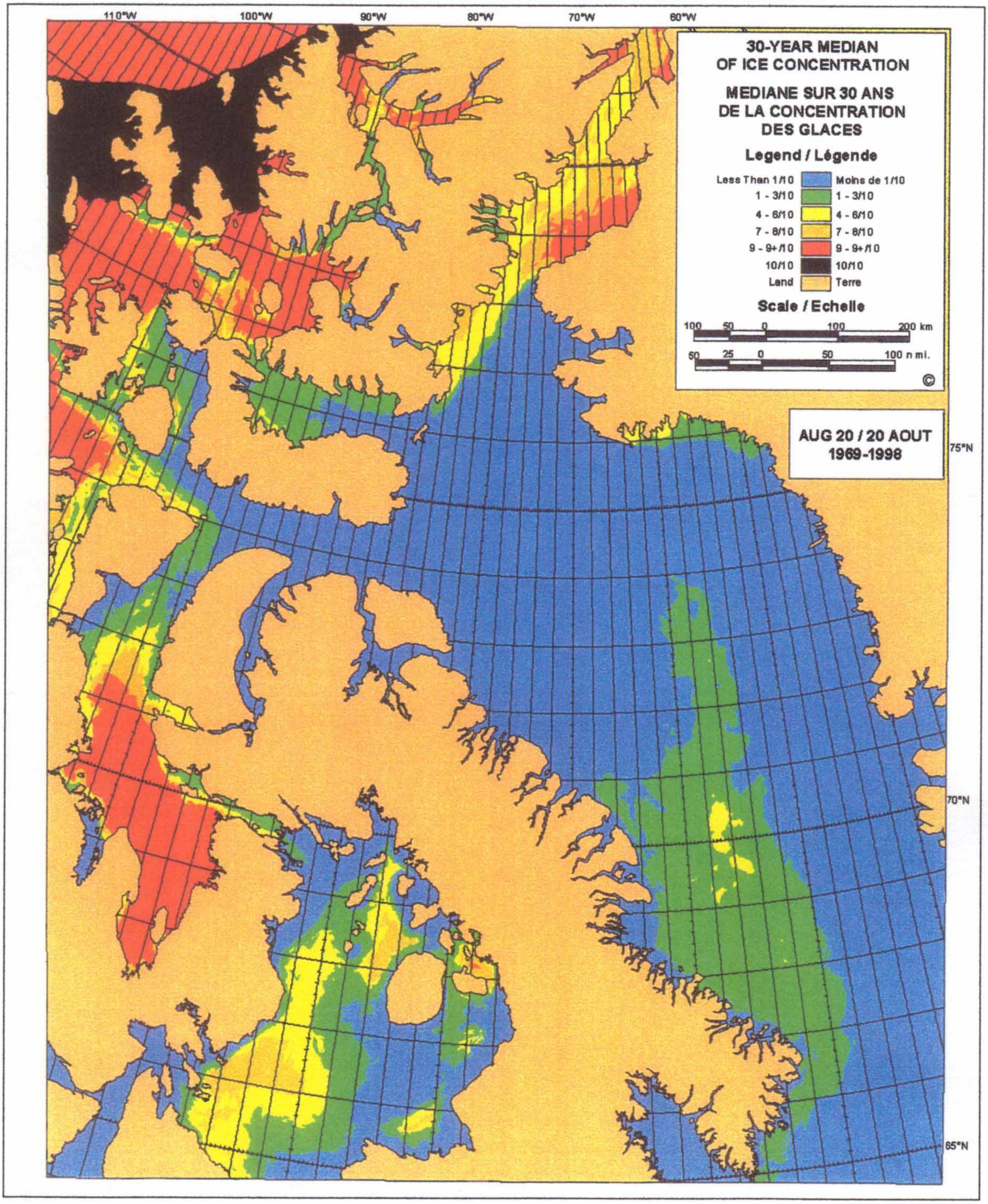
Old ice presents a significant hazard to shipping in the eastern Parry Channel. The old ice moves south in the late summer and fall into Penny Strait and further into McDougall Sound and Wellington Channel entering Barrow Strait. The typical pattern of movement is for old ice to drift along the east side of Bathurst Island past Little Cornwallis Island and into McDougall Sound in late August in concentrations from trace to one tenth. As the drift continues, an ice dam will form in mid-September between Bathurst Island and Cornwallis Island in southern Queen's Channel. This dam prevents further movement of old ice into McDougall Sound. However, the continued southward drift of old ice deflects into Wellington Channel and will subsequently drift southward along the Cornwallis Island coastline into eastern Barrow Strait. Old ice in concentrations from a trace to as high as six tenths may be encountered across eastern Barrow Strait in the fall prior to freeze-up. Old ice drifting south from Nares Strait does not reach the entrance of Lancaster Sound until late September at the earliest.

