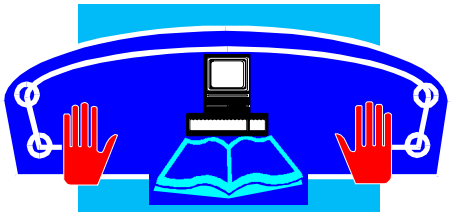

Eastern Arctic/baffin Region Port Facilities Study; Final Report

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EASTERN ARCTIC/BAFFIN REGION

PORT FACILITIES STUDY

FINAL REPORT

PREPARED **FOR:**

The Government of the Northwest Territories

and

The Government of Canada

PREPARED BY:

REID CROWTHER & PARTNERS

and

NOVACORP CONSULTING LTD.

31434

January 1990

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The views expressed are the views of the authors and no responsibility for them should be attributed to the above agencies.

EASTERN ARCTIC/BAFFIN REGION

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EXECUTIVE SUMMARY

Communities located in Canada's Eastern Arctic are accessible only by air for most of the year as Arctic waters become ice packed during the Fall, Winter and Spring. The short open water season is critical to local residents as they carry on traditional pursuits such as fishing and hunting, income generating activities through tourism and commercial fishing and for the annual sealift operation which brings in needed fuel, supplies, materials and equipment from Southern Canada.

The Eastern Arctic has been home to the Inuit and their ancestors for thousands of years. Traditionally, the Inuit led a nomadic existence, but over the past several decades virtually all area residents have taken up a community lifestyle. Many still rely on subsistence fishing and hunting, however, for their very livelihood. Communities are small . ..ranging in population from less than 100 (Grise Fiord) to about 3,000 (Iqaluit).

While use of the community waterfronts is key during the open water season, few marine structures have been constructed to date. Several government agencies and departments have programs for wharf and harbour facilities in the Northwest Territories including the Federal Department of Fisheries and Oceans (DFO) and Transport Canada. Other agencies are directly interested in the availability of marine facilities including the communities themselves, the Government of the Northwest Territories (GNWT), the Department of Indian and Northern Affairs (DINA) and marine service operators.

In response to the need for marine facility development in Eastern Arctic communities, GNWT initiated a study in mid-1983 to evaluate these needs and to recommend solutions. The study was carried out by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc., both of Vancouver. It was directed by a Steering Committee with representation from GNWT's Department of Transportation, DINA, DFO and Transport Canada. This Executive Summary outlines the principal findings and recommendations of the study.

Reid Crowther

The communities addressed in the report are listed below:

- Arctic Bay
- Broughton Island
- Cape Dorset
- Clyde River
- Grise Fiord
- Hall Beach
- Igloolik
- Iqaluit
- Lake Harbour
- Nanisivik
- Pangnirtung
- Pelly Bay
- Pond Inlet
- Repulse Bay
- Resolute Bay
- Sanikiluaq

The location of each is shown on the following map of the Eastern Arctic and Baffin Region.

Eastern Arctic Port Roles and Utilization

Waterfront use in the Eastern Arctic, while restricted to a two to four month period; is generally crucial to the traditional pursuits and livelihood of Eastern Arctic residents. Not only are local boats used extensively for subsistence hunting and fishing, but commercial fishing is evolving in some areas, tourism is generating opportunities for boat tours and, importantly, annual sealift operations out of Montreal are relied on heavily, except in Pelly Bay, to transport needed fuel, goods, materials, supplies and equipment into these communities during the open water season.

Marine facility development in the Eastern Arctic to date has been limited. Ice conditions make it difficult and expensive to construct facilities. The lack of marine structures, however, local needs are becoming greater for facility development and improvement to increase safety, improve the quality of life, support economic development and facilitate annual sealift operations.

Canada's Eastern Arctic communities are an important part of the country's heritage and culture and important in establishing sovereignty in the North. The people living in these communities endure hardships like high transportation costs and limited economic development opportunities. Improvements in marine facilities can strengthen these Eastern Arctic settlements both **socially** and economically.

Based on our research and community visits, we defined four specific types of port demand in the study region for purposes of our analysis. These are summarized below:

- **cargo** shipments ...primarily generated by the dry cargo and bulk petroleum product resupply needs of the communities which are transported by deep-sea ships operating out of Southern Canada (...primarily Montreal...) and known as the annual sealift.

- local boating activity ...for subsistence hunting and fishing as well as transport to outpost camps with boats ranging in size from 5 metres to 15 metres.

- commercial fishing ...which occurs, or could occur based on exploratory fishing results, in some but not all communities with boats being used which range in length up to 25 metres.

marine related tourism ...generated by the increasing popularity of the region as a tourist destination and consisting of marine supported hiking, hunting, fishing and sightseeing expeditions as well as limited cruise industry activity.

The extent of demand in each category varies considerably by community. All settlements except Pelly Bay, however, are served by the annual sealift with three vessels calling in each during the open water season (...a dry cargo vessel, a bulk petroleum tanker and The Bay's resupply ship). Iqaluit, being larger, is visited by several dry cargo vessels annually.

Local boating activity occurs in all Eastern Arctic communities. Since a very restricted wage economy exists in most locations (...except Iqaluit and Nanisivik...) the use of small boats for subsistence hunting and fishing during the open water season is critical to the well being of local residents.

Commercial fishing is limited but expanding. In those communities where it does or can occur, however, the industry generates important local income and different demands for marine facilities because of the larger boats employed.

Marine related tourism is expanding and an important local income generator in several, but not most, Eastern Arctic settlements. It too places a different type of demand on waterfront facilities because of the need to transport people to and from tour boats and cruise ships.

Marine facility development can improve the quality of life, generate social benefits and/or encourage economic activity in all of the communities included in this study. Individual community profiles contained in Appendix "A" of the main report should be reviewed for a better understanding of specific demands in each case.

Future Marine Facility Demand

Our evaluations of Eastern Arctic community needs from a marine facility perspective indicate that improvements are needed. Demand growth is expected . .. but at a nominal level. Nevertheless, the inadequacy of marine facilities in general at the present time suggests that current hardships and . restrictions can only become more pronounced unless some development in this area takes place.

We do not expect the method of annual sealift operations to change dramatically. Newer ships and equipment are expected as longer term contracts are arranged and some increase in containerization is expected by one or two operators. Generally, however, sealift operations will continue much as they have, a gradual but low growth (...1"A to 3% annually...) in longer term volume will occur in most settlements and year-to-year dry cargo volumes will continue to fluctuate in response to community construction projects. Unless major investment in fixed piers is made by the Federal Government, tankers can be expected to continue discharging bulk petroleum products using floating hoses . ..a method that appears to have worked satisfactorily to date.

Our analysis has shown that a nominal increase in local boating activity is likely to occur in most communities in response to population growth. Slightly larger boats could become more popular as and when suitable protection is provided via breakwater construction.

Commercial fishing expansion opportunities in the future are limited and restricted to only a few communities. They will, however, occur and should be encouraged because of their importance to local income generation. Marine facility improvements can help in this regard in appropriate locations.

Our work has also shown that marine related tourism opportunities can expand further in a select number of communities. Because of the growing importance of this seasonal income generator, it too should be encouraged . ..and can be with selected marine facility development.

In summary, current marine facility demand remains largely unsatisfied. A gradual increase in waterfront use is expected in all Eastern Arctic communities. In several, tourism and commercial fishing opportunities can and should be encouraged by specific marine facility development.

Port Development Priorities and Master Plan

We developed a set of recommendations for marine facility development in the communities of the Eastern Arctic. These recommendations were based on our research, analysis and appreciation of current and evolving needs in each individual settlement. They are physically different by community, responsive to local demands and conditions and represent an underlying philosophy concerning marine facility development in the Eastern Arctic as summarized below:

- waterfront utilization, in most communities is sufficient in comparison with other communities in Canada to warrant marine facility developments;

- major deep-sea wharf developments in many or all communities would be excessively expensive, unlikely affordable over the short to medium term and generate costs far exceeding economic benefits with justification only likely to be based on an analysis of environmental risk factor reduction;

- practical and achievable development recommendations which have a reasonable potential of being funded are preferable to extensive facility recommendations serving all needs and demands however, a "minimum" or "threshold" level of facility development should be provided which generates tangible benefits so as to avoid investments with pre-set limits which may not result in any real benefits and could be of little value:

- facility development plans should, where appropriate, represent an initial phase of a more elaborate but demand-supported plan so that longer term investment can build on initial investment to benefit waterfront users;

- tanker unloading facilities would involve major investment in jetties or other structures which could well be uneconomical given the success achieved to date with the use of floating hoses to pump petroleum products ashore; and

- facility development plans and designs need to respect and take advantage of locally available manpower, resources and equipment where practical.

Our recommendations for each community are detailed in Appendix "A of the main report along with supporting information in each case.

To provide a prioritized set of recommendations, we evaluated the importance of each within the community and the relative importance and urgency of all developments on an inter-community basis. Our evaluation took into account several key criteria. These are described briefly below in order of decreasing importance relative to our evaluation:

- safety enhancement . ..the importance of facility development to protect people, property and equipment and to facilitate effective emergency response, including environmental issues

- economic activity support . ..the value of facility development in maintaining, expanding or developing economic activity within the community and in facilitating annual sealift operations

- quality of life improvement . ..the extent to which facility development will lessen hardships faced by local residents and make living and traditional pursuits easier

- per capita value ...the relative cost to benefit one person providing a measurement of the project's value or extent of benefit per dollar spent

- need for minimum protection . ..the importance of marine facilities in a community on the sole basis of whether useable, local facilities exist or not; and

- affordability . ..an indication of the relative affordability of the project based on its total cost recognizing that budgets are limited

Our marine facility development recommendations, by community, as well as the results of our intra-community and inter-community analysis of these recommendations is summarized in the following exhibit. This table demonstrates our assessment of the relative importance and urgency of each development recommendation.

It is important to note that second or third priority projects are still, in most cases, urgently required . .. but they are not considered as critical as first priority projects when all development criteria are considered for all communities on a comparative basis.

Funding and Implementation

While several government departments are directly interested in Eastern Arctic marine facility development, the mandates of two departments indicate primary responsibility for development which may occur:

- Department of Fisheries and Oceans - Small Craft Harbours Branch; and
- Transport Canada - Coast Guard Northern

The Department of Indian and Northern Affairs is concerned that effective development occurs but has no program budget to allocate to this end. GNWT's Department of Transportation is also keenly interested in facilitating development but has only a limited capital budget under its “Community Wharves Program”.

Specific projects fall more directly under the mandates of DFO or Transport Canada while others clearly suggest joint responsibility. In all cases GNWT should have a direct interest and role, albeit one which is mainly a facilitator and only partially a financier.

We identify, in Chapter 7 of our report, departmental responsibilities for all development projects. These are not intended to represent commitments for project funding, but rather indications of where funding may be sourced. The following tables summarize our conclusions on this subject.

DEVELOPMENT PROGRAM RESPONSIBILITY SUMMARY

PRIMARY RESPONSIBILITY	NUMBER OF PROJECTS	CUMULATIVE CAPITAL COST(1)
DFO/(GNWT)	15	$10,066,000
TC/(GNWT)	7	$ 895,000
DFO/TC/(GNWT)	3	$ 4,575,000
GNWT	2	$ 189,000
	27	$15,725,000

(1) Capital costs are preliminary and estimated in 1990 dollars.

Itis importantto recognize that these responsibilities can be effectively met overa period of, say, five years. Regardless, however, both the federal and territorial governments will need to work cooperatively and alloocate funds from programs which are already in high demand and/or through special one-time commitments to bring the proposed marine facility development program to fruition. Only then can Eastern Arctic communities experience the social and economic benefits described and can they play an effective role in exercising Canadian sovereignty in the Arctic.

EASTERN ARCTIC MARINE FACILITY DEVELOPMENT
PRIORI TY AND CAPITAL COST SUMMARY

PRIORITY		CAPITAL	FUND I NG/DEVELOPMENT
1	0 Broughton Island - Breakwater & Wharf	$230,000	DFO/GNWT
1	o GriseFiord - Breakwater & Dredging	666,000	DFO/GNWT
1	o Hall Beach - Breakwater	$447,000	DFO/GNWT
1	o Igloolik - Breakwater & Wharf	520,000	DFO/GNWT
1	o Iqaluit - Dredging Trench	260,000	OFO/GNWT
1	o Pangnirtung - Phase I - Dredging, Breakwater & Wharf	1,975,000	DFO/GNWT/TC
1	o Pond Inlet - Breakwater	455,000	DFO/GNWT
1	o Pond Inlet - Marshaling Area	25,000	DFO/GNWT
	Total Cost of First Priority Projects:	$4,578,000	
2	0 Cape Oorset - Breakwater & Sloped Wharf	2,000,000	DFO/GNWT
2	o Cape Dorset - Beach Clearing	25,000	GNWT/TC
2	o Clyde River - Breakwater & Wharf	780,000	DFO/GNWT/TC
2	o Clyde River - Beach Cleaning & Marshal l ing Area	45,000	GNWT/TC
2	o Iqaluit - Amphibious Barges	360,000	GNWT/TC
2	o Resolute Bay - Breakwater & Wharf	600,000	DFO/GNWT
2	o Resolute Bay - Sealift Anchors	20,000	GNWT/TC
2	o Sanikiluaq - Breakwater & Wharf	351,000	DFO/GNWT
2	o Sanikiluaq - Barge Wharf	300,000	GNWT/TC
	Total Cost of Second Priority Projects:	$4,481,000	
3	0 Arctic Bay - Breakwater & Wharf	$412,000	DFO/GNWT
3	o Broughton Island - Roadway Rip-Rap	75,000	GNWT
3	o Lake Harbour - Breakwater & Sloping Wharf	2,680,000	DFO/GNWT
3	o Lake Harbour - Beach Clearing & Marshaling Area	45,000	GNWT/TC
3	o Nanisivik - Breakwater	114,000	GNUT
3	o Pangni rtung - Phase I I - Breakwater, Floats & Gangway	910,000	DFO/GNWT
3	o Pelly Bay - Breakwater Wharf & Ramp	510,000	DFO/GNWT
3	o Repulse Bay - Breakwater	1,820,000	DFO/GNWT/TC
3	o Repulse Bay - Beach Improvement & Ramp	100,000	GNWT/TC
	Total Cost of Third Priority Projects:	$6,666,000	
	TOTAL COST - ALL PROJECTS	$15,725,000	

(1) All capital cost estimates are preliminary, estimated in 1990 dollars and based on utilizing available local equipment.

Reid Crowther

1. INTRODUCTION

The Eastern Arctic/Baffin Region in Canada's Northwest Territories encompasses all of the communities on Baffin Island, three on the Melville Peninsula, one on the Simpson Peninsula, one on Cornwallis Island, one on the southern shore of Ellesmere Island and one in Hudson Bay. Totaling sixteen in all, these communities are remote, isolated and except for Arctic Bay to Nanisivik have no regional road connections. It is these sixteen organized municipalities that are the subject of this report.

All of the Eastern Arctic communities concerned are located on the coast and depend seasonally on water access for their well-being, livelihood, regional links and resupply of goods and materials from the south. Only Pelly Bay is not served by the sealift. So too do they depend on the regional air service network and air connections with southern Canada for the resupply of high priority freight, passenger travel and all transportation requirements when the winter ice prevents any connection by water. While marine related activities and services are critical to residents in these northern communities, in most cases wharves and dock facilities are non existent, inadequate or in very poor condition.

Several government agencies and departments have responsibility for wharf and harbour facilities in the Northwest Territories (NWT) including the Federal Department of Fisheries and Oceans (DFO) and Transport Canada. Other agencies are directly interested in the availability of facilities including the communities themselves, the Government of the Northwest Territories (GNWT), the Department of Indian and Northern Affairs (DINA) and marine service operators. In the study area, there are no DFO or Transport Canada controlled port facilities except the commercial wharf at the Nanisivik mine site which, while operated by the mine, is owned by Transport Canada. Transport Canada has established Public Harbours at both Pond Inlet and Nanisivik, under the Public Harbour Regulations, which provides authority for the regulation of shipping.

No federal programs for upgrading NWT port facilities have been developed. In the early 1980's, Transport Canada developed a proposed Arctic Marine Services Policy which would lead to upgrading programs. Development of this policy was completed but it was never approved by the Federal Cabinet.

The Eastern Arctic Sealift is the major shipping operation in the region. Lack of proper dock facilities impacts the efficiency of the sealift operation and increases the risk of losses in terms of damage to community goods. Similar problems and risks apply to ocean resource harvesting by community

residents, affecting their very livelihood. The lack of berthing facilities for the tanker traffic increases the risk of environmental damage through potential oil spills with the use of floating lines and anchored vessels.

In response to these needs, GNWT initiated a study in mid-1989 to evaluate marine facility requirements in the communities, to assess the capital cost implications, to prioritize the improvements and to identify capital program responsibiiities among the various government agencies. The study was carried out by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc., both of Vancouver. It was directed by a Steering Committee with representation from GNWT's Department of Transportation, DiNA, DFO and Transport Canada.

Our work on this project was undertaken from July through November 1989. it invoived visits by the Study Team to the communities concerned in early September, meetings and a workshop session in Yellowknife, meetings and discussions with marine carriers who operate ships into the Eastern Arctic/Baffin Region and a variety of other research involving organizations, companies and government departments which are directly or indirectly involved and/or interested in marine facility development in the sixteen communities.

This document is the Final Report for the study. it outlines our research findings, analysis results, conclusions and recommendations in a manner which will direct and guide effective marine facility development in the Eastern Arctic over the next decade.

2. EASTERN ARCTIC PORTS AND THEIR ROLES

The sixteen Eastern Arctic communities addressed in this report are listed in alphabetical order below:

- Arctic Bay
- Broughton Island
- Cape Dorset
- Clyde River
- Grise Fiord
- Hall Beach
- Igloolik
- Iqaluit
- Lake Harbour
- Nanisivik
- Pangnirtung
- Pelly Bay
- Pond Inlet
- Repulse Bay
- Resolute Bay
- Sanikiluaq

All of these communities are located in the Northwest Territories and all are organized hamlets, except Iqaluit which achieved "Town" status in 1980 and Nanisivik which is a mining company operated townsite. All are located north of the 60th parallel except Sanikiluaq which is situated in the southeast corner of Hudson Bay. Eleven hamlets are positioned on or above the Arctic Circle.

The geographic locations of each of these sixteen Eastern Arctic communities are shown in Exhibit 2.1.

This chapter discusses the communities which are included in this report in general terms...their history, role and future. It provides a context within which our research findings, analysis results, conclusions and recommendations fit.

2.1 Historical Perspective

The Canadian Eastern Arctic has been home to the Inuit and their ancestors for thousands of years. Traditionally, the Inuit led a nomadic existence within specific regions of the Eastern Arctic, moving to follow and in search of marine mammals, animals and fish resources. Explorers from Britain and Europe began to visit the Eastern Arctic in the 16th and 17th centuries. During the last two centuries, trade in furs, sealskin and other products was established with overseas and southern Canadian companies.

LOCATION PLAN

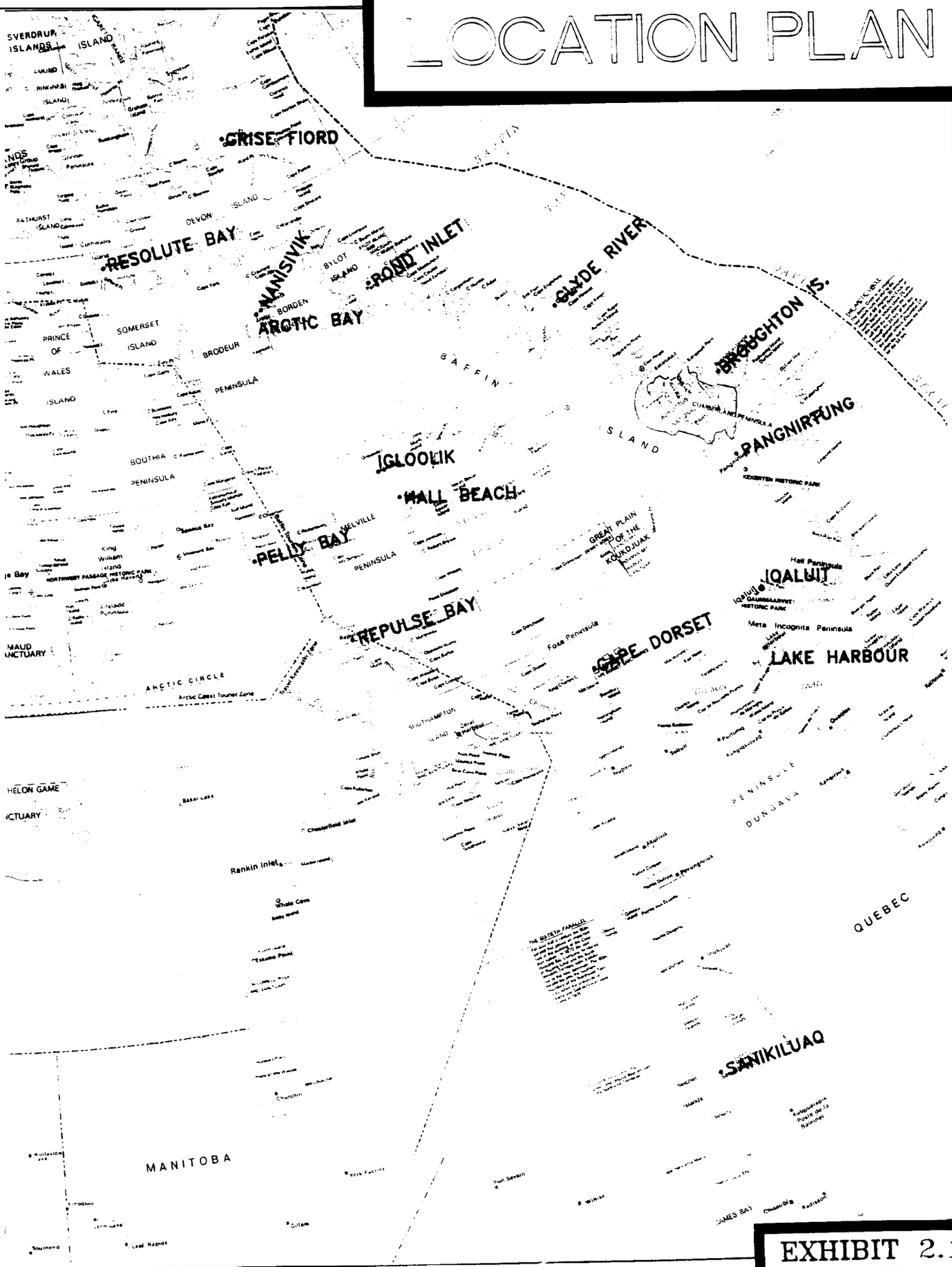


EXHIBIT 2.1

It was only during the 1900's that community settlements began to evolve to a significant extent in the Eastern Arctic. This evolution expanded in many areas through the early to mid-1 940's as religious missions were established and as Hudson Bay Company trading posts were set UP. Gradually, a wage based **economy began to appear in some settlements as economic opportunities, based primarily on trade with the south, were taken advantage of. Settlement development progressed even further as nursing stations were established, government offices** were set up, RCMP detachments were developed **and especially,** in some locations, as air bases were constructed during World War **II and as DEW Line Sites were developed in the 1950's.**

For social and economic reasons, more and more original people of the Eastern Arctic moved off the land " and into community settlements during the 1950's and 1960's. This centralization into **cohesive community groups expanded over the 1960's and 1970's in many areas as fur and** sealskin **markets collapsed, removing the traditional way of generating** income from many **I nuit families.**

Over the last two decades, some communities have been established through Federal government efforts to express and exercise Canadian Sovereignty in and over Northern Canada while at the same time attempting to alleviate poor economic conditions among the Inuit. One example is Grise Fiord to which families from Port Harrison (Quebec) and Pond Inlet were relocated in the early 1950's.

Community settlement has now effectively seen its completion. Few Inuit still live "on the land" although many continue traditional pursuits and some still relocate to outpost camps during the Summer fishing and hunting season.

2.2 Community Roles Today

Today the communities in the Eastern Arctic are organized settlements of families sharing a common language, culture and social bond. Medical, police and other social services are available in each case and both transportation and communication links with the rest of Canada are firmly established.

As socioeconomic entities, each community functions relatively independently. With the exception of a road between Arctic Bay and Nanisivik, no roads exist outside these settlements. They all rely totally on air and marine transport for resupply. Wage employment has evolved more dramatically in some communities than in others... notably in the larger centres such as Iqaluit. In most hamlets, local people continue to rely heavily on traditional hunting, fishing and sometimes trapping for their livelihood. These initiatives and characteristics are expected to continue over the foreseeable future.

Northern Sovereignty and economic stability continues to be an important issue for the Government of Canada. To these ends, and to continually improve the quality of life for residents of the Eastern Arctic, the federal and territorial governments continue to provide assistance where appropriate to the communities examined in this study.

All of the settlements we evaluated have experienced significant rates of population growth over the past two decades... generally on a small population base. These growth rates have typically slowed but are expected to continue at steady levels (... between 2°A and 3% annually as projected by the GNWT Bureau of Statistics). Most hamlets are home to several hundred full-time residents although they vary in size from just under one hundred (... Grise Fiord...) to over 3,000 (...Iqaluit).

2.3 The Importance of the Waterfront in Eastern Arctic Communities

This study deals with marine facilities in the 16 Eastern Arctic communities listed above. Since sea ice occurs in all areas during the Fall, Winter and Spring, waterfront activities only take place over a two to four month period. Nevertheless, waterfront use is generally crucial to the traditional pursuits and livelihood of Eastern Arctic residents. Not only are local boats used extensively for subsistence hunting and fishing, but commercial fishing is evolving in some areas, tourism is generating opportunities for boat tours and, importantly, annual sealift operations out of Montreal are relied on heavily, except in Pelly Bay, to transport needed goods, materials, supplies and equipment into these communities during the open water season.

Marine facility development in the Eastern Arctic to date has been limited. Ice conditions make it difficult and expensive to construct facilities. Because of the lack of marine structures, however, local needs are becoming greater for facility development and improvement to increase safety, improve the quality of life, support economic development and facilitate annual sealift operations.

Canada's Eastern Arctic communities are an important part of the country's heritage and culture and important in establishing national sovereignty in the North. The people living in these communities endure hardships like weather, high transportation costs and limited economic development opportunities. Improvements in marine facilities can, however, strengthen Eastern Arctic settlements both socially and economically. We have evaluated the needs and opportunities for marine facility development in each community and describe what we believe to be practical and achievable recommendations in the balance of this report.

3.0 PORT DEMAND - THE PAST, PRESENT AND FUTURE

The development of port facilities in the Eastern Arctic/Baffin Region needs to be based on waterfront utilization in each community concerned, both now and in the future. Traditionally, port demand and development is related directly to cargo throughput. The communities of the Eastern Arctic, however, face a different set of factors. Not only is the annual "sealift" of concern to the people of the region, but so too are local fishing and hunting activities by boat and the marine oriented tourism industry.

In this chapter we profile waterfront utilization and demand in the communities of concern. We relate this to the communities themselves, their social traditions and their economic base. We compare historical demands with waterfront utilization trends and project port demand in the future. We consistently describe waterfront use and demand in a manner which enables facility development plans to be described later in this report which are effective beneficial, practical and achievable.

3.1 Community Port Demand Classification

During our work on this study we visited and met with representatives from the Eastern Arctic/Baffin Region communities of concern. These visits and meetings, combined with interviews of marine carriers, boat owners and government officials, enabled us to determine the types of port demand and utilization which occur now and which will likely occur in the future.

All of the communities concerned are remote and isolated. Each depends heavily on marine and/or air transportation linkages with the south for resupply. Surface inter-community connections do not exist (except for the Arctic Bay-Nanisivik Road) and are impractical to develop. The residents of each community also make significant use of their waterfront during the short (2 to 4 month) ice-free season for traditional pursuits, recreational and commercial activities.

Because of the importance of various types of waterfront use in the Eastern Arctic/Baffin Region, we have defined four specific types of port demand for purposes of this study. These community port demand classifications are described below:

Nat Coll of Maintenance

- Cargo Shipments

This type of demand is generated by the resupply needs of the communities. It consists primarily of the inbound movement of both dry cargo and bulk petroleum products from sources of supply in the South. These shipments occur during the ice-free season by general cargo vessels and tankers. Private marine carriers transport dry cargo and bulk petroleum shipments as part of the annual "sealift" organized by the Territorial and Federal Governments. Private transport companies supplement the annual sealift operation for specific customers. A very limited number of outbound dry cargo shipments take place destined for southern locations, except for the ore exported from Nanisivik.

- Local Boating Activity

This type of waterfront utilization occurs in all Eastern Arctic/Baffin Region communities. Local residents make use of their own boats, ranging in size from 5 metres to 15 metres, for" subsistence hunting and fishing. These boats are also used for local transport to and from outpost camps and for guiding, outfitting and sightseeing expeditions (... which is addressed under the tourism demand classification).

- Commercial Fishing

Some Eastern Arctic communities are involved in both commercial and exploratory fishing activity. The latter could well lead to commercial fishing industry expansion in some areas in the future. Existing and future commercial fishing activities place demands on the waterfront where they do or will occur. Commercial fishing boats are larger than other local boats, ranging in size up to 25 metres. Their needs are, therefore, quite different but important economically to the communities involved.

- Marine Related Tourism

This category of port demand accounts for the increasing number of tourists who visit Eastern Arctic communities during the ice-free season. Travelers arriving by air place demand on waterfront facilities because of their involvement in marine supported hiking, hunting, fishing and sightseeing. In recent years the cruise industry has also shown some interest in the area and, at the selected ports where these ships call, passengers are disembarked and embarked via the local waterfront for sightseeing and shopping.

Each of these four types of community waterfront demand is distinct. Each must be and is addressed to ensure that marine facility development plans account for the various and unique port activities which take place in Eastern Arctic communities.

3.2 Cargo Shipment Characteristics, Trends and Forecasts

Community resupply by water in the Eastern Arctic is important to local residents, businesses and organizations. Most communities have only one opportunity annually to bring in freight by water from the south at rates which are considerably lower than the only alternative, air transport. Indeed, the arrival of the annual "sealift" ship is an important event for many people in the region.

We have reviewed and analyzed cargo shipments by sea to each of the communities addressed in this study. Based on the types of cargo involved and the transportation arrangements made, shipments have been categorized as follows for purposes of this report:

- Sealift Service (Government Arranged)
  - Dry cargo shipments.
  - Bulk petroleum product shipments.

- Private Service
  - The Bay cargo shipments.
  - Independent contractor cargo shipments.

The above services effectively account for all of the marine cargo resupply shipments in the Eastern Arctic communities concerned. Accordingly, it is these services and their freight which place demands on local ports. The principal exceptions to these freight demands, which are not addressed in this study, are Canadian Coast Guard's Northern Operations which move limited amounts of freight for their own purposes and bulk lead-zinc shipments transported outbound on the M.V. Arctic from the mine at Nanisivik destined for Europe. Pelly Bay is not serviced directly by sealift operations at the present time and supplies to that hamlet must be transshipped by air from neighboring communities.

3.2.1 Historical/Current Profile of Cargo Shipments

Exhibit 3.1 summarizes inbound dry cargo shipments by community over the past six years. In each case and for each year, shipment totals are broken down into those transported by the "sealift" and those transported by "private services".

The majority of freight is transported to Eastern Arctic communities by the sealift operation and those tonnages between 1984 and 1989 demonstrate the following:

- significant variations occur annually for any specific community, likely resulting from construction projects which generate comparably significant freight demand on an occasional basis, and

- in general, for all communities listed together, sealift shipments have experienced a reasonably steady growth of close to three percent annually over the 1984 to 1988 period.

Bulk petroleum product shipments to the Eastern Arctic communities are summarized in Exhibit 3.2 over the 1984 to 1989 period. It shows the following:

- in most communities shipments have increased gradually over the 1984 to 1989 period, likely reflecting a gradual increase in consumption which parallels population and economic base expansion, and

- annual variations in the amount of product shipped by community are marginal when compared with annual fluctuations in dry cargo tonnages.

Rescan Chowmei

EXHIBIT 3.1

HISTORICAL INBOUND DRY CARGO SHIPMENTS
Metric Tonnes
1984-1989

	1964			1965			1966			1967			1966			1989		
	Sealift	Private"	Total	Sealift	Private"	Total	Sealift	Private	Total	Sealift	Private	Total	Sealift	Private	Total	Sealift	Private	Total
Arctic Bay	130	156	286	838	164	1,002	461	173	534	474	186	659	429	193	622	478	203	681
Broughton Island	239	144	363	417	162	569	390	160	650	677	146	823	603	150	653	663	362	1,025
Cape Dorset	909	301	1,210	603	317	920	722	334	1,056	1145	289	1,434	736	349	1,085	1379	439	1,816
Clyde River	334	166	500	391	176	566	318	184	502	259	189	44.9	348	341	669	451	229	660
Grise Fiord	163	N/A	163	459	N/A	459	414	N/A	414	131	N/A	131	493	N/A	493	362	N/A	362
Hall Beach	1005	114	1,119	1294	120	1,414	395	126	521	736	127	603	363	204	E-97	1160	211	1,371
Igloolik	361	184	545	646	194	640	427	204	631	1165	254	1,419	669	217	876	744	171	916
Iqaluit	3713	S29	4,042	3824	978	4,802	4824	1029	5,853	3998	1163	6,161	3503	1667	5,170	3867	2564	6,541
Lake Harbour	749	129	676	264	136	400	265	143	428	242	127	369	313	137	450	714	143	857
Nanisivik	147	N/A	147	350	WA	350	66	N/A	06	31	N/A	31	46	N/A	46	6a	N/A	56
Pangnirtung	870	338	1,206	1718	356	2,074	976	376	1,351	1143	322	1,465	1836	396	2,236	1372	303	1,675
Pelly Bay	—	--	--	--	--	—	--	--	- -	--	--	--	--	--	--	--	--	—
Pond Inlet	921	225	1,146	656	237	1,093	793	249	1,042	881	276	1,157	621	202	823	1164	287	1,451
Repulse Bay	323	106	429	371	112	483	231	118	349	207	125	412	596	145	741	223	163	406
Resolute Bay	853	30	663	995	31	1,026	667	33	700	1 36a	34	1,402	1599	34	1,633	670	30	700
Sanikiluaq	251	103	354	446	106	556	335	114	449	164	116	300	224	169	393	425	172	597
TOTAL	10,ss6	2,925	13,893	13,474	3,060	16,564	11,306	3,242	14,546	12,721	3,353	16,074	12,261	4,206	16,497	13,870	6,287	18,157

*Estimate based on information supplied by Transport Igloolik Inc.

EXHIBIT 3.2

HISTORICAL INBOUND BULK PETROLEUM SHIPMENTS
Metric Tonnes
1984-1989

	1964 Sealift	1985 Sealift	1986 Sealift	1=7 Sealift	1988 Sealift	1989 (6) Sealift
Arctic Bay	1,209	1,063	1,202	1,742	1,406	1,760
Broughton Island	1,887	1,710	1,495	1,842	2,574	1,792
Cape Dorset	2,712	2,335	2,269	2,411	2,291	3,044
Clyde River	1,885	1,270	1,748	1,642	1,631	2,206
Grise Fiord	560	564	553	580	566	1,681
Hail Beach	7,647	7,655	8,345	7,927	9,191	9,285
Igloolik	2,713	2,167	2,586	2,207	2,926	3,047
Iqaluit (1)	N/A	N/A	N/A	N/A	N/A	N/A
Lake Harbour	884	883	1,029	955	803	1,121
Nanisivik (2)	NIA	N/A	N/A	N/A	N/A	N/A
Pangnirtung	2,764	2,300	2,537	2,999	2,929	3,615
Pelly Bay	—	—	—	—	—	—
Pond Inlet	3,172	2,324	3,409	3,187	3,582	5,175
Repulse Bay	945	1,010	1,487	1,497	1,106	1,376
Resolute Bay (3)	N/A	N/A	N/A	N/A	N/A	NIA
Sanikiluaq (4)	N/A	NIA	N/A	N/A	N/A	NIA
TOTAL (5)	26.378	23,290	26,660	26,990	29,005	34,102

(1) Iqaluit bulk petroleum shipments are transported by Shell Oil, not the government's sealift operation, and were therefore not included in this exhibit.

(2) Nanisivik bulk petroleum shipments are transported by the mine and are therefore excluded from this exhibit.

(3) Resolute Bay bulk petroleum shipments are transported by Imperial Oil and are therefore excluded from this exhibit.

(4) Sanikiluaq bulk petroleum shipments are not transported by the government's sealift operation and are therefore excluded from this exhibit.

(5) Total bulk petroleum shipments are for the government sealift only and therefore exclude shipments to Iqualuit, Nanisivik, Resolute Bay and Sanikiluaq.

(6) 1989 sealift shipments are recorded in cubic metres which were converted to metric tonnes using an average ratio of 1.1 cubic metres/metric tonne.

Exhibit 3.3 summarizes both inbound and outbound dry cargo shipments via the sealift to ail 15 communities (except Pelly Bay, not now serviced by sealift) concerned over the 1984 to 1989 period.

EXHIBIT 3.3

SEALIFT DRY CARGO SHIPMENT SUMMARY

1984-1988

(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
INBOUND	10,968	13,474	11,306	12,721	12,291	13,870
OUTBOUND	580	374	1,217	643	211	N/A

Outbound shipments via the sealift from Eastern Arctic communities are only a fraction of total inbound movements. Total outbound shipments also vary significantly from year-to-year. In summary, outbound shipments impact only marginally on port demand and identification of any upward or downward trends in this area would be speculative at this stage.

3.2.2 Future Cargo Shipment Development Factors

A number of factors were evaluated as part of our work to forecast cargo movements in the communities concerned. These are identified below along with our findings and conclusions.

- Community Population Base Growth

Most Eastern Arctic communities are experiencing growth in total population. This growth will lead to gradual, but frequently nominal, expansion of resupply shipments of dry cargo and bulk petroleum products.

- Community Infrastructure Development

Many communities have experienced expansion to residential and institutional facilities. This has led to short-term fluctuations in resupply shipments as construction materials are brought in, principally by the sealift operation. We expect that this infrastructure development will continue over the short and medium term and that it will continue to generate fluctuations in demand for dry cargo shipments inbound to specific communities.

- Air Freight Service Impact

Air freight services are the only alternative to marine services for bringing in dry cargo to the Eastern Arctic. This situation will not change. We believe, however, that customers will continue to make use of marine services in the future, as long as they remain available at significantly lower rates than air freight. It is simply not economical to bring in certain types and/or volumes of freight by air. We conclude, therefore, that there will be limited, if any, impact on marine cargo demand by air carriers unless rates and/or service levels change dramatically.

- Marine Service Technology

Marine carriers serving the Eastern Arctic generally operate earlier generation ships and, for the most part, use ships' gear to unload onto barges which, in turn, are unloaded by mobile equipment to the high water mark. It is evident that longer term contracts for sealift carriers will be concluded beginning in 1990. This should enable the carriers to modernize their equipment and, perhaps, their fleet. We did not, however, uncover evidence that would suggest any basic change to marine technology or service which would impact on port demand or facilities. Some increase in containerization of cargo by some carriers is expected as newer vessels are employed with suitable ships' gear. Deep-sea tug/barge operations may be used to carry dry cargo into some areas. The existing system appears to work, however, and will unlikely change from the perspective of the carriers themselves.

- Distribution Centre Potential

We investigated the possibility that one Eastern Arctic centre (e.g. Iqaluit) could serve as a marine distribution centre for other communities. While some limited redistribution from Iqaluit already occurs, we concluded that major distribution centre development is unlikely. The handling costs, the non-existence of surface connections between communities and the limited volumes suggest that such a development is unlikely.

3.2.3 **Cargo Shipment Forecasts**

Sealift shipment levels to each community were evaluated and projected separately. These assessments and cargo shipment forecasts, by community, are described in the individual community analyses contained in Appendix "A". In this section we summarize the factors considered and the results of these community evaluations.

Several factors were assessed a a variety of research was carried out to enable us to develop conclusions on future marine cargo shipment demand in the Eastern Arctic. Key considerations addressed and our findings are summarized in the following paragraphs:

- natural population base growth is projected in all Eastern Arctic communities by the GNWT Bureau of Statistics which, we believe, will result in a gradual expansion of inbound cargo shipments via the sealift, except in Nanisivik where, eventually, a major decline is projected once the mining operation closes.

- major industry development (e.g. mining, oil and gas exploration and production) is not expected to occur in the medium term near any of the communities concerned, therefore, no impact on local/regional resupply or export via community - based marine facilities is anticipated over the next five years;

- local economic/industrial development initiatives will continue, and in some communities will result in slightly higher port demand than would be expected by natural population growth;

- existing and projected cargo mix results in higher than normal volume/tonne ratios which will, in part, lead to slightly larger vessels on average as throughput increases and cubic capacity continues to be an issue with carriers; and

- increased containerization for cargo shipped to Eastern Arctic ports is likely with longer term contracts for carriers with suitable equipment, but container investment and restrictions imposed by available shore-based equipment will limit the expanded use of standard containers.

In general, we do not expect major medium term marine cargo volume changes to or from the communities concerned. Gradual expansion in demand is anticipated following historical trends and population growth. Our analyses of factors relating to such concerns as loading/unloading methods and freight unitization are of more significance to port facilities than the graduai growth in total shipments anticipated, but even in these cases major deviations from present operations are not expected over the next five to ten years.

In Exhibit 3.4 we summarize our forecasts of and growth rates for annual sealift tonnage shipped into the Eastern Arctic communities addressed. For simplicity oniy three years are shown: 1989, 1995 and 2000. Annual forecasts for each community are included for both dry cargo and buik petroieum products in the appropriate section in Appendix “A”.

EXHIBIT 3.4

FORECAST OF SEAL I FT SHIPMENTS TO THE EASTERN ARCTIC
1989 - 2000
(Metric Tonnes)

	Dry Cargo					Bulk Petroleum Products				
	1989*	Annual Growth	1995	Annual Growth	2000	1989*	Annual Growth	1995	Annua 1 Growth	2000
o Arctic Bay	537	4.6%	703	2.9%	811	1,646	4.6%	.2,155	2.9%	*2,486*
o Broughton Island	682	3.0%	814	3.0%	943	2,353	3.0%	2,810	3.0%	*3,257*
o Cape Dorset	881	2.5%	1,022	.2.5%	1,156	2,174	2.5%	2,521	2.5X	*2,852*
o Clyde River	357	2.9%	424	5.0%	541	1,672	2.9%	1,986	5.0%	*2,535*
o Grise Fiord	332	2.3%	381	2.3%	426	573	2.3%	657	2.3%	*736*
o Hall Beach	574	4.0%	726	4.0%	884	9,151	4.0%	11,592	4.0%	*14,103*
o Igloolik	986	3.0%	1,177	3.0%	1,305	2,660	3.0%	3,176	3.0%	*3,682*
o Iqaluit**	3,899	3.0%	4,655	3.0%	5,394	N/A	3.0%	N/A	3.0%	N/A
o Lake Harbour	296	3.5%	364	3.0%	422	884	3.5%	1,086	3.0%	1,259
o Nanisivik**	280	1.8%	311	N/A	Nil	Nil	N/A	Nil	N/A	Nil
o Pangni rtung	1,717	2.8%	2,026	2.8%	2,326	3,014	2.8%	3,557	2.8%	4,084
o Pelly Bay	Nil	N/A	Nil	N/A	Nil	Nil	N/A	Nil	N/A	Nil
o Pond Inlet	642	3".0%	766	3.0%	889	3,640	3.0%	4,346	3.0%	5,039
o Repulse Bay	500	4.5%	651	4.0%	792	1,452	4.5%	1,890	4.0%	2,300
o Resolute Bay**	1,656	1.0%	1,750	5.0%	2,233	N/A	1.0%	N/A	5.0%	N/A
o Sanikiluaq**	193	2.0%	217	2.0%	240	N/A	2 0%	N/A	2.0%	N/A
o TOTAL**	13.532	2.8%	15.987	2.9%	18,422	29,229	3.4%	35,776	3.4%	42,333

* 1989 sealift shipments in this table vary from actual levels since a trend-line analysis was used to estimate the 1989 base for forecasting purposes, thus avoiding any unusual swings that occurred in 1989.

** Bulk petroleum product shipments to Iqaluit, Nanisivik, Resolute Bay and Sanikiluag are not and will not be carried by the sealift and are therefore excluded from this table.

3.3 Local Boating Activity

Marine facility development in many communities can improve safety, encourage commercial activities and enhance the traditional water-based pursuits of local residents. The needs for marine facilities vary by community depending on their use of local boats, their reliance on traditional hunting andfishingduring the

open water season, economic development initiatives underway, the community's exposure to weather and waves and the extent to which marine facilities have been developed to date.

Our evaluation of local boating activity and its impact on the need for marine facilities cannot be summarized since each community is unique. Our findings as they pertain to this important use of the waterfront are detailed, by community, in Appendix "A. In general, local boating activity is the sinale most important issue concerning marine facility development demand in the communities of the Eastern Arctic. Because of the relatively small size of locally based boats (...approximately 5 metres to 15 metres in length...), local boating activity demand is also the easiest to address from a development and cost perspective.

3.4 Commercial Fishing

Only a few communities in the Eastern Arctic have had measurable success in the commercial fishing industry. A variety of the hamlets, however, are involved in exploratory fishing and some are at the initial stage of establishing a commercial fishery.

Commercial fishing opportunities vary dramatically by community with some showing virtually no potential for development while others demonstrate solid, economic potential in this area over the next decade. Our findings regarding commercial fishing potential for each specific community are detaiied in the respective sections of Appendix "A. To the extent that potential in this industry exits, development will be encouraged by and piace increased demand on local marine facilities. Generallv. physical development solutions to address commercial fishing demands are integrated with recommended developments which address local boatina activitv demands.

3.5 Marine Related Tourism

As is the case with the commercial fishing industry, tourism industry activity and development potential varies considerably amongst the communities of the Eastern Arctic. Generaiiy the area is becoming better known, receiving increased exposure to tourism markets and is developing tourist packages, infrastructure and amenities.

Carefully planned and controlled development of the tourism industry in the Eastern Arctic is expected. The smallness of the communities suggests that large numbers of tourists should be avoided. if not seasonal arrivals of hundreds of peopie in a hamlet may upset residents and impact negatively on the local socioeconomic base. Managed tourism is beneficial, however, and because of the expense of travailing to

these communities, special market niches can and should be pursued... especially those resulting in low volume, high value activity.

Tourism activity expansion will impact on waterfront utilization and marine facility demand in two principal ways:

- the increased use of local boats for guided sightseeing, hunting, fishing and other tours or expeditions by tourists; and

- the impact of the cruise industry as its vessels call at selected Eastern Arctic communities and its passengers disembark to visit local sights and stores.

Our marine facility development recommendations address the needs generated by the tourism industry as well as the economic opportunities represented. The importance of this industry, now and in the future, is detailed on a community-by-community basis in Appendix “A”.

4. SEALIFT PROFILE, ISSUES AND FUTURE TRENDS

Most settlements in the Eastern Arctic/Baffin Region are only free of ice and accessible by ship for two to four months annually. During this period, generai cargo ships and tankers transport various supplies and commodities to the northern communities of concern in this study. The sealift vessels, for the most part, operate out of Montreal.

In this chapter we profile the annual sealift operation to the Eastern Arctic. Its operations place demands on the community waterfronts and marine facilities, if only several times annually. Consequently, the sealift, its characteristics and its evolving trends are of strategic importance in our evaluation of marine facility development in each of the Eastern Arctic communities addressed herein.

4.1 Profile of the Sealift Operations

For the purposes of this report, Eastern Arctic sealift operations have been broken down into three separate categories as follows:

- government organized dry cargo operations;
- government organized tanker operations for bulk petroleum products; and
- private sealift operations.

Together, these seasonal marine services resupply northern communities, except Pelly Bay, and transport the goods, materials and equipment required by northern residents and for development projects in these communities. All freight not transported by the annual sealift must be flown into or out of the northern settlements.

As noted, Pelly Bay is the only one of the communities studied which is not served by the sealift operation for the delivery of dry cargo and petroleum products. This is due to the severe ice conditions in the Gulf of Boothia which restrict the navigation period, the lack of any navigation charts and the need for a Class III Arctic vessel to operate within this zone. This is discussed in more detail in Appendix “A” - "Pelly Bay Harbour Marine Facilities Assessment”.

4.1.1 Sealift Organization

Government organized sealift operations are coordinated by Transport Canada - Coast Guard Northern out of Ottawa. The Government of the Northwest Territories plays an important role in liaising with Transport Canada and coordinating all GNWT related shipments. Transport Canada is responsible for hiring space on ships, acting as booking agent, negotiating rates, collecting from shippers and paying the carriers. They also administer claims for materials damaged or lost in transit.

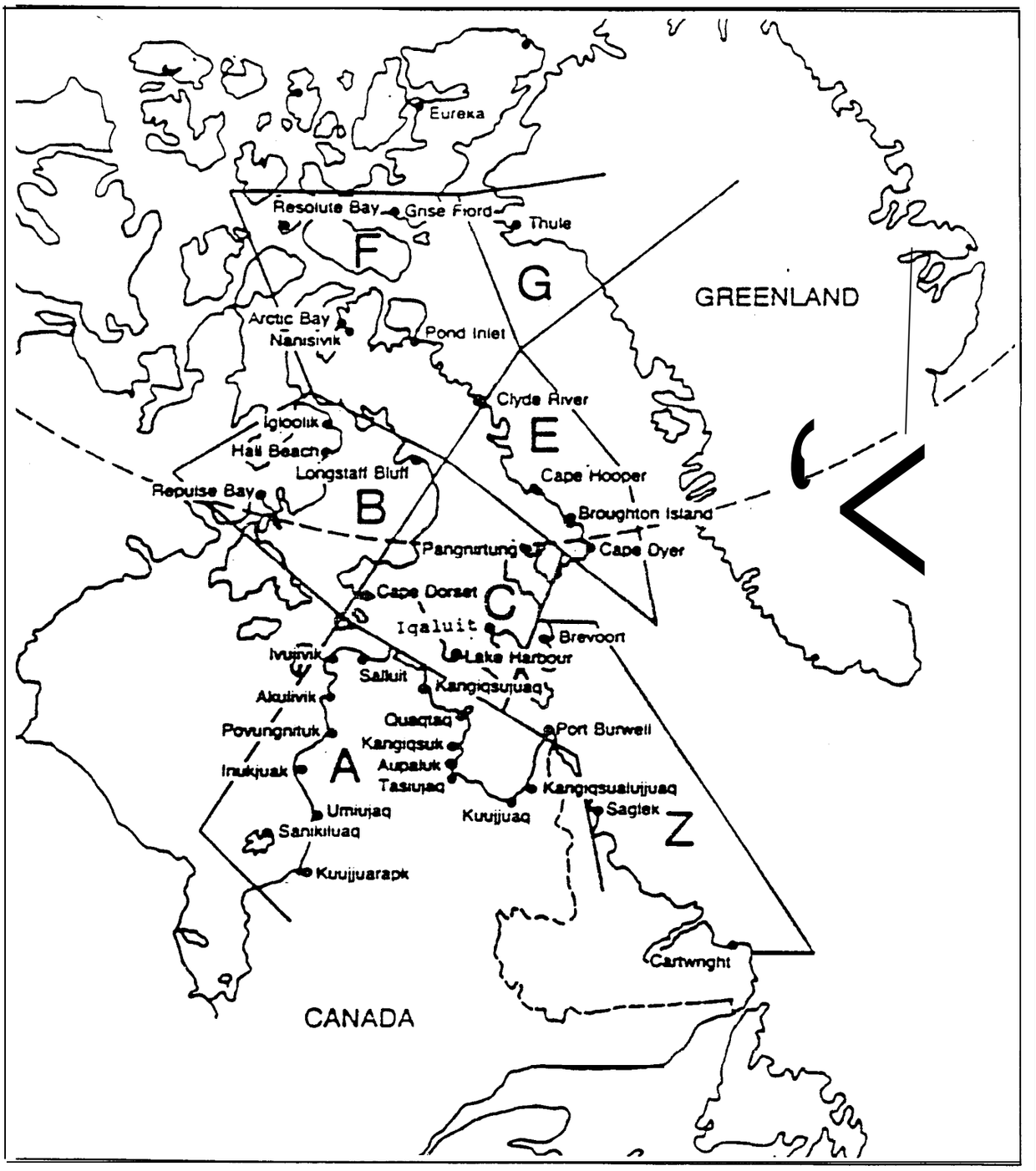
Private sealift operations, for all intents and purposes, are limited to vessels owned and operated by The Bay, originally for the resupply of their stores in each community (...which are now owned and managed by - Northern Stores Ltd.). The Bay's ships, operated under their subsidiary Transport Igloolik Inc., move between Montreal and most Eastern Arctic communities during the ice-free season. In recent years Transport Igloolik has been carrying cargo for consignees other than Northern Stores and is increasing its role as a common carrier during the annual sealift period.

4.1.2 Sealift Geographic Regions

The ships operated by Transport Igloolik call at all Eastern Arctic communities with retail outlets owned by Northern Stores Ltd. Government arranged sealift vessels, both dry cargo ships and tankers, call at all of the Eastern Arctic communities addressed in this study except Pelly Bay. Dry cargo is transported by air into Pelly Bay from Spence Bay while bulk petroleum products are air lifted to the hamlet from Hall Beach.

For purposes of contracting marine services, Coast Guard Northern has subdivided the Eastern Arctic into seven geographic areas, five of which are of relevance to this study. The areas are described on the map in Exhibit 4.1. The communities are listed below adjacent to their corresponding sealift area:

- Area A - Sanikiluaq
- Area B - Igloolik
  Hall Beach
  Repulse Bay
- Area C - Cape Dorset
  Iqaluit
  Lake Harbour
  Pangnirtung



SEALIFT ZONES

EXHIBIT 4.1

- Area E - Broughton Island
  Clyde River
- Area F - Arctic Bay
  Grise Fiord
  Nanisivik
  Pond Inlet
  - Resolute Bay

Coast Guard Northern contracts annually with a number of general cargo marine operators and a number of tanker operators to service these geographic areas. We understand that the areas are being redefined . slightly for the 1990 sealift season.

The government organized sealift calls at all communities, except Iqaluit, only once for general cargo and only once for bulk petroleum products. Transport Igloolik also calls at most Eastern Arctic communities once seasonally. Pelly Bay is the only exception...that community receives no sealift service due to severe ice conditions. Iqaluit is serviced by the government organized sealift from three to five times annually.

4.1.3 Sealift Vessel Characteristics

The dry, general cargo vessels working in the Eastern Arctic sealift trade vary considerably in size and basic characteristics. All ships are ice strengthened ranging in class from Ice Class I to Ice Class III. In Exhibit 4.2 we profile several unnamed vessels which, for purposes of our analysis, provide an understanding of the range of general cargo ship involved in the trade.

TYPICAL DRY CARGO SEAL I FT VESSEL CHARACTERISTICS

	Gross Tonnage	Net Tonnage	DWT (Tonnes)	L.O.A.	Breadth (Extreme)	Draft (Maximum)
(1)	10,034	7,005	12,802	140 m	21.5 m	9.5 m
(2)	4,462	3,086	6,472	110 m	15.7 m	6.8 m
(3)	2,125	1,018	3,627	104 m	15.6 m	5.9 m
(4)	987	541	1,778	66m	10.6 m	N/A

Metric Tonne: 1000 Kilograms

Gross Tonnage: is the total enclosed space or internal capacity in term of 100 cu. ft. to the ton.

Net **Tonnage:** is the measurement of the carrying capacity of the vessel in terms of cargo after the subtraction of fuel compartments, engine room, crews quarters, bridge etc., from gross tonnage.

Deadweight Tonnage (DWT): is the carrying capacity of the vessel in terms of cargo tonnes of 2240 *pounds .*

Most of the dry cargo ships servicing the Baffin Region are relatively old (...generally over 20years...) and all make use of ships' gear for unloading purposes.

Bulk petroleum product tankers working in the Eastern Arctic sealift trade show less variation in size than do their counterparts carrying dry cargo. A profile of two of the three vessels which operated in 1989, again unnamed, is provided in Exhibit 4.3.

EXHIBIT 4.3

TYPICAL SEAL I FT TANKER CHARACTERISTICS

	Gross Tonnage	Net Tonnage	DUT (Tonnes)	L.O.A.	Draft (Maximum)
(1)	7,687	5,397	13,626	131 m	7.9 m
(2)	4,981	3,629	N/A	116 m	N/A

4.1.4 **Sealift Unloading Operations**

At none of the Eastern Arctic communities addressed, except Nanisivik, is there an existing wharf structure where either dry cargo ships or tankers can moor directly to shore to discharge. This is because of the considerable cost associated with building suitable structures given the ice conditions and large tide ranges in most locations as well as the relatively low volume of dry cargo and petroleum products unloaded in each community.

The sealift system has necessarily evolved in a manner characterized by innovative unloading in the region. Dry cargo vessel and tanker unloading operations are profiled below.

Dry cargo vessels **typically anchor some distance off** shore and discharge their cargo into barges, which are carried on-board. The barges are moved to the shore with tugs which, again, are carried on-beard. Mobile cranes are used to unload cargo ashore where it is moved, according to contract, to the high water mark.

Lighter barges used range in size upwards from 10 metres x 8 metres x 1.7 metres to the largest one in use today which is 20 metres x 9 metres and draws four feet of water. Tugs, carried on-board the vessels, range in size from 50 H.P. to 250 H.P.

Some variations to this unloading procedure occur but, typically, these operations don't vary substantially. Generally, they are acknowledged to work well under the circumstances. In Iqaluit, vessels are occasionally brought close enough to shore to rest on the bottom at low water (LWL) so flat bed trailers can be moved directly to the ships' side for low tide unloading. In Resolute Bay, a filled area is connected by barge directly to the ships' side where unloading takes place onto flat bed trailers (...which is possible due to the steep bottom immediately offshore).

Tankers carrying bulk petroleum products to the Eastern Arctic typically anchor off-shore and connect to shore tanks via a floating hose during good weather. Product is pumped to shore with carefui watch being maintained on the floating hose to ensure no leakage or damage occurs from floating ice, currents or wave action.

Bulk petroleum product unloading via floating hose has, reportedly, worked well in all communities. Some minor spills have occurred because of hose breakage (e.g. at Hall Beach and Pond Inlet). These situations were brought under control quickly, however, and little environmental damage occurred. Steps are being taken regularly to improve the safety of the operation, strengthen the hoses and reduce the risk of any possible environmentally damaging mishaps.

4.2 Sealift Issues and Trends

Our visits to the communities of the Eastern Arctic and our research with the marine carriers serving these communities has enabled us to identify a number of issues and trends which will shape the sealift in future years. These are summarized in the following paragraphs:

4.2.1 Contract Length

In recent years, the government organized sealift operation to the Eastern Arctic has been contracted to private carriers on a year-to-year basis. These short-term arrangements are partially, but only partially, responsible for the relatively old vessels, (...generally more than 20 years...) used by contracted carriers to the North.

We understand that devolution of the sealift operation to GNWT will not take place over the forseeable future. We also understand that the federal' government will consider, in 1991, negotiating three-year contracts for the Eastern Arctic sealift with marine carriers. Three year contracts will be signed with tanker operators in 1990. As longer contracts are arranged they will provide the carriers with longer term stability and should enable them to invest to a greater extent in northern marine services. We expect, as a result, that some improvements will be made to vessels and equipment employed in the sealift operation. While improvements are anticipated, and the average vessel age may decrease, major technology changes are not expected to result from longer contracts over the next five to ten years.

4.2.2 Containerization

Some marine carriers operating in the Eastern Arctic have equipment better suited to handling containers than do others. Carrier attitudes on increased containerization of cargo vary depending on equipment suitability.

We expect that gradual increases in sealift dry cargo containerization will take place in the years ahead. The restrictions on containerization expansion are four-fold:

Reid Crowther

- available ships' gear;
- container investment required;
- cargo mix; and
- the inability in most communities to handle containers on-shore.

Other than newer ships with enhanced container handling capabilities, these restrictions are not expected to change significantly over the study period. While some increase in containerization of cargo is expected, therefore, it is not expected to be sufficient to change unloading methods in the communities of the Eastern Arctic.

4.2.3 **Community Involvement**

It was reported to us that, in many communities, both interest and involvement in sealift unloading operations is low. This leads to difficulties such as securing a clear beach area for cargo, inadequate removal and marshaling of freight and receiving responsibilities. Some carriers feel that advance interest and involvement . . . prior to sealift vessel arrival... by the community would enhance unloading operation efficiencies and lead to generally improved service arrangements. Local commitment through a contracted receiver/distribution of inbound freight has worked well in several settlements and would be advantageous in most communities.

4.2.4 **Air Transportation Alternative**

While air transportation is the only alternative to the sealift for moving goods, materials, equipment and petroleum products to the Eastern Arctic, we do not expect that the air mode will impact on future sealift operations. Both marine operations and air operations maintain a secure share of transportation demand. Assuming both modes continue to serve the Eastern Arctic with more-or-less the same levels of service, and with more-or-less the same freight rate differential, model shares of the transportation market are not expected to change in any noticeable way.

4.2.5 **Environmental Protection**

The pristine nature of Canada's North suggests the efforts to protect the environment will always be critical. Sealift vessels operating in the Eastern Arctic are ice reinforced and Canadian Coast Guard ships are present during the open water season. We expect that initiatives will continue to prevent any risk of mishaps which would impact on the environment . . . including Coast Guard's presence and the

maintenance and improvement of navigational aids. While important, these initiatives will not impact on throughout demand at the communities concerned.

The only possible implication for marine facility development arising from environmental protection is the possibility that fixed jetties will be constructed for tanker unloading. We believe the likelihood of this is low and address the issue further in Chapter 5. Todate, tanker unloading using floating hoses has worked well and the capital cost of fixed facilities is considerable. To the extent that fixed tanker jetties are required, this will impact in a major way on marine facility program costs, but likely in no noticeable way on vessels employed on petroleum product throughout demand.

4.2.6 **Distribution Centre Development**

We believe that the likelihood of developing a major distribution centre in Iqaluit for the redistribution of sealift dry cargo to smaller communities is low. While the economics have not been evaluated in detail, our experience indicates that such a development would not prove economically viable. Roads do not exist between communities (...except between Arctic Bay and Nanisivik...) and the cost of marine equipment required combined with multiple handling and the inability of distributing vessels to handle heavy lifts would, we believe, make such a concept an economic impossibility. This said, some limited re-distribution by small boat does occur and can be expected to continue out of Iqaluit.

4.2.7 **Locally Based Equipment**

Most communities have only a few pieces of equipment that can be used to handle sealift dry cargo. Generally, the capacity of local equipment is limited.

This situation is not expected to change, generally, over the study period. If larger equipment becomes more generally available in the Eastern Arctic, we expect it would facilitate sealift operations if it was used on vessel arrival to distribute arriving cargo. While such local equipment upgrading is unlikely over the medium term, if changes occur over the longer term a movement towards increased sealift containerization of freight could be expected.

5. MARINE FACILITY DEVELOPMENT CRITERIA

Our work has included both general and community specific evaluations for marine facility development in the Eastern Arctic. Community specific results are included in Appendix "A". In this chapter we discuss a variety of general issues, conditions, demands and solutions relevant to marine facility development in the study area.

5.1. Marine Facility Recommendation Classification

The community ports in the Baffin Region are all at the same stage of development, serving the same needs and struggling with the same problems. Iqaluit, because of its relative size and tidal conditions, intensifies some of the issues existing at other sites.

For the Eastern Arctic's marine facility development plan, our recommendations have been categorized according to the type of waterfront use they address as follows:

- The local community based traffic consisting of numerous small boats utilized for hunting, fishing, trapping and supply of outpost camps throughout the open water season, including local commercial fishing activity.
- Sealift dry cargo using freighters unloaded via barges over the beaches using makeshift temporary facilities on shore.
- Sealift petroleum products delivered generally once per year by tanker, the tanker being moored by ships' gear and lines leading ashore where necessary and discharging through a floating hose system.

In the remaining three sections of this chapter we describe the issues, factors and design solutions associated, in general, with each of these three primary types of part utilization

5.2 Local Community Use and Commercial Fishing

The vessels in general use consist of three basic types. the most common being a 6 metre fibreglass canoe, outboard powered and capable of short trips. The second is a 7 metre Lake Winnipeg style fibreglass boat with a cuddy cabin and powered by twin 70 HP outboard motors, The third type consists of more heavily built "Peterhead's" generally 15 metres in length, of wooden construction, totally enclosed, inboard powered and capable of long voyages and carrying several tonnes of freight. In addition there are numerous small open aluminum runabouts.

These vessels are used primarily for hunting marine mammals, food fishing and access to the land for trapping. The vessels provide transportation of goods and people to the outpost camps and traditional - summer hunting and fishing areas. In certain communities a commercial fishery exists now or is being examined through test fisheries for future exploitation. A minor but growing use is for the movement of tourists, sports fishermen and hunters by water to nearby areas.

This type of traffic has a number of obvious needs to function safely and effectively as listed below:

- protection of the vessels from storm conditions while not in use;
- access to the shore that is not weather dependent for the loading and unloading of people, catch or freight;
- the ability to safely load and unload heavy items of freight or equipment; and
- the capability for vessel haulout and launching, either for repairs or seasonal storage.

Experience shows that operators of small outboard powered boats will continue to beach them immediately adjacent to their homes, even after the provision of a nearby breakwater. The advantages of loading and unloading directly from the house to the boat and vice versa, the security from vandalism or theft and often the lack of motorized transportation from the home to the breakwater site suggest that this type of traffic will not be a heavy user of new marine facilities. This does not diminish, however, the importance of a breakwater for these users. It will be utilized when required for the handling of heavier items or when returning in adverse weather conditions which make beach landing unsafe. New facilities must be able to accommodate this type of use. The demand for concentrated facilities however, will thus be largely restricted to the bigger vessels. keeping in mind the necessity to meet genuine small boat requirements when they arise.

5.2.1 **Facilities Required**

In general, a number of typical marine facilities are required in many Eastern Arctic communities as summarized below:

- a breakwater large enough to shelter all the vessels which cannot be readily hauled up, onto the beach;
- an entrance channel to the breakwater area that is unobstructed, leading into a basin of sufficient size and depth to accommodate the traffic;
- a vertical faced berth large enough to accommodate the biggest vessei likely to use the harbour providing sufficient space for average size vessels to load and unload without unreasonable delays and allowing for vehicle access to the berth.
- a ramp suitably sloped to permit the haulout or launching of the larger vessels, with a flat area at its head to permit boat repairs or seasonal storage;
- a shore based crane, either mobile or fixed on the dock, for the handling of heavy lifts (up to 5 tonnes);
- an upland area adjacent to the basin and berth suitable for the provision of services to the vessels, storage of catch, fueling, freight movement, etc; and
- Pontoon floats for easier moorage and movement of people in certain harbors due to large tide ranges or to accommodate larger number of vessels in a smaller space.

Floating docks + Thed Can Be Hauled out in Winter

5.2.2 **Facility** Design Considerations

We believe that an essential component of a successful community wharf program in the Eastern Arctic is the effective integration of local materials, local labour and community commitment to the projects undertaken. In recommending the types of construction best suited to satisfying the need for, harbour facilities in these communities, we have concentrated as much as possible on the types of structures which can be built with local materials, labour and available equipment.

The difficulties imposed on marine facility construction by the northern environment (e.g. severe ice conditions, extreme tide ranges and high transportation costs for material and equipment) were also recognized as a major factor in selecting the type of structures which can effectively and economically meet local needs.

During the final design of marine facilities the difficulties of ongoing maintenance to marine structures under arctic conditions must be recognized. The fact that community work forces are restricted in the heavy equipment available, further restricts the range of suitable alternatives.

The types of facilities recommended below are an attempt, so far as possible, to address these development restrictions and considerations.

5,2.3 Breakwater

As all communities are favoured with a supply of rock it is proposed that all breakwaters be of the rubble mound type. These can be constructed to reduce ice damage through the flattening of normal design slopes, the shaping of the exposed ends and the use of the heaviest rock which can be handled by local equipment. In addition the rubble mound can be used to wrap around and protect the vertical faced landing berths that are required for loading and unloading.

In locations of extreme tidal range this type of structure requires large quantities of material resulting in high costs of construction. The inputs are all local, however, so that the benefits stay within the northern economy.

Rubble mound breakwaters are normally designed not to be overtopped by wave action, particularly those with a quay or berthing face on the inside. Conditions in the Arctic are somewhat unusual in that the severe ice conditions, with the rafting and ice push up that can occur, may very well exceed the design requirements imposed by storm wave conditions. The flatter slopes required due to the necessity to use smaller than optimum rock in their construction will aid in dissipating much of the storm wave energy and will also accommodate the ice push up where it occurs. Fortunately, during conditions when the structure may be over topped by ice the harbour is not being used and facilities such as floats, cranes and bollards will have been removed for storage.

Rubble mound breakwaters, by their interference with the wave energy path, cause the approaching waves to diffract or bend around the end of the structure into what may appear to be a well protected area. This must be taken into account in setting the length and direction of the breakwater.

Rubble mounds located in areas of "active" beaches interfere with the natural transport of beach material (littoral drift) by the local wave conditions. This can cause serious problems for the beach, through starvation and subsequent erosion of the downstream beach and through the infilling of basins and channels which may trap the moving material.

Before the final design of a rubble mound breakwater can be undertaken, it is essential that information in the following areas be obtained as accurately as possible:

- hydrographic soundings of the site;
- type of bottom material;
- wind and wave data;
- ice conditions;
- beach material and littoral drift potential;
- capability of local equipment to handle the largest rock sizes.

Failure to obtain this information may force overdesign and higher costs, or the much greater risk of structural failure.

Information obtained during our short community visits must be considered preliminary and of a reconnaissance nature. It is essential that more detailed data be obtained. However, based on our preliminary evaluations, we developed what we consider to be a suitable, typical concept for breakwater and crib wall development in most Eastern Arctic communities. This concept is described in Exhibit 5.1 and Exhibit 5.2.

5.2.4 Entrance Channels

Given the small size of vessel utilizing the community harbours, their shallow draft and their maneuverability, entrance channel dimensions are not as critical as they are for large commercial vessels. The main consideration will be to ensure unobstructed access at all stages of the tide. Where financial constraints on total project costs preclude this, access can be restricted to various tide levels as long as safety is not compromised. A clear depth of 1.5 metres at low tide with a width of 15 metres would be adequate for virtually all vessels using these harbors. Excessive width and depth will tend to encourage the movement of loose ice into the harbor area causing difficulties for the users.

5.2.5 Vertical Faced Berth

Vessels can be more easily unloaded if they can be secured alongside a fixed structure with a vertical face so that material can be readily transferred from one to the other. As the vessels involved are small, the height of the dock above the water surface must be kept to a minimum, 1 metre preferably. In areas with substantial tides this causes problems either by forcing the vessel to wait for higher tidal stages to more easily move the cargo or by requiring the installation of a crane.

In areas of extreme tidal ranges these problems can be largely overcome by means of sloping the top surface of the fixed berth area to form a ramp so that at least a short length of dock is always close to the water level. Generally a slope of 10% is a compromise between excessive ramp length and too steep a grade for vehicle use.

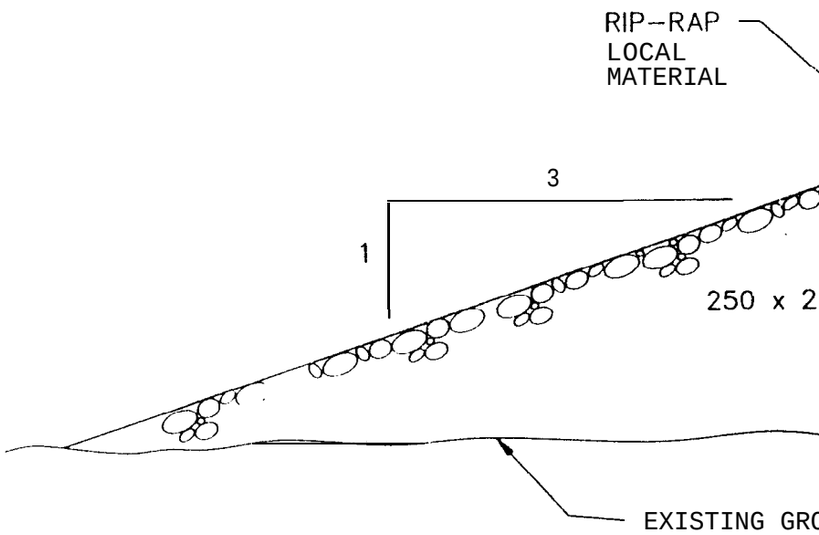
In order to obtain maximum protection for loading and unloading and to minimize cost it is desirable to incorporate the vertical berth as the inside face of the breakwater. The ramp or vertical berth require a minimum width of 4 metres for vehicle traffic. Where it is economically feasible to do so, this width should be increased to permit two lanes of traffic and to allow vehicles room to turn,

5.2.6 Sloped Ramp

A sloping ramp can serve several purposes for the community harbour. It can be incorporated into the breakwater and unloading berth to accommodate those sites with extreme tide ranges, it can be utilized to launch and haulout large vessels and it can be used by the sealift barges where needed.

Given the level of activity expected, a gravel surfaced ramp would be adequate for all users.

Where the tide range is small and the ramp is not required as part of the vertical faced berth, it should be located away from the berthing area so that vessels may be hauled up away from the vehicle and other traffic. For most vessels standard boat trailers would be the most efficient method of launching and retrieving, using a light vehicle for power. The Peterhead type boat would require a four-wheeled trailer with stronger bunks to support the vessel. These could be made locally frcm spare vehicle parts. A slope of 12% should be used for the ramp to enable larger boats to use the ramp.



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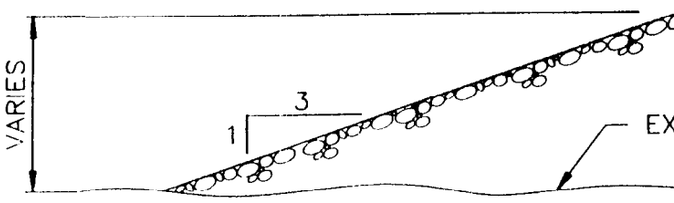

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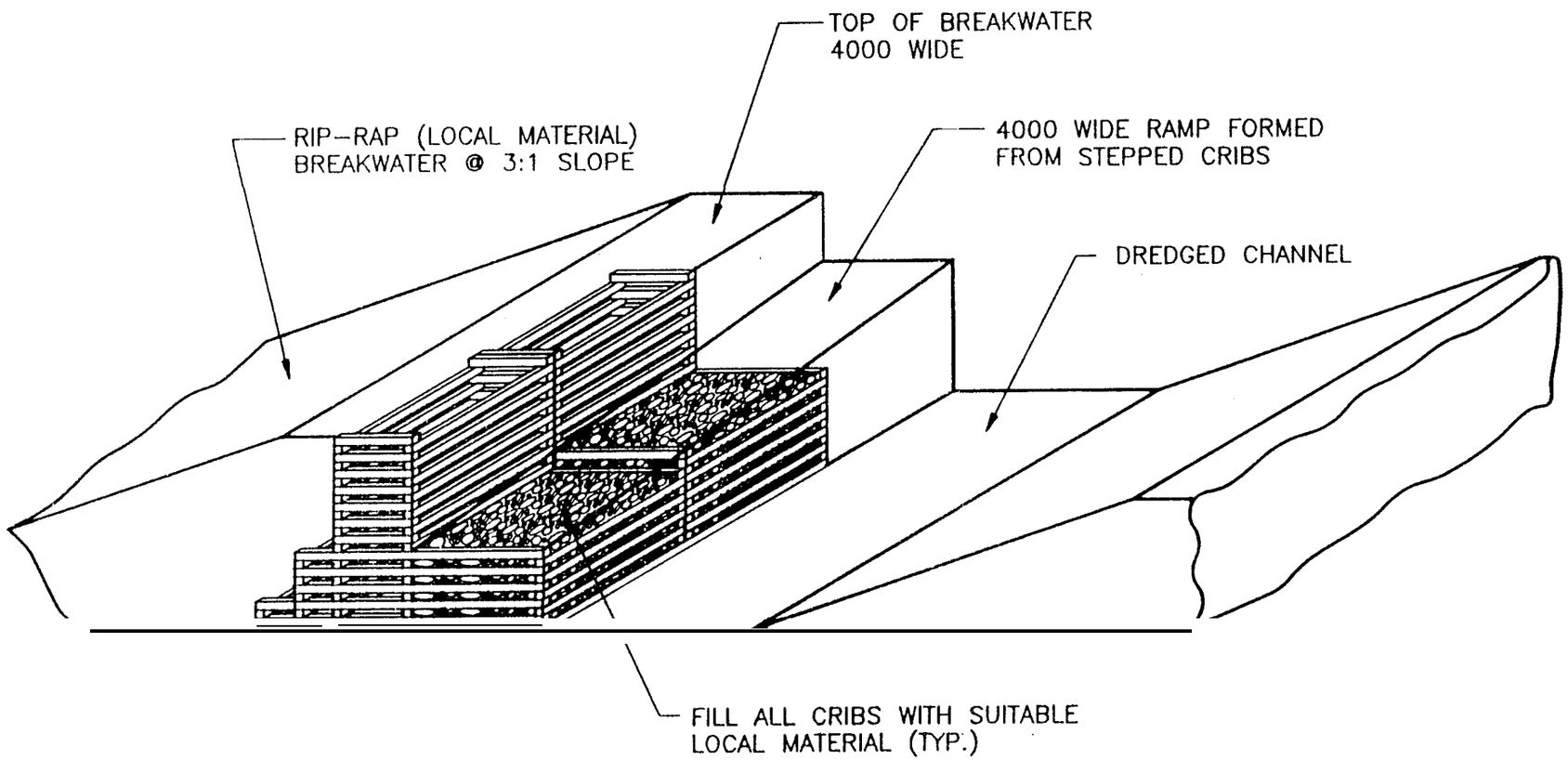

SOMETR C OF TYPICAL CRIB WALL/BREAKWATER CONSTRUCTION

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EXHIBIT 5.2

5.2.7 **Crane**

A **small stiff leg crane suitable** for 2-5 tonne lifts, either permanently mounted on the dock or movable, would be useful in servicing the bigger boats, in the movement of supplies, catch or engine repairs. A number of possible variations exist. The crane should be hand operated if it is to be part of the dock, for simplicity of maintenance and operation. This type of crane can be purchased as a unit and they are commonly installed on public docks in Southern Canada. In areas where there is significant ice push up the crane must be removed at the end of each season. Suitable cranes with a hand operated winch, readily remountable for storage, can be obtained at an approximate cost of **$12,000.**

5.2.8 **Service Area**

A harbour without an adjacent upland area dedicated to the servicing of the vessels and users is severely restricted in its utility. it is essential that an area large enough to store vessels hauled out for the winter, to temporarily accommodate fuel drums, freight, parking and similar uses be provided at the shore end of the ramp and adjacent to the loading berth. Any new freezer capacity for country food and commercial fish catch should be located in this area to reduce handling.

5.2.8 Floats

The provision of floating berths in the Eastern Arctic is something to be considered very seriously by each community. They also have obvious advantages for the mooring of small boats. They provide easy access for people but require adequate gangways to the shore to accommodate the tidal range. Floating berths permit vessels to raft together safely and can accommodate more vessels in a smaller area of water. However, they require maintenance of their connections and moorings and, because of Arctic conditions, will have to be dismantled and stored each season for re-assembly the following year. These problems can be reduced by designing the floats in short sections for easier handling and by ensuring they are rugged enough to stand up to the abuse of seasonal removal. They can be designed to be skidded up the ramp or to be moved by forklift. The floats would be secured in position using anchors and chain.

As the majority of vessels used in the Baffin Region are suitable for beaching during the operating season, only sufficient float length should be provided for the larger vessels and for loading and unloading of the *smaller vessels.* This will reduce capital costs and keep operational problems to a minimum.

For ease of construction, subsequent handling and to keep capital costs low, a float design based on timber frames with expanded polystyrene billets is recommended. The floats would require a sturdy frame with a bottom skid to protect the flotation material.

5.3 Sealift Dry Cargo

To provide a berth for the direct unloading of dry cargo vessels currently serving the Eastern Arctic would require fixed structures sufficiently strong to withstand local ice movements and the potential overtopping by rafting of pack ice. This would require either:

- steel sheet pile structures filled with local granular material;
- smooth faced heavily constructed timber cribs suitably protected at exposed corners with steel plating, again filled with granular material; or
- steel sheet pile cells for a landing face, filled with granular material and connected to the shore with more lightly built cribbing or sheet piling.