The minimum ice condition for the region is achieved by mid-September after which freeze-up begins.

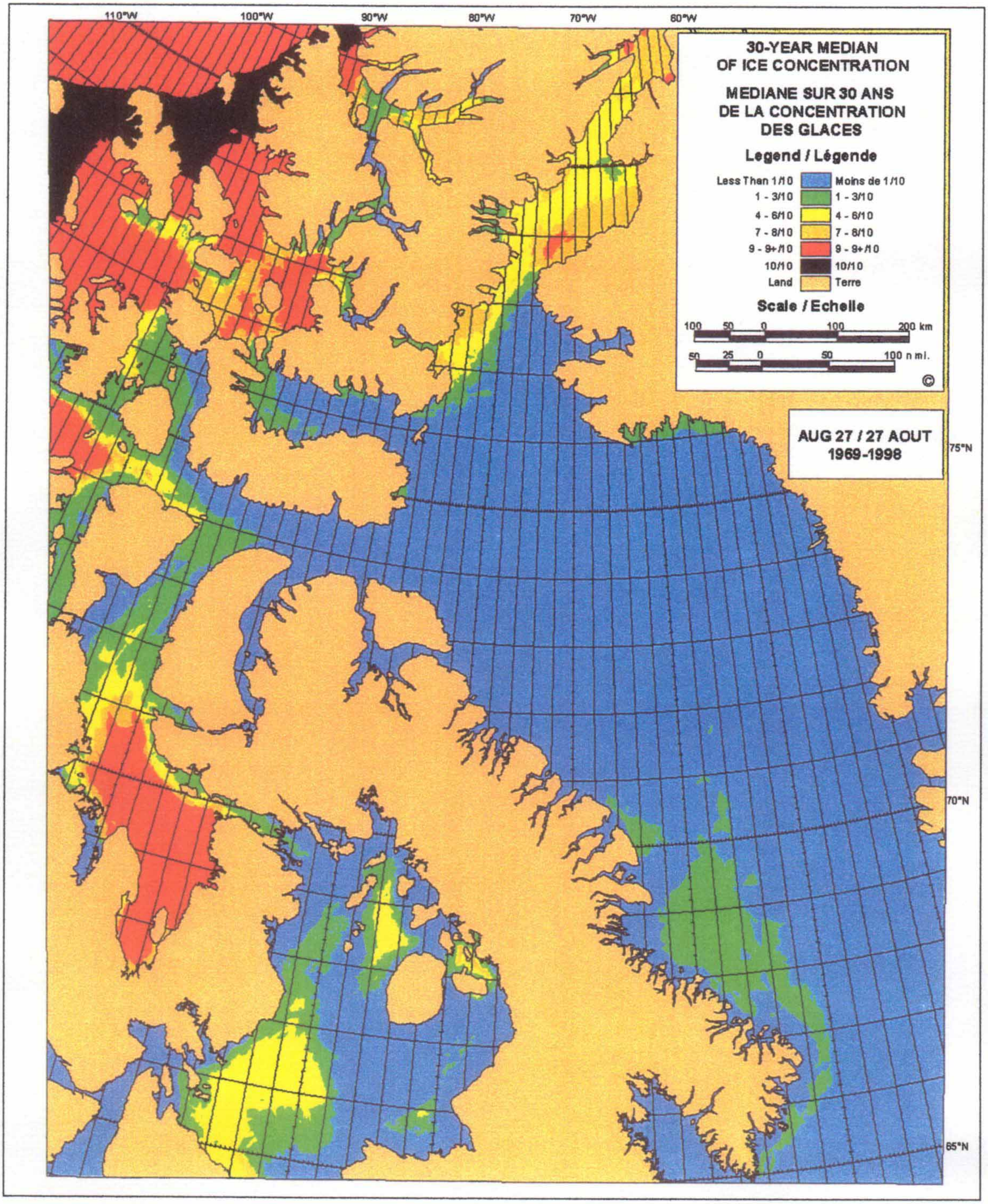
3.0 <u>Weekly Summaries</u>

The six following figures show the 30-year median ice concentration for the region from mid-August to mid-September.


30-YEAR MEDIAN OF ICE CONCENTRATION
MEDIANE SUR 30 ANS DE LA CONCENTRATION DES GLACES
Legend / Légende
Less Than 1/10 Moins de 1/10
1 - 3/10 1 - 3/10
4 - 6/10 4 - 6/10
7 - 8/10 7 - 8/10
9 - 9+/10 9 - 9+/10
10/10 10/10
Land Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
AUG 13 / 13 AOUT
1969-1998
110°W
100°W
90°W
80°W
70°W
60°W
75°N
70°N
65°N


30-YEAR MEDIAN OF ICE CONCENTRATION
MEDIANE SUR 30 ANS DE LA CONCENTRATION DES GLACES
Legend / Légende
Less Than 1/10 — Moins de 1/10
1 - 3/10 — 1 - 3/10
4 - 6/10 — 4 - 6/10
7 - 8/10 — 7 - 8/10
9 - 9+/10 — 9 - 9+/10
10/10 — 10/10
Land — Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
AUG 20 / 20 AOUT
1969-1998
110°W
100°W
90°W
80°W
70°W
60°W
75°N
70°N
65°N