These structures would require a clear depth at low water of 8.5 metres on the berthing face to be usable at all tidal stages with a minimum berth length of 100 metres to adequately secure the vessels. This length could be reduced where it is possible to install shore anchors for use in securing bow and stern lines.

It is unlikely in the short or medium term that the economic benefits or the potential program budgets will support the construction of such facilities, given the low freight volumes and infrequency of vessel visits. Our generai conclusion however, based on our community visits, locally expressed opinions and subsequent discussions with vessel operators, is that this type of structure, while desirable and obviously capable of improving service is not essential. There are instead a number of more feasible improvements to the sealift delivery system where, for the expenditure of relatively little money, real improvements can be achieved. These break down into structural and operational improvements. The structural improvements are as follows:

- beach clearing and channel improvements;
- marshaling and storage area improvements;
- gravel beach ramp improvements; and
- vertical faced unloading berths to accommodate barges.

Each of these improvements is described briefly in the following paragraphs.

5.3.1 Beach Clearing and Channel Improvements

At many Eastern Arctic communities the sealift takes place over a beach which is obstructed to varying degrees by boulders, either at the immediate shoreline or on the tidal flat. Where this occurs, a program should be undertaken to clear a defined beach and approach channel across the flat. Permanent leading marks can then be established on shore to ensure that the barge can be more safely brought to shore for unloading.

For those communities faced by an extensive shoal area at low water, such as Iqaluit and Pangnirtung, the desirability of deepening an approach channel to assist the small boat traffic is augmented by the benefit that such a channel would have for barge access at low water.

5.3.2 Marshaling Area

A marshaling area immediately behind the landing beach should be dedicated by the community to the reception of sealift freight and improved, where required, by grading and gravelling both the road from the landing beach and the marshaling area itself. This would permit faster unloading and safeguard the freight being delivered. The area could be utilized for boat storage or other local needs when not used for sealift purposes, provided it is policed by the community prior to sealift arrival to ensure that it is not obstructed. This area and function should be a dedicated part of the official community land use plan. Municipal and Community Affairs should encourage the establishment of such areas.

5.3.3 Gravel Beach Ramp

Each community should have an improved gravel beach ramp at the upper end of the beach sufficient to ground the sealift barges for unloading by forklift. Where a ramp is also required for launching and retrieving local vessels then both types of use should be combined where feasible into one structure, particularly where large tidal ranges, make the construction of a ramp expensive. For communities with lower tidal ranges the low cost of ramp construction would permit a location to be selected which best suits the sealift marshaling area. A ramp width of 20 metres with a slope of 10% is desirable. The ramp should be built into the existing beach grade as much as possible to minimize maintenance.

5.3.4 **Vertical Faced Unloading Berths**

Where a vertical faced unloading berth is constructed for use by local boat traffic it should, where possible, be constructed so that a sealift barge may conveniently land alongside. This would be particularly useful in those locations of extreme tidal range having a ramped vertical crib faced dock since, if the depths along side were adequate, a barge could be conveniently unloaded at any tide stage.

5.4 Sealift Petroleum

The provision of permanent tanker berths is not considered economically viable at this time due to the high costs and low level of activity. While not recommending permanent jetties for tanker berthing, we did develop order-of-magnitude capital cost estimates to indicate the level of investment that would be required if these were to be constricted. Justification for such facilities is the reduction of risk of environmental damage through potential oil spill. This is beyond the scope of this study. Without detailed pre-engineering at each specific site, it is difficult to provide accurate estimates the cost for these structures. For estimating purposes, it was assumed that steel sheet pile cells can be constructed on satisfactory bottom material. The typical berth would consist of three independent steel sheet pile cells of varying diameters to suit the widely varying range of tide in the Region. The cells would be connected by steel catwalks to provide access and to support the necessary piping systems. The shore connection to the berth would vary to suit local conditions but would normally consist of gravel and rock fill, making use of any existing breakwater configuration where possible. Inability to drive steel piling would require drilling and rock anchoring, considerably increasing the cost of the structures.

Due to the need to resist ice pressures and ice rafting on these structures the cells would extend well above the maximum high tide, again varying to suit local ice conditions.

We estimate, that the cost of providing the cells, catwalks and causeway will range from $3.1 million to $8.5 million, depending on the community concerned. Total investment required for all communities will, therefore, be significant.

If more accurate estimates are required at specific sites, a program of detailed pre-engineering field work will be required. Such a program should include the following:

- a hydrographic survey to determine sea bed;
- a geotechnical survey of the bottom material to establish bearing capacity and pile driving conditions;
- beach assessment to determine the extent, if any, of littoral drift problems;
- determination of local ice conditions and movements to assess ice pressures and dangers of overtopping; and
- wind and wave data collection and interpretation to determine exposure conditions and berthing problems for the tanker.

Some additional technical information concerning our evaluation of fixed petroleum product unloading facilities is included in Appendix "B" of this report. Capital investment requirements for these facilities in each community are included in the community profiles in Appendix "A.

6. PORT DEVELOPMENT RECOMMENDATIONS, PRIORITIES AND MASTER PLAN

The primary objective of our work was to develop and prioritize practical, achievable, demand-responsive recommendations for marine facility development in each Eastern Arctic community. These recommendations, and their supporting evaluation results, are described for each of the sixteen Eastern Arctic communities in Appendix "A. We have prepared these community sections in a manner that each is independent and self-explanatory. To a major extent, they are, in fact, independent of each other since the only common link amongst waterfront demands in the hamlets is the sealift operations themselves, involving specific vessels calling at a variety of communities.

This chapter of ihe report summarizes key elements of our community marine facility recommendations. It is essential, however, that the material in Appendix "A also be reviewed for an appropriate understanding of the recommendations and their supporting demand conclusions. Importantly, this chapter concludes with an objective assessment of the relative importance, or priority level, for the recommendations described. It results in a prioritized Master Plan for Eastern Arctic marine facility development over the next decade.

6.1 Marine Facility Recommendations

Our recommendations for marine facility development in the Eastern Arctic vary considerably from community to community as can be seen in Appendix "A". The direction and sense of these recommendations, along with a community-by-community summary of specific projects, and their costs, is provided in the following paragraphs.

6.1.1 General Direction of Facility Development

After careful research and analysis, we have prepared a set of recommendations which, we believe, will prove beneficial to the hamlets of the Eastern Arctic and the governments which will contribute to the investment required. These recommendations are physically different by community and responsive to local demands and conditions. They represent an underlying philosophy concerning marine facility development in the Eastern Arctic as summarized below:

- marine facility development is, in general, needed in most locations vis-à-vis other Canadian communities and the demands which are evident;

- major deep-sea wharf developments in many or all communities would be excessively expensive, unlikely affordable over the short to medium term and generate costs far exceeding economic benefits with justification only likely based on an analysis of environmental risk factor reduction;

- practical and achievable development recommendations which have a reasonable potential of being funded are preferable to extensive facility recommendations serving all needs and demands. A "minimum" or "threshold" level of facility development should be provided which generates tangible benefits so as to avoid investments with pre-set limites which may not result in any real benefits and could be of little value;

- facility development plans should, where appropriate, represent an initial phase of a more elaborate but demand-supported plan so that longer term investment can build on initial investment to benefit waterfront users;

- tanker unloading facilities would involve major investment in jetties or other structures which could well be uneconomical given the success achieved todate with the use of floating hoses to pump petroleum products ashore; and

- facility development plans and designs need to respect and take advantage of locally available manpower, resources and equipment where practical.

These underlying principles have been applied throughout our evaluations and are reflected in our recommendations.

6.1.2 **Community Recommendations Summary**

During our work we visited the communities of the Eastern Arctic/Baffin Region, discussed the concerns and needs in each case with local representatives, evaluated demand for waterfront facility utilization in the future and assessed local requirements in the context of sealift system trends and development expectations. These efforts resulted in a number of specific conclusions and recommendations which relate directly to marine facility improvement and development in the Eastern Arctic.

Our recommendations for each community are detailed in Appendix "A" along with supporting information in each case. These recommended projects are summarized in Exhibit 6.1, by community, along with preliminary capital costs in 1990 dollars.

6.2 Marine Facility Development Master Plan

The recommendations listed in Exhibit 6.1, their importance within each community and their recommended timing were qualitatively evaluated as an entire set of potential actions. This combined intra-community and inter-community evaluation was used to develop a master program or plan for marine facility development in the Eastern Arctic over the next decade.

6.2.1 Master Planning Criteria Considered

A variety of criteria were combined with our experience and familiarity with the Eastern Arctic communities to assess the relative importance of our marine facility development recommendations. These criteria were not applied in a quantitative manner but, rather, were incorporated into our qualitative, internal evaluation of development priorities. Our evaluation, nevertheless, took into account that some criteria are more important than others vis-à-vis marine facility development priorities in the Eastern Artcic. The criteria are listed below in decreasing order of importance:

- safety enhancement . . ..the importance of facility development to protect people, property and equipment and to facilitate effective emergency response, including environmental issues;

- economic activity support... the value of facility development in maintaining, expanding or developing economic activity within the community and in facilitating annual sealift operations;

- quality of life improvement . . ..the extent to which facility development will lessen hardships faced by local residents and make living and traditional pursuits easier;

- per capita value . . ..the relative cost to benefit one person providing a measurement of the project's value or extent of benefit per dollar spent;

EXHIBIT 6.1

COMMUNITY RECOMMENDATIONS AND COSTS

COMMUNITY	RECOMMENDATION	CAPITAL COST (1)
Arctic Bay	Breakwater and Wharf	$ 412,000
Broughton Island	Breakwater & Wharf	230,000
	Roadway Rip-Rap	75,000
Cape Dorset	Breakwater and Sloped Wharf	2,000,000
	Beach Clearing	25,000
Clyde River	Breakwater and Wharf	780,000
	Beach Clearing & Marshaling Area	45,000
Grise Fiord	Breakwater and Oredging	666,000
Hall Beach	Breakwater	447,000
Igloolik	Breakwater and Wharf	520,000
Iqaluit	Dredging Trench	260,000
	Amphibious Barges	360,000
Lake Harbour	Breakwater and Sloping Wharf	2,680,000
	Beach Clearing & Marshaling Area	45,000
Nanisivik	Breakwater	114,000
Pangnirtung	Phase I - Dredging, Breakwater and Wharf	1,975,000
	Phase 11 - Breakwater	760,000
	- Floats and Gangway	150,000
Pelly Bay	Breakwater, Wharf and Ramp	510,000
Pond Inlet	Breakwater	455,000
	Marshalling Area	25,000
Repulse Bay	Breakwater	1,820,000
	Beach Improvement, Ramp	100,000
Resolute Bay	Breakwater and Wharf	600,000
	Sealift Anchors	20,000
Sanikiluaq	Breakwater and Wharf	351,000
	Barge Wharf	300,000
	TOTAL ALL COMMUNITIES	$15,725,000

(1) All capital cost estimates are preliminary, estimated in 1990 dollars and based on utilizing available local equipment.

- need for minimum protection . . ..the importance of marine facilities in a community on the sole basis of whether useable, local facilities do or do not exist; and

- affordability . . ..an indication of the relative affordability of the project based on its total cost recognizing that budgets are limited.

These criteria were not given specific values because of the qualitative nature of the assessment. Their relative importance was considered, however, as mentioned above, some were extremely important in some hamlets while others proved to be key in other communities.

6.2.2 Comparative Evaluation of Community Recommendations

We evaluated our development recommendations in all 16 Eastern Arctic communities relative to each other for each criteria described above. This was a qualitative exercise but it, in our opinion, fairly judged the relative merits of these recommendations amongst communities for each criteria. Evaluation results show our judgment of the priority of community projects relative to those in other communities for each criteria considered.

Exhibit 6.2 summarizes the conclusions of this evaluation.

EXHIBIT 6.2

MARINE FACILITY DEVELOPMENT CRITERIA ASSESSMENT

DECREASING ORDER OF CRITERIA IMPORTANCE

	Safety Enhance-ment	Quality of Life Improvement	Per Capita Value	Economic Activity Support	Need For Minimum Protection	Afford ability
o Arctic Bay	Lou	Low	Medium	LOW	Low	Medium
o Broughton Island	High	Medium	High	Medium	Medium	High
o Cape Dorset	Medium	High	Low	Medium	High	LOW
o Clyde River	Medium	Low	Low	Medium	Medium	Medium
o Grise Fiord	High	Medium	Low	Low	High	Medium
o Hall Beach	High	Medium	Medium	Low	High	Medium
o Igloolik	Medium	Medium	High	High	High	Medium
o Iqaluit	Medium	Medium	High	Medium	Medium	High
o Lake Harbour	Medium	Medium	LOW	Medium	High	LOW
o Nanisivik	Medium	Low	Medium	LOW	Low	Medium
o Pangnirtung	Medium	Medium	Low	High	High	Low
o Pelly Bay	Low	Medium	Medium	Medium	Medium	Medium
o Pond Inlet	Medium	Medium	High	Medium	High	Medium
o Repulse Bay	Low	Medium	Low	Low	High	LOW
o Resolute Bay	Medium	Medium	Low	High	High	Medium
o Sanikiluaq	Medium	Medium	High	Medium	Low	High

In Exhibit 6.2, "low" indicates that the recommendations for the community concerned are not as critical as are recommendations for some other communities relative to the specified criteria alone. "High" indicates the reverse. For example, marine facility development recommendations for Grise Fiord are judged to enhance safety significantly more in that hamlet than would the developments recommended in Arctic Bay because of the exposure and some protection in the latter case.

6.2.3 Master Development Plan

The culmination of our intra-community and inter-community analysis of marine facility development recommendations is summarized Exhibit 6.3. This table demonstrates our assessment of the relative importance and urgency of the development recommendations described earlier.

It is important to note that second or third priority projects are still, in most cases, urgently required... but they are not considered as critical as first priority projects when all development criteria are considered for all communities on a comparative basis.

Our priority evaluation and assessment is judgmental but factors in the criteria described and their relative importance. Providing numerical values to each criteria and each community/criteria rating (i.e. “high”, “medium” and “low) will result in priority grouping more-or-less as shown. We have, however, purposely avoided such a quantitative analysis because it is also judgmental and subject to discussion and argument. These factors could delay the initiation of a development program which is urgently required.

We have identified three priority groups in Exhibit 6.3 because of the impossibility of accurately comparing and assessing the relative urgency and importance of all 26 development recommendations. We believe strongly that all developments recommended should be implemented since each is practical, not excessive and required for a variety of reasons. Some, however, are more critical than others and the Master Plan presented in the exhibit will enable those responsible for funding the marine facility development program to spread the investment needed over several years.

EXHIBIT 6.3

EASTERN ARCTIC MARINE FACILITY DEVELOPMENT
PRIORITY AND CAPITAL COST SUMMARY

PRIORITY LEVEL	COMMUNITY - RECOMMENDATION	CAPITAL COST(1)
1	o Broughton Island - Breakwater & Wharf	$230,000
1	o Grise Fiord - Breakwater & Dredging	666,000
1	o Hall Beach - Breakwater	$447,000
1	o Igloolik - Breakwater & Wharf	520,000
1	o Iqaluit - Dredging Trench	260,000
1	o Pangnirtung - Phase I - Dredging, Breakwater & Wharf	1,975,000
1	o Pond Inlet - Breakwater	455,000
1	o Pond Inlet - Marshalling Area	25,000
	Total Cost of First Priority Projects:	**$4,578,000**
2	o Cape Dorset - Breakwater & Sloped Wharf	2,000,000
2	o Cape Dorset - Beach Clearing	25,000
2	o Clyde River - Breakwater & Wharf	780,000
2	o Clyde River - Beach Cleaning & Marshaling Area	45,000
2	o Iqaluit - Amphibious Barges	360,000
2	o Resolute Bay - Breakwater & Wharf	600,000
2	o Resolute Bay - Sealift Anchors	20,000
2	o Sanikiluaq - Breakwater & Wharf	351,000
2	o Sanikiluaq - Barge Wharf	300,000
	Total Cost of Second Priority Projects:	$4,481,000
3	o Arctic Bay - Breakwater & Wharf	$412,000
3	o Broughton Island - Roadway Rip-Rap	75,000
3	o Lake Harbour - Breakwater & Sloping Wharf	2,680,000
3	o Lake Harbour - Beach Clearing & Marshaling Area	45,000
3	o Nanisivik - Breakwater	114,000
3	o Pangnirtung - Phase II - Breakwater, Floats & Gangway	910,000
3	o Pelly Bay - Breakwater Wharf & Ramp	510,000
3	o Repulse Bay - Breakwater	1,820,000
3	o Repulse Bay - Beach Improvement & Ramp	100,000
	Total Cost of Third Priority Projects:	**$6,666,000**
	TOTAL COST - ALL PROJECTS	**$15,725,000**

(1) All capital cost estimates are preliminary, estimated in 1990 dollars and based on utilizing available local equipment.

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7. IMPLEMENTATION GUIDELINES

The research and analysis we carried out during this study provided information which will prove beneficial in bringing the Eastern Arctic marine facility development program to fruition. It concerns both implementation funding responsibilities and implementation considerations which need to be addressed. We summarize the information and our relevant conclusions in this chapter.

7.1 Funding and Development Responsibilities

Two federal government departments have mandates for wharf and harbour facilities in the Northwest Territories . ..the Department of Fisheries and Oceans (DFO) and Transport Canada (TC). A variety of other organizations and agencies are directly interested in the availability and condition of marine facilities in the region including each individual community, the marine carriers who operate the annual sealift, the Government of the Northwest Territories and the Federal Department of Indian and Northern Affairs. *In the* study area there are no DFO or Transport Canada controlled port facilities, except the commercial whart at Nanisivik which is operated by. the mine but owned by Transport Canada. Transport Canada has established "public harbours" at both Iqaluit and Nanisivik under the Public Harbour Regulations, which provides authority for the regulation of shipping.

Responsibilities for promoting, initiating, funding and guiding the development of marine facilities in the Eastern Arctic will remain with the senior levels of government . ..both territorial and federal. Only a few government departments can access the resources or leverage the funding required to ensure that the required development occurs including the following:

- Federal Department of Fisheries and Oceans;
- Transport Canada; and
- GNWT's Department of Transportation.

Each can contribute in different ways and at different levels to the development program. Each will also have its own priorities and focus on those recommendations which parallel individual departmental mandates.

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Other government departments such as DINA have a direct interest in the availability of marine facilities and the welfare of the communities without any programs which can contribute to funding. Nevertheless, these departments can play a valuable, supporting role by encouraging development funding from available sources of funds.

In the following sections we describe briefly the mandates of those government departments which are expected to play an important role in facilitating Eastern Arctic marine facility development.

7.1.1 Fisheries and Oceans Canada - Small Craft Harbours Branch

The Department of Fisheries and Oceans operates a national program of public harbours under the direction of the Small Craft Harbours Branch (SCH). The legal mandate for the, Branch is the Fishing and Recreational Harbours Act which provides authority for the Minister to construct and operate harbours and to make contributions for fishing harbours and for recreational harbours across Canada.

The program objective is "to plan, construct, manage and maintain a system of fishing harbours to meet the needs of the commercial fishing industry and to assist recreational boating". Its priorities are as follows:

- to ensure the safety of people and vessels;
- to avoid disruption at fishing harbours; and
- to undertake preventative maintenance of harbours.

There exist some 2255 harbours and facilities across Canada which vary widely in size and scope to meet local needs. Of the total, 1414 are primarily fishing harbours and 841 are recreational in nature. They have a cumulative value of $2.5 billion.

The Eastern Arctic/Baffin Region falls within the Central and Arctic Region of DFO. The SCH regional office is located in Burlington, Ontario, while an area office responsible for the Northwest Territories is located in Winnipeg.

SCH's program budget has fluctuated widely in the past in response to numerous employment initiatives and special programs, such as the current Harbour Revitalization Program (HRP). Recent national budget figures are:

- 1988-1989 $145.3 Million
- 1989 - 1990 $133.1 Million

The program has established a system of harbour classification which is based on the number of total meters in length of the vessels normally berthed at the site as follows:

Category	Fishing Vessles	Recreational Vessels
A	>800 Vessel Meters	>800 Vessel Meters
B	300-900 Vessel Meters	100-900 Vessel Meters
c	1-400 Vessel Meters	<200 Vessel Meters

There is some overlap amongst the categories to permit some regional discretion as to the importance of the harbour to the community.

The SCH program also established Guidelines of Harbour Accommodation as the basis for providing an equitable level of service across the country. These guidelines are to be interpreted rationally to meet specific site requirements. The structures proposed within this report fall within the scope of these guidelines and, in order to minimize cost, can be considered to be at the lower end of the scale of acceptability.

Regional shares of the national budget for major maintenance and new capital projects are allocated on the basis of priority needs for harbour repair and improvement and on the regional variance from the national guidelines for harbour services and performance. However actual budget distribution takes into account “historical distribution patterns”. The budget is reviewed and approved by the Minister. For the 1990/1 991 fiscal year the review process is scheduled to take place in February, 1990 in Ottawa.

The necessary engineering and construction supervision is normally provided to SCH by the Department of Public Works on a cost recovery basis, utilizing either in-house staff or consultants.

Because of the difficulties of operating and protecting the 2500 harbours across Canada the SCH Branch has been promoting the long term leasing of harbours to local user groups or local municipal councils by establishing Harbour Authorities in the community. The Authority would be a legally incorporated non profit body capable of managing and maintaining the facility. It would establish the local rules, and set and keep the fees from the users. Major maintenance and expansion would still be paid for by SCH. Where revenues do not cover operating costs the deficit would be covered by SCH, at least in the beginning. A number of these Authorities are being set up across Canada, primarily by local municipal councils. The Minister has stated that where a community agrees to form a Harbour Authority, they will receive priority consideration in funding programs.

The Community Wharf Program within the Eastern Arctic/Baffin Region clearly consists of users who would normally fall within the mandate of the Small Craft Harbour program, including those listed below:

- commercial fishermen;
- subsistence fishermen;
- hunters of marine mammals;
- recreation/tourist activities; and
- sports fishermen.

7.1.2 Transport Canada - Canadian Coast Guard

The Coast Guard's mandate for the supply of community oriented marine facilities is related to their responsibility for the provision of public facilities for "the movement of goods and people". This function is fulfilled in southern Canada by the construction and operation of wharves and floats in isolated communities and through a system of tariffs are used by local residents and by commercial marine carriers such as coastal freighters and barges. These needs exist in the Northwest Territories and are met by Coast Guard in the MacKenzie River system, the Athabasca system and along the western Arctic coast.

Facilities in the Eastern Arctic/Baffin region which are of direct benefit to the sealift operation or to the handling of local freight and even the transport of people between communities or outpost camps all fall within the mandate of Canadian Coast Guard. It would thus not be unreasonable, therefore, for the agency to provide assistance in the construction of unloading berths, gravel ramps and even breakwater protection where these would benefit services of goods and people.

Canadian Coast Guard funds have not been provided for marine facility development in the past in the Eastern Arctic/Baffin Region. It is understood that the Western Regional Coast Guard spent $500,000 in 1988 on essential maintenance of their facilities in the Northwest Territories river, lake and Arctic coast area.

Transport Canada may be unable to accept to be responsible for new facilities in the Eastern Arctic since they are currently not taking responsibility unless the facility is cost recoverable in five years. They may, however, be receptive to grants for specific projects and could serve as an important influence in encouraging cabinet level allocation of special funds for the proposed marine facility program..

7.1.3 Department of Indian and Northern Affairs

Department of Indian and Northern Affairs does not now contribute directly to marine facilities for native peoples but has provided grants for various infrastructure and training programs aimed at strengthening native economic development, participation in the fishing industry and tourism. Past examples of economic expansion vehicles supported by DINA include the. Native Economic Development Program (now an element of the Canadian Aboriginal Economic Strategy) and the Northern Native Fishing Corporation at Port Edward British Columbia where funding was available for vessels and infrastructure purchases..

In several Eastern Arctic communities successful participation in the commercial fishery is only possible with larger boats, which are currently impractical due to lack of harbor facilities. There are a number of examples of unutilized fish quotas which cannot be safely or economically exploited due to the lack of suitable vessels, harbour facilities and collection depots. The Department of Indian and Northern Affairs may be prepared to consider annual or project specific contributions to a community wharf program which would open up these opportunities given the importance of the marine resource to the native peoples of the region.

7.1.4 GNWT - **DEPARTMENT OF TRANSPORTATION**

The Government of the Northwest Territories recognizes the importance of marine facilities in the north to the social and economic well being of residents, especially in remote coastal communities. Its budget to contribute in a major way to such a capital intensive program is, however, restricted.

in recent years, GNWT established the Community Wharves Program under the Department of Transportation. The program is intended to facilitate marine facility development in those communities where it is needed the most. Working with the Federal Government, GNWT hopes to use its staff and limited capital resources as leverage to generate ongoing and expanded federal funding for needed marine facility projects.

The capital budget for the Community Wharves Program in fiscal 1989/1990 was $500,000. This has recently been inceased to $750,000 for the 1990/1991 fiscal year.

7.1.5 Department Responsibilities Summary

It is not possible or advisable for us to indicate which projects will be, or should be, funded by individual government departments. Various government departments will determine when, to what extent and in what manner the proposed program will be funded. These decisions will be based on demands, needs and priorities described in this report; departmental budgets, priorities and meetings; and political, social and economic realities.

To provide some direction and guidance for the decisions which are urgently required, we have evaluated each recommendation described earlier as to the primary and secondary benefits generated. This analysis has enabled us to identify departments which should play a role in each case because of their stated mandates.

In Exhibit 7.1, we have re-summarized the development recommendations made by community along with their estimated capital cost. Alongside each recommendation, we have identified those government departments which, we believe, should take primary or joint responsibility for development initiation, planning, funding and implementation.

We note that our reference to GNWT in the exhibit refers primarily to the Department of Transportation and its Community Wharves Program. That reference has been made for every recommendation because of GNWT'S concern for all Eastern Arctic communities. It is unrealistic to expect that GNWT will take a leading role in the funding of ail, or even several, of the developments proposed because of their limited program budget. Nevertheless, the territorial government is expected to play an important role in the planning and initiating of all projects, in working with the federal government and in liaising with the communities themselves.

The indication of responsibilities in Exhibit 7.1 is not intended to represent a commitment by the department shown to participate in any of the developments proposed. Actual commitments will need to be discussed, negotiated and secured on the basis of this document.

In summary, a number of proposed projects fit primarily into DFO's mandate, several fit into Transport Canada's mandate and a few appear to meet the objectives of both of these federal government departments. All recommendations fit within GNWT's mandate and address their objectives vis-à-vis marine facility development. A profile of responsibility levels is provided in Exhibit 7.2.

Exhibit 7.2

DEVELOPMENT PROGRAM RESPONSIBILITY SUMMARY

PRIMARY RESPONSIBILITY	NUMBER OF PROJECTS	CUMULATIVE CAPITAL COST(1)
DFO/(GNWT)	15	$10,066,000
TC/(GNWT)	7	$ 895,000
DFO/TC/(GNWT)	3	$ 4,575,000
GNWT	2	$ 189,000
	27	$15,725, 000

(1) Capital costs are preliminary and estimated in 1990 dollars.

It is evident from Exhibit 7.2 that the majority of funding responsibility for the proposed program tends to rest with DFO (...in the range of $12 million at 1990 price levels...) although Transport Canada's indicated share is significant at about 20 percent (...approximately $3.1 million at 1990 price levels). The weighting toward DFO responsibility results from our focus on providing facilities which are affordable and which satisfy basic safety, subsistence and economic needs, rather than costly permanent structures which can handle very infrequent port calls by deep-sea ships. We emphasize that responsibility indications are not intended *to* dictate program commitments but, rather, indicate where the majority of responsibility lies based on existing mandates. Other sources should be pursued (e.g. native economic development programs, native land claims investment funds, the Department of National Defence, special allocations by the federal government for social, cultural, economic or sovereignty reasons, etc. Furthermore, the recommended program can be effectively implemented over a five to ten year time frame, significantly spreading the commitment from the funding sources eventually agreed on. In some way, however, these levels of capital investment in the marine infrastructure of Canada's Eastern Arctic need to be found to provide the region's people with basic assets which are important to their livelihood, social well being and economic stability.

7.2 Implementation Considerations

A number of considerations were uncovered during our work which need to be addressed as implementation proceeds. These are described briefly in the following paragraphs.

7.2.1 Environmental Impact

The facilities recommended in the report will produce minimal impacts on the physical environment. Site specific issues such as the effect of littoral sand movement down wave from the breakwaters and the possible erosion of downstream beaches will have to be assessed individually. No potential contaminants are anticipated in any of the dredged materials and no problems are anticipated in the use of dredge spoil for breakwater core or ramp construction or beach front disposal. The concentration of vessels within a more confined harbour area will raise issues of garbage disposal, waste engine oil etc. which must be addressed by the community.

Specific information was not obtained on the presence of fish and marine life in the immediate vicinity of the structures. Except at a community such as Pelly Bay where the harbour for small craft is within the entrance to the adjacent river known to have runs of Arctic Char, however, there is little likelihood of significant impact on fish. The sites as a whole do not appear to be in areas of productive marine habitat but consist of sandy, gravelly, intertidal areas.

Sealift operations, in general, will be made safer by the shelter from the breakwaters, possible use of improved ramps and beach clearing. This will reduce the risk of accidental damage or spillage of cargo.

The handling of petroleum products is not affected in the short or medium term by the recommended structures. The long term possibility of fixed tanker unloading berths offers obvious benefits in the reduction of risk factors. Their cost, however, is considerable and indicates that other operational measures should be fully exhausted before commitments are made to the construction of such facilities.

Prior to finalizing the location and type of structures in any of the Eastern Arctic communities, contact must be made with the necessary Territorial and Federai agencies such as Renewable Resources, Fisheries and Oceans and Environment to ensure concurrence with the proposal.

7.2.2 **Compromise** Solutions for High Cost Recommendations

At certain communities in the study area, primarily those along the southern coast of Baffin Island where tide ranges in excess of 10 metres occur, it is extremely expensive to provide “ail tide” access to a

sheltered harbour. This is reflected in the preliminary estimates for the communities of Cape Dorset, Lake Harbour, Pangnirtung and Repulse Bay and in the difficulties in operating at Iqaluit.

A practical alternative for the community - based small boat traffic in these situations is to concentrate solely on providing shelter by building a breakwater which is only accessible on a "half-tide" or better, allowing vessels to "ground-out" at lower tide elevations. This practice limits the usefulness of the harbour and does require careful attention to tidal conditions on the part of the users. A number of public harbours exist under such conditions in Southern Canada, notably in the area of the Bay of Fundy.

Before recommending such a course of action, it would be highly desirable to discuss the pros and cons of such a minimal facility with the local communities concerned. It would be possible in most instances to reduce the breakwater capital costs by 50% at the obvious expense of convenience and safety.

7.2.3 Community Liaison

Our research included visits to the Eastern Arctic communities and discussions with representatives from every hamlet in the region. It was clear in a few locations that promises had been made previously that had not been followed through. In a few cases too, facilities had been constructed that did not meet community expectations or satisfy their needs.

While local politics are difficult to predict in these isolated communities, and while local expectations can vary over time, we consider it essential that a well planned and monitored community liaison program be implemented with respect to marine facility evaluation, planning, design and construction. Most of our recommendations are focused on community needs and benefits. Local residents will make, by far, the most use of new or expanded facilities. Their needs must be addressed. Their involvement in the development process needs to be ensured so that the benefits from marine facility development are optimized. With the process employed in this study, the community liaison process has been initiated and we recommend strongly that it be continued in a consistent and straightforward manner.

7.2.4 Construction Scheduling

We have based our conceptual designs, recommendations and cost estimates on making maximum practical use of available equipment, materials and manpower in each community. Because equipment and manpower is limited in each settlement, it will be important during the implementation process to schedule construction in a manner which takes into account other local development projects. The availability and capability of local equipment, labor and contractors must be assessed and managed in

advance. This will contribute in a major way to minimizing costs, optimizing local benefits, increasing local acceptance and ensuring a timely and productive development program.

7.2.5. Implementation Summary

The considerations described above are impotant. they must be addressed as implementation plans are established. Of most importance, however, is the need to move forward quickly with the proposed development program. Action and effective, beneficial facilities will establish the government's credibility amongst the residents of the Eastern Arctic. Indeed, it will enable them to improve their well being and opportunities for the future. Program implementation, despite which community facilities are constructed first, is considerably more important than delaying development because of indecision on community priorities. All Eastern Arctic communities will realize that action is being taken, when it is taken and that their turn is near.

EXHIBIT 7.1

COMMUNITY RECOMMENDATIONS COSTS AND RESPONSIBILITIES

COMMUNITY	RECOMMENDATION	CAPITAL COST(1)	FUNDING/DEVELOP RESPONSIBILITIES
Arctic Bay	Breakwater and Wharf	$ 412,000	DFO/GNWT
Broughton Island	Breakwater & Wharf	230,000	DFO/GNWT
	Roadway Rip-Rap	75,000	GNWT
Cape Dorset	Breakwater and Sloped Wharf	2,000,000	DFO/GNWT
	Beach Clearing	25,000	GNWT/TC
Clyde River	Breakwater and Wharf	780,000	DFO/GNWT/TC
	Beach Clearing & Marshaling Area	45,000	GNWT/TC
Grise Fiord	Breakwater and Dredging	666,000	DFO/GNWT
Hall Beach	Breakwater	447,000	DFO/GNWT
Igloolik	Breakwater and Wharf	520,000	DFO/GNWT
Iqaluit	Dredging Trench	260,000	DFO/GNWT
	Amphibious Barges	360,000	GNWT/TC
Lake Harbour	Breakwater and Sloping Wharf	2,680,000	DFO/GNWT
	Beach Clearing & Marshaling Area	45,000	GNWT/TC
Nanisivik	Breakwater	114,000	GNWT
Pangnirtung	Phase I - Dredging, Breakwater and Wharf	1,975,000	DFO/GNWT/TC
	Phase 11 - Breakwater	760,000	DFO/GNWT
	- Floats and Gangway	150,000	DFO/GNWT
Pelly Bay	Breakwater, Wharf and Ramp	510,000	DFO/GNWT
Pond Inlet	Breakwater	455,000	DFO/GNWT
	Marshalling Area	25,000	DFO/GNWT
Repulse Bay	Breakwater	1,820,000	DFO/GNWT/TC
	Beach Improvement, Ramp	100,000	GNWT/TC
Resolute Bay	Breakwater and Wharf	600,000	DFO/GNWT
	Sealift Anchors	20,000	GNWT/TC
Sanikiluaq	Breakwater and Wharf	351,000	DFO/GNWT
	Barge Wharf	300,000	GNWT/TC
	TOTAL ALL COMMUNITIES	$15,725,000	

(1) All capital cost estimates are preliminary, estimated in 1990 dollars and based on utilizing available local equipment.

(2) "DFO" ...indicates Federal Department of Fisheries and Oceans - Small Craft Harbours Branch.
"TC" ...indicates Transport Canada - Canadian Coast Guard.
"GNWT" ..indicates Government of the Northwest Territories Department of Transportation.

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APPENDIX "A'

COMMUNITY PROFILES, DEMANDS AND DEVELOPMENT PLANS

APPENDIX "A' - PREAMBLE

The following material is separated into sixteen sections, one for each Eastern Arctic community included in this study. Each section relates the community to the various marine facility demands currently or expected to be experienced. Each also provides recommendations which will guide waterfront development in an effective and affordable manner.

All of the individual community sections have the same format as follows:

- Introduction
- Hamlet Overview
- Waterfront Utilization and Demand
- Site and Harbour Profile
- Development Recommendations
- Development Cost Estimates

Our recommendations for each community are considered in terms of:

- local community use/commercial fishing;
- sealift dry cargo; and
- sealift petroleum.

The emphasis of the conceptual designs recommended has been placed on practical solutions with due regard for the materials and equipment which are readily available. The general intent is that the majority of the work, certainly for local community facilities, can be carried out by local forces using locally available equipment and thus impact on the prosperity of the community.

There is, in most cases, a minimum capital cost expenditure necessary in order to achieve any appreciable benefit to the community. Where pratical, concepts have been designed such that facilities can be extended as development progresses.

In the case of the sealift, and especially facilities to accommodate delivery of petroleum products, the magnitude of the problem is such that the work cannot normally be carried out by the local community.

It should also be emphasized that the designs presented are of a conceptual nature. In most cases, further pre-engineering information is necessary to develop feasible designs. This information would typically include a detailed geotechnical assessment, accurate site surveys, and reliable tidal measurements.

Community sections are included in alphabetical order with pages lettered/numbered to facilitate their identification by hamlet as follows:

Community	Page Lettering/Numbering Code
Arctic Bay	AB.1, 2,3 . . . . .
Broughton Island	BI.1, 2,3 . . . . .
Cape Dorset	CD.1, 2,3 . . . . .
Clyde River	CR.1, 2,2 . . . . .
Grise Fiord	GF.1, 2,3 . . . . .
Hail Beach	HB.1, 2,3 . . . . .
Igloolik	IG.1, 2,3 . . . . .
Iqaluit	IQ.1, 2,3 . . . . .
Lake Harbour	LH.1, 2,3 . . . . .
Nanisivik	NS.1, 2,3 . . . . .
Pangnirtung	PG.1, 2,3 . . . . .
Pelly Bay	PB.1, 2,3 . . . . .
Pond Inlet	PI.1, 2,3 . . . . .
Repulse Bay	RB.1, 2,3 . . . . .
Resolute Bay	RS.1, 2,3 . . . . .
Sanikiluaq	SK.1, 2,3 . . . . .

APPENDIX "B"

PETROLEUM BERTH FACILITIES ASSESSMENT

1. INTRODUCTION

As part of the Eastern Arctic/Baffin Region Port Facilities Study, preliminary cost estimates have been prepared for the provision of permanent tanker berths at the various communities.

This appendix is intended to explain in a little more detail how these estimates were produced and to describe the type of facility envisaged for the typical tanker berth.

2. ASSUMPTIONS

Detailed pre-engineering data was not available for each specific site.

It was therefore necessary to make certain basic assumptions regarding site conditions, particularly in the following areas:

- tidal range;
- seabed elevations;
- geotechnical conditions;
- ice conditions;
- wind and exposure;
- littoral drift.

The accuracy of the cost estimates for the tanker facilities will be directly affected by the accuracy of the basic assumptions made. More detailed cost estimates would require additional pre-engineering work.

3. TYPICAL TANKER BERTH

The typical berth is shown in Sketch SK3. It consists in concept of three sheet pile cells of up to 12 metres in diameter filled with granular material.

The cells would be interconnected by Steel catwalks which could be removed during closure periods. The catwalks would provide access and could also support the piping necessary for transporting the petroleum product.

Connection to the shore would be made via a rock mound causeway breakwater utilizing existing facilities as much as possible. Since the breakwater would need to extend out to accommodate a vessel of 8 metres draft, the cost of this structure may vary significantly depending on site conditions.

Sheet pile cells would offer the most economical alternative, but may not be feasible at every site for a variety of reasons. Alternatives such as precast concrete cribs, steel sheet pile bulkheads are possible but likely more expensive.

Sites where the use of sheet pile cells are not considered practical are identified below. The alternatives to this type of structure have not been evaluated in detail, but may involve for example concrete crib construction and would certainly prove to be substantially more expensive than the sheet pile cell type facility.

4. PROBLEM SITES

- Cape Dorset — In view of the large tide range of 8.3 metres, the required height of the sheet pile cells may be too high to accommodate an 8-metre draft vessel.

- Iqaluit — There is a very large tide range of 11.6 metres at this site. Local conditions are further complicated by very high winds and adverse geotechnical conditions. A major terminal at Innuit Head was the subject of a detailed report in 1978, which would indicate a capital cost of approximately $20M at 1990 prices.

- Lake Harbour — There is a very large tide range of 12.6 metres at this site and extensive rock outcrops near shore. Construction of a tanker facility here would certainly warrant major construction which would be extremely expensive.

- Pelly Bay — This community is not serviced by the sealift and is currently resupplied by air. The main reason for this is the extent of the ice pack during the summer season. Clearly it would be extremely difficult to get heavy construction equipment and material into this site and there would be no demand for the facility in any case.

m	Repulse Bay	There is a large tide range of 6.8 metres at this site which would necessitate the use of very long sheet piles.

5. COST ESTIMATES

The attached table gives a comparison of cost estimates for providing the typical tanker facility shown in Sketch SK3 for the various communities in the Study.

For the purposes of this estimate the cost of providing the sheet pile cells, access arrangement and mobilization are taken as constant for each site. The cost of providing the breakwater structure varies significantly for site to site depending on the tide range and assumed seabed elevations.

Allowances for engineering/survey costs and contingency have also been included

Cost estimates for the problem sites at Iqaluit, Lake Harbour and Pelly Bay have not been included.

At Cape Dorset and Repulse Bay, where the practicality of constructing this type of facility is marginal, cost estimates have not been included.

EXHIBIT B-1

TANKER FACILITY

COMMUNITY	ROCK FILL cum.	COST $1,000	STEEL CAISSON COST	ENGINEERING COST	CONTINGENCY $1,000	TOTAL COST $
Arctic Bay	61,000	3,050	2,100	509	1,000	6,659,000
Broughton Island	18,000	900	2,100	300	600	3,900,000
Cape Dorset			Not Feasible			
Clyde Rivr	89,000	4,450	2,100	650	1,300	8,500,000
Grise Fiord	14,000	700	2,100	280	560	3,640,000
Hall Beach	6,000	300	2,100	240	480	3,120,000
Igloolik	19,000	950	2,100	300	600	3,950,000
Iqaluit(1)			Innuit Head Cost Update			20,000,000
Lake Harbour			Not Feasible			
Nanisivik			Already in Place			
Pangni rtung	60,000	3,000	2,100	500	1,000	6,600,000
Pelly Bay			Not Serviced by Sea Lift			
Pond Inlet	23,000	1,150	2,100	300	600	4,150,000
Repulse Bay			Nor Feasible			
Resolute Bay	7,000	350	2,100	250	500	*3,200,000*
Saniki luaq	19,000	950	2,100	300	600	3,950,000

(1) This cost represents updated cost of complet terminal for petroleum and dry cargo.

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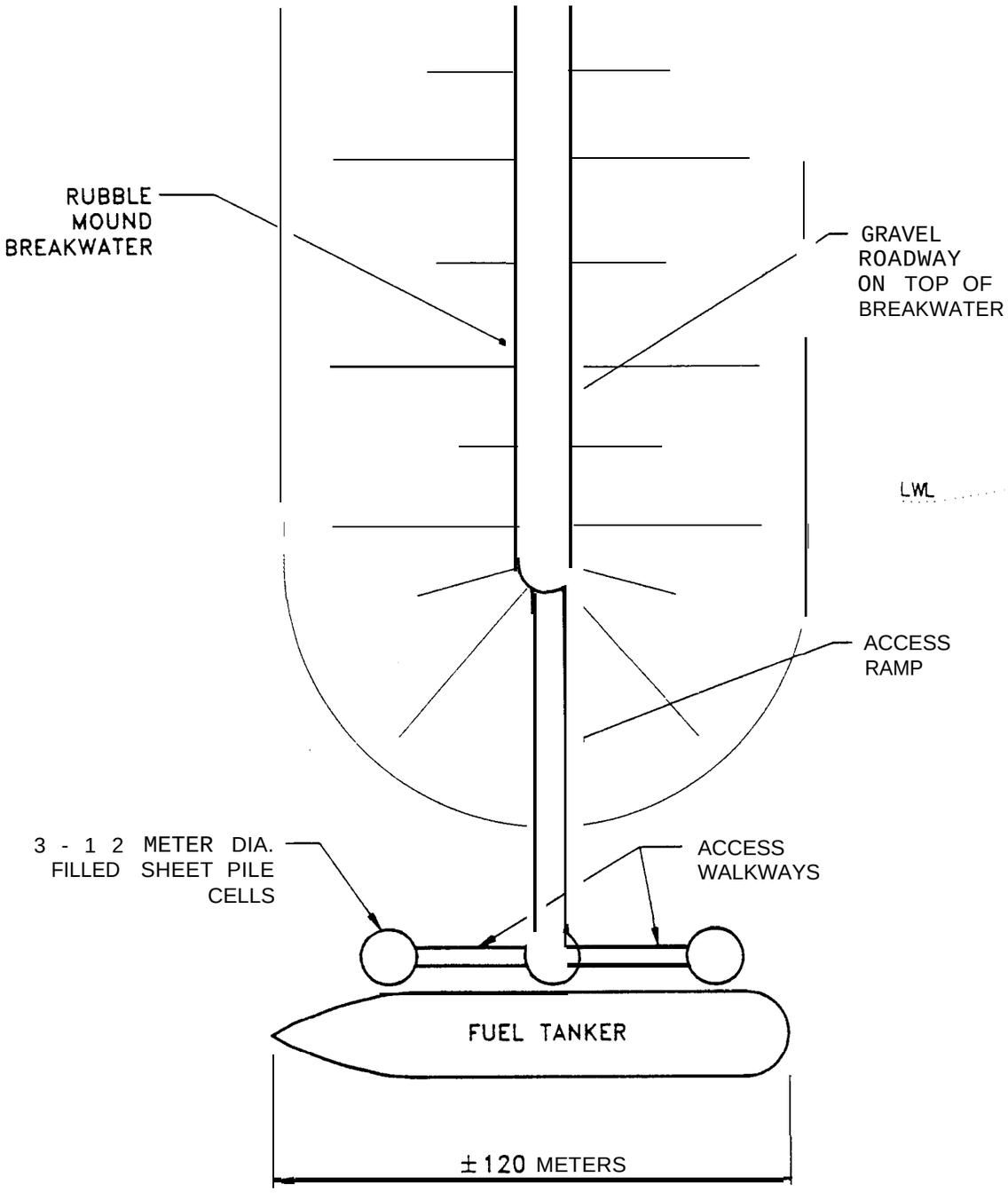
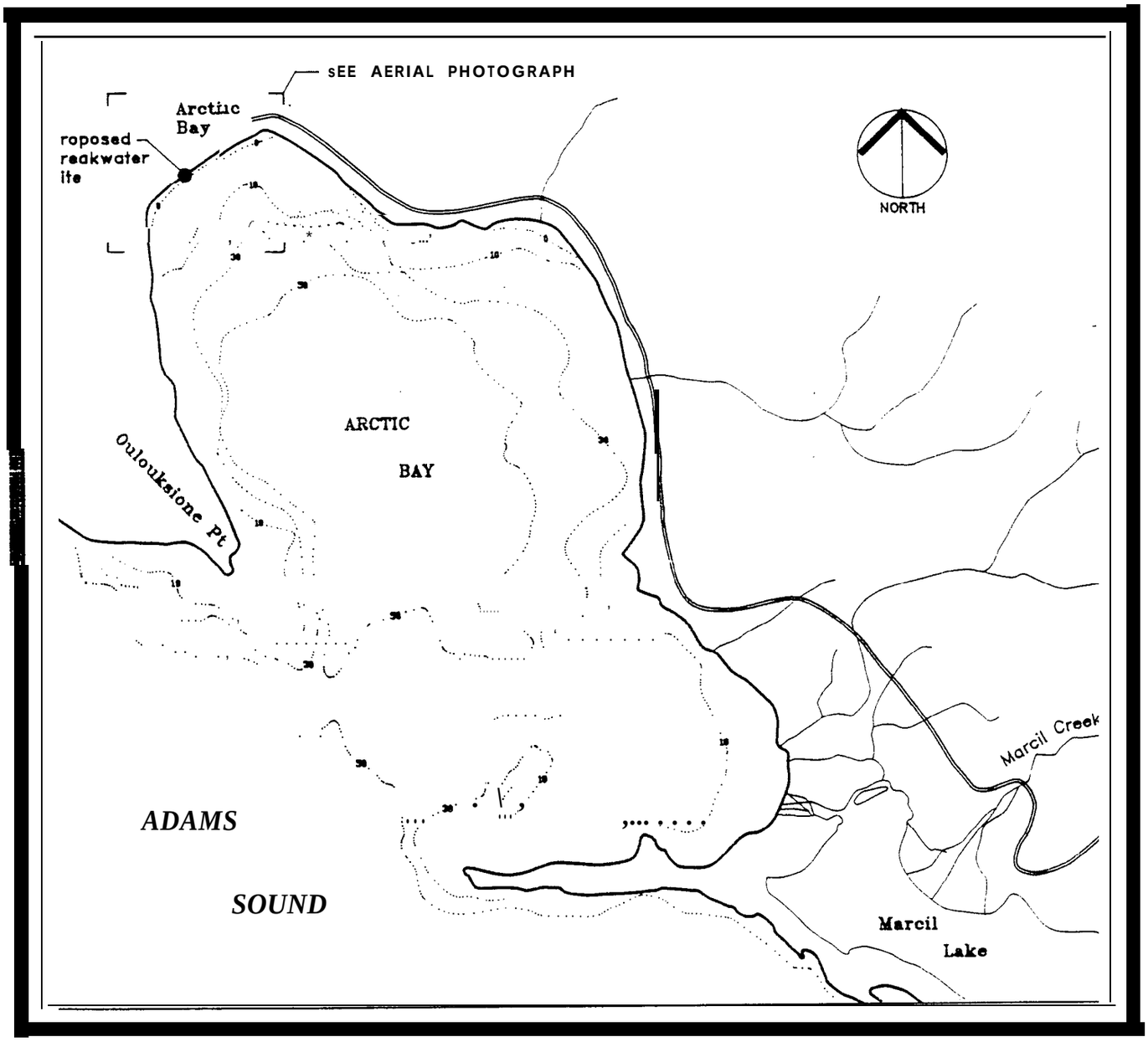


TYPICAL TANKER BERTH

(SCALE 1:750)

EXHIBIT B.1

MARINE FACILITIES ASSESSMENT



Natural Scale 1:40,000

Soundings in Meters

ARCTIC BAY HARBOUR

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ARCTIC BAY HARBOUR
MARINE FACILITIES ASSESSMENT

TABLE OF CONTENTS

Introduction

This short report summarizes the finds of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Hamlet of Arctic Bay Overview

The Hamlet of Arctic Bay is located at the Northwestern end of Baffin Island adjacent to Admiralty Inlet and Lancaster Sound. Census data from 1986 indicates the community is home to just under 500 residents.

The permanent settlement of Arctic Bay began with the establishment of a Hudson's Bay Company trading post during the 1920's. Year round settlement expanded during the 1950's and 1960's with residents relying primarily on traditional hunting, trapping and fishing activities for their livelihood. The development of a lead-zinc mine at nearby Nanisivik was important in transforming Arctic Bay into the largely wage-employed economy that it is today. In recent years, promotional efforts have attracted a growing number of tourists on package tours directed towards ice-flow edge sightseeing in the Spring and polar bear hunting in the Winter. The hamlet's council expects considerable residential base growth and continued economic expansion from tourism.

Waterfront Utilization and Demand

Arctic Bay residents make continuous use of the local waterfront during the Spring, Summer and Fall. When the ice recedes from the shore, supplies are moved by boat to the ice to extend the hunting season. Adjacent Victor Bay is also used by local boats and could well experience more activity in the future. **Annual sealift vessels generally call at Arctic Bay three** times per year (i.e. a general cargo ship, a bulk petroleum product ship and The Bay's cargo ship).

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Arctic Bay. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations arrive three times annually in Arctic Bay carrying dry cargo and bulk petroleum products. The following table profiles government organized sealift shipments and shows that dry cargo throughput has varied considerably from year-to-year over the past six years. These variations result from the small local residential base combined with comparatively large cargo movements when local construction projects are underway.

SEALIFT SHIPMENTS TO ARCTIC BAY
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
▪ Dry Cargo	130	838	461	474	429	478
▪ Petroleum Products (Bulk)	1,209	1,063	1,202	1,742	1,406	1,760

Bulk petroleum product shipments to the community demonstrate a more steady trend over recent years. Fluctuations shown in the above table result less from annual consumption changes and more from the time of year the tanker calls at Arctic Bay and shore tank capacities.

Both dry -cargo and bulk petroleum shipments to Arctic Bay are expected to increase in proportion to population base expansion. Annual peaks will continue to occur in response to construction projects.

After large growth rates on a relatively small base in the 1960's, Arctic Bay's population growth has leveled off (7.6% per annum from 1971 to 1976 and 2.1 % per annum between 1976 and 1986). Part of this leveling off was due to the larger actual number of residents and part was due to the fact that some families moved to the Nanisivik mine site for employment opportunities.

GNWT's Bureau of Statistics projects continued growth in Arctic Bay's residential base (...averaging 2.9% per annum over the 1986 to 1996 period). Since these projections exclude net migration, and since the Nanisivik mine is slated to close over the next several years, we expect that some 15 families will move back to Arctic Bay at some point over the medium term.

Our sealift shipment forecasts are based on these natural and in migration population growth expectations. They do not and cannot reflect annual peaks based on construction projects. Steady growth in cargo and bulk petroleum throughput is expected, however, over the longer term based on our understanding of population and local economic trends.

Sealift shipment levels to Arctic Bay are projected in the following table over the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO ARCTIC BAY
1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993(2)	1994
o Dry Cargo	537	553	568	585	664	683
o Petroleum Products (Bulk)	1,646	1,694	1,743	1,793	2,036	2,095

	1995	1996	1997	1998	1999	2000
0 Dry Cargo	703	723	744	766	788	811
0 Petroleum Products (Bulk)	2,155	2,218	2,282	2,348	2,416	2,486

(1) 1989 shipment levels are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 are based on population growth expectations.

(2) 1993 estimates reflect a net in migration to Arctic Bay of 15 families (60 people) from the Nanisivik mine site.

Local Boating Activity

Residents of Arctic Bay make regular use of the waterfront for fishing and hunting. There are some 25 locally based canoes and Lake Winnipeg boats which can operate over a longer season than many Eastern Arctic communities. Hunting off the sea ice while the shoreline is exposed to open water takes place and requires supplies to be moved from shore to the ice edge. Two larger boats (13-metre longliners) make regular use of the waterfront as well.

Local boating activity will continue. It will increase as families relocate from Nanisivik, although some may choose to operate their boats off the beach in nearby Victor Bay, especially during the Spring hunting season.

Smaller boats account for most of the activity in Arctic Bay. The nature of their use, however, means that supplies are being loaded onto these boats and harvested animals and marine mammals are being unloaded. Development which would facilitate these activities would be beneficial to the boat owners. The community would like to have an extended tie-up area on the local wharf and better protection from the south wind. All boats are beached on shore successfully at the present time resulting in little moorage basin demand except for the long liners and during loading/unloading. Increased boating activity is also expected as package tours bring in more tourists (...this subject is addressed more fully later in this section).

Commercial Fishing Activity

Commercial fishing activity in Arctic Bay is limited at the present time although the hamlet is optimistic about its future. Some **20,000** pounds of Char has been exported from the community annually over the past several years. Exploration clam dredging and summer fisheries are underway which, if successful, could result in expanded commercial fishing activity and the more frequent loading and unloading of larger, commercial fishing vessels in the harbour area.

For existing and future larger commercial boats, the hamlet has indicated that an accessible (...vertically faced...) wharf for loading and unloading is of primary importance. A ramp would be useful as **well in** the hamlet's opinion, but would only benefit commercial vessel owners.

While some commercial fishing activity expansion in Arctic Bay is possible, it will likely be some years before the level of vessel activity involved will increase significantly. Certainly, however, existing **commercial boats** will continue to place demands on the waterfront and make use of marine facilities availabie.

Tourism Activity

The Arctic Bay based Ikajutit Hunters and Trappers Association has, in recent years, marketed sightseeing and hunting packages successfully. Groups of tourists (...up to 35...) now arrive to experience local floe edge hunting activity, go on polar bear expeditions or travel to the North Pole. Plans are in place to extend

the tourism industry with new expeditions (e.g. kayaking above the Arctic Circle) and with more promotion of existing package tours.

The implications for marine facilities from tourism industry expansion are **not enormous.** Larger **boats are used** for many tour groups and, therefore, the potential for more large boat (e.g. 12 - 15 metres) activity in the harbour is good. Expanded wharf facilities with a vertical face to facilitate loading and unloading of commercial fishing boats as well as locally based smaller boats, will benefit those involved in the marine side of the tourism industry as well.

Arctic Bay did not even make the "primary destination" list in the 1988 Baffin Visitors Survey. While tourism volumes are low, however, the tourism product offered appears to be high in quality and the economic value of each tourist to the local community is undisputably high.

Waterfront Utilization and Demand Summary

In summary, waterfront use in Arctic Bay extends over a longer season than in other locations. Boating activity is important for subsistence hunting, packaged tours for tourists and a limited commercial fishery. Some marine facility improvements are required, especially as waterfront use is expected to increase. Hamlet council identified the need to extend the existing pushout and curve it around to provide protection for boats. Sealift operations are reported to function relatively smoothly except for maneuvering area congestion on shore arising from small boat storage.

Site and Harbour Profile

Relevant characteristics of Arctic Bay's harbour and the extent to which marine facility development has taken place to date is summarized below.

- Tides — Mean Tides **1.5M**; Large Tides 2.5M; Mean Water Level 1.2M
- Tidal Zone — Approximate grade 10%.
- Soil Conditions — The surface is black shale, shingle and sand. Above the HWL is a minor embankment with a low slope over the immediate upland followed by low hilly terrain.

- Site Topography — The settlement is located on the northerly side of a small and well protected bay. There are high hills to low mountains located within 2.5 to 5 kilometres of the community.

- Ice — First year ice is typical with a good possibility of second year ice. No ice was seen during our inspection. There is likely to be ice rafting to HWL or above. No ice has accumulated on top of the existing push out. The open water period runs from the first week in August to the end of September. Fast ice would run out to the LWL contour.

- Exposure — Protected from all but the south vector. Summer storms blow from the south. Estimated 1 metre harbour chop, waves run over and along the existing pushout.

- Littoral Drift — None in evidence.

A pushout with 25 to 140 kilogram rock on its slopes has been constructed on the westerly side of the settlement. The west side of the pushout slopes down to provide a vertical landing face of gabions (1). There is a possibility of ice damage shown by broken shale laying on the bottom in front of the gabions.

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(1) Gabions are prefabricated heavy wire mesh boxes placed to form vertical walls and filled with local gravel when in position.

Development Recommendations

Our evaluation of community needs and growth combined with our assessment of local conditions and marine development opportunities has enabled us to prepare a number of specific recommendations for marine facility development in Arctic Bay. These are summarized below.

Local Community Use

The main priority at Arctic Bay is provision of a wharf offering protection to smaller vessels. The tide range is not excessive, and it is not thought essential to provide a sloping ramp.

We recommend that marine facility development in Arctic Bay incorporate the following minimum requirements:

- Extension of the existing pushout by providing a rubble mound breakwater, curved around to provide the required shelter.

- Provision of a vertical face on the inside of the breakwater by incorporating timber cribs filled with rubble.

Sealift Dry Cargo

There is a good gravel beach which is presently used by the sealift. The current arrangements work well and are satisfactory.

A breakwater run out in the direction of the storm waves could permit a barge to be brought in and beached at high tides and unloaded at all tides.

Provision of a dock for the sealift would require a major structure, which would be expensive and generate economic benefits considerably lower than the costs involved.

Sealift Petroleum

Excellent holding for anchorage can be obtained in the N.W. part of Arctic Bay. Tankers currently pump oil direct to the shore via floating lines.

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Provision of a mooring facility for oil tankers would require major construction. A rubble mound causeway would need to be constructed out to deep water with sheet pile cells providing mooring dolphins and access arrangements. The capital costs would far exceed any direct economic returns experienced as a result.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Arctic Bay. They are summarized in sketch form in Figure AB.1.

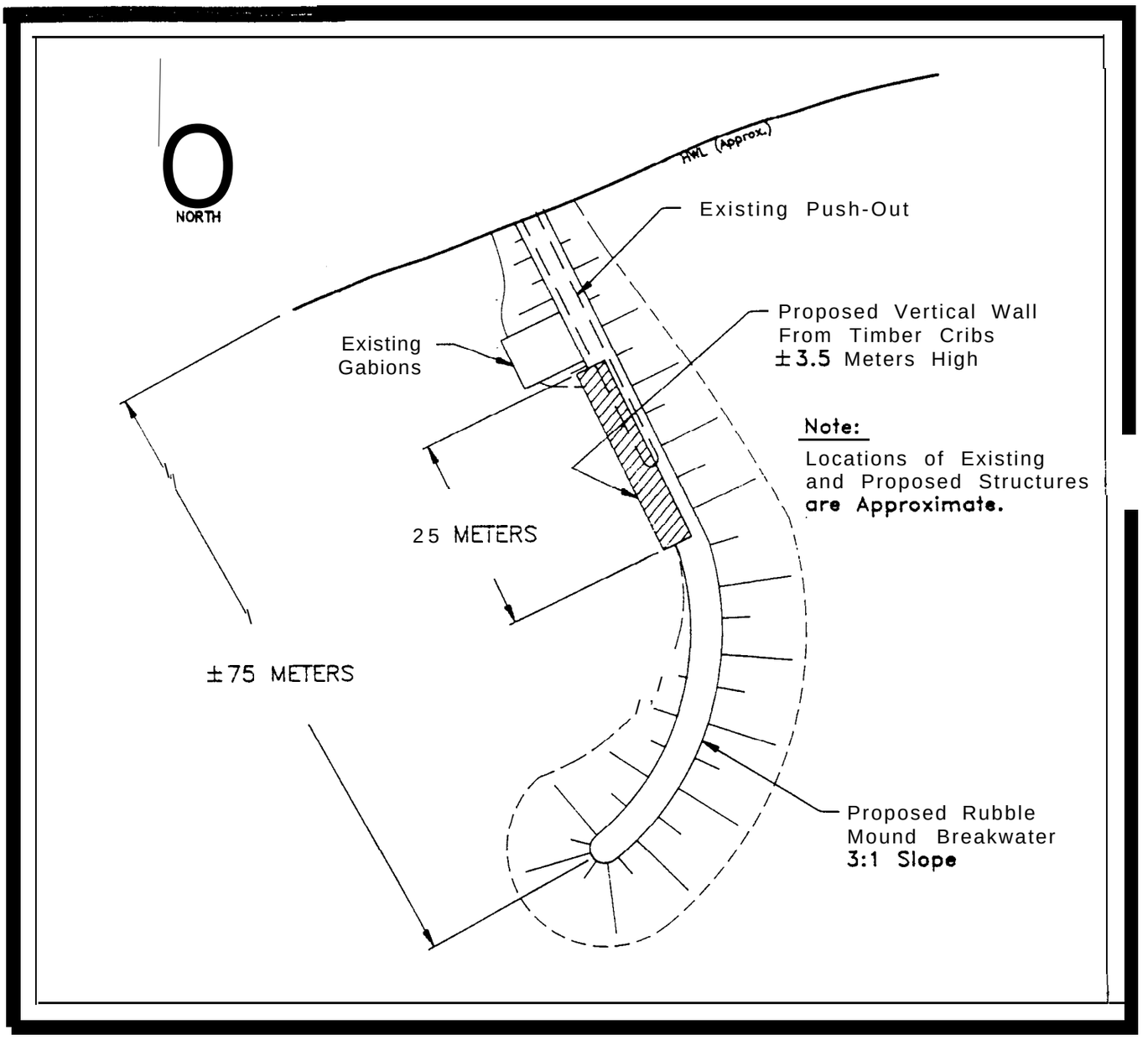
Development Cost Estimates

Our preliminary cost estimates, in 1990 dollars, have been prepared on the basis of several assumptions and reflect the development recommendations and possibilities described above. One restriction we encountered was that accurate sounding data was not available for the community. Seabed elevations, which would directly impact on the cost of any proposed structure, have been assumed from estimated grades within the tidal zone and approximate charted depths beyond.

The following is a summary of our preliminary cost estimates, in 1990 dollars, for marine facility development in Arctic Bay.

Local Facility

▪ excavation and preparation	**$40,000**
▪ breakwater construction	**240,000**
▪ crib wall construction	**36,000**
▪ engineering and survey	**32,000**
▪ contingency	**64,000**
	$412,000



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ARCTIC BAY
CONCEPTUAL PLAN

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Sealift Dry Cargo

Since the current arrangements for the sealift are satisfactory, no sealift dedicated developments have been recommended. No cost estimate has been prepared, therefore, for improvements in this area.

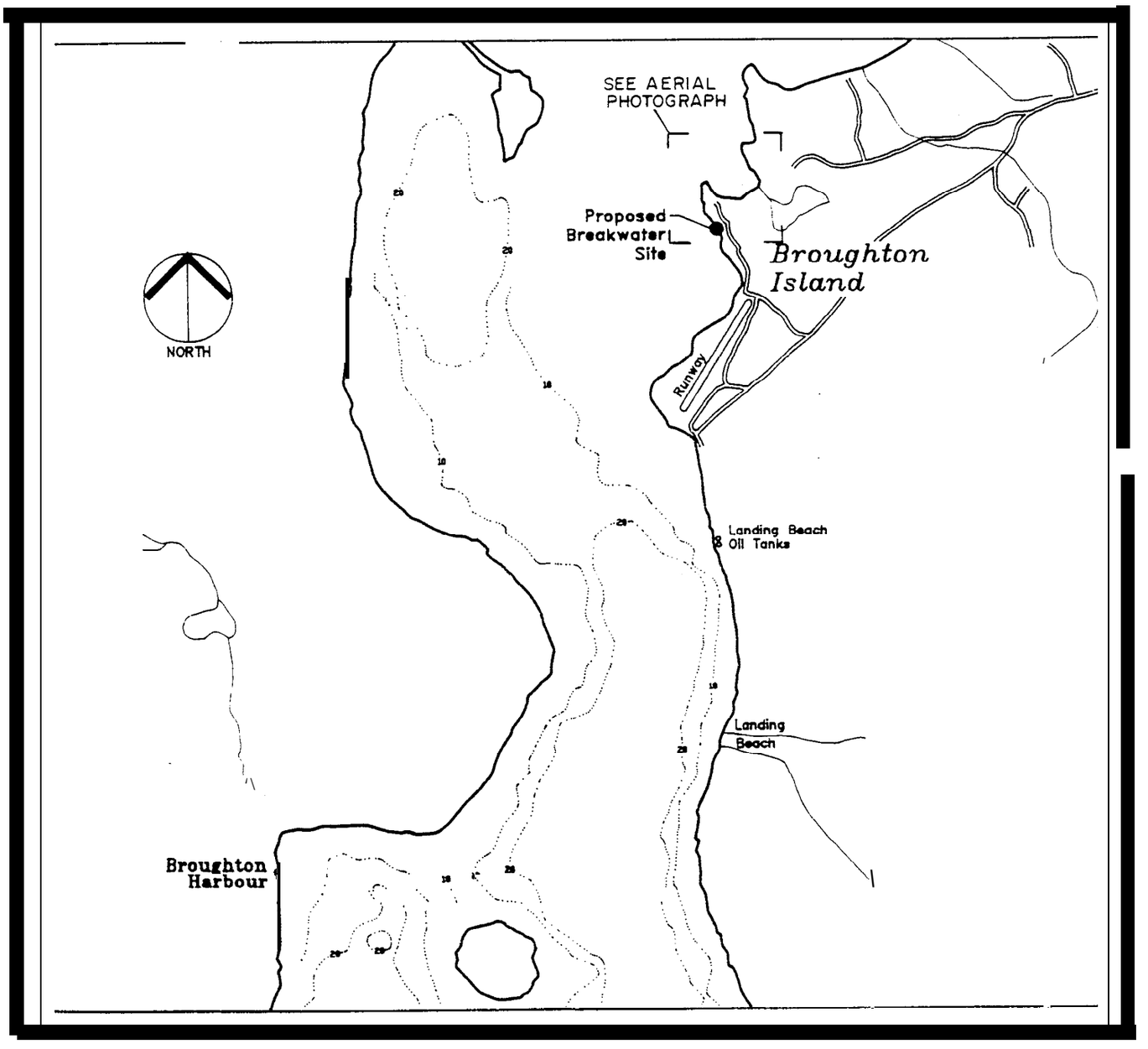
Sealift Petroleum

Without detailed survey or geotechnical information, the following is a very approximate estimate of providing a mooring facility for fuel delivery.

■ 0	mobilization	$500,000
■	breakwater construction to deep water	3,050,000
■	sheet pile cells and fill	1,400,000
■	access arrangements	200,000
❑	engineering and survey	500,000
■	contingency	100,000
		$6,350,000

Our facility development recommendations directed towards local boating activity for Arctic Bay are reasonable, effective and appear to be at an affordable level. On the other hand, although mooring facility/fixed link development for tanker unloading is possible, it would be extremely costly and the investment required would far outweigh any direct economic benefits experienced.

MARINE FACILITIES ASSESSMENT



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Soundings in Fathoms

BROUGHTON ISLAND

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BROUGHTON ISLAND
MARINE FACILITIES ASSESSMENT

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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Hamlet of Broughton Island

The Hamlet of Broughton Island is home to some 450 people. It is located just off the northeastern coast of Baffin Island, on Cumberland Peninsula, some 483 kilometres north of Iqaluit by air and nearly 2400 kilometres northeast of Yellowknife.

Broughton Island's settlement was first established during 1956 and 1957 as Inuit families moved there to help build the DEW Line Station. During the late 1950's and early 1960's, the Federal Government opened an administrative office in the community, The Bay opened a store and DIAND moved the people from Padloping Island to the hamlet.

Broughton Island's residents rely primarily on traditional hunting and fishing for their livelihood.

Waterfront Utilization and Demand

Because of their reliance on hunting and fishing, the residents of Broughton Island rely heavily on the waterfront to move their boats, supplies and harvest. A small breakwater has been developed to provide some protection to local boats in poor weather. But the hamlet has indicated that further improvements are required to facilitate waterfront activities during the open water season (... normally August to October).

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled up to develop a number of conclusions on waterfront utilization and demand in Broughton Island. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Broughton Island during the open water season. Dry cargo shipments fluctuate widely in response to development project demands while bulk petroleum product shipments shown less variation. A summary of sealift shipments to Broughton Island between 1984 and 1989 is provided in the following table.

SEALIFT SHIPMENTS TO BROUGHTON ISLAND
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
■ Dry Cargo	239	417	390	677	503	663
■ Petroleum Products (Bulk)	1,887	1,719	1,495	1,843	2,574	1,792

There appears to be a gradual increase in dry cargo shipments to the community, likely in response to gradual population growth. A similar, small upward trend has occurred with bulk petroleum product shipments. We expect these trends to continue.

Sealift shipment levels can be expected, generally, to increase with the population and economic base of the community. While population growth has stabilized (i.e. a 5.7% per annum increase between **1966** and 1976 vs a 2.3°A per annum increase between 1976 and 1986), continued expansion is projected by the GNWT Bureau of Statistics. These forecasts show a 3% per annum growth rate between 1989 and 2000.

Sealift shipment levels to Broughton Island are projected in the following table over the 1989 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO BROUGHTON ISLAND
1990 - 2000
(Metric Tonnes)

	1989[1]	1990	1991	1992	1993	1994
o Dry Cargo	682	702	723	745	767	790
0 Petroleum Products (Bulk)	2,353	2,424	2,496	2,571	2,648	2,728

	1995	1996	1997	1998	1999	2000
o Ory Cargo	814	838	863	889	916	943
0 Petroleum Products (Bulk)	2,810	2,894	2,981	3,070	3,162	3,257

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

These forecasts reflect the upward trend expected in sealift shipments to Broughton Island. Annual variations will occur to these levels as a result of higher or lower demand for construction related supplies such as building material.

Local Boating Activity

The community relies heavily on local boat utilization for subsistence hunting and fishing. There are some 30 to 40 canoes, one longliner and five Lake Winnipeg boats based in the hamlet.

The importance of local boating activity is expected to continue, although major activity increases are not expected over the foreseeable future. Current problems faced by the community include the extent to which the existing breakwater does not protect local boats, the difficulty or impossibility of beaching canoes when ice washes into the boat harbour and the need to drag the boats onto the beach every night causing equipment damage. Eventually, a float in the boat basin would make fish and meat unloading much easier for local fishermen and hunters.

Commercial Fishing Activity

Only a limited amount of commercial fishing takes place in Broughton Island at the present time. In 1989, the community began to take steps to expand the Arctic Char fishery with a view to marketing frozen filets (... there is a fish processing room and a freezer in the community). Currently, about 10,000 pounds of Char is exported to Iqaluit annually via the Hunters and Trappers Association, some of this in fillet form. Local representatives suggest that commercial halibut and cod fisheries are eventually likely and exploratory shrimp fishing was carried out in 1989. Although Turbot has not yet been found, local people are confident that it too represents an opportunity.

Given the interest in commercial fishing and fish processing in Broughton Island and given the available skills and facilities, we expect that some commercial fishing expansion will occur over the next several years. Air transport costs to ship the product out are one of the biggest constraints. However, increasing activity in this area can be expected to increase the demand for improved marine facilities.

Marine Tourism Activity

The tourism industry in Broughton Island is limited. One reason for this is that the ice/freeze-up period lasts late into the traditional Arctic tourism season (e.g. in 1989 the community experienced land-fast ice though August... although usually the open water season starts in early August).

Broughton Island is a “stepping-off” point for tourists who are hiking to Pangnirtung. Four registered guides are resident in the community and some guiding activity occurs... although it is limited.

The community feels that there is potential to develop the tourist industry. We basically concur with this view, although we have not evaluated the industry’s potential in detail. The co-op operates a hotel in town now and a new hotel on the waterfront is being developed.

We feel that Broughton Island can, and will in time, capitalize more on tourism potential. This will impact on waterfront activity and the boats required to provide guided tours. Although ice will always restrict the tourist season and, therefore, its value, trained guides could promote and expand visitor tours to northern park areas which are inaccessible from Pangnirtung, the historical whaling station and area archaeologic! sites. Marine taxi service to other, more ice-free, locations could also be provided. Local women have proven skills in making prints and wall hangings, although local crafts are now limited primarily to kamiks

and slippers. The crafts industry could expand if more visitors are attracted to the community, and could become more productive off-season by marketing crafts to the South.

In summary, marine tourism and facility demand will grow as **more tourists are attracted to Broughton Island** over its short open water season. We expect this to occur over the medium term... but also that it will increase boating activity only marginally. Improved marine facilities catering to local boaters, however, will also serve as an encouragement to tourism industry expansion

Waterfront Utilization and Demand Summary

In **summary, the most important marine facility demand in Broughton Island is improved protection of local boating activity and equipment. Opportunities are evident in the commercial fishing industry and, to a** more limited extent, in the tourism industry. As both are capitalized on, marine facility demand and utilization will increase. Sealift operations function relatively well, but improved breakwater protection would provide benefits **in terms of reliability and unloading capabilities.**

Site and Harbour Profile

Relevant characteristics of Broughton Island Harbcur and the extent to which marine facility development has taken place to date is summarized below.

▪	Tides	Mean Tides	1.OM
		Large Tides	1 **.6M**
		Mean Water Level	0.8M
m	Tidal Zone	Between high and low water the beach grade is approximately 5%.	
▪	Soil Condition	The surface consists of shingle, sand and boulders. It is generally firm and flat with a small embankment above HWL.	
▪	Site Topography	Located in a fiord with high mountains and ice caps situated to the west. Strong Katabatic winds come down the inlet from the uplands.	

- Ice — First year, second year and older ice is probable. Several growlers were seen in the immediate area. Evidence of ice damage can be seen on both sides of the existing pushout. Occasional ice rafting occurs up to 4-metres. Fast ice would run out from shore to approximately LWL

The open water period runs from August to around the third week in September.

- Exposure — Broughton Channel is open to storms to the north. NW gales would have refracted into the channel. Heavy summer winds from the head of the inlet produce damaging waves to boats, possibly up to 4-metres high.

- Littoral Drift — No evidence of littoral drift around could be seen the pushout. Some drift may occur along the shoreline near the sealift.

A small boat pushout is located at the centre of the settlement with the sealift area further up the channel. The pushout has rip-rap on both sides, some of which is blasted rock. Damage to this structure has occurred due to ice and wave action.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The main issue at Broughton Island is the provision of a protected area for small boats. Floats are probably not justified at this settlement since the tide range is small.

We recommend that marine facility development incorporate the following minimum requirements:

- Extension and improvement to the existing pushout to provide a breakwater.

- Provision of a vertical landing face within the breakwater using rubble filled timber cribs.

Further protection to small boats could be provided by a future rubble mound breakwater on the opposite side to the existing one. This could be done as a later stage of development depending on the performance of the first stage facility.

Sealift Dry Cargo

The Dew Line beach close to the oil tanks is an excellent sandy beach which can be worked at all stages of the tide and is not affected by wind or swell. Occasionally this beach is blocked by ice which has drifted south. One problem with the sealift at this location is the necessity to maintain the gravel road from the Dew Line to the community, which can be washed out by wave and ice action. A program of rip-rapping should be undertaken hereto protect the exposed road shoulder.

Generally, it is felt that the sealift operation is working well and marine facility development dedicated to the sealift is not considered to be a high priority in Broughton Island.

Sealift Petroleum

Deliveries to the settlement are currently made direct from tankers through a 10 cm floating hose. Tankers moor 0.2 miles off the beach with stern lines to the shore. Oil is then transferred from the beach tanks to the site tanks by tanker truck.

A mooring facility for oil delivery would necessitate a major structure, which could take the form of a sheet pile wall type structure or a rubble mound breakwater out to sheet pile cells. This type of construction would warrant mobilization of an outside contractor with specialized equipment.

Marine Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Broughton Island. They are summarized in sketch form in Figure B1.1.

Development Cost Estimates

Preliminary cost estimates, in 1990 dollars, have been prepared which reflect the development recommendation described above. We made several assumptions when preparing these cost estimates as follows.

- seabed elevations have been assumed from estimated grades; and
- it is assumed that a minimum level of construction equipment is available at the community.

Cost estimates are summarized below according to the principal user of facility development recommendations.

Local Facility

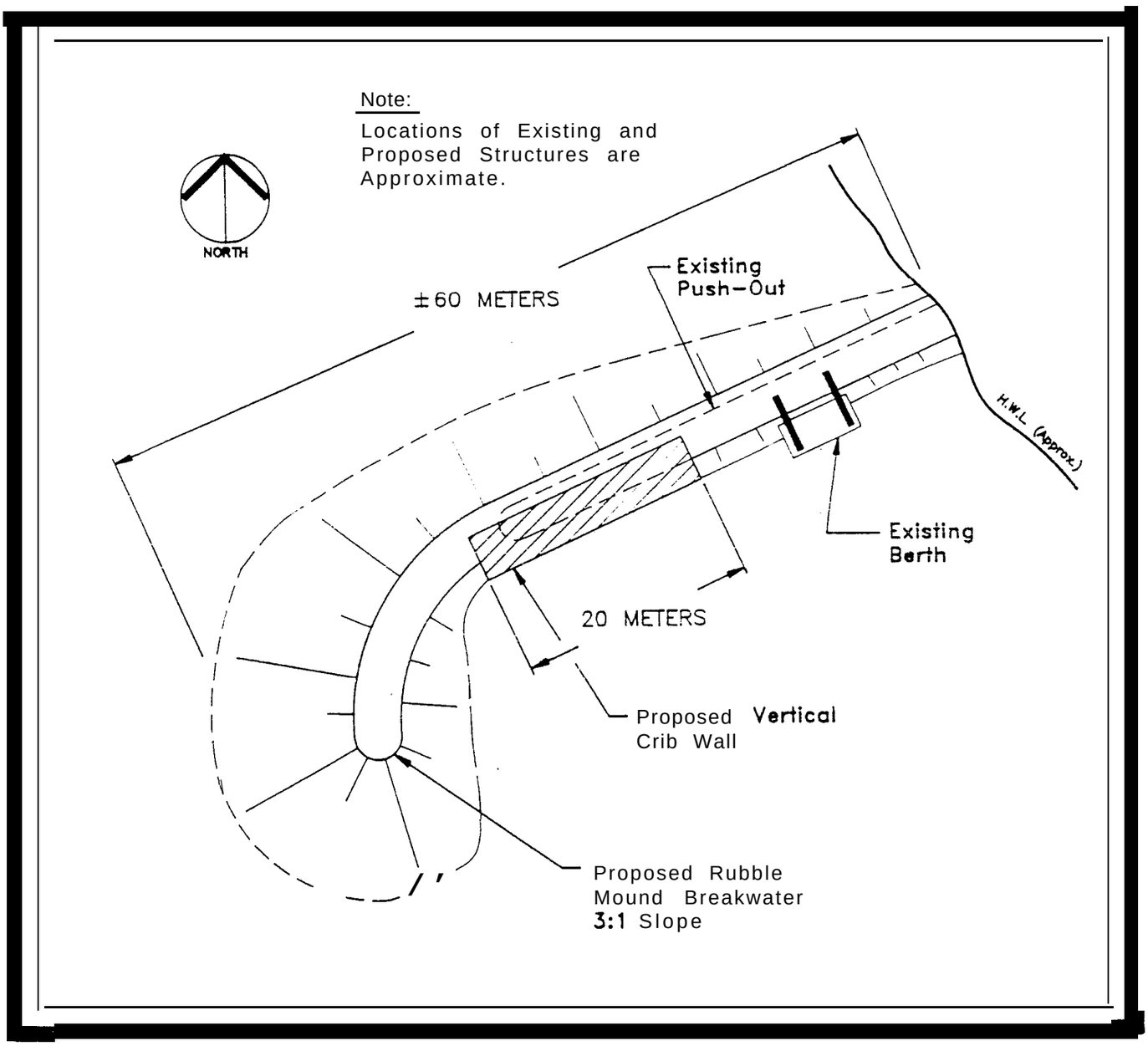
excavation of channel and basin	$30,000
construction of breakwater on east side	120,000
construction of crib wall and ramp	26,000
engineering and survey	18,000
contingency	36,000
	$ 230,000

Sealift Dry Cargo

No cost **estimate** has been prepared since the current arrangement appears to be satisfactory, however the exposed shoulder of the road to the unloading beach should be rip-rapped at an estimated cost of $75,000.