Canada


110°W
100°W
90°W
80°W
70°W
60°W
30-YEAR MEDIAN OF ICE CONCENTRATION
MEDIANE SUR 30 ANS DE LA CONCENTRATION DES GLACES
Legend / Légende
Less Than 1/10 — Moins de 1/10
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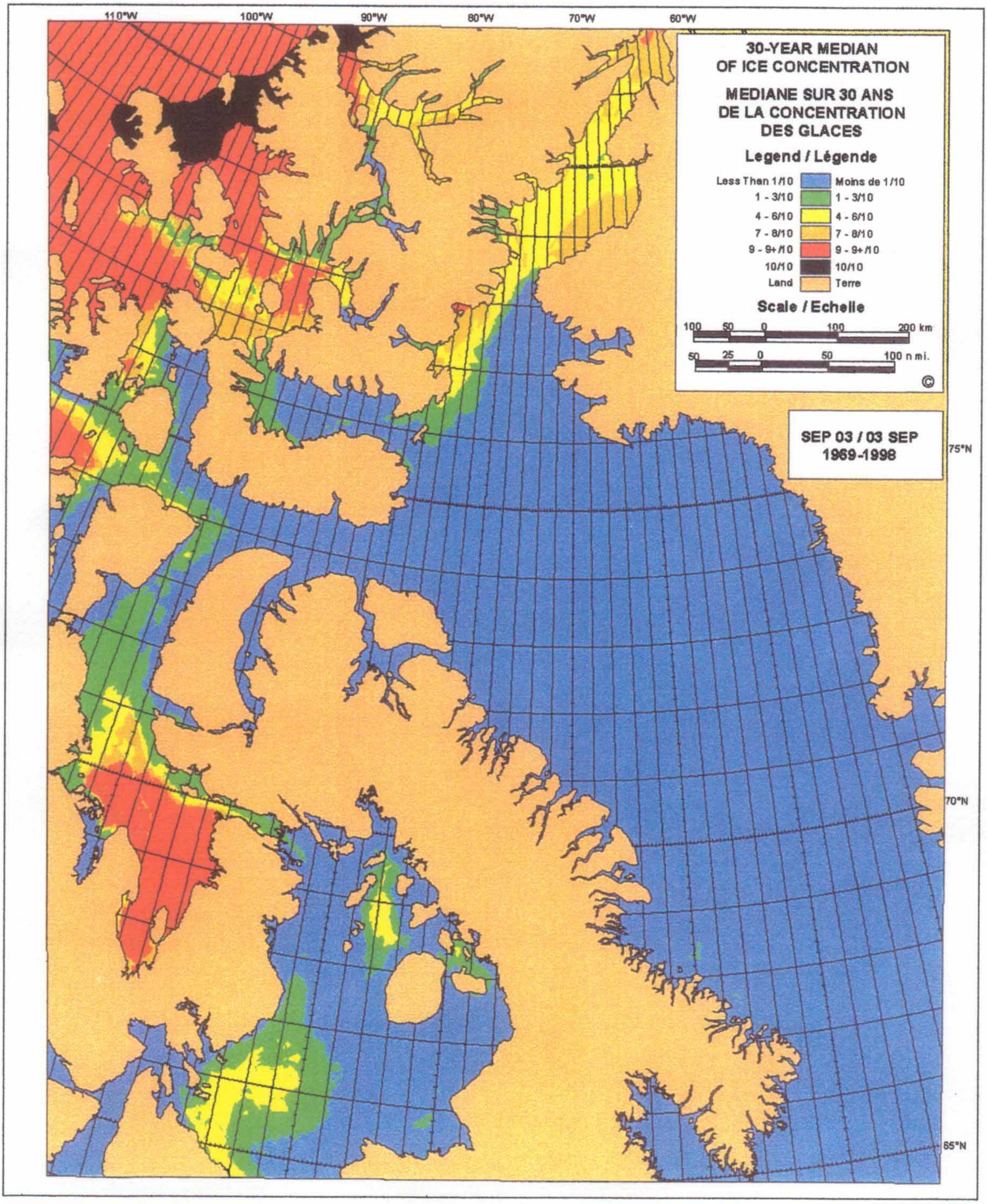