Sealift Petroleum

The cost of a deep water facility for mooring tankers is estimated at $3.9 million.



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BROUGHTON ISLAND CONCEPTUAL PLAN

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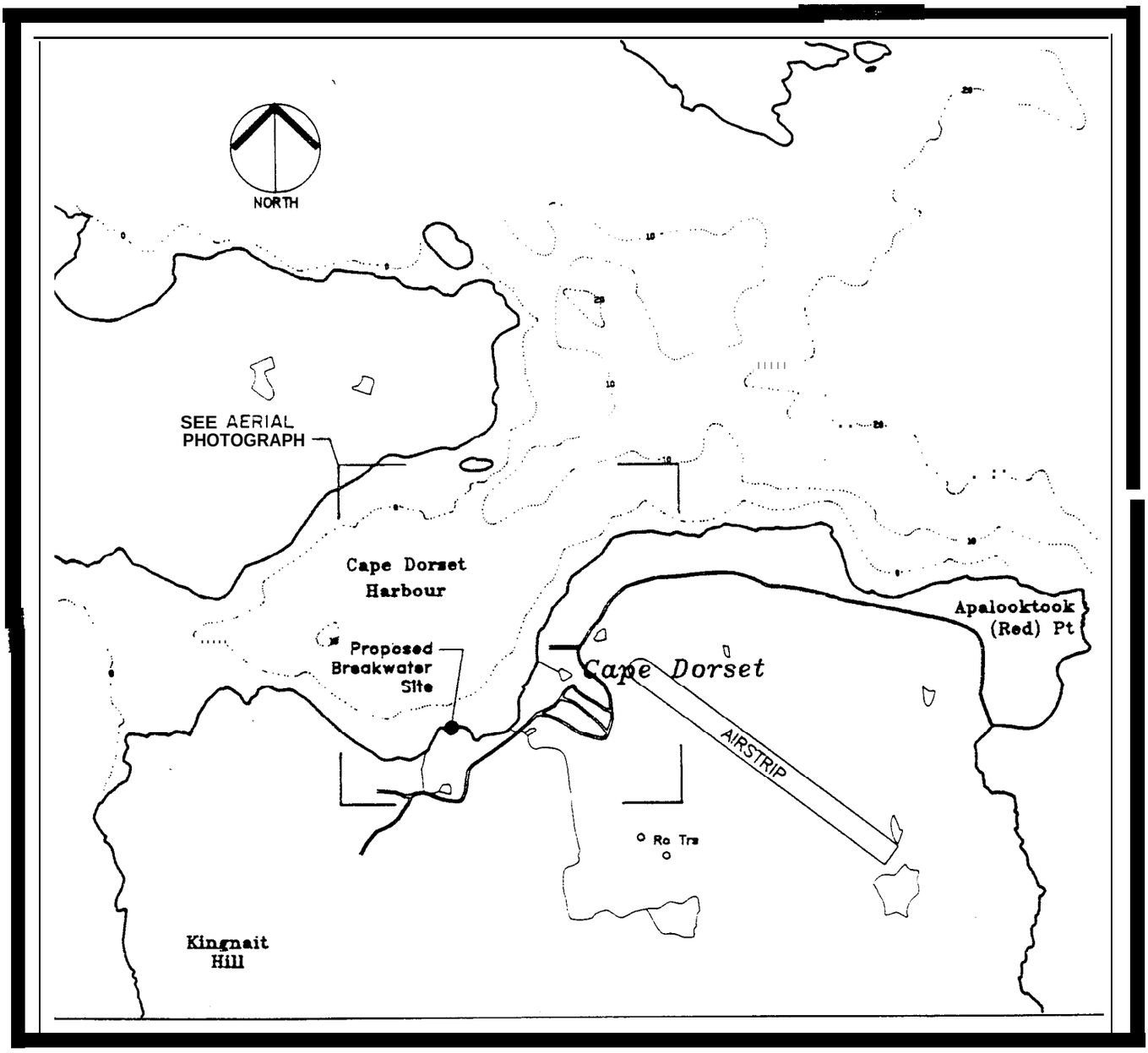
MARINE FACILITIES ASSESSMENT



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Soundings in Fathoms

CAPE DORSET HARBOUR

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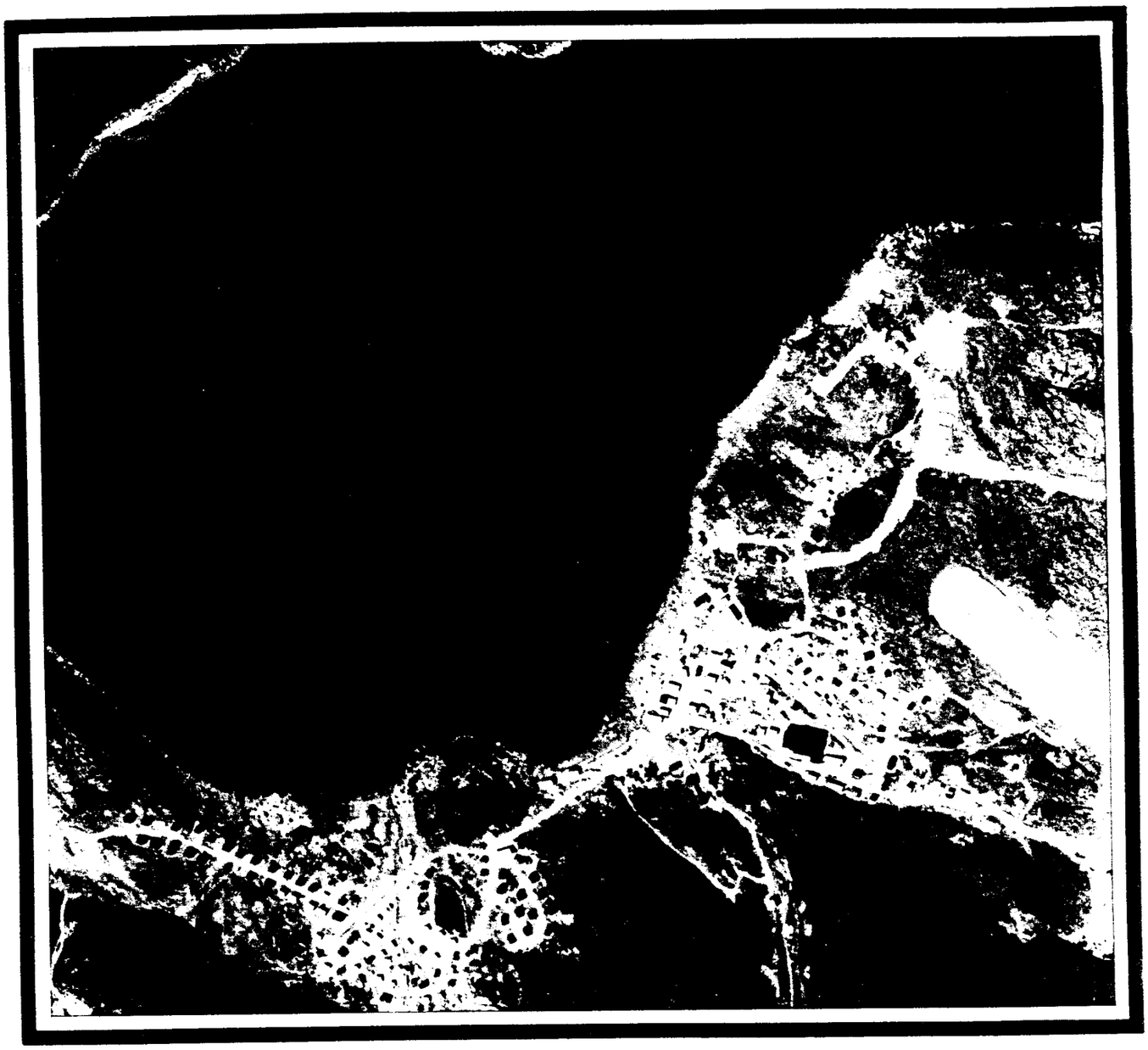

CAPE DORSET HARBOUR

CAPE DORSET HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Cape Dorset Overview

Cape Dorset is situated on the south coast of Foxe Peninsula which divides Foxe Basin from Hudson Strait on the southwestern corner of Baffin Island. With about 970 residents, the community is 401 kilometres by air west of Iqaluit and 1,891 kilometres by air northeast of Yellowknife.

It was at Cape Dorset that the remains of an ancient Inuit people, who flourished between 100 BC and 100 AD, were first found. While the Hudson's Bay Company established a trading post at Cape Dorset in 1913, Inuit only began to expand the settlement in the late 1940's and early 1950's as the market for white fox collapsed and the people moved from the land to the community. During the 1950's, carving and handicraft production expanded. The West Baffin Eskimo Co-Operative was formed in 1959.

Since the early 1960's Cape Dorset's economy has evolved on the basis of carving and graphic art. Local craftspeople have become widely known for their skills an the industry now represents the economic mainstay of the community. Sealing activity continues to be a popular traditional pursuit of local residents.

Waterfront Utilization and Demand

Although access to the sea has traditionally been important, to the people of Cape Dorset, the community's economic base has evolved in a manner which is less reliant on traditional pursuits. The sealift, however, continues to be an important activity and tourism opportunities which impact on the waterfront are being capitalized on.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Cape Dorset. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Cape Dorset during the open water season (...miJulyly to mid-November). An upward trend in sealift shipments has been established in response to a continually expanding population base in the community. The following table summarizes sealift shipments levels over the period from 1984 and 1989.

SEALIFT SHIPMENTS TO CAPE DORSET

1984-1989

(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
■ Dry Cargo	909	603	722	1,145	736	1,379
■ Petroleum Products (Bulk)	2,712	2,335	2,269	2,411	2,281	3,044

The shipment levels shown above show considerable variation which, for dry cargo, result from peaks generated' by construction projects. Bulk petroleum shipment variations result from different arrival dates by sealift tankers each year which result in higher or lower requirements each year. We expect that petroleum product consumption is increasing proportionally with population growth.

Future sealift shipment levels are projected on the basis of population growth expectations. Cape Dorset's growth has slowed but continues at a steady pace (e.g. 6.6% annually from 1966 to 1976 vs 2.6% annually from 1976 to 1986). The GNWT Bureau of Statistics projects continued population growth in the community at an average annual rate of 2.5% between 1989 and 1990. We have used this growth forecast to estimate future sealift shipment levels, which are summarized in the following table.

SEALIFT SHIPMENT FORECASTS TO CAPE DORSET
1990 - 2000
(Metric Tonnes)

	1989[1]	1990	1991	1992	1993	1994
■ Dry Cargo	881	903	926	949	972	997
■ Petroleum Products (Bulk)	2,174	2,228	2,284	2,341	2,400	2,460

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	1,022	1,047	1,0%3	1,100	1,128	1,156
■ Petroleum Products (Bulk)	2,521	2,584	2,649	2,715	2,783	2,852

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

Actual dry cargo shipments by sealift can be expected to vary upwards or downwards from the above estimates depending on the level of local construction activity in any given year.

Local Boating Activity

Cape Dorset residents rely less on traditional pursuits which require local boat use than many other communities in the Eastern Arctic. **Nevertheless, boating activity is important to some families for hunting, especially marine mammals during the open water season.**

There are some 25 canoe and Lake Winnipeg boats and 3 long liner, Peterhead style. The larger boats are used to transport carving **rock and supply the outpost camp and** for longer hunting trips. The harbour is partially sheltered but during the Summer months winds from the west are frequent and cause problems to the users.

Commercial Fishing Activity

There is some commercial fishing in the community with 7 licences issued during 1 987/1 988 and 22 special sealing licences (the largest number in any Eastern Arctic community. More than 90 Beluga Whale were harvested.

it is understood that a fishery potential assessment study is underway for this area.

Marine Tourism Activity

The community is widely recognized for the expertise of its carvers. There are a number of specific attractions for tourists in the general area and tourism is regarded as extremely important. It is currently the 4th most popular destination after Iqaluit, Pangnirtung and Pond Inlet (reference Baffin Visitors Survey - 1988). There were two cruise ship (170 passenger) calls in 1989. It is reported that 30 people are employed part-time in the tourism industry.

Day trips are now made by boat to the Thule and Dorset ruin sites, to the Dewey Soper Bird Sanctuary and to the wreck of the supply ship Nascopie for diving.

This traffic is expected to grow and will be assisted by the development of harbour facilities. The value of package tourists to this community in 1987 was $99,000 (reference Baffin Package Tour Analysis - 1988).

Float Plane Activity

The community would like to be able to handle float plane traffic safely to encourage tourism, however, without a moorage facility this is difficult.

Waterfront Utilization and Demand Summary

In **summary, the seasonal use of the Cape Dorset waterfront is** of high importance to all segments of the community. The traditional pursuits are actively engaged in now and with the anticipated expansion of an already thriving tourism industry there will be significant benefits from the provision of marine facilities.

Site and Harbour Profile

Relevant characteristics of Cape Dorset and the extent to which marine facility development has taken place to date is summarized below.

- Tides

Mean Tides	5.2M
Large Tides	8.3M
Mean Water Level	3.6M

- Tidal Zone — Approximate 5% grade.

- Soil Conditions — The beach surface is shingle, sand and boulders, generally firm. There is flat ground within the settlement, generally the upland is rocky and hilly.

- Site **Topography** — The settlement is located on an island within a small bay ending in a fiord-like inlet. The beach looks secure, but very strong winds sweep down from the mountains. This area along the north shore of Hudson Strait is subjected to very high tides.

- Ice — First year and second year is anticipated, none is observed at the time of inspection.

  No ice damage reported although some ice pans ccme into the area after break-up. The"fast ice would extend from shore to roughly the 4-metres contour above LWL.

  Open water period runs from the first week in July to the end of September.

- Exposure — The worst winds and waves come from the mountains from the N.W. The winds from the south (Hudson Strait) are not as severe and would have to refract over 120 degrees to impact on the beaching area.

- Littoral Drift — This is not believed to be a factor at this site.

No structures were visible in the area except for buoys placed in the anchorage area.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The main factor affecting the choice of a local marine facility at Cape Dorset is the relatively high tide range in the order of 8.3 metres maximum.

A breakwater needs to be constructed at this site, combined with a vertical dock face which could be constructed utilizing timber cribs. It would also be necessary to incorporate some form of ramp so that access and boat haul-out can be achieved at as much of the tide range as possible. It is not considered practical to provide a ramp which would afford access at all tide levels as this would impact significantly on the cost.

We recommend that marine facility development at Cape Dorset incorporate the following minimum requirements:

- Construction of a rubble mound breakwater to provide approximately 2 metres of water at low tide.
- Construction of a timber crib wall together with stepped crib to act as a ramp and provide boat access to 2 metres above low water level.

Sealift Dry Cargo

It is considered that the current arrangements for the sealift are satisfactory at this community. Improvements to the sealift would be achieved with the ramp provided above, however beach clearing to assist sealift barge operations should be undertaken as a separate item.

Sealift Petroleum

In view of the high tidal range in the order of 8.3 metres maximum, it would be difficult to justify the expense of a marine facility for unloading tankers. The construction of such a facility would involve major marine construction to accommodate this tide range.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Cape Dorset. They are summarized in sketch form in Figure CD. I.

Development Cost Estimates

Local Facility

■	Excavation & Preparation	$90,000
■	Breakwater Construction	1,150,000
■	Timber Cribs & Ramp	310,000
■	Engineering & Surveys	150,000
■	Contingency	300,000
		$2,000,000

Sealift Dry Cargo

A program of beach boulder removal with the subsequent cleared channel marked with temporary buoys would assist the unloading of sealift cargo. This would cost $25,000.

Sealift Petroleum

The cost of providing a deep water facility for mooring tankers is estimated at $6.7 million, however, due to the large tidal range further investigation is needed into the feasibility of any structure.

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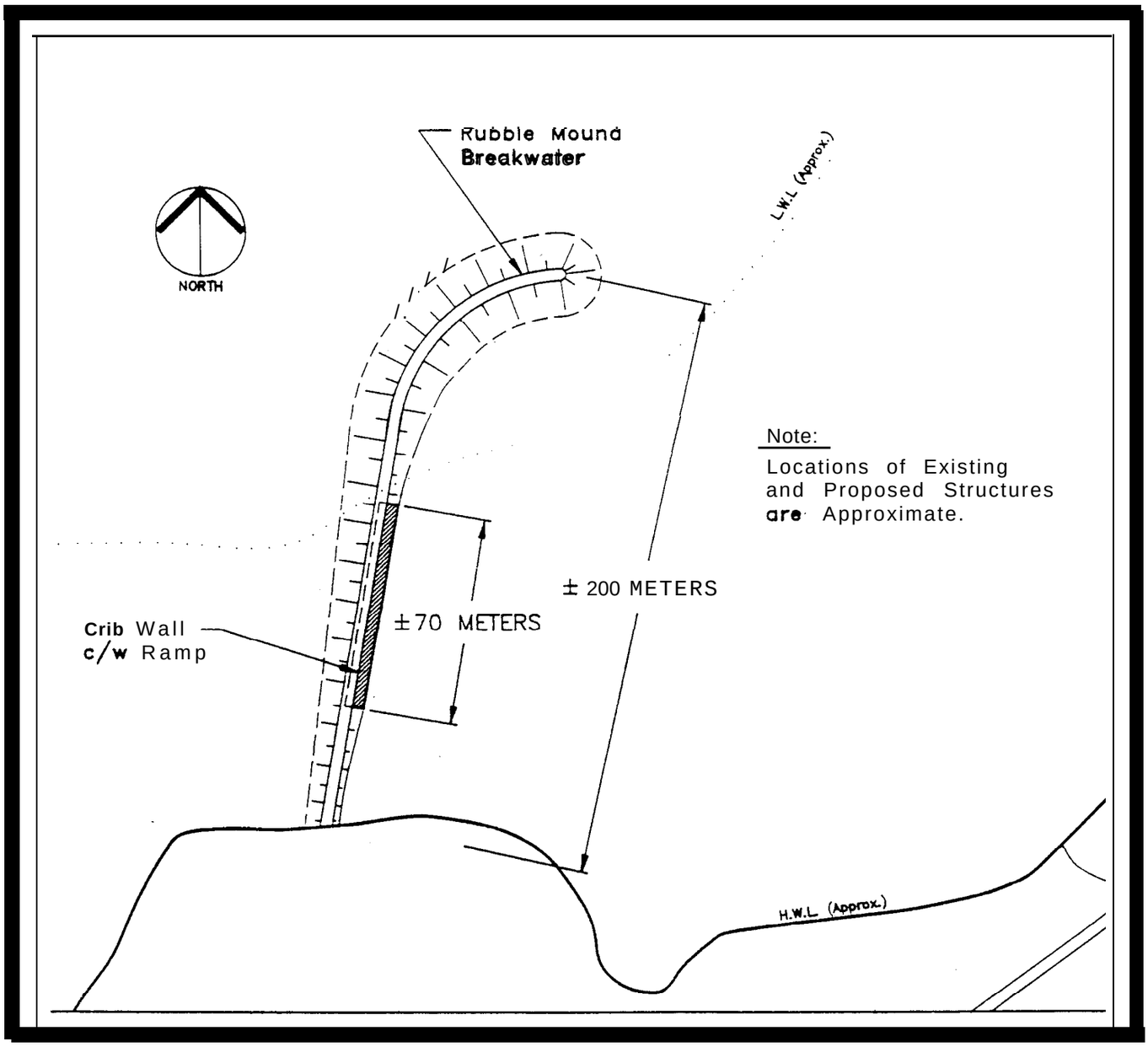

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CAPE DORSET
CONCEPTUAL PLAN

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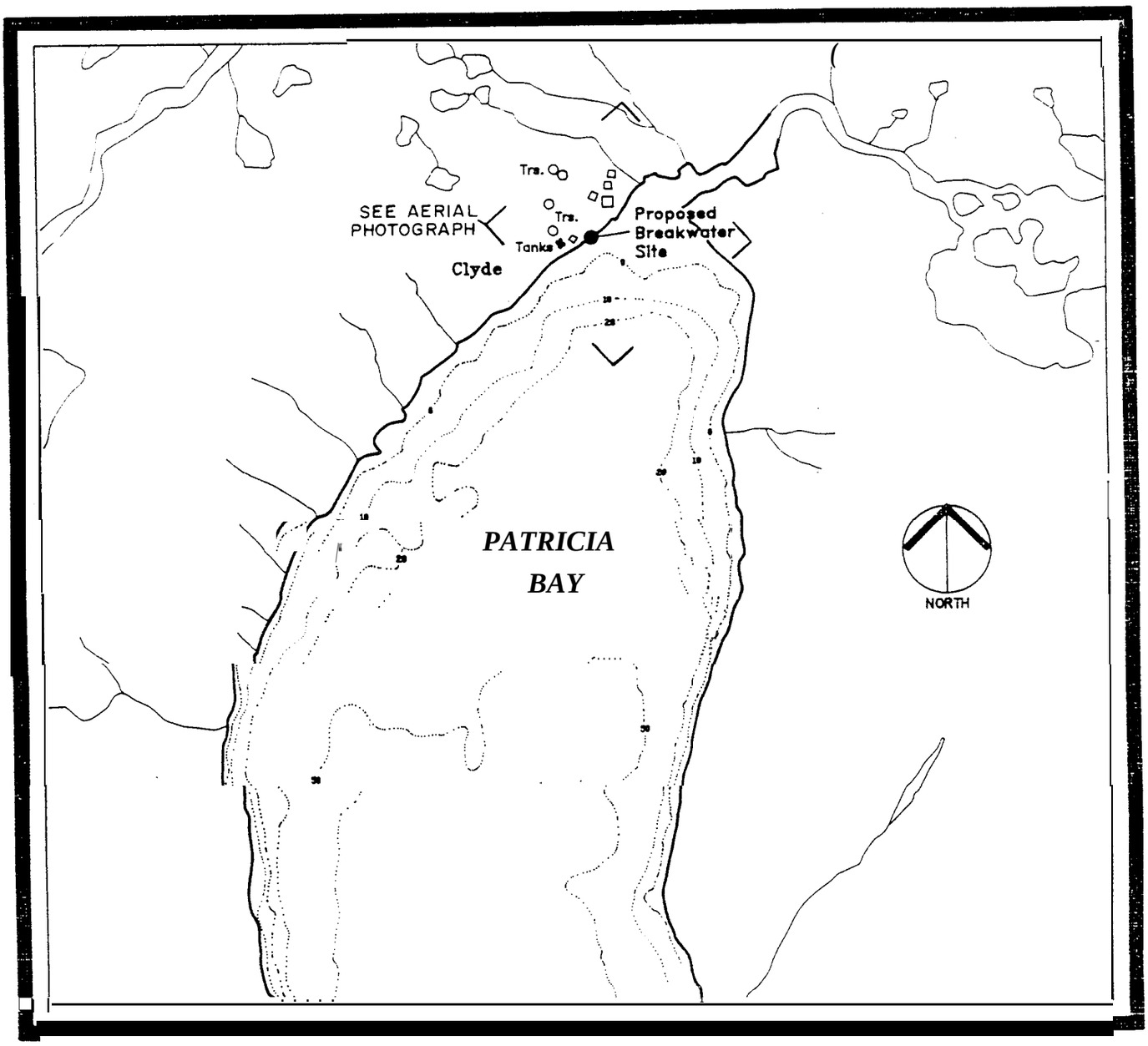
MARINE FACILITIES ASSESSMENT



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Soundings in Fathoms

CLYDE RIVER HARBOUR

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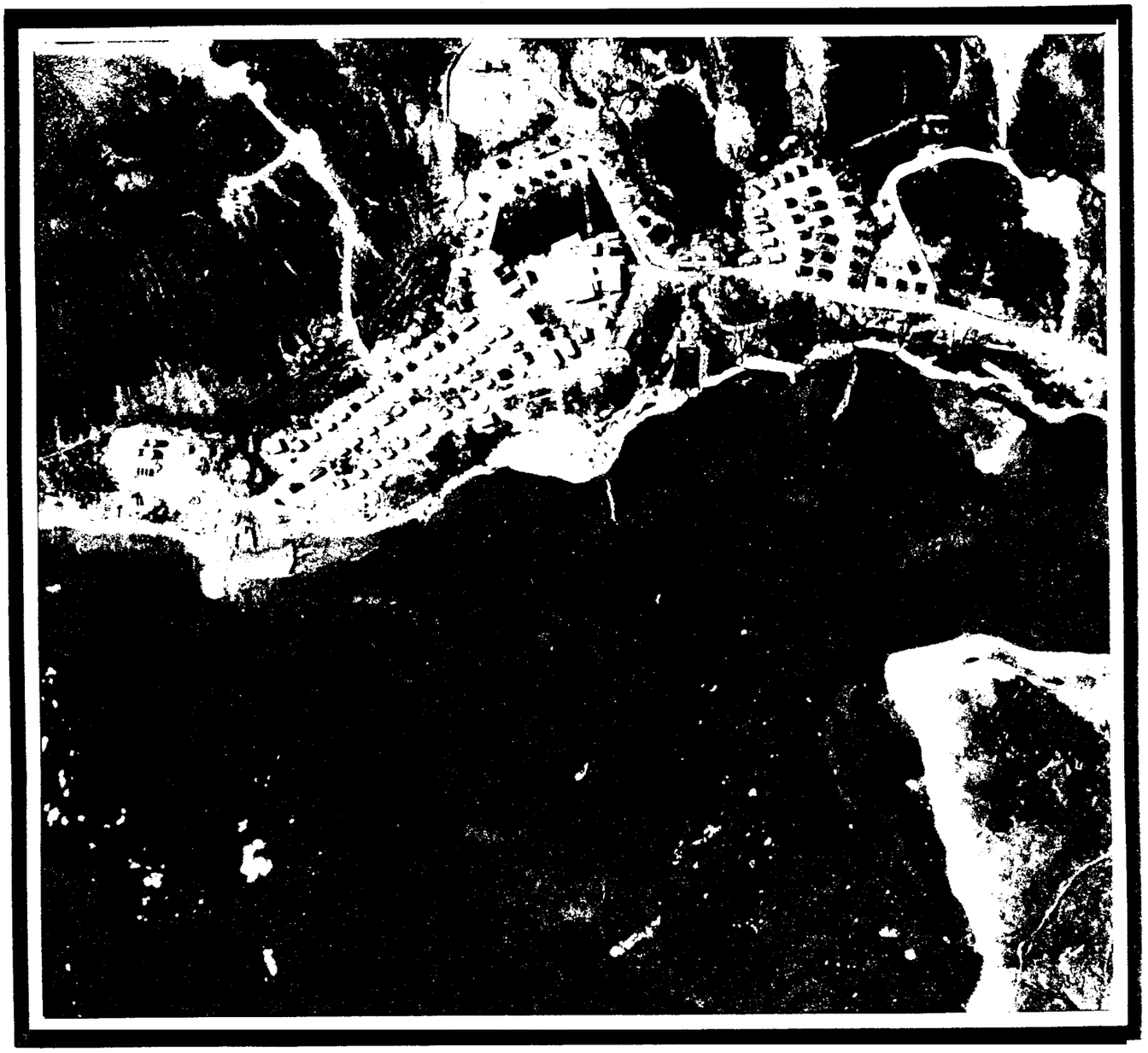
MARINE FACILITIES ASSESSMENT



CLYDE RIVER HARBOUR

CLYDE RIVER HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Hamlet of Clyde River Overview

Clyde River is located about half way along the northeast coast of Baffin Island some 740 kilometres by air directly north of Iqaluit. With a population of about 475 full-time residents, the hamlet is characterized primarily by traditional hunting and trapping activities and its peopie still iive off the iand for a large part of the year. Revenue from the sealing industry has dropped drastically in recent years and the community has sought other ways to generate income. Over the past few years some success has been achieved in establishing some limited tourism and commercial fishing activities. A siik screening project empioyed up to 14 people for several years but encountered problems and closed down. Local residents are anxious to find new ways of generating employment in the coming years.

Waterfront Utilization and Demand

As with most Eastern Arctic communities, Clyde River has traditionally relied on access to the sea for its livelihood and weil being. Unlike some hamlets in the region, this reliance continues to dominate the socioeconomic base locally, especially since the decline in sealing. Ongoing and expanded use of waterfront facilities is expected in the future.

Our visit to the hamiet, combined with our discussions locally and our research of marine demands, has enabied us to develop a number of conclusions on waterfront utilization and demand in Clyde River. These findings and conclusions are summarized in the foliowing paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Clyde River three times annually. Actual inbound shipments via the sealift to the hamlet are summarized in the following table for the last six years.

SEALIFT SHIPMENTS TO CLYDE RIVER
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	334	391	318	259	348	451
Petroleum Products (Bulk)	1,885	1,270	1,748	1,642	1,631	2,206

The sealift statistics show little in the way of trends in Clyde River...and, if anything, the trend is slightly downwards except in 1989. This reflects the very slow population base growth in recent years. Indeed, the GNWT Bureau of Statistics estimates that Clyde River's population decreased slightly in 1987. This slowing in growth has been dramatic in relation to the community's considerable expansion at an average rate of 151A% annually between 1961 and 1976.

With recent efforts to establish tourism and commercial fishing activities, we expect that government involvement will help hamlet initiatives to **become successful.** This, in turn, can lead to sustained growth which, in the medium-term, is expected to be steady but not dramatic.

The GNWT Bureau of Statistics projects a population base growth in Clyde River averaging 2.5% annually over the 10-year period ending in **1996.** We have projected sealift shipment increases at this rate from 1989 to 1994 and expanded the growth thereafter to 5% **annually reflecting** some success in economic ventures and some resulting in-migration.

Dry cargo volumes arriving in Clyde River will fluctuate around these projections in response to future development projects. Our sealift shipment levels to Clyde River are projected in the following table over the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO CLYDE RIVER

1990 - 2000

(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
■ Dry Cargo	357	366	375	384	394	404
■ Petroleum Products (Bulk)	1,672	1,714	1,756	1,800	1,845	1,891

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	424	445	467	491	515	541
■ Petroleum Products (Bulk)	1,986	2,085	2,190	2,299	2,414	2,535

(1) **Projections after 1989 use the population forecast rate applied to the base year (1988).**

Local Boating Activity

Residents of Clyde River make frequent use of the waterfront during the open water season which usually runs from mid-July to mid-November. Because of their dependence on hunting, unhampered activities along the shoreline would be especially advantageous in the community. Local boats include 15 canoes, 1 8-metre boat and a 15-metre scallop dragger... all of which are **used primarily for hunting.**

We do not anticipate major increases in local boating activity (...except for some commercial fishery expansion which is discussed later). We do expect, however, that the importance of local boat use will continue to be critical to the very livelihood of Clyde River residents. Some increases in activity from tourism industry growth are expected.

The Hamlet of Clyde River indicated to us that improved protection from storm winds and waves is required for local boats. Waves of two to three metres reportedly come straight into the bay and push material from the existing breakwater into the basin behind the structure. Community representatives clearly indicated a need also for dredging and enlarging the small boat basin. Unloading operations are reportedly unsafe in bad weather.

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Commercial Fishing Activity

Local residents are confident that commercial **fishing activity** will evolve in Clyde River. To date only limited success has been achieved. It is reported, however, that the scallop fishery is being studied and that opportunities exist to harvest Atlantic Cod, Arctic Char, shrimp and halibut.

The scallop dragger, which draws 2-metres, may be employed in the fishery in the years ahead. Over the medium term it is possible that commercial fishing operations will increase boating activity in the harbour and result in larger boats being purchased. Generally, any action that facilitates the anchoring, mooring and/or unloading of the scallop dragger will be sufficient to accommodate any larger vessels that are used in the future.

Marine Tourism Activity

Clyde River has only recently become supportive of tourism industry development. The hamlet is taking steps to expand local tourism activity which will, because of its nature, impact on waterfront utilization and facility demand. The emphasis on tourism promotion will be directed towards marine oriented sightseeing tours to see birds, bowhead whales, bears and the like. The community has established a Tourism Committee to pursue this opportunity. Guiding, hunting and fishing charters are other attractions which can and will be promoted.

We expect that some noticeable expansion in the tourism industry will occur in Clyde River and that this will impact on the need for marine facilities. In fact, improved capability to board tourists from a wharf structure or float would add to the value of the visitor's experience and help the community to capitalize on tourism opportunities.

Waterfront Utilization and Demand Summary

In **summary, seasonal use** of the Clyde River waterfront is critical to the traditional activities of local residents. These traditional pursuits are more critical to the livelihood of residents than in many other Eastern Arctic communities. Nominal expansion in sealift throughput, local boating, tourism and commercial fishing activity is anticipated... all of which could benefit from some improvements to existing marine facilities.

Site and Harbour Profile

Relevant characteristics of Clyde River Harbour and the extent to which marine facility development has taken place to date is summarized below.

- **Tides**

Mean Tides	1.OM
Large Tides	1.4M
Mean Water Level	0.7M

- **Tidal Zone** The beach from high to low tide is very flat with an approximate 1 % grade.

- **Soil Conditions** The beach surface is shingle, sand and boulders. The beach is firm. Scattered boulders show up in the tidal zone and below LWL Above HWL the settlement is flat.

- **Site Topography** The settlement is located within a relatively long and narrow inlet. The entrance to the inlet has islands at the outer end. The settlement is exposed to heavy winds sweeping down from the mountains in the interior through the valley formed by the river.

- **Ice** First year ice with second year ice is a possibility. Continual damage is reported to the outer corner of the pushout, mainly due to wave action. Ice rating is not a problem.

  The winter fast ice would extend from shore to roughly .3 metres below the LWL contour. Open water is normally from the first week in July to the end of September.

- **Exposure** The harbour is exposed to wave action along a narrow inlet running north/south. Islands at the outer end would break up any pack ice. Waves from strong winds can wash over the pushout.

- **Littoral Drift** Littoral drift is not a significant factor at this site.

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A pushout type docking facility has been provided, with an old barge at the outer end. A rock boulder breakwater was also placed to the east of the pushout, although many of the boulders are now scattered around due to wave action, creating a shingle and sand bar behind it. The outer end of the pushout is being destroyed by overtopping and needs reinforcement.

Development Recommendations

Our recommendations for marine facility development in Clyde River are summarized below according to their category of principal utilization.

Local Community Use

in order to meet the needs of this community, the existing pushout should be extended out further and a vertical dock face incorporated within it. The vertical face could be provided by means of timber cribs filled with rubble or freedraining type material. Since the tidal range in Clyde River is only **1.4 meters at the most, it is not considered necessary to provide a ramp structure to facilitate boat haul-out.**

Other improvements should include excavation and improvement of the existing breakwater structure which is no longer very effective.

We recommend that marine facility development in Clyde River incorporate the following minimum requirements:

- Improvement of the existing pushout using rockfill.
- Provision of a vertical dock face in the improved pushout using timber cribs.
- Improvement of the existing breakwater using rockfill.
- Excavation of a “basin” area to allow for 2.5 metre draft.

Sealift Dry Cargo

Anchorage within Patricia Bay is very good and offers protection from all except southerly winds. The existing pushout enables the unloading of cargo at all stages of the tide, although it is only a few inches above high water level and cargo can only be unloaded at the end of the pushout. Improvement to the pushout and the provision of a **vertical dock face, as outlined, for local community use will also serve to** help unloading arrangements **for** the sealift.

It is recommended that some improvement be made to the unloading/marshalling area on the shore.

Sealift Petroleum

Currently, tankers moor stern to the beach, with stern lines out to shore anchors set back about 30 meters from the shoreline. Oil is pumped direct to the shore through 600 meters of floating hose.

A mooring facility for tankers would involve extension of the existing push-out to deep water to allow for sufficient draft with mooring provided by sheet pile cells. This type of facility would require major construction involving specialized equipment from an outside contractor.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Clyde River. They are summarized in sketch form in Figure CR.1.

Development Cost Estimates

Preliminary cost estimates, in' 199o dollars, have been prepared which reflect the development recommendations described above.

Detailed sounding information was not available for Clyde River. Seabed elevations and grades have been assumed in the preparation of the following cost estimates and these approximations, to the extent they vary from our assumptions, will impact on the actual cost of developing the facility.

No allowance has been made for the mobilization of construction equipment. It is understood that construction equipment in Clyde River is limited and an allowance for mobilization should be taken into consideration.

Local Facility

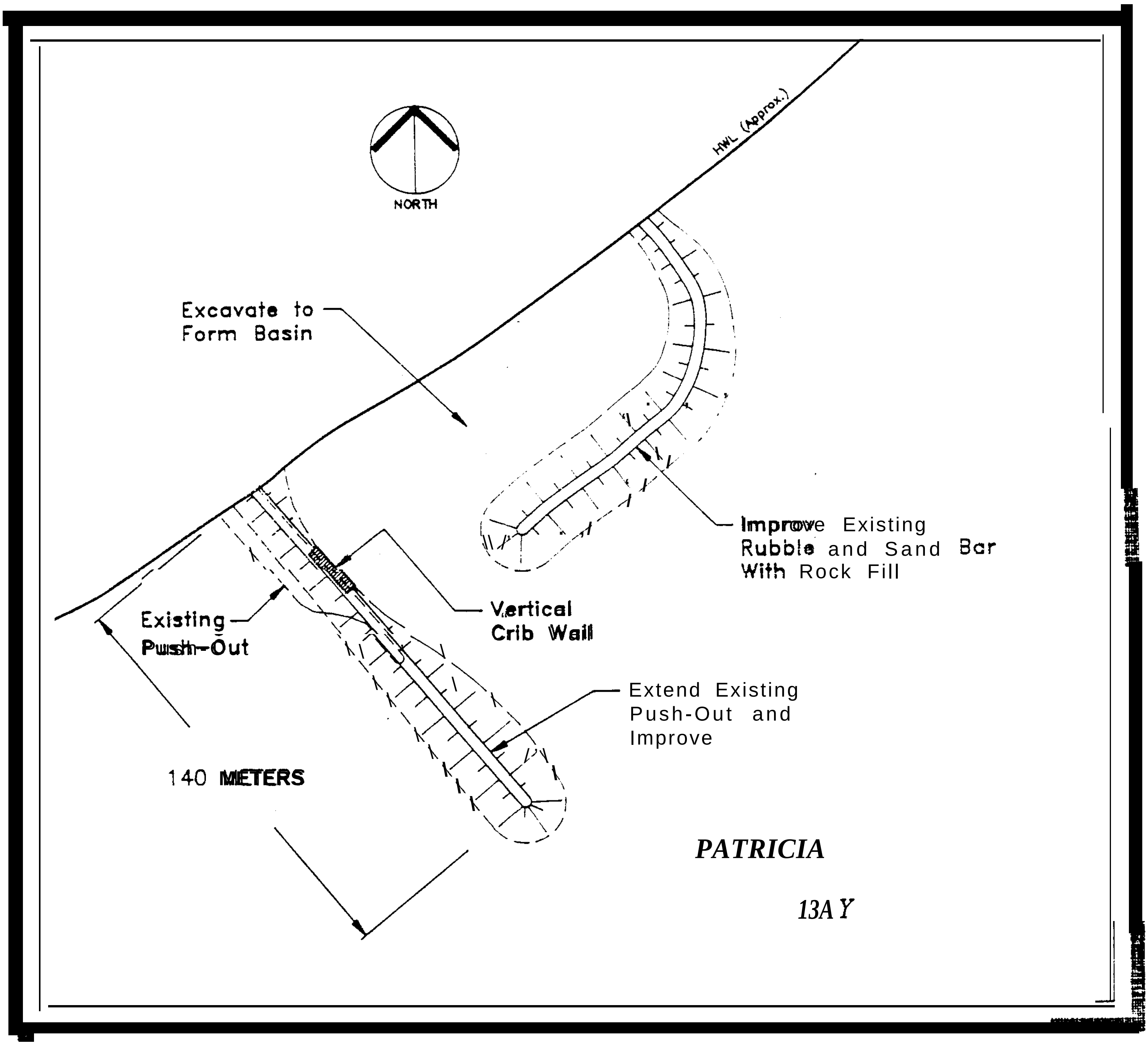
▪ Excavation & Disposal of Material	$210,000
▪ Rockfill for Pushout & Breakwater	360,000
▪ Timber Cribs for Wharf	30,000
▪ Engineering & Survey	60,000
▪ Contingency	120,000
	$780,000

Sealift Dry Cargo

Without detailed information showing the existing marshaling area, it is difficult to estimate cost of improvement. We have, therefore, estimated an allowance for marshaling area upgrading of $45,000.

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $8.5 million.



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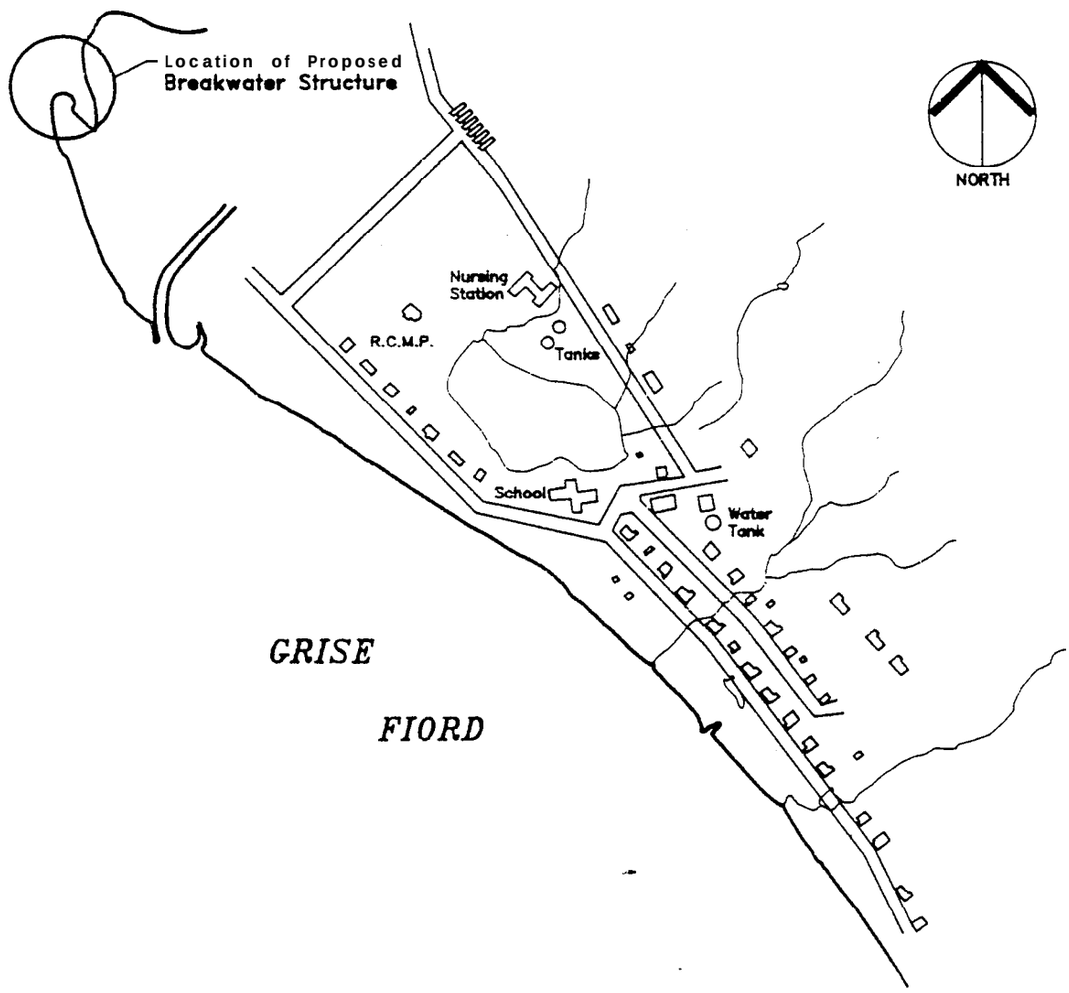
CLYDE RIVER CONCEPTUAL PLAN

MARINE FACILITIES ASSESSMENT



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GRISE FIORD HARBOUR

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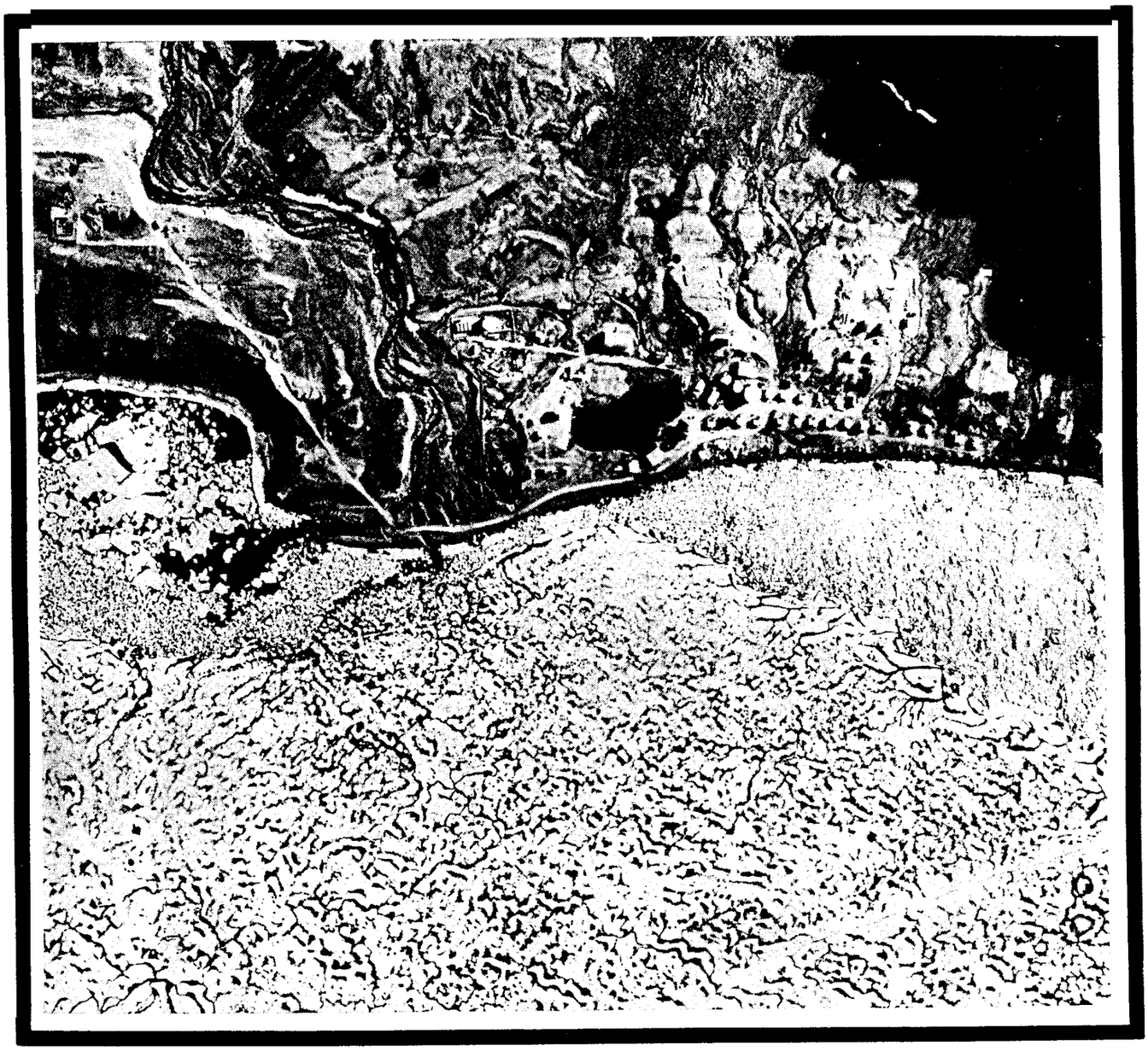
MARINE FACILITIES ASSESSMENT



GRISE FIORD HARBOUR

GRISE FIORD HARBOUR
MARINE FACILITIES ASSESSMENT

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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Grise Fiord Overview

The Hamlet of Grise Fiord is home to less than 100 people and located on the south coast of Ellesmere Island some 383 kilometres by air northeast of Resolute Bay and 1,931 kilometres northeast of Yellowknife. It is the most northerly organized community in Canada.

In an effort to alleviate poor economic conditions among the Inuit and to assist in establishing Canadian sovereignty over the Arctic Islands, the Federal Government moved families from Port Harrison, Quebec and Pond Inlet to Grise Fiord around 1953. This was supplemented with additional residents which moved to Grise Fiord when the RCMP post was relocated from Craig Harbour.

Residents of Grise Fiord rely on hunting extensively for their livelihood. The community is situated in a picturesque setting and a game-rich area. Some commercial sales of musk-ox and mukluk take place and tourism activity appears to be increasing slowly. A small community, Grise Fiord cannot accommodate large number of tourists but a cruise ship has called at the hamlet in recent years.

Waterfront Utilization and Demand

Grise Fiord residents rely heavily on boating to reach their hunting grounds during the open water season. The annual sealift is important to the community as it is elsewhere. Tourism activity is also increasing. All of these activities enhance the need for marine facility development, primarily to lower risks involved and enhance safety.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Grise Fiord. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Grise Fiord during the short open water season. Because of the small residential base, dry cargo shipments can vary dramatically from year to year as the result of construction projects. This is demonstrated in the following table as is the relatively steady level of bulk petroleum products shipments, except for an unusually high volume in 1989.

SEALIFT SHIPMENTS TO GRISE FIORD
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	163	459	414	131	493	382
Petroleum Products. (Bulk)	560	564	553	580	566	1,681

Over the last 20 years the population of Grise Fiord increased marginally (...from 98 people to 114 people between 1966 and 1986 according to the GNWT Bureau of Statistics). Estimates developed since 1986 show that the community has dropped in size to 76 full-time residents in 1988. The hamlet, however, claims it is home to some 100 people...so there is some discrepancy as to the current population base.

Population growth is projected for Grise Fiord over the 1989 to 2000 period by the GNWT Bureau of Statistics (...approximately 2.3% annually). We expect that sealift shipments will parallel this growth, but that dry cargo shipments will regularly generate increased volume fluctuations in response to development projects.

Sealift shipment levels to Grise Fiord are projected in the following table over the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO GRISE FIORD

1990 - 2000

(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
■ Dry Cargo	332	340	347	355	364	372
■ Petroleum Products (Bulk)	573	586	600	613	628	642

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	381	389	398	407	417	426
• Petroleum Products (Bulk)	657	672	687	703	719	736

(1) 1989 estimates are calculated as the average of 1984-1989 dry cargo shipments and based on a trend line analysis of 1984 - 1988 statistics for bulk petroleum shipments. Projections after 1989 use the population forecast rate applied to the base year (1989).

These nominal increases in sealift shipment levels will have no appreciable impact on?heneed for marine facilities in Grise Fiord although some minor operational improvements could facilitate unloading activity.

Local Boating Activity

The use of locally based boats in Grise Fiord is an essential part of the community's subsistence activity during the open water season. Most boats are canoes or Lake Winnipeg boats in the hamlet. The larger boats are preferred for longer distance hunting trips and tours for visitors.

While a larger boat or two may be purchased in Grise Fiord to take advantage of tourism potential, in part, no appreciable increase in waterfront utilization is anticipated, Nevertheless, local boat owners consistently indicated to us the importance of protecting existing equipment from storms and providing water access to the community for those returning under heavy wind and weather conditions. Local boats have been damaged in storms and sometimes hunters cannot get into the community when they return from hunting trips.

It is evident that safety and emergency response needs to be improved in Grise Fiord. Protection would also make boating operations easier for hamlet residents and encourage the purchase of larger boats.

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Facility development providing suitable protection would prove advantageous to future generations too and is strongly supported by the community.

Commercial Fishing Activity

There is essentially no commercial fishing activity in Grise Fiord. During 1987/1988 no commercial fishing licences and no exploration licences were issued in the community. Effectively therefore, commercial fishing does not, and is not expected to, place any significant demand on marine facilities in the foreseeable future.

Marine Tourism Activity

Tourism is Grise Fiord's primary focus with respect to economic development activity. The hamlet encourages its growth because of its importance to local people...including handicraft sales, guiding and sightseeing. The community feels that marine facility development, which provides protection for local boats, will encourage larger boat purchases which are necessary to support tourism industry expansion.

In addition to traditional fly-in/boat tour oriented tourism, Grise Fiord has experienced valuable benefits from the cruise industry. During the last few years a cruise ship has called at the community with passengers purchasing goods and local residents being able to visit the ship. The hamlet is positive with respect to tourism, especially the cruise industry, and marine facility development could assist with the movement of passengers to and from shore. Indications are that the cruise industry activity experienced recently will continue.

Waterfront Utilization and Demand Summary

In summary, Grise Fiord requires marine facility development to increase the safety associated with local boating activity and to expand the community's capability to respond to marine-based emergencies. While waterfront utilization is not expected to increase dramatically, marine faciiity development could also encourage tourism industry expansion and enhance the experience of fly-in and cruise industry visitors.

Site and Harbour Profile

Relevant characteristics of Grise Fiord and the extent to which marine facility development has taken place to date is summarized below.

- **Tides**

Mean Tides	2.3M
Large Tides	4.0M
Mean Water Level	1.7M

- **Tidal Zone** — The beach below high water is estimated to slope at a 10% grade.

- **Soil Conditions** — The surface material is shingle, sand and cobbles. Nested boulders or part of a reef showed up in front of the settlement near the LWL The back shore is gravel embankment roughly 1 metre high leading to a flat area with semi-hilly terrain behind.

- **Site Topography** — The settlement is located on the north shore of Jones Sound, close to where the Sound empties into Baffin Bay. It is located in a small bay forming part of a large fiord.

- **Ice** — First year ice, second year ice and older is likely on this beach. Ice pans and some growlers are grounded out on a half tide. Occasional rafting on the shore is probably the rule rather than the exception. The winter fast ice would extend out from shore to roughly the 2-metre contour above LWL. Open water runs from the first week in August to the third week in September.

- **Exposure** — The beach has complete exposure from the Sound from S.E. to S.W. with almost full exposure from west along the Sound. Very strong winds occur in August to October. Frequent high swells with waves washing over the beach front road were reported. Recent damage to boats from storm action has occurred.

- **Littoral Drift** — The beach appears to be in active movement from east to west. A bar has formed at the westerly end of the settlement with a small tidal lagoon behind it.

There are no existing structures. Some boat trailers were visible on the beach for the larger boats.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The first priority at Grise Fiord is to provide a sheltered area for small boats. The site is very exposed and strong winds with high waves are likely. The beach along the settlement area is very poor holding ground and anchoring is not possible. We recommend that marine facility development in Grise Fiord incorporate the following minimum requirements.

- Deepening of the lagoon behind the existing gravel spit.

- Construction of a rubble mound breakwater out to deep water using the dredged material and beach boulders.

Sealift Dry Cargo

The sand and gravel beach in front of the settlement can be used at all stages of the tide.

It was reported that consideration be given to some clean-up of the beach area and also to provide aids to navigation, in particular permanent leading marks to the boat anchorage area. Otherwise the arrangements for the sealift appear to be satisfactory.

Clean up of the beach area could possibly be incorporated in the breakwater construction proposed for the local community facility.

Sealift Petroleum

Current arrangements involve the pumping of oil direct to the shore through 250 meters of 10 cm floating hose.

In view of the exposed nature of the beach, Improvement to existing arrangements would necessitate construction of a major facility. This type of mooring facility could likely take the form of an extension to the proposed breakwater/causeway out to deeper water combined with installation of sheet pile cells.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Grise Fiord. They are summarized in sketch form in Figure GF.1.

Development Cost Estimates

Preliminary cost estimates have been prepared in 1990 dollars which reflect the development recommendations described above. It is possible that maintenance of the entrance to the basin may be required due to littoral drift.

Existing excavation equipment at the community may not be of sufficient capacity to carry out the proposed construction. It is understood that a D-5 CAT is available at Grise Fiord, although something compatible with a D-8 CAT would probably be required. One approach may be to try to use existing equipment, and if not successful, allow for mobilization of more suitable equipment.

Preliminary cost estimates for the proposed facilities are as follows:

Local Facility

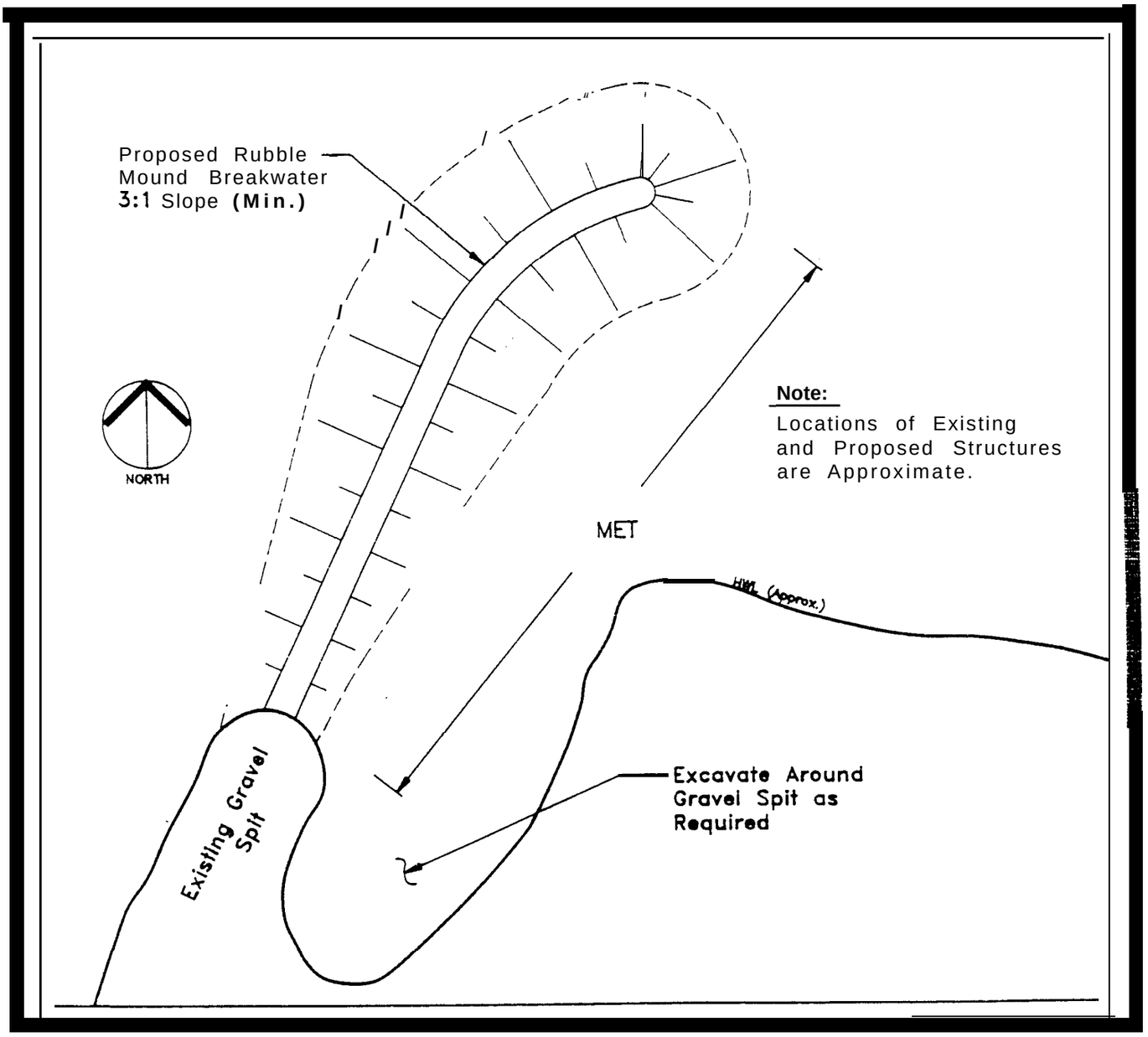
▪ Excavation & Preparation	$60,000
▪ Breakwater Construction	456,000
▪ Engineering & Survey	50,000
▪ Contingency	100.000
	$666,000

Sealift Dry Cargo

Clean up of the beach area could probably be included in the excavation and preparation of the breakwater construction.

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $3.64 million.



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GRISE FIORD
CONCEPTUAL PLAN

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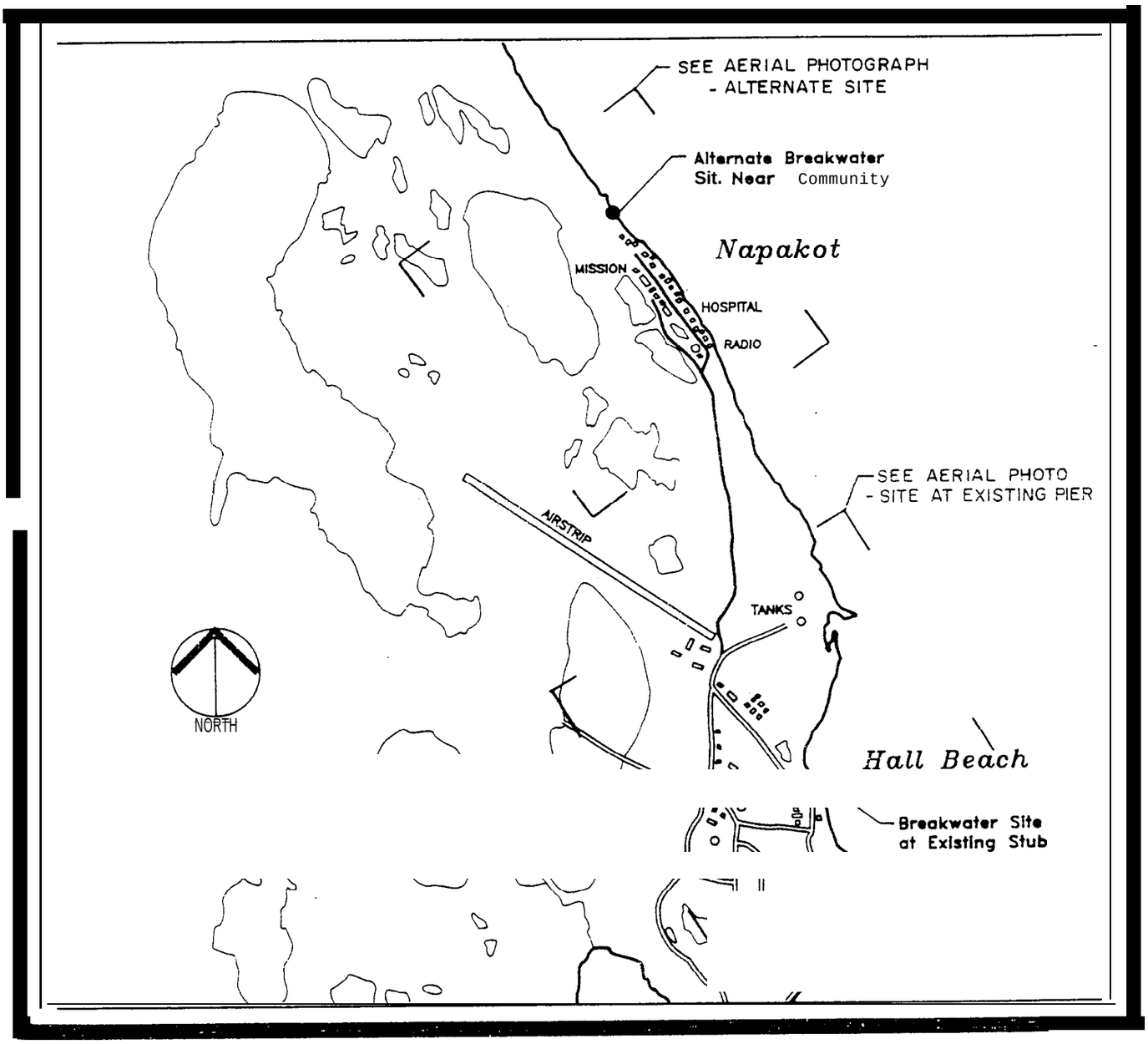
MARINE FACILITIES ASSESSMENT



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HALL BEACH

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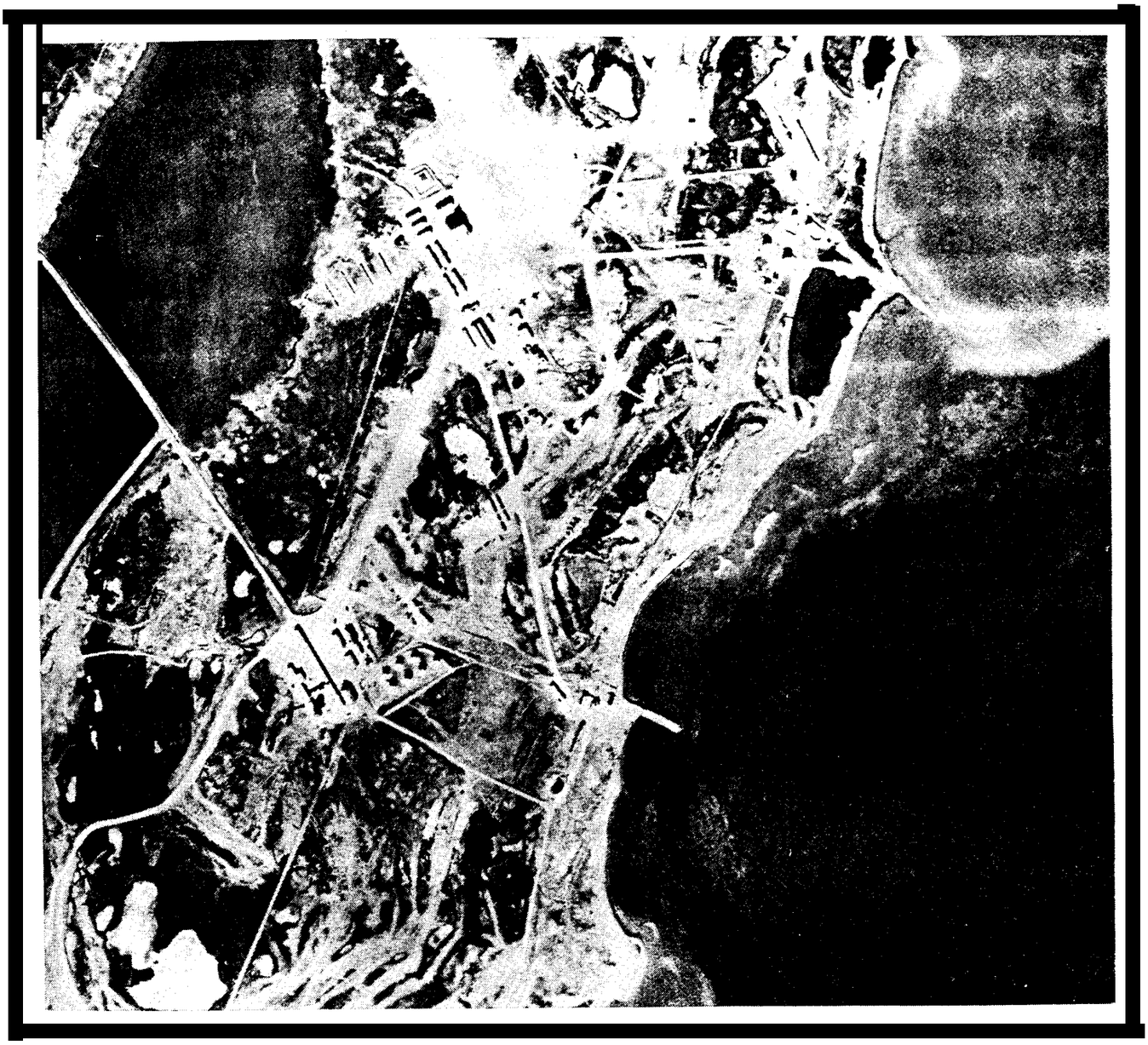
MARINE FACILITIES ASSESSMENT



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HALL BEACH
ALTERNATE SITE

HALL BEACH HARBOUR
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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Hall Beach Overview

Home to about 476 people, the Hamlet of Hall Beach is located on the western shore of Foxe Basin and the eastern coast of Melville Peninsula. The community is 840 kilometres by air northwest of Iqaluit and 1,650 kilometres northeast of Yellowknife.

The current settlement at Hall Beach began when Inuit were attracted to the area when the Hall Beach (Foxe Main) DEW Line Station was set up in 1955. Government installations followed and, even after the construction boom was over, the community retained a relatively high dependence on wage employment. During the 1950's and 1960's Inuit migrated to Hall beach from outpost camps in the region.

While the wage economy is important in Hail Beach, local people continue to hunt, fish and trap in the traditional manner. The hamlet continued to expand over the 1970's and 1980's and has reached, today, a position where a blend of traditional activities and wage employment are relied on for the livelihood of the people.

Waterfront Utilization and Demand

Waterfront activities in Hall Beach consist of local boat use for subsistence hunting and fishing, and annual sealift operations. As expansion in these areas of utilization takes place, demands for marine facilities will increase.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Hall Beach. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Hall Beach during the open water season. The following table profiles sealift shipments to the community between 1984 and 1989.

SEALIFT SHIPMENTS TO HALL BEACH
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
■ Dry Cargo	1,005	1,284	395	736	383	,1,160
• Petroleum Products (Bulk)	7,647	7,655	8,345	7,927	9,191	9,285

Based on the above table, the trend in dry cargo shipments via the sealift was down between 1985 and 1987 in comparison with the high volumes moved in 1984, 1985 and 1989. These peak years resulted from local activity. To develop our forecast of dry cargo sealift activity, we normalized the 1984 and 1985 volumes by relating them to 1986 levels in the same ratio that 1984 and 1985 bulk petroleum product shipments relative to the 1986 level. Trend line analysis was used to provide base 1989 estimates for both product categories. These were used, in turn, to project sealift volumes using population/economic base growth expectations.

The GNWT Bureau of Statistics projects Hall Beach population growth at an average rate of 2.7% annually between 1989 and 2000. This forecast assumes zero net migration. We believe that current and future eccnomic development initiatives in the community will result in sealift shipment growth higher than this at 4% annually.

Sealift shipment levels to Hall Beach are projected in the following table over the 1990 to 2000 period.

SEAL I FT SHIPMENT FORECASTS TO HALL BEACH

1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
Dry Cargo	574	597	621	646	671	698
Petroleum Products (Bulk)	9,161	9,527	9,909	10,305	10,717	11,146

	1995	1996	1997	1998	1999	2000
Dry Cargo	726	755	786	817	850	884
Petroleum Products (Bulk)	11,592	12,055	12.537	13,039	13,561	14,103

(1) 1989 estimates are based on a trend line analysis of 1984 1988 statistics, with 1984 and 1985 levels being *normalized* for dry cargo. Projections after 1989 use our estimate of combined population and economic growth applied to the base year (1989).

Variations to the above dry cargo forecasts can and will occur in any specific year depending on development projects taking place...much the sameas isreflected in1984and 1985 shipment levels.

Local Boating Activity

The people of Hall Beach continue to rely, to an important extent, ontraditional hunting and fishing at the same time that wage employment forms an important part of the economic base. As the population increases this tendency is expected to continue and during the open water season, boating activities and harbour use will remain popular. There are 30-40 canoe and Lake Winnipeg boats beached along the shore.

It was reported that in 1987/1988 43 Walrus and 12 Beluga Whales were taken. No Narwhal were taken although a quota of 10 were available.

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Commercial Fishing Activity

The lack of larger local boats limits the possible expansion of commercial fishing activity. It is understood that additional quotas exist in the neighboring areas of Baffin Island which require larger boats for safe fishing. There were 19 commercial fishing licences issued for 1987/1988 season. There were 10 marine mammal export permits issued **for 1987/1 988 season.**

Marine Tourism Activity

There is **little reported tourist activity** in this community.

Waterfront Utilization and Demand Summary

In summary, local boat use of Hall Beach's harbour area is expected to increase steadily over the next decade as are the sealift shipment levels to the community. This increase combined with the lack of any facilities for the local resident **user and the** exposed nature of the beach make it difficult to pursue subsistence and commercial fishing activities.

Site and Harbour Profile

Relevant characteristics of Hall Beach Harbour and the extent to which marine facility development has taken place to date is summarized below.

▪ Tides	Mean Tides	0.8M
	Large Tides	1.3M
	Mean Water Level	0.6M
▪ Tidal Zone	The estimated grade of the beach from high to low water is 10OA.	
▪ Soil Conditions	The surface material is fine gravel/shingle/sand, mainly firm. The shore is flat above HWL. A 2 metre high pad of gravel has been brought in along the waterfront to build up the settlement area.	
▪ Site Topography	The settlement is located on the west shore of Foxe Basin. The ground in the immediate region is flat with no intervening terrain to reduce winds from the hinterland.	

- Ice

First year, second year and older ice is likely. No ice in view at the time of the visit. The end of an existing pier has been crushed by ice. No ice pile up is reported above HWL Winter fast ice would extend from shore to the LWL. Open water period is from the first week in August to the third week in September.

- Exposure

The beach is fully exposed from S.S.W. to N.E. A small bar was seen at high water about 30 metres off shore fronting the Hamlet office. Severe erosion is shown on the north side of the existing stub-pier.

- Littoral Drift

The beach runs roughly straight for some distance and appears to be a beach in movement.

The Dew line radar site south of the settlement has a stub wharf approximately 40 metres long. The wharf consists of vertical culverts on each side made up from bolted sections. The wharf is not used by the sealift except as a mooring point for the tanker's stern line. The outer end has been damaged severely by ice.

Development Recommendations

Preliminary cost estimates, in 1990 dollars, have been prepared which reflect the development recommendations described above. As with other communities, several assumptions have been made in preparing these cost estimates.

Local Community Use

The main priority for Hall Beach is the provision of a sheltered area 'for small boats. In view of the exposure factor which runs from southwest to northeast, it would be necessary to build two breakwaters. The precise location for breakwaters is not likely to seriously effect the cost due to the uniformity of the beach. the location should be confirmed with the community.

Two important questions arise at this site, which directly impact on the feasibility of constructing the breakwater structures.

Firstly, there is some doubt as to whether suitable rock material is available nearby for the breakwaters.

Secondly, there is the potential problem of littoral drift which needs to be addressed prior to any construction.

It could be possible to extend the existing sealift site stub pier for use as one breakwater, with a second breakwater constructed to the north. Tide levels are not very high in this area, so that a sheltered harbour could be effectively provided, however it is some distance from the community which would limit its usefulness.

The requirements for a local facility at Hall Beach are summarized as follows:

- Carry out sufficient pre-engineering to determine effects of littoral drift and availability of rock for breakwater construction;
- Construct rock mound breakwater by extending existing stub wharf **out to deep water;**
- Construct second breakwater to the north of the first breakwater providing a sheltered area for small boats.

Sealift Dry Cargo

Cargo for both the Dew Line station and the settlement is landed at the Dew Line beach. Vessels anchored off the landing beach have to be prepared to move instantly as the holding is unreliable.

Clearly, the main problem at Hall Beach is the exposure factor. It is difficult **to foresee what type of facility** could be built in practical terms to improve the situation for the sealift.

Certainly, the first step would be further pre-engineering and survey work.

Sealift Petroleum

Bulk oil is discharged at the Dew Line site with tankers moored 0.2 miles east of the Jetty, with stern lines to the Jetty. Oil is discharged direct to the shore pipeline through two **10 cm** floating hoses.

Again, exposure is the main factor at this site and it is hard to imagine justifying the cost of the type of facility which would be required to improve on the current discharge method.

Assuming that suitable rock is available nearby and that breakwaters are technically feasible, the preliminary cost estimates are as follows:

Marine Facility Development Summary

The recommendation and development possibility described above provided sound direction for marine facility development in Hall Beach. They are summarized in sketch form in Figure HB.I.

Development Cost Estimates

Preliminary cost estimates in 1990 dollars have been prepared which reflect the development recommendations described above.

Local Facility

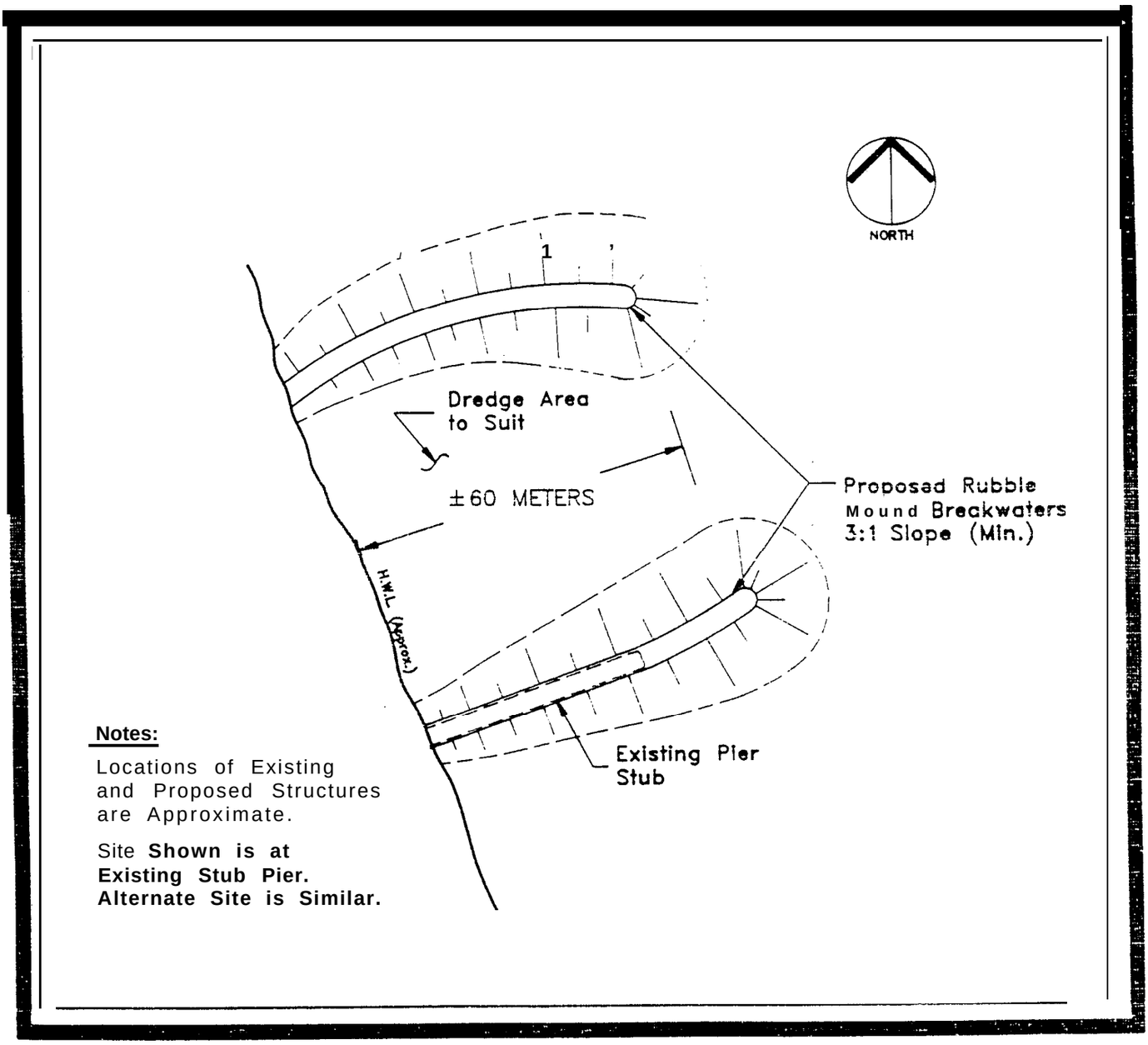
▪ Excavation and Site Preparation	$30,000
▪ Construction of Rock Mound Breakwaters	312,000
▪ Engineering & Survey	35,000
▪ Contingency	70,000
	$447,000

Sealift Dry Cargo & Petroleum

No cost estimates have been prepared for these facilities as the system appears to be satisfactory.