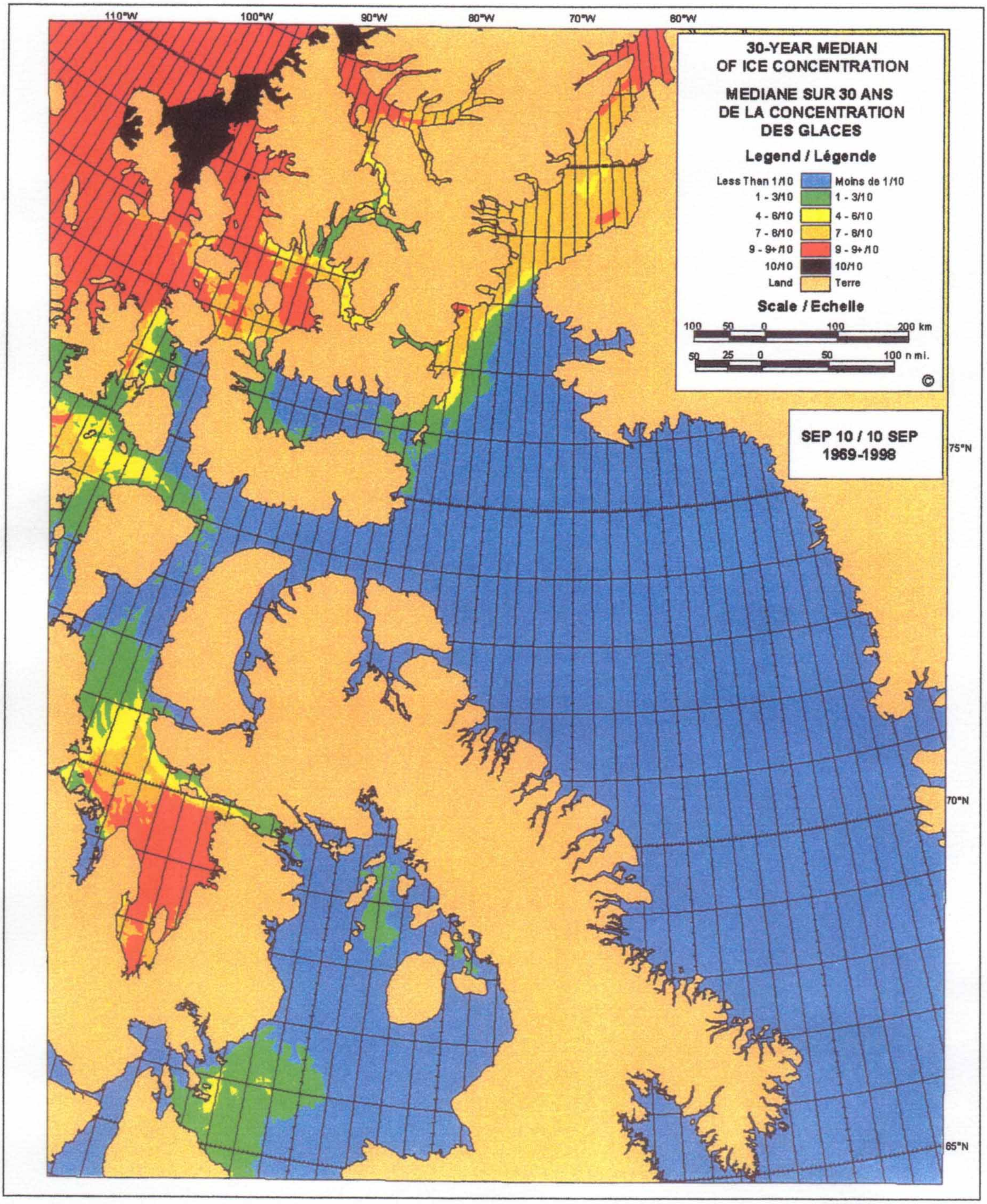
4 - 6/10 — 4 - 6/10
7 - 8/10 — 7 - 8/10
9 - 9+/10 — 9 - 9+/10
10/10 — 10/10
Land — Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
AUG 27 / 27 AOUT
1969-1998
75°N
70°N
65°N