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $3.2 million.



Notes:

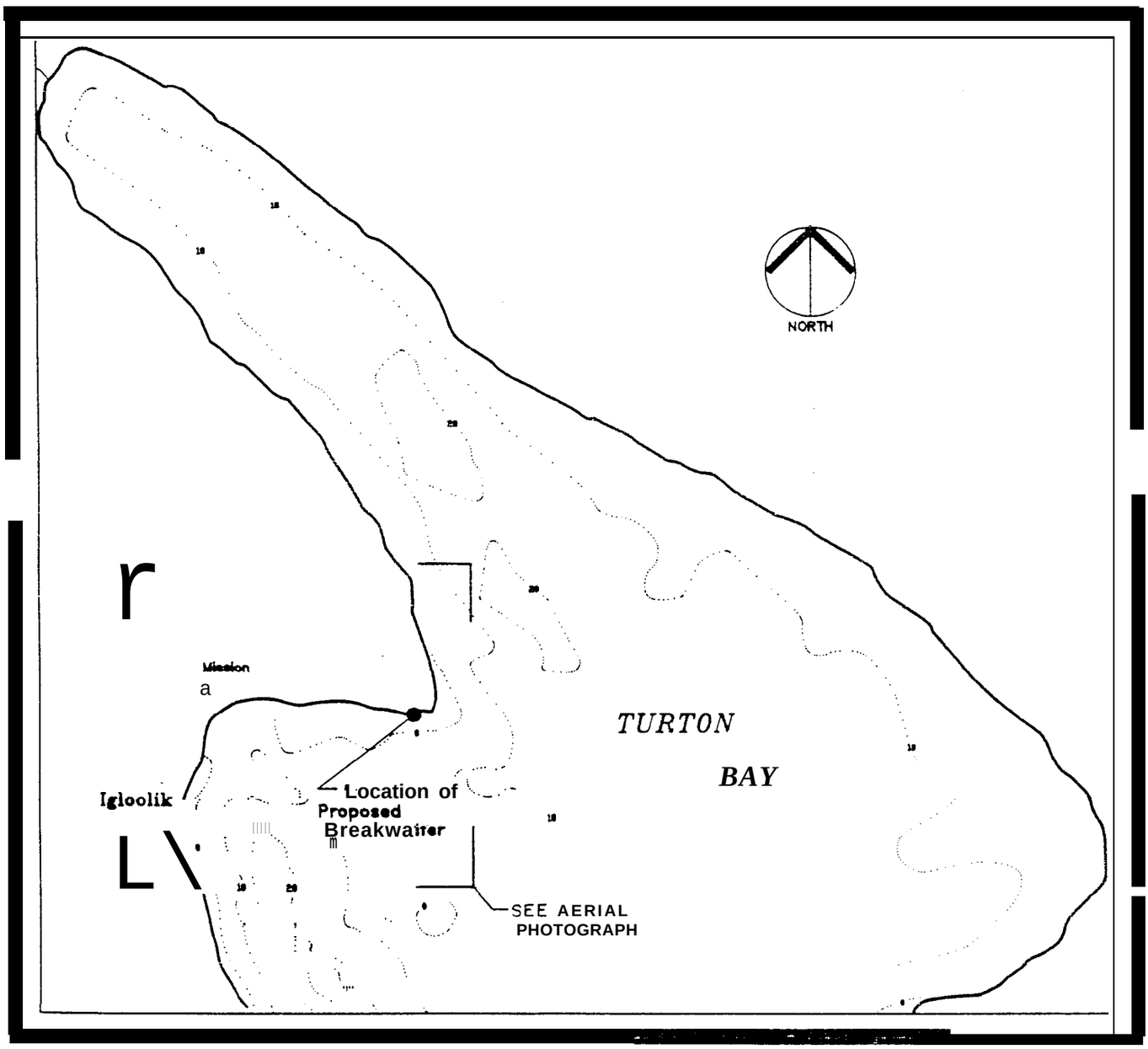
Locations of Existing and Proposed Structures are Approximate.

Site **Shown is at Existing Stub Pier. Alternate Site is Similar.**

Natural Scale 1: 1,000

HALL BEACH
CONCEPTUAL PLAN

MARINE FACILITIES ASSESSMENT



Natural **Scale 1:37,500**

Soundings in Meters

IGLOOLIK HARBOUR

MARINE FACILITIES ASSESSMENT

IGLOOLIK HARBOUR

IGLOOLIK HARBOUR
MARINE FACILITIES ASSESSMENT

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introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Igloolik Overview

Igloolik is one of the larger Eastern Arctic communities with a population of about 922. The island community is located immediately off the northeast coast of Melville Peninsula some 362 kilometres by air northeast of Repulse Bay and 1,641 kilometres by air northeast of Yellowknife.

Settlements have existed on Igloolik Island, almost continuously, for thousands of years. The modern era settlement in Igloolik began in the 1920's when a mission was established. Inuit migration to the area and a Hudson's Bay Company post in 1939 gradually resulted in settlement expansion. During the 1950's and 1960's the community continued to grow. Igloolik has continued to evolve in recent years with marine mammal. harvesting, hunting, fishing and trapping activities continuing to predominate. Handicrafts are also produced locally and a research centre is located in the community.

Waterfront Utilization and Demand

During the open water season the waterfront of Igloolik is used regularly by local boat owners ana the annual sealift.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization at Igloolik. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift **operations bring** dry cargo and petroleum products, in bulk, to Igloolik during the **open water** season. The following table profiles sealift shipments to the community **between 1984 and 1989.**

SEALIFT SHIPMENTS TO IGLOOLIK

1984-1989

(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	361	646	427	1,165	659	744
Petroleum Products (Bulk)	2,713	2,167	2,586	2,207	.2,926	3,047

Sealift dry cargo shipments have varied considerably in recent years while sealift petroleum product shipments have remained relatively consistent. **The former reflects freight demand peaks** in certain years generated by construction projects. Variations such as these are expected to continue **in the future.**

Excluding **unpredictable dry cargo demand peaks, we expect that sealift shipments levels will increase roughly in proportions to population and** economic activity **growth in Igloolik. Consensus show that local population** growth has slowed, but also has been steady, over the past two decades (e.g. 7.5% annually from 1966 to 1976 vs 2.4% annually between 1976 and 1986). The GNWT Bureau of Statistics forecasts Igloolik population **growth at 2.9% per** year between 1989 and 2000. This will make it the third largest settlement in the Eastern Arctic (... next to Iqaluit and Pangnirtung).

Our sealift shipment forecasts parallel these population growth expectations. We estimate increases at 3% annually after 1989. These projections are summarized in the following table for the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO IGLOOLIK
1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
■ Dry Cargo	986	1,016	1,046	1,077	1,110	1,143
■ Petroleum Products (Bulk)	2,660	2.740	2,822	2,907	2,994	3,084

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	1,177	2,213	1,249	1,287	1,325	1,365
■ Petroleum Products (Bulk)	3,176	3,271	3,370	3 # 471	3,575	3,682

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

As mentioned above, local construction projects will increase dry cargo shipments in any given year behind the forecast levels as the result oftemporarypeak demand.

Local Boating Activity

Residents of Igloolik make considerable use ofthe waterfront. They are heavily dependent on hunting. It was reported that there were 600 domestic fishermen and 300 seal fishermen in 1987/1988. There were41 Walrus and 7 Beluga Whales taken in 1987/1988. There were 20 Lake Winnipeg style fibreglass boats, one older 15-metre Peterhead and a very large number of fibreglass canoes on the beach during our visit.

While the waterfront is particularly protected the beach is still open to local wind generated waves making launching and haulout of even small canoes difficult. Improved protection and haulout facilities would permit the purchase and use of larger vessels needed for commercial fishing and tourism.

Commercial Fishing Activity

The community is anxious to improve its participation in the commercial fishing industry. there were 42 commercial licences and 23 marine mammal export permits issued in 1987/1988. There is a community

Arctic char quota of 100,000 pounds which cannot be caught due to the lack of suitable larger boats, which require more secure harbour facilities.

The DFO has indicated that there could be a commercial shrimp fishery.

Marine Tourism Activity

Tourism is relatively unimportant in the community, with 4 package tours generating 53 visits worth $84,000. The community wishes to encourage this activity.

Waterfront Utilization and Demand Summary

In summary, seasonal use of the waterfront is critical to the traditional activities of the residents and to their participation in the commercial fishery. Marine activity is expected to grew and would be much assisted by the development of secure facilities for boat moorage and haulout.

Site and Harbour Profile

Relevant characteristics of Igloolik Harbour and the extent to which marine facility development has taken place to date is summarized below.

▪ Tides	Mean Tides	2.2M
	Large Tides	3.1M
	Mean Water Level	None Given
▪ Tidal Zone	The beach is grade is broken; from HWL it runs at a 10% grade to mid-tide then flattens out to approximately to 5% out to LWL	
▪ Soil Conditions	The surface is firm gravel/sand. Beach access is good along the entire settlement shore. The upland consists of a low grade for 100 metres, then rises slowly.	
▪ Site Topography	The settlement is located on an island within Foxe Basin just off-shore of the Melville Peninsula. The settlement is located at the center of a small bay which offers good protection from ice and storms.	

- Ice — First year, second year and older ice is probable. Growlers with some blue ice were seen in the bay. No evidence of ice pile-up or damage within the bay. The winter fast ice would extend out from shore to roughly the 2-metre contour above LWL Open water period occurs from the first week in August to the 3rd week in September.

- Exposure — The beach is well protected except for S.E. sector winds. 2.5 to 3.0 metre waves on the beach at high water during bad storms.

- Littoral Drift — Not observed and not believed to be a factor at this site.

There were no existing structures observed in the community.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The main priority for this community is the provision of a breakwater combined with a vertical face wharf-type structure.

As with other communities, a rubble mound breakwater could be constructed with timber cribs used to incorporate the vertical face.

There was some discussion as to the preferred location for this breakwater. Igloolik is generally well protected and the council would prefer a structure to the northeast of the community.

The maximum tide range of 3.1 metres does not warrant a ramp type structure, although this would be an asset and could be considered for some future development, particularly to assist in hauling larger commercial boats.

We recommend that marine facility development in Igloolik incorporate the following minimum requirements.

- Construction of a rubble mound breakwater to the northeast of the community;

- Construction of a vertical wall using rock-filled timber cribs.

High waves are a potential problem at this site, requiring the top of the breakwater elevation to be about 1.5 metres above HWL

Sealift Dry Cargo

Good anchorage, which is also well protected, can be obtained in Turton Bay. Barges run up to a gravel/sand beach which is workable at all stages of the tide.

The sealift operation is considered to work well and therefore no facility changes are proposed here.

Sealift **Petroleum**

Oil tankers moor with two anchors and stern lines to the shore approximately 0.7 miles off shore. Oil is delivered direct to the shore through a 10 cm floating hose.

An unloading facility for oil tankers would involve construction of a breakwater/causeway out to deep water and provision of sheet pile cells for mooring.

The breakwater structure proposed for local community use would not be suitable **for extension to incorporate a tanker unloading facility because of its location. It may, therefore,** be worthwhile considering locating the breakwater to the west of the community where the water is deeper and **could be extended** for use as a tanker mooring facility.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Igloolik. They are summarized in sketch form in Figure IG.7.

Development Cost Estimate

Preliminary cost estimates have been prepared in **1990** dollars which reflect the development recommendations described above.

Local Facility

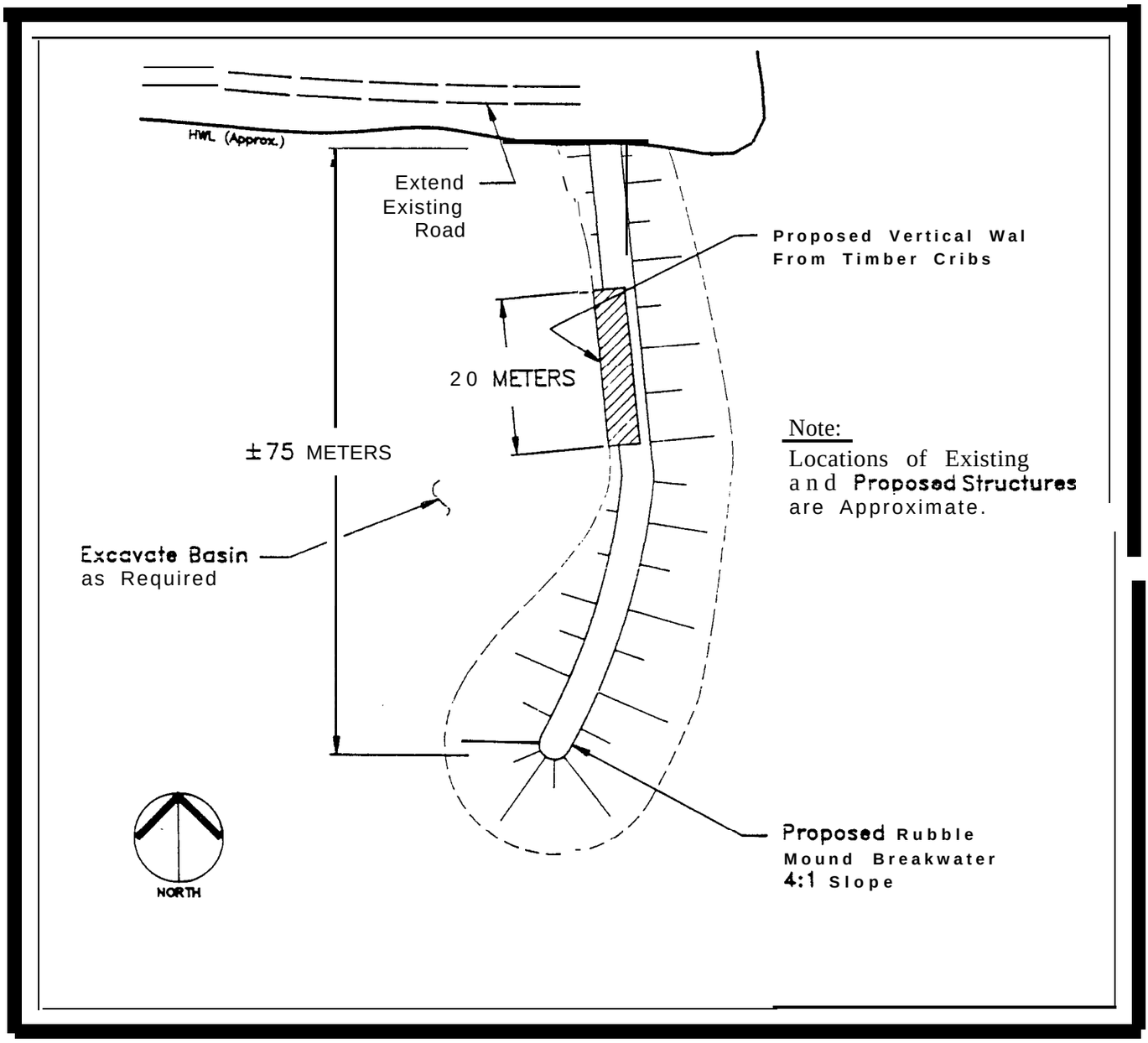
▪ Construction of Rock Mound Breakwater	$300,000
▪ Construction of Timber Crib Wharf	40,000
▪ Extension of roadway	60,000
▪ Engineering & Survey	40,000
▪ Contingency	80,000
	$520,000

Sealift Dry Cargo

No estimate has been prepared as the sealift appears to work satisfactorily at this community.

Sealift Petroleum

The cost providing a **deep water mooring facility for tankers is estimated at $4.0 million.**



Natural Scale 1:750

IGLOOLIK HARBOUR CONCEPTUAL PLAN

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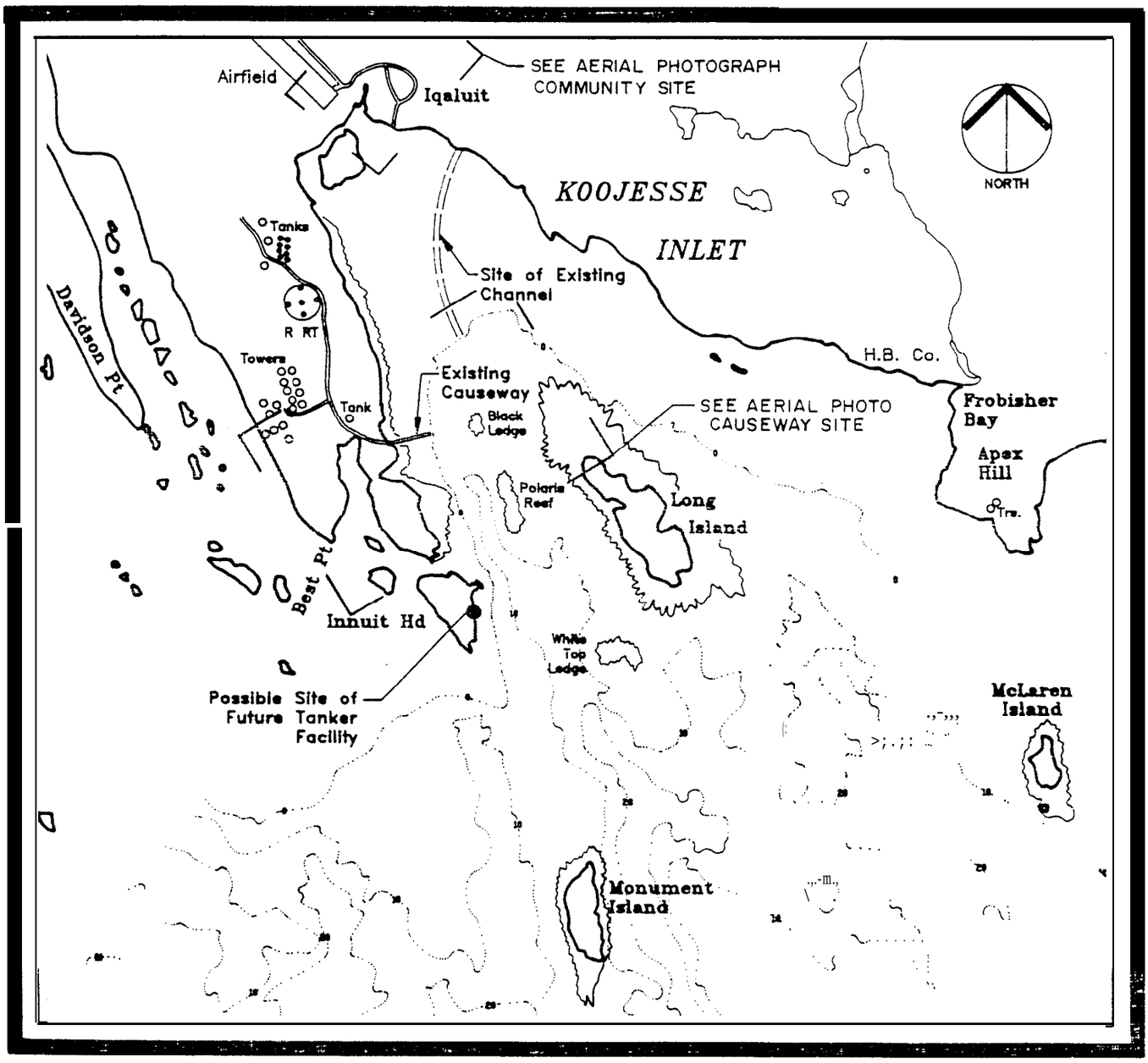
MARINE FACILITIES ASSESSMENT



Natural Scale 1:40,000

Soundings in Fathoms

IQALUIT HARBOUR

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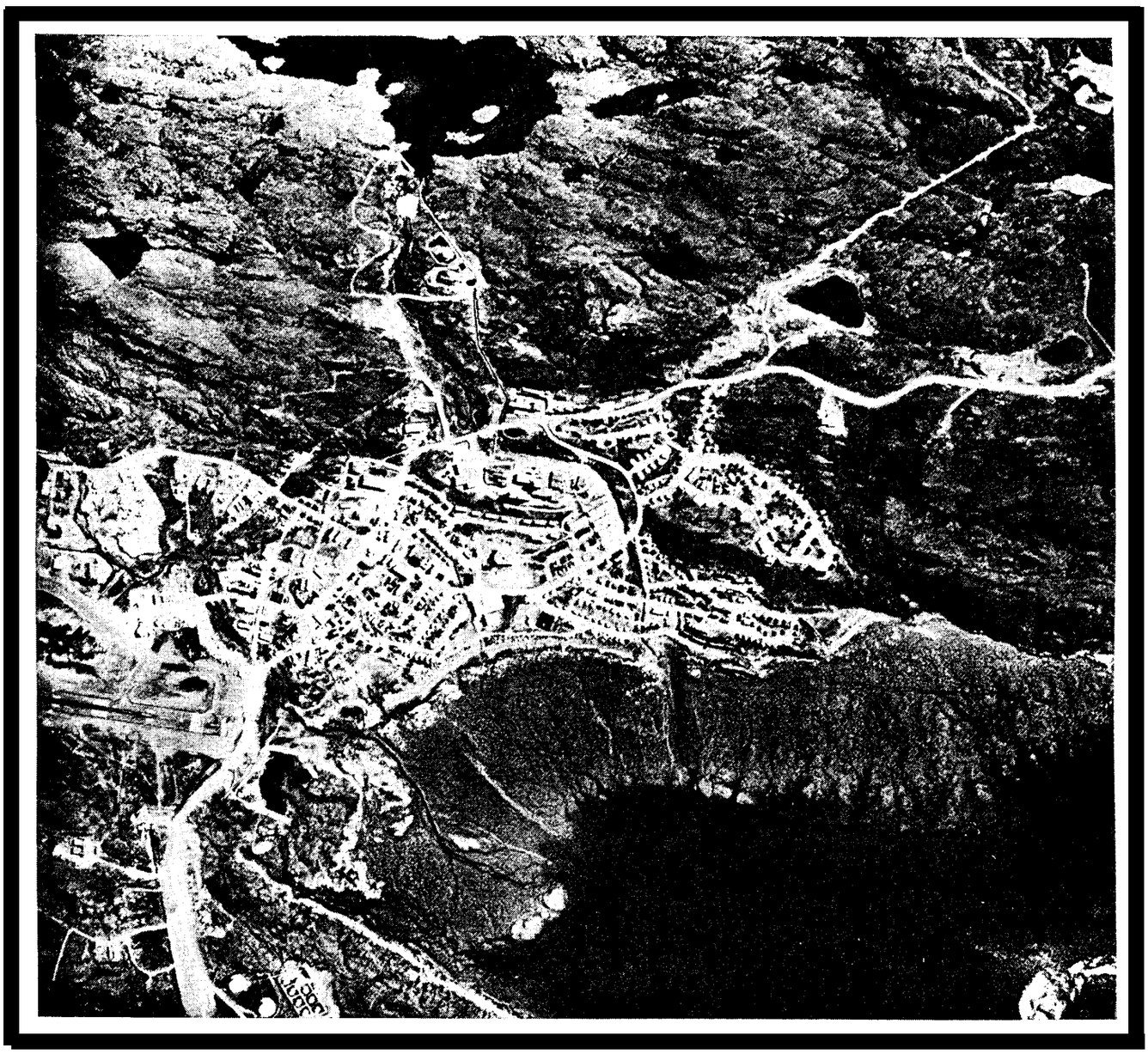
MARINE FACILITIES ASSESSMENT



IQALUIT
COMMUNITY SITE

MARINE FACILITIES ASSESSMENT

IQALUIT
EXISTING CAUSEWAY SITE

IQALUIT HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc on behalf of the Governments of the Northwest Territories and Canada.

Town of Iqaluit Overview

Iqaluit, formerly Frobisher Bay, is located on Frobisher Bay on the southern end of Baffin Island. Some 2,261 kilometres by air east of Yellowknife and 2,060 kilometres by air north of Montreal, the community is the largest in the Eastern Arctic with a 1988 population estimated at 3,039.

While having a long history, most of the development at Iqaluit occurred as a result of the USAF's construction there of the largest air base in the North in 1942-1943. The base was turned over to the Canadian Air Force between 1946 and 1950, and the Hudson's Bay Company also moved into the community from Ward Inlet at that time.

Throughout the 1950's and 1960's, government increased its presence in Iqaluit and Inuit continued to move to the community. It grew as a government, transportation, communications and educational centre during the 1960's and 1970's. Public sector and economic base growth has resulted in a wage dominated economy in Iqaluit. The community achieved Town status in 1980 and changed its name from Frobisher Bay to Iqaluit on January 1, 1987.

Waterfront Utilization and Demand

Iqaluit is the largest centre for sealift shipments in the Eastern Arctic. A sizeable number of local Inuit, however, carry on with traditional hunting and fishing pursuits by small boat during the open water season. Commercial fishing expansion is possible which will generate even more waterfront activity. Iqaluit is also the most popular visitor destination in the Baffin Region.

Our visit to the Town, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Iqaluit. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Iqaluit during the open water season. Because of its size and the volumes involved in the sealift, Iqaluit is the only Eastern Arctic community where sealift ships call several times. The tide range, however, is large and, combined with the gently sloping sea bottom below HWL, necessitates that vessels anchor a considerable distance from the shore. Unloading operations for dry cargo are limited, as a result, to about ten hours daily.

Dry cargo shipments to Iqaluit by sealift have remained relatively steady over the past five years with variations reflecting increased demand resulting from development projects. The following table profiles dry cargo shipments by sealift to the Town over the 1984 to 1989 period.

SEALIFT SHIPMENTS TO IQALUIT
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	3,713	3,824	4,824	3,998	3,503	3,987
Petroleum Products	(Bulk)(1)	N/A	N/A	N/A	N/A	N/A	N/A

(1) Petroleum products are shipped in bulk to Iqaluit by Shell Oil, not the sealift, and are not, therefore, included in this table.

While experiencing rapid population growth between 1961 and 1966 (...26°A per annum...), Iqaluit's growth rate has slowed over the past two decades but the population base is still increasing steadily (e.g. 4.3% per annum from 1966 to 1971, 2.9% per annum from 1971 to 1976 and 2.4% per annum from 1976 to 1986). Sealift volume increases reflect this growth but respond more dramatically to investment and construction levels in the community.

Between 1989 and 2000, the GNWT Bureau of Statistics is projecting population growth in Iqaluit averaging 1.9% per annum. This is slightly lower than the Baffin Region's population growth (...2.5% annually...) and

slightly higher than the 1.7% per annum projected for the Northwest Territories in total. It assumes zero net migration, however, which may result in an understatement of growth because of the actual and perceived job opportunities in Iqaluit.

We expect that sealift shipments will increase more-or-less in response to population and economic base expansion in Iqaluit. We have used a growth rate of 3% annually for purposes of our analysis. Sealift shipment levels to Iqaluit are projected in the following table over the 1990 to 2000 period.

SEAL I FT SHIPMENT FORECASTS TO IQALUIT

1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
Dry Cargo	3,399	4,016	4,136	4,250	4,388	4,520
Petroleum Products (Bulk)(1)	N/A	N/A	N/A	N/A	N/A	N/A

	1995	1996	1997	1998	1999	2000
Dry Cargo	4,655	4,795	4,939	5,087	5,239	5,394
Petroleum Products (Bulk)(2)	N/A	N/A	N/A	N/A	N/A	N/A

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Project ions after 1989 use the population forecast rate applied to the base year (1989).

(2) Petroleum products are shipped in bulk to Iqualuit by Shell Oil, not the seal ift. This ex expected to continue and, therefore, these forecasts are not included in the above table.

Annual fluctuations above and below these projections can be expected in response to construction activity in the community.

A twice seasonal, marine freight service operated in 1989 between Iqaluit and Pangnirtung. It appears likely that this service will continue and may expand to service other communities, but that major distribution expansion out of Iqaluit is not likely. To the extent that this service continues, it will also continue to piace demand on the Iqaluit waterfront.

Reid Crowther

Local Boating Activity

In proportional terms, local boating activity in Iqaluit is not nearly as important as it is in other Eastern Arctic communities which are smaller and less dependent on a wage economy. Nevertheless, in absolute numbers, local boating activity is significant, during the open water season. Some local residents continue to hunt and fish to supplement their livelihood. Increasing use is being made of small boats for visitor tours.

A channel was dredged several years ago to allow small boat access to the water at most tide levels. The sea bottom between HWL and LWL is also hard, with a gentle slope, which permits trailers to be backed to the waters edge. Local research, however, pointed out that some improvement of the channel is required to improve access and to bring local boats closer to shore for unloading.

Major increases in local boating activity, excluding those which may arise from commercial fishing industry expansion, are net anticipated.

Commercial Fishing Activity

To date, commercial fishing activity around Iqaluit has been very limited. Only five commercial fishing licences were issued in the community during the 1987/1988 season. Marine mammal export permits over the same period were much higher at 65. In fact this was the largest number of permits issued of any community in the Eastern Arctic. Quotas for marine mammals over the period include 10 Narwhal, while actual harvesting included 36 Beluga and 29 Walrus.

A limited number of exploratory commercial fishing licences have been issued in Iqaluit in recent years. Of particular interest lately has been the potential for the shrimp industry and a shrimp processing plant in Iqaluit. A recent study(1) suggests that the plant... would be potentially economically feasible". If it is developed and used, the plant would attract shrimp boats to Iqaluit where they would unload generating additional pressure tor appropriate marine facilities. Our research, however, including discussions with Fisheries and Oceans Canada, suggests that processing will likely occur onboard commercial fishing boats unless the shrimp can be caught in Frobisher Bay. The extent of any future commercial fishing industry expansion in Iqaluit remains, therefore, uncertain at the present time.

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(1) "Preliminary Feasibility Study - Baffin Marine Fisheries Infrastructure - Phase I" - Tavel Limited - Dartmouth, Nova Scotia - September, 1989.

1,

Marine Tourism Activity

A limited number of marine tour opportunities can now be taken advantage of in Iqaluit including visits to the old community and the Thule ruins. Several guide/outfitters are also located in town.

We believe that marine tourism development in Iqaluit can and will occur as initiatives are taken by local entrepreneurs. These would be encouraged by marine facilities which enable visitors to board and unload from tour boats. The tourism base already exists with Iqaluit being the most popular tourist destination in the Baffin Region.

Site and Harbour Profile

Relevant characteristics of Iqaluit Harbour and the extent to which marine facility development has taken place to date are summarized below.

- Tides

Mean Tides	7.3M
Large Tides	11.6M
Mean Water Level	5.9M

- Tidal Zone — The beach slope is estimated at 5%.

- Soil Conditions — Surface material is generally firm sand with scattered boulders along the settlement shore. A high tide berm has been built up. From the berm the land generally rises up into a low hill.

- Site Topography — The town is located at the end of a very long bay with the end of the bay breaking into smaller fiord-like inlets. The uplands on either side consist of low to medium hilly terrain with low mountains in the background. Winds generally follow the terrain with the worst wind exposure coming down the bay.

- Ice — First year ice only. Growlers do not penetrate up as far as the town site. During ice break-up in the spring, ice piles up on the tidal flats near the town. Gabions immediately below HWL show no ice damage. The winter fast ice would extend out from shore to roughly the 6-metre contour above LWL.

Open water generally runs from mid-July to the 3rd week in September immediately off-shore. Deep sea shipping commences the first week in August due to ice conditions in Davis Strait.

- Exposure

Strong winds and waves coming down the inlet are a major factor here. Southeast winds have 10% exceedance of over 20 km/hr. Wave heights of over 1 meter can also be expected.

- Littoral Drift

Some drift can be expected due to the extensive tidal zone. Filling behind the old sealift wharf is suspected to be caused by wave action. Any channel excavated perpendicular to the wave front within the tidal zone could be expected to be filled in about 2 to 4 years.

At the sealift storage area some attempts have been made at building a pushout with a small landing barge at the outer end and iog crib work along the northerly face. This structure is not in good repair with a bar build-up along the crib and damage to the southerly side.

A long causeway across the inlet from the town was noted but tankers do not use this site for unloading fuel.

Council excavated a channel into HWL from some point above LWL although some local reports say there has been considerable fill-in.

Development Recommendations

Our recommendations for marine facility improvements/deveiopment in Iqaluit are summarized below according to the principal type of use to which they are tailored.

Local Community Use

Severai important factors affect the evacuation of alternative schemes for local community use.

Iqaluit has a very high tidal range of up to 11.6 meters, and the area is exposed to strong winds. There are extensive tidal flats and there is the probability of infill from littoral drift.

The main priority for small boats is to provide protection and access to open water at ail tidal ranges.

In view of the factors discussed above and the topography of the site, the most beneficial scheme for small boats would be to excavate further the existing channel and allocate funds to maintain it.

Sealift Dry Cargo

The landing beach used by the sealift has been cleared of boulders and graded sufficiently to allow ships of 2000 tons and more to beach in order to unload cargo. Traction of vehicles on the beach is good.

In view of the large tidal range, however, delays in unloading cargo are encountered waiting for barges to unload and return on the tide.

The main priority for the sealift is to reduce the delay in unloading cargo by giving barges accessibility at more range of the tide. There is an existing causeway structure located to the west of Black Ledge and it is possibie to construct a wharf at the end of this structure to give about 1 -metre of water at LWL.

There are disadvantages to this scheme, however, in that relatively high capital cost would be necessary for comparatively low benefit to the community. There is insufficient water in this area to bring a tanker in and ships will still have the problems of anchoring in an exposed area.

Physical facility development options which would result in more efficient sealift operations are described below. However, it may be more beneficial to look at the sealift in terms of operational solutions rather than structural ones. We have done this and also describe below what we believe to be a suitable, reasonably priced solution to the operational problems encountered by sealift vessels in Iqaluit.

A wharf which would allow sealift vessel off-loading directly to shore can only be considered if its capital costs are kept to a minimum. In 1978 a terminal development plan was produced by Public Works Canada which provided a deep sea terminal at Inuit Head for a cost of $10 million including warehouse and road connection. in 1990 dollars this proposal would approach $25 million. In our opinion this is an unrealistic option given the likely benefits from the projected levels of traffic. This terminal would at least be accessible to both dry cargo ship and tanker.

A possible cheaper alternative would be to modify the existing rock causeway extending it by 75 metres facing one side with a sheet pile wall and preparing a pad at approximately low water level suitable to receive a dry cargo ship for grounding. The vessel would approach at high tide and lie alongside until the cargo was unloaded, leaving on the next suitable tide. There are problems with exposure to waves,

maintenance of the grounding pad and the difficulty of driving steel piling in the exposure conditions at this site. This proposal would still cost in the order of $6 million.

It would be similarly possible to build a smaller version of the above grounding platform at the causeway useable by the typical sealift barges at all tides. While this would speed up the unloading process the construction costs are of the same order of magnitude and would require the use of at least a truck mounted mobile crane suitable of handling cargo from the barge to trucks on the causeway at low tide.

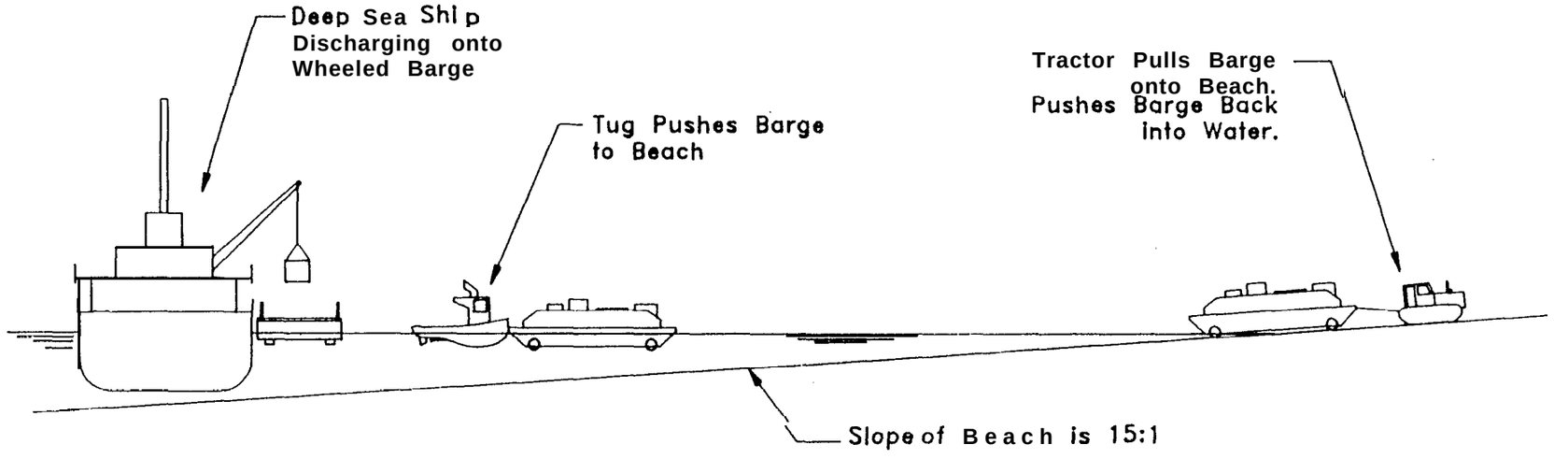
Both of these alternatives would require considerable engineering effort to determine specific site feasibility and costs. Neither appear to be acceptable from a benefit cost perspective.

An operational solution to sealift unloading difficulties was conceptualized by the Study Team after careful review of a variety of operational possibilities. It is simple and cost effective. It takes advantage of specially designed Iqaluit-based, dedicated barges on wheels or 'bogies' which are, effectively amphibious. The barges would receive ships' cargo alongside and be moved to shore by ships' tugs, as is presently the case. Subsequently, a tractor-type vehicle (e.g. A D-7, D-6 or even a front-end loader) would meet the barge at the water's edge and haul it up the beach to the marshaling area for unloading. This method will work, in part because of the hard sea bottom below HWL and its gentle slope in Iqaluit. The tractor equipment is readily available in the community and would be rented. The system is simple and repairs could be made locally as required. It is an effective method because it easily resolves sealift unloading constraints associated with the high tides and long shore-to-ship distance in Iqaluit.

A conceptual sketch of this proposed operational solution in Iqaluit is provided in Exhibit IQ.1.

Detailed technical and economic feasibility analysis must be undertaken before this operational solution is implemented. Our preliminary review, however, suggests the following characteristics could be suitable:

- two barges would be required...each being approximately 12.5-metres long x 6-metres beam x 1.7-metres) drawing about 1.2-metres;
- cargo carrying capacity of each barge would be approximately 52 long tons;
- the weight of each empty barge would be approximately 20 long tons without wheels and about 24 long tons with wheel assemblies installed; and
- barge construction time would be about 10 weeks.



PROPOSED METHOD OF CARGO DISCHARGE AT IQALUIT

(NTS)

EXHIBIT IQ. **1**

We believe this reasonably priced operational solution to sealift operational problems will generate important benefits and that it should be evaluated in detail at the earliest possible time.

Sealift Petroleum

Current arrangements involve tankers anchoring off Inuit Head and pumping oil direct through about 250 metres of 15 cm floating hose. Soundings indicate that it is not feasible to bring tankers in further north and that there are also navigation problems.

A major port facility at Inuit Head was the subject of a detailed study in 1978. The report proposed a concrete crib-type structure built in Quebec and towed into place on site for the main structure.

Alternative schemes which were considered involved construction of sheet pile cells. However, in view of the geotechnical conditions and potential construction difficulties, the concrete crib structure was preferred.

Cost of the terminal was estimated at $10 million in 1978. Given that this proposal included roadway, storage shed, lighting and security, it is difficult to imagine that a similar type of structure would cost less than $20 million in 1990 dollars.

A re-evaluation of the 1978 study may be in order if a petroleum unloading facility receives priority for development.