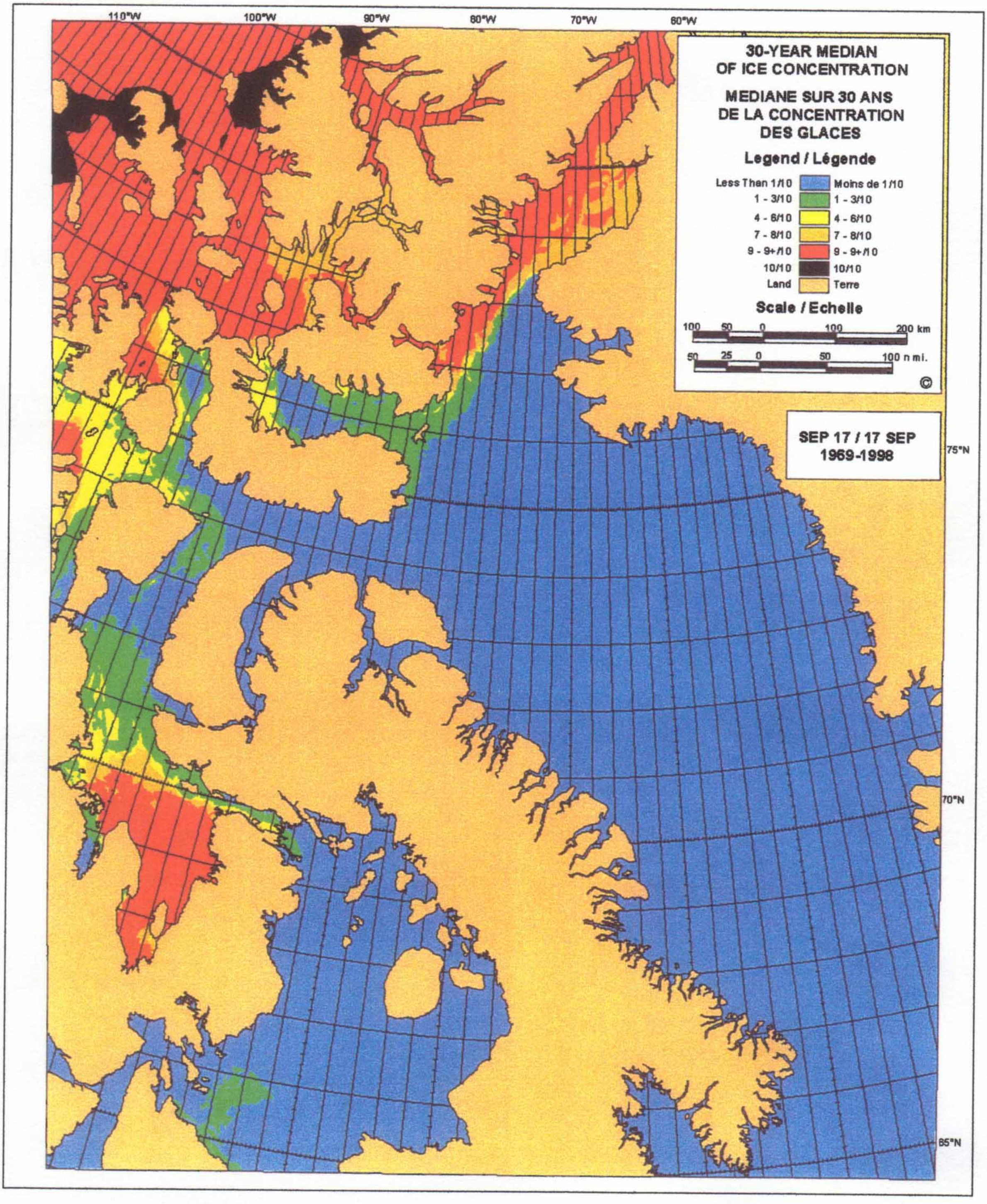
Canada


30-YEAR MEDIAN
OF ICE CONCENTRATION
MEDIANE SUR 30 ANS
DE LA CONCENTRATION
DES GLACES
Legend / Légende
Less Than 1/10 | Moins de 1/10
1 - 3/10 | 1 - 3/10
4 - 6/10 | 4 - 6/10
7 - 8/10 | 7 - 8/10
9 - 9+/10 | 9 - 9+/10
10/10 | 10/10
Land | Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
SEP 03 / 03 SEP
1969-1998
110°W
100°W
90°W
80°W
70°W
60°W
75°N
70°N
65°N

Canada


110°W
100°W
90°W
80°W
70°W
60°W
30-YEAR MEDIAN
OF ICE CONCENTRATION
MEDIANE SUR 30 ANS
DE LA CONCENTRATION
DES GLACES
Legend / Légende
Less Than 1/10 Moins de 1/10
1 - 3/10 1 - 3/10
4 - 6/10 4 - 6/10
7 - 8/10 7 - 8/10
9 - 9+/10 9 - 9+/10
10/10 10/10
Land Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
SEP 10 / 10 SEP
1969-1998
75°N
70°N
65°N

Canada


110°W
100°W
90°W
80°W
70°W
60°W
30-YEAR MEDIAN
OF ICE CONCENTRATION
MEDIANE SUR 30 ANS
DE LA CONCENTRATION
DES GLACES
Legend / Légende
Less Than 1/10 Moins de 1/10
1 - 3/10 1 - 3/10
4 - 6/10 4 - 6/10
7 - 8/10 7 - 8/10
9 - 9+/10 9 - 9+/10
10/10 10/10
Land Terre
Scale / Echelle
100 50 0 100 200 km
50 25 0 50 100 n mi.
©
SEP 17 / 17 SEP
1969-1998
75°N
70°N
65°N

Canada