Development Cost Estimates

Preliminary cost estimates have been prepared, in 1990 dollars, which reflect the development recommendations described above.

Local Facility

Without detailed sounding or survey information of the existing channel, it is difficult to estimate the cost of improving the channel. Nevertheless, we suggest that an initial capital cost of $260,000 is reasonable for this work, with periodic maintenance cost of $50,000 annually thereafter.

Sealift Dry Cargo

Three possible **sealift** dry cargo improvements were described above. **Preliminary** cost estimates for the physical development options are referenced above but not detailed because of their expense and uneconomical characteristics. **Preliminary** cost estimates for the amphibious barge operational solution are provided below.

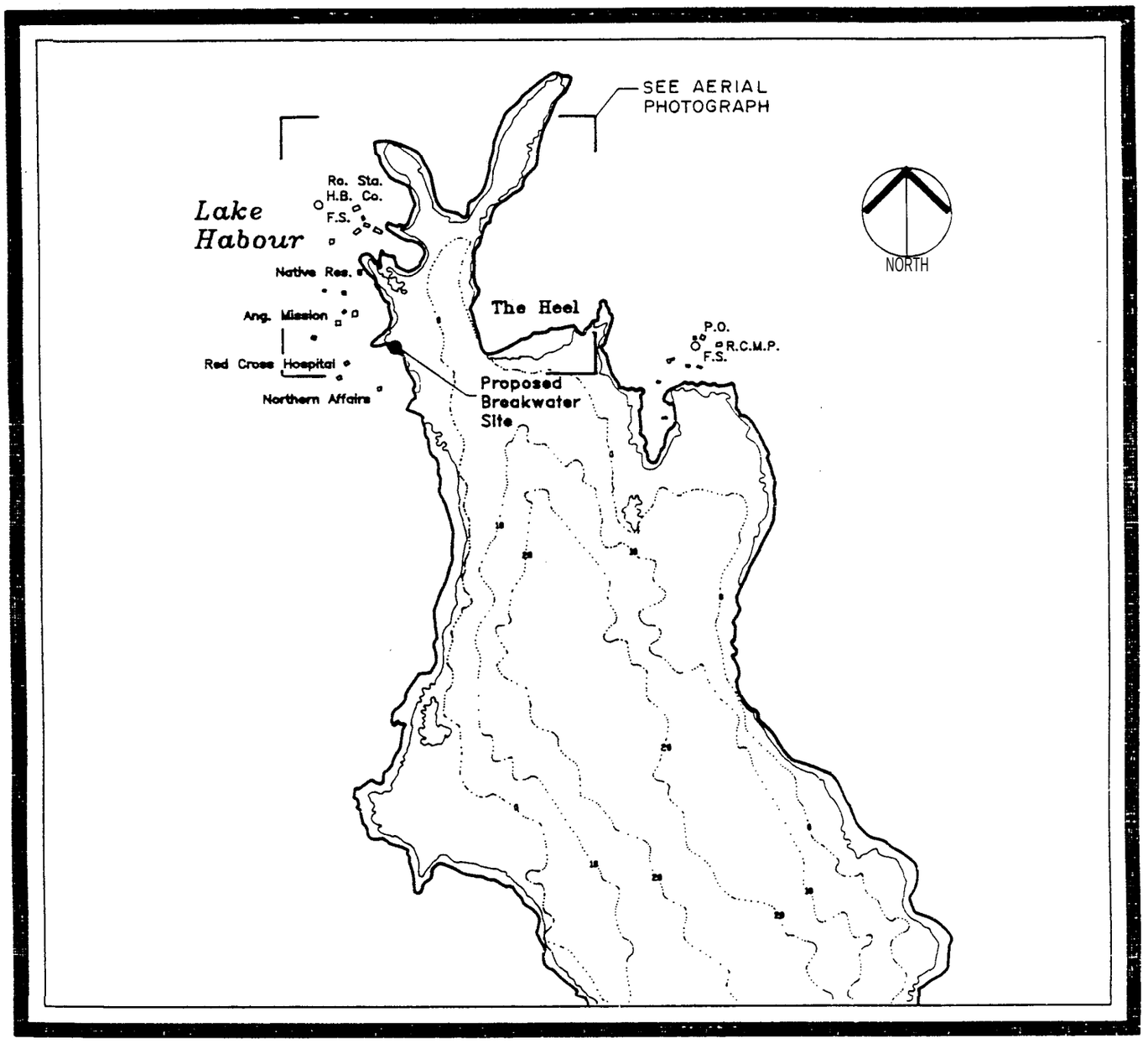
Amphibious Barges

■	Feasibility Study	$40,000
■	Barge Design/Construction (2)	**$140,000**
■	Wheel Design/Assembly/installation	,$170,000
■	**Montreal** /Iqaluit Delivery (Allowance)	$ 10,000
	Total	$360,000
	Operational Costs:	$15,000/Annum (To be confirmed)

Sealift Petroleum

Re-evaluation of the 1979 study would indicate capital cost in the region of $25 million.

MARINE FACILITIES ASSESSMENT



Natural Scale 1:12,000 **Soundings in Fathoms**

LAKE HARBOUR

MARINE FACILITIES ASSESSMENT

LAKE HARBOUR

IAKE HARBOUR HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Lake Harbour Overview

Lake Harbour is a community of about 341 people on the south coast of Meta Incognita Peninsula at the southeastern end of Baffin Island. The hamlet is 120 kilometres south of Iqaluit and some 2,245 kilometres by air northeast of Yellowknife.

The south Baffin Inuit have inhabited the Lake Harbour area for centuries. During the early to mid-1 900's, the settlement grew as the Hudson's Bay Company opened a permanent store in 1911 and the RCMP set up a post in 1927. Despite a whale boat building operation between 1953 and 1960, many residents migrated to Frobisher Bay. During the 1960's, however, a number of families moved off the land into the settlement.

Lake Harbour's population has grown consistently over the past two decades. Local people still rely on hunting and fishing for their livelihood, but have also demonstrated their skills at ivory and soapstone carving and scrimshaw etching in the tradition of the whalers.

Waterfront Utilization and Demand

Traditional use of boats for hunting and fishing continues to dominate Lake Harbour's waterfront during the open water season. Sealift operations and some limited tourism activities also place demands on marine facilities.

Two attempts to fly into Lake Harbour on September 15 and September 16th were unsuccessful due to low cloud. Members of the NWT Transportation Infrastructure Strategy Committee were eventually successful in visiting the community and meeting with the Hamlet Council. Additional information was provided from

our discussion with the Renewable Resources Officer. Our findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Lake Harbour during the open water season. The following table summarizes sealift shipments levels to the community between 1984 and 1989.

SEALIFT SHIPMENTS TO LAKE HARBOUR
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	749	264	285	242	313	714
Petroleum Products (Bulk)	884	883	1,029	995	803	1,121

Dry cargo shipments have shown a consistent upward trend since 1985. The much higher level in 1984 reflects unusually high construction activity at that time. Bulk petroleum product shipments have remained fairly consistent and reflect a gradual upward trend over the 1984 to 1989 period.

We expect that sealift shipment levels to Lake Harbour will grow at approximately the same rate as the local population and economy. The community's population expanded at a rate of 9.2% annually between 1966 and 1976. The growth rate between 1976 and 1986 was lower (3.4% per annum) demonstrating a slow down in the rate of growth. According to the GNWT Bureau of Statistics, Lake Harbour's population is expected to grow at a rate of 2.5°A annually between 1989 and 2000.

Based on these forecasts, the fact that they exclude net migration and **our appreciation** of **economic** development opportunities, we have projected a 4 percent increase in sealift volumes between 1989 and 1992 which will slow slightly to 3% annually thereafter. Our forecasts for sealift activity between 1990 and 2000 are shown in the following table.

SEALIFT SHIPMENT FORECASTS TO LAKE HARBOUR
1990 - 2000
(Metric Tonnes)

	1989[1]	1990	1991	1992	1993	1994
■ Dry Cargo	296	308	320	333	343	353
■ Petroleum Products (Bulk)	884	919	956	994	1,024	1,055

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	364	375	386	398	410	422
■ Petroleum Products (Bulk)	1,086	1,119	1,152	1,187	1,222.	1,259

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics, after normalizing 1984 dry cargo volumes. Projections after 1989 our estimates of population/economic growth applied to the base year (1989).

The above dry cargo forecasts will vary as construction projects generate temporary demand increases in any specific year.

Local Boating Activity

Residents of Lake Harbour make frequent use of the waterfront to pursue traditional hunting and fishing activities. There were 160 locally registered domestic Char fishermen, 7 Narwhal, 34 Beluga Whale and 8 Walrus harvested in 1987/1988. Caribou harvest potential is 12,500 annually, the third highest in the Baffin Region.

These uses will grow as population increases and increase need for marine development.

The community is becoming interested in commercial fishing and in tourism as future means of economic development. The larger vessels now transport carving rock to the Hamlet and to Iqaluit for sale.

Currently there are some 35 fibreglass canoes, a few Lake Winnipeg style vessels and 3 long liner Peterhead vessels in the community. The lack of protection causes difficulties in launching and hauling out of the vessels. Lack of beach areas restricts available space for vessel storage.

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The community requested a breakwater and a landing flat in the area fronting the Bay Store.

Commercial Fishing Activity

No commercial fishing licences were issued in 1987/1988, however, the Renewable Resources Officer indicated the possibility of scampi fishing starting up.

Marine Tourism Activity

There is little tourism activity at present. A new Territorial Park in the Soper River Valley will encourage hiking activity. The hotel has 12 double rooms available which limits potential traffic.

Waterfront Utilization and Demand Summary

In summary, seasonal use of the waterfront is critical to the traditional activity of local residents. These activities are of major importance to this community due to lack of alternatives such as tourism. Nominal expansion is expected in sealift throughput and in local boating activity. There is unknown potential for a commercial fishery. The current users would benefit from development of marine facilities.

Site and Harbour Profile

Relevant characteristics of Lake Harbour and the extent to which marine facility development has taken place to date is summarized below.

■ Tides	Mean Tides	7.7M
	High Tides	12.6M
	Mean Water Level	6.6M
■ Tidal Zone	Beach slope is estimated grade 10%.	
■ Soil Conditions	Surface is generally sand/gravel with many boulders. Steep banks above HWL surround the entire community. Shoreline is exposed rock.	

- Site Topography — Lake harbour is located on the southern end of Baffin Island on the Meta Incognita Peninsula. It is located at the upper end of a drowned valley 23 km from the open sea. The settlement occupies a rocky foreshore with high bluffs impending the use of the beach.

- Ice — Ice movements from shore fast to outer, take place above line of low tide. No other information available.

- Exposure — Lake Harbour is generally fairly well sheltered although winds in northerly and southerly directions do influence unloading operations. Climate is relatively mild for the Arctic region.

- Littoral Drift — Not reported to be a problem.

No existing structures are reported. Anchor buoys are currently used for small boats. The sealift unloads on the area in front of the Hudson Bay Company which is considered to be quite small and overcrowded. It is also occupied by local small boats.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The main factor which governs the development of marine facilities at Lake Harbour is the very large tide range of 12.6 meters. This presents problems for all types of facility including a wharf type structure for small boat usage.

The main priority at this community is to provide some means of access to the boats at as much of the tide range as is practical. A breakwater should also be provided to offer protection to the boats.

Council requested some sort of floating structure. This may not be practical, however, in view of the very high tide range and the need for a long access gangway at low tides.

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Construction of a breakwater combined with timber cribs and a stepped ramp formed from timber cribs could provide protection to small boats together with access at most of the tide range. The slope of the stepped cribs would be set at a maximum of about 10% to permit boat haul-out.

The maximum height of the cribs should not exceed about 9 meters, which would mean that boats could access the ramps with approximately 5 meters of water above low water level. More information is also required regarding seabed elevations, to confirm these approximations.

We recommend that marine facility development in Lake Harbour incorporate the following minimum requirements:

- Provision of rock mound breakwater to offer protection to small boats;
- Construction of vertical face wharf type structure using timber cribs;
- Construction of ramp structure using stepped timber cribs to provide access at most of the tide range.

As a pre-requisite for any proposal at Lake Harbour further community input is required.

Sealift Dry Cargo

In view of the very high tide range, it is difficult to envisage what type of facility could **in practical terms** help this community as far as the sealift is concerned. Clean-up of the existing beach is required and construction of a local community wharf with a ramp structure may improve the sealift operation.

Sealift Petroleum

No proposal for a tanker mooring facility is presented here. Lake Harbour is clearly a problem site considering the very high tide range and extent of rock outcrops. Whatever type of facility is feasible, its cost would be extremely high and difficult to justify for this community.

Marine Facility Development Summary

These recommendations and development possibilities described above provide sound direction for marine facility development in Lake Harbour. They are summarized in sketch form in Figure LH.1.

Development Cost Estimates

Preliminary cost estimates have been prepared in 1990 dollars which reflect the development recommendations described above.

The following cost estimates are based on information available at present, which can only be considered as very approximate.

Details for availability of equipment and material, specific site location and further survey data would be required for more accurate estimates.

Local Facility

m	Excavation and Bed Preparation	$210,000
m	Construction of Rock Mound Breakwater	1,350,000
m	Construction of Timber Crib Wall & Ramp	520,000
m	Engineering & Survey	200,000
■	Contingency	400,000
		$2,680,000

Sealift Dry Cargo

No estimates have been prepared for these facilities other than beach cleaning and marshaling area improvement $25,000.

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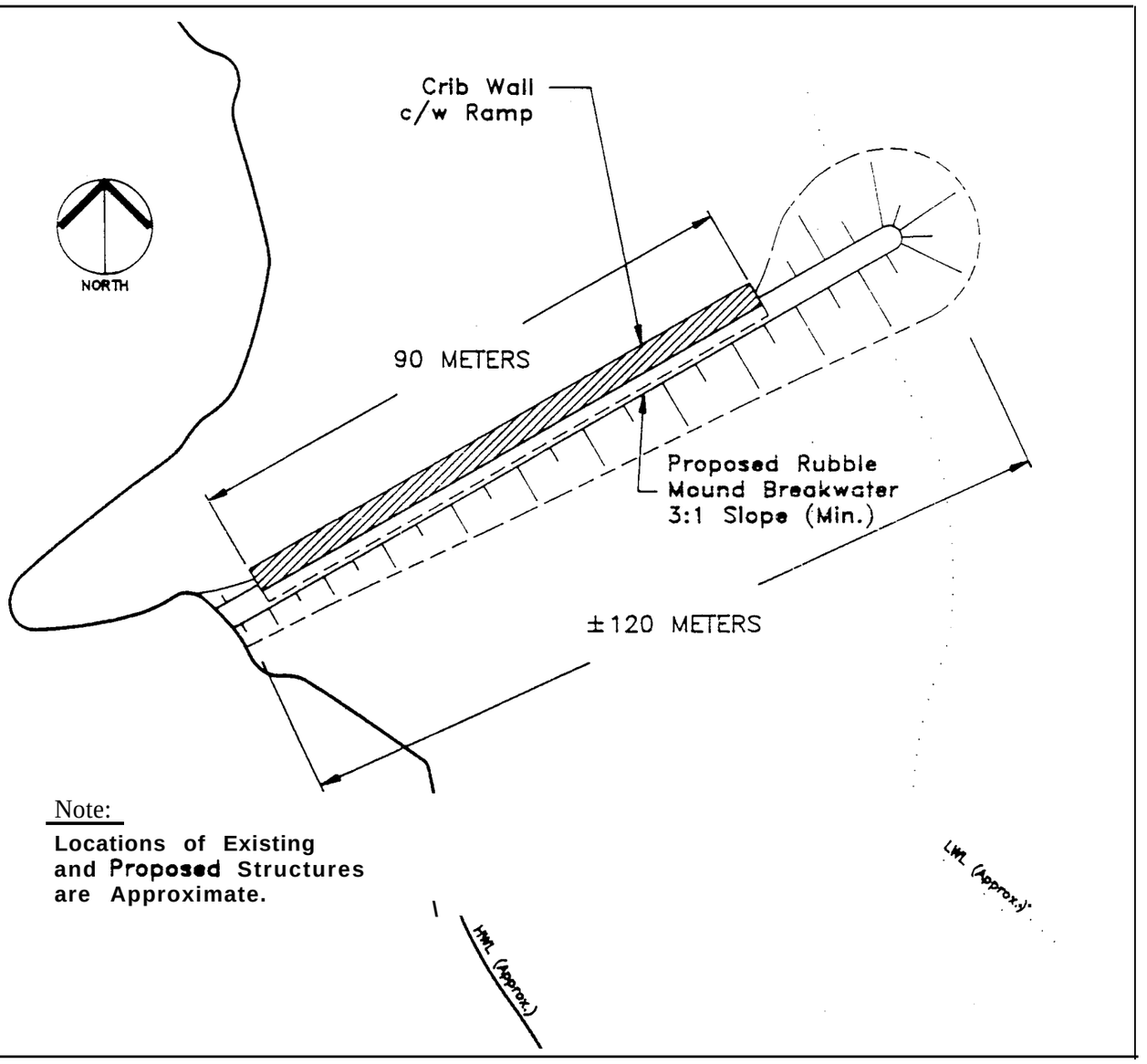

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LAKE HARBOUR CONCEPTUAL PLAN

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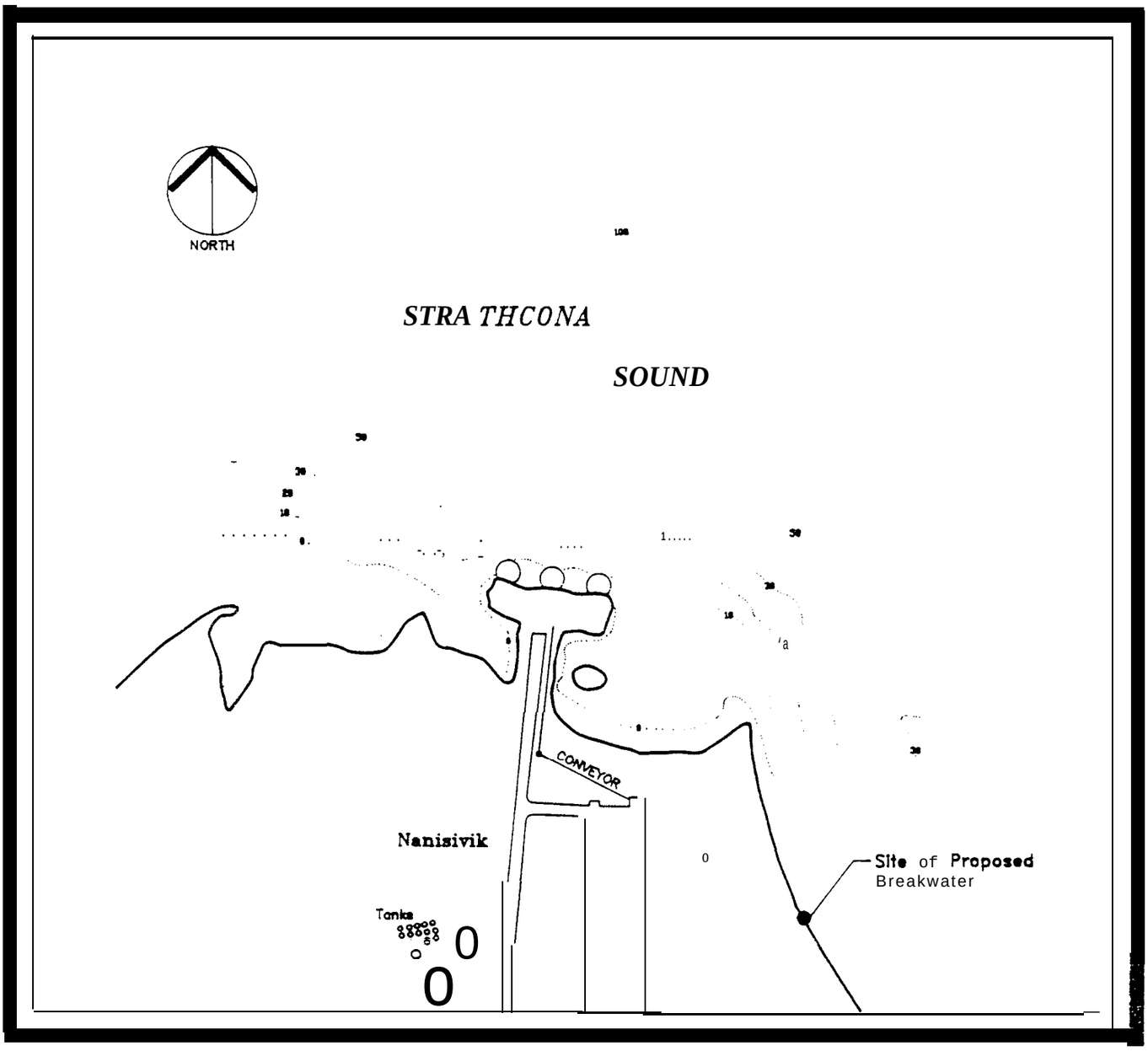
MARINE FACILITIES ASSESSMENT



Natural Scale **1:5000**

Soundings in Meters

NANISIVIK HARBOUR

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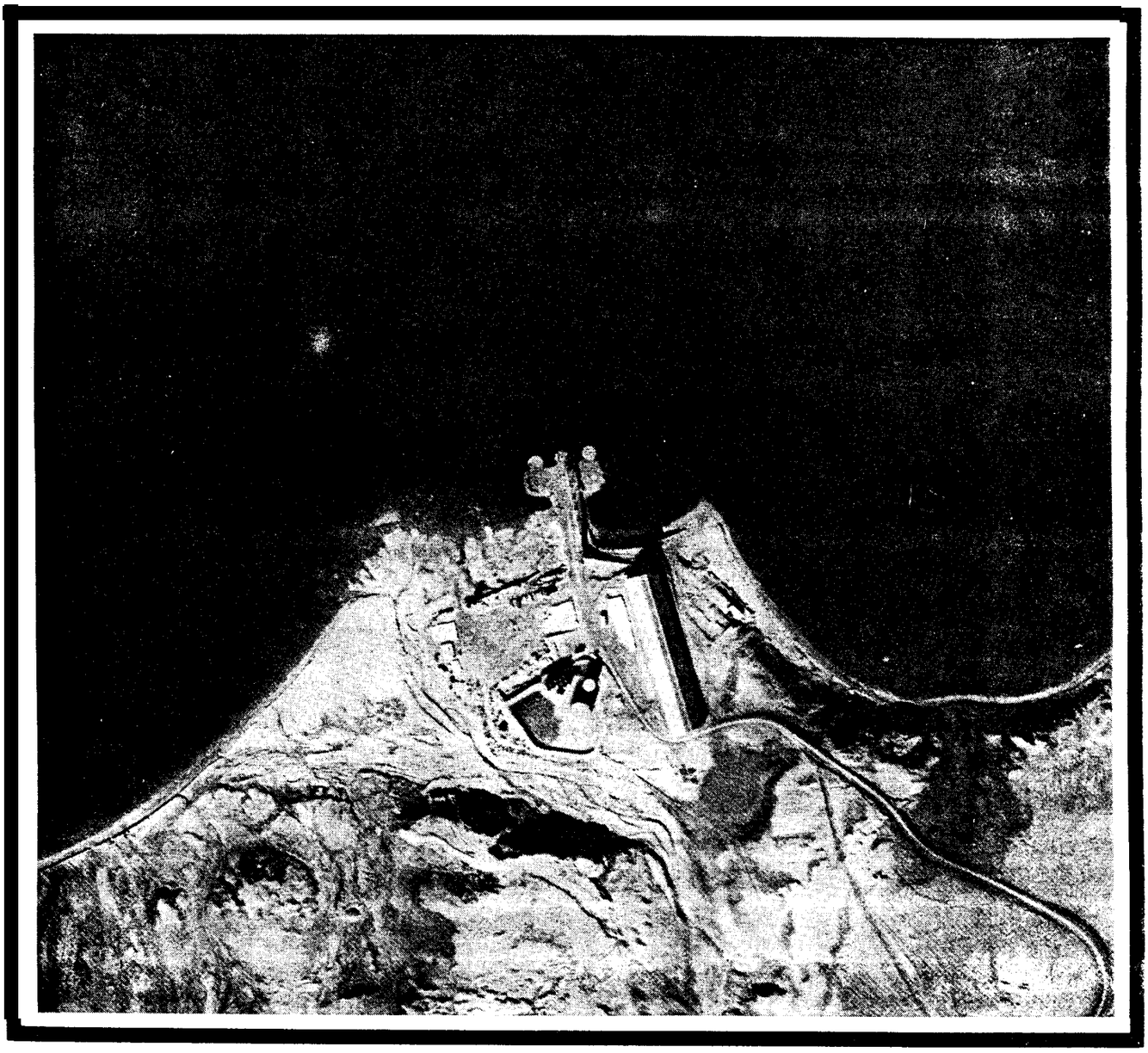
MARINE FACILITIES ASSESSMENT



NANISIVIK HARBOUR

NANISIVIK HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Nanisivik Overview

Nanisivik is a mining community of about 317 people located on Borden Peninsula at the northwest end of Baffin island. It is connected by road to Arctic Bay, some 40 kilometres away. On the shore of Strathcona Sound, a deep water fiord off Admiralty Inlet, the community is some 1,280 kilometres by air northwest of Iqaluit.

Nanisivik became established in 1974 when an agreement was signed between Mineral Resources International (MRI) and the Government of Canada which permitted a mine to be developed on the site. The townsite was developed as part of an industrial complex to mine, process and export silver, lead and zinc from. the deposit. Today the mine employs Inuit as well as southern workers on a rotation system.

Nanisivik Mines Ltd., a wholly owned subsidiary of MRI, holds the mining assets in Nanisivik. It constructed and maintains the townsite. The complex mines approximately 2,000 tonnes of ore daily.

Waterfront Utilization and Demand

Nanisivik's waterfront is comprised of two principal areas:

- the mine's deep-water load out facility; and
- the local boat harbour and beach.

The residents of the townsite rely only marginally on boating activity for traditional hunting and fishing since a wage economy predominates. The load out facility's dock is used for sealift unloading as wel! as ore exports.

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Our visit to Nanisivik, combined with our discussions in the Nanisivik/Arctic Bay area and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Nanisivik during the open water season. Significant levels of resupply are also flown in to Nanisivik's airport by the mine on a regular and year round basis.

Total sealift dry cargo tonnages vary considerably depending on the amount brought in by air, on mine site construction projects, and whether or not the M.V. Arctic picks up resupplies for the mine site in Montreal on its way to load ore at Nanisivik. Bulk petroleum product shipments are much more consistent as is the population base of the community.

The following table summarizes sealift shipment levels to Nanisivik over the 1984 to 1989 period.

SEALIFT SHIPMENTS TO NANISIVIK
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
■ Dry Cargo	147	350	68	31	46	58
■ Petroleum Products (Bulk)(1)	N/A	N/A	N/A	N/A	N/A	N/A

(1) Petroleum products are shipped in bulk to Nanisivik by the mine, not the sealift, and are not, therefore, included in this table.

Dry cargo volume peaks in 1984 and 1985 likely resulted from construction projects occurring over that period and less emphasis on the M.V. Arctic for resupply.

The GNWT Bureau of Statistics projects a population base expansion for Nanisivik averaging 1.8% annually between 1989 and 2000. This natural growth will occur and gradually increase sealift demand over the medium term. However, proven and potential ore reserves in the area have a definite life. Eventually the mine will close and the townsite, for all intents and purposes, will close unless other uses for the area can

be found. The latest date that this may occur is reported to be 1998...although some estimate that reserves will run out in the next four or five years.

The Canadian Military is examining the possibility of setting up a training base in Nanisivik. Other locations are also being considered. If such a development occurs, it would ensure the longer term existence of the community. Otherwise, Nanisivik's future is uncertain, and we understand that the Military requires a site well before optimistic estimates of ore reserve life will allow.

Our forecasts of sealift shipments reffect the future uncertainty of Nanisivik and assume that most marine resupply needs will be carried by the government organized sealift as opposed to the mine's ore carrier. They are summarized in the following table.

SEALIFT SHIPMENT FORECASTS TO NANISIVIK
1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994(2)
■ Dry Cargo	280	285	290	295	300	306
■ Petroleum Products (Bulk)(3)	N/A	N/A	N/A	N/A	N/A	N/A

	1995(2)	1996(2)	1997(2)	1998(2)	1999	2000
■ Dry Cargo	311	317	323	328	Nil	Nil
■ Petroleum Products (Bulk)(3)	N/A	N/A	N/A	N/A	N/A	N/A

(1) 1989 estimates are based on an average of 1984 and 1985 dry cargo levels increased by 3% annually and a trend line analysis of 1984 - 1988 bulk petroleum statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

(2) Shipment levels in these years are uncertain and depend on the mine continuing in operation.

(3) Petroleum products are shipped in bulk to Nansivik by the mine, not the sealift. This is expected to continue and, therefore, these forecasts are not included in the above table.

The dry cargo forecasts shown above will vary depending on local construction projects. But these will be less likely to occur as the mine approaches its practical life. All forecasts will change if the Canadian Military decides to locate its training centre at Nanisivik.

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Local Boating Activity

A number of families have boats located in Nanisivik and use them infrequently for traditional hunting and fishing. These activities are far less important for social and subsistence reasons than in most other Eastern Arctic communities since all families that own boats are also involved in mine complex employment. The townsite is also relatively far (...a few kilometres...) from the beach restricting easy access.

We do not expect the level of local boating activity to change in Nanisivik until the mine closes and, possibly, the Military sets up operations. **In** both cases, local boating activity will decline as many owners relocate to Arctic Bay.

Commercial Fishing Activity

There is no commercial fishing activity taking place in Nanisivik and none is projected **to develop.**

Marine Tourism Activity

While tourists do visit the MRI mine site and the Arctic Bay-Nanisivik marathon brings many visitors to the area for a short period in the Summer, boat tours out of Nanisivik Harbour are non-existent. This is not expected to change. Regardless of what happens to the Nanisivik townsite, tourists who wish to hunt, fish or sightsee are expected to take advantage of existing and future opportunities available in Arctic Bay thereby impacting on marine facility needs in that community and not in Nanisivik.

Waterfront Utilization and Demand Summary

in **summary, waterfront utilization in** Nanisivik **will** continue as is without any significant change until the **status of mining** activity in the community changes. The mine is expected to close in the mid to late **1990's resulting in the townsite being** closed unless the Canadian Military decides to locate its training base in the settlement.

Site and Harbour Profile

Relevant characteristics of Nanisivik Harbour and the extent to which marine facility development has taken place to date is summarized below.

▪ Tides	Mean Tides	1.5M
	Large Tides	2.5M
	Mean Water Level	1.2M
▪ Tidal Zone	Beach gradient approximately 10%.	
▪ Soil Conditions	Surface soils consist of sand shale and dolomite drift.	
▪ Site Topography	The community is situated on the south shore of Strathcona Sound, a deep water fiord off Admiralty Inlet and the Borden Peninsula of Baffin Island. The area is bordered by high sedimentary cliffs.	
▪ Ice	No information was available on ice conditions.	
▪ Exposure	Winds are predominantly from ?he northwest and severe gusting can occur.	
▪ Littoral Drift	No information available but does not appear to be a problem.	

A **major deep-sea** wharf is located here constructed of gravel filled steel sheet pile cells connected to shore with a rock and gravel causeway. The depths alongside exceed 9.1 metres. The wharf is equipped with a 300-metre long conveyor loading system for he lead zinc ore.

Additional rock has been placed along the shore side of the cells to combat erosion or ice damage.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use,

Local Community Use

As no community meeting took place at this site it is difficult to assess the actual use and requirements. It appears however that there are only a few local users, with small boats for recreation and hunting. These vessels can be kept beached. Should the level of activity increase here we recommend that marine facility development in Nanisivik incorporate the following minimum requirements:

- Construction of a rubble mound breakwater east of the mine wharf;
- Construction of gravel ramp to assist the launching and hauling out of small boats.

A plan view of the breakwater and ramp developments recommended in Nanisivik is includes in Figure NS.1.

Sealift Dry Cargo

The sealift does not require facilities at this site. The exiting wharf is suitable for any conceivable dry cargo and petroleum delivery required to the site.

Development Cost Estimates

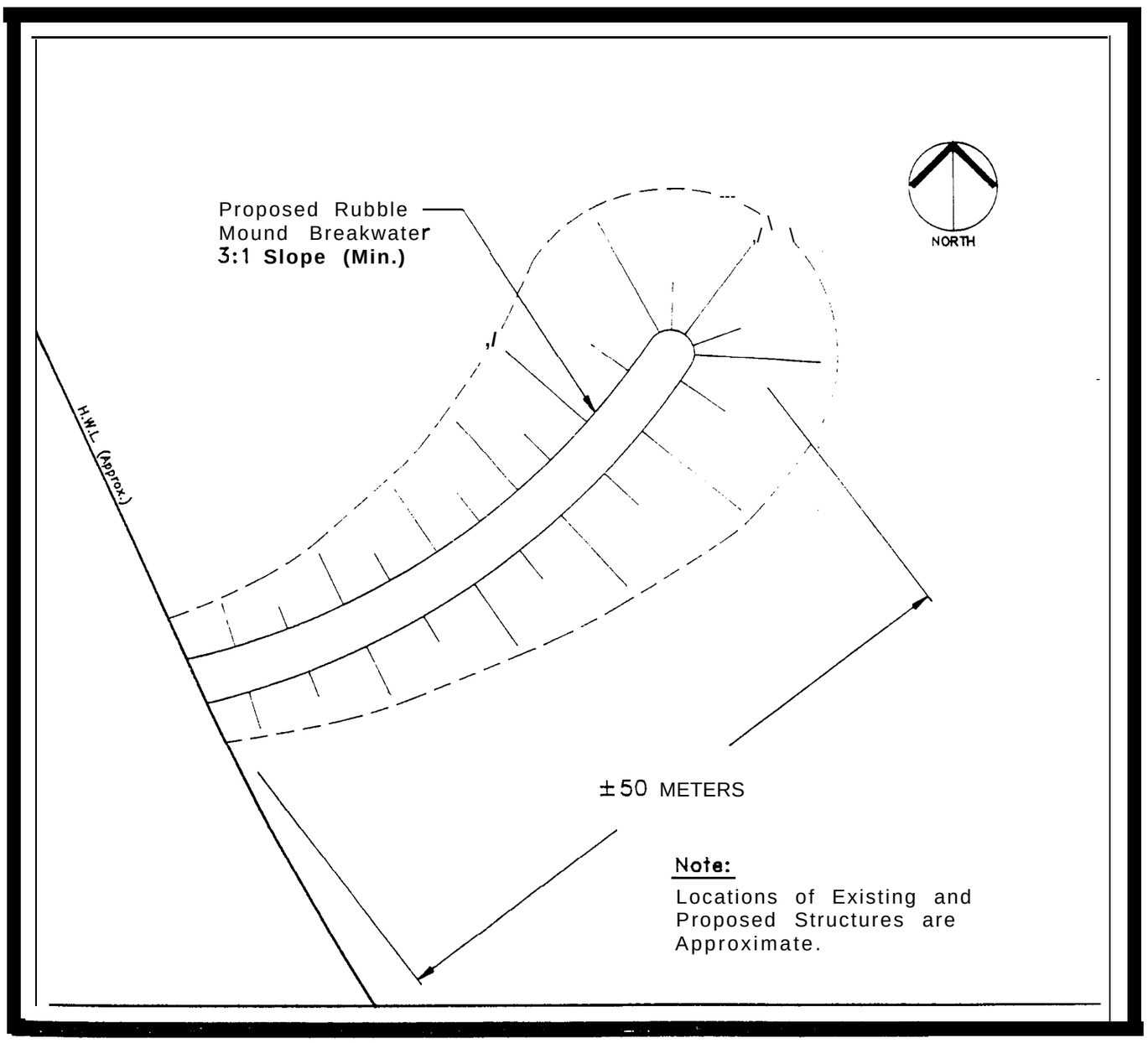
Preliminary cost estimates have been prepared, in 1990 dollars, which reflect the development recommendations and possibilities described above. These are summarized below.

Local Facility

Excavation & Site Preparation	$20,000
Construction of Rock Breakwater	60,000
Ramp Preparation	10,000
Engineering & Survey	8,000
Contingency	16,000
	$114,000

Sealift Dry Cargo and Petroleum

No developments are recommended for the sealift dry cargo or petroleum operations at this site as the existing wharf adequately meets the needs.

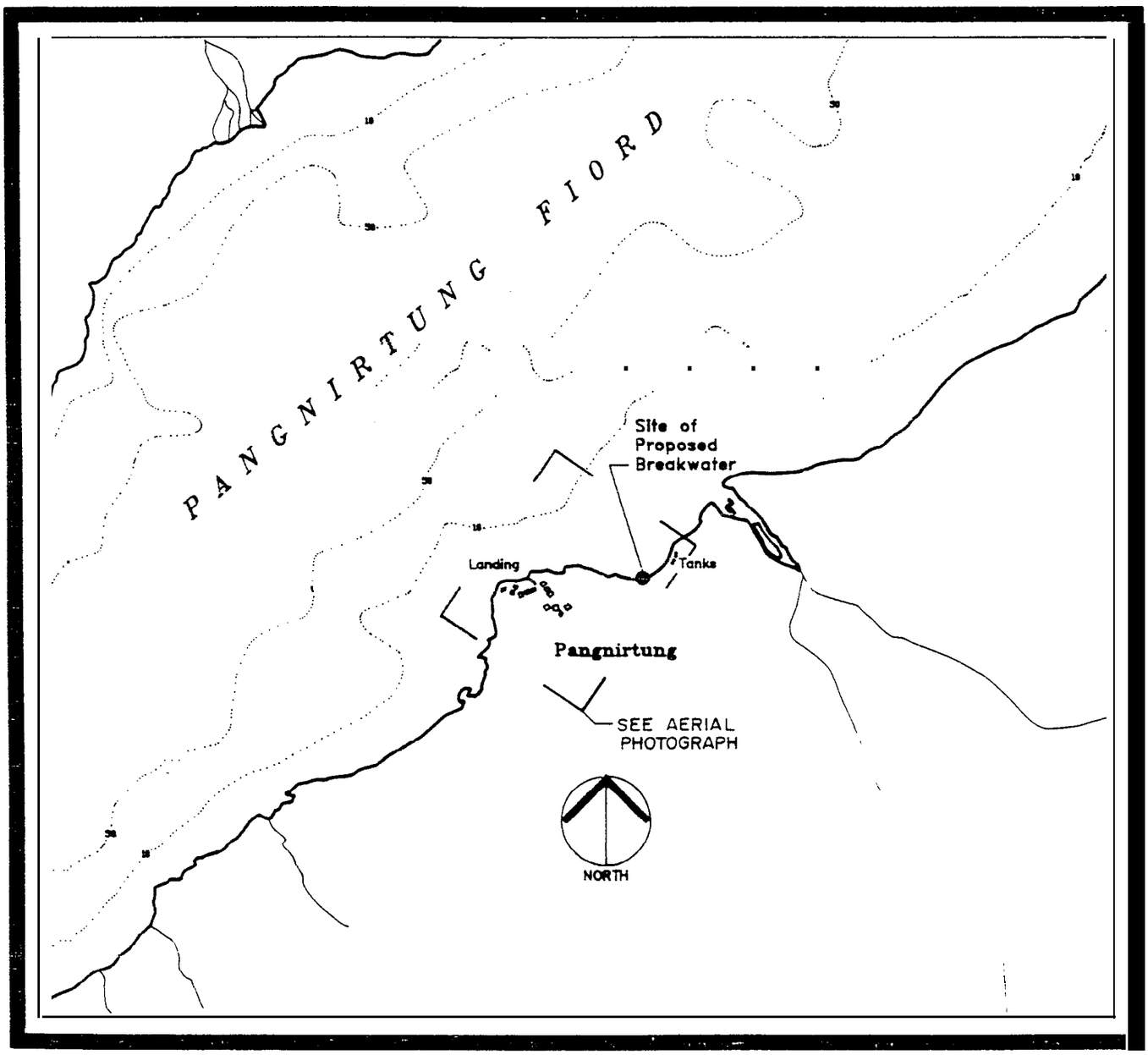


Natural Scale 1:500

NANISIVIK
CONCEPTUAL PLAN

Reid Crowther

MARINE FACILITIES ASSESSMENT



Natural Scale 1:36,585 **Soundings in Fathoms**

PANGNIRTUNG HARBOUR

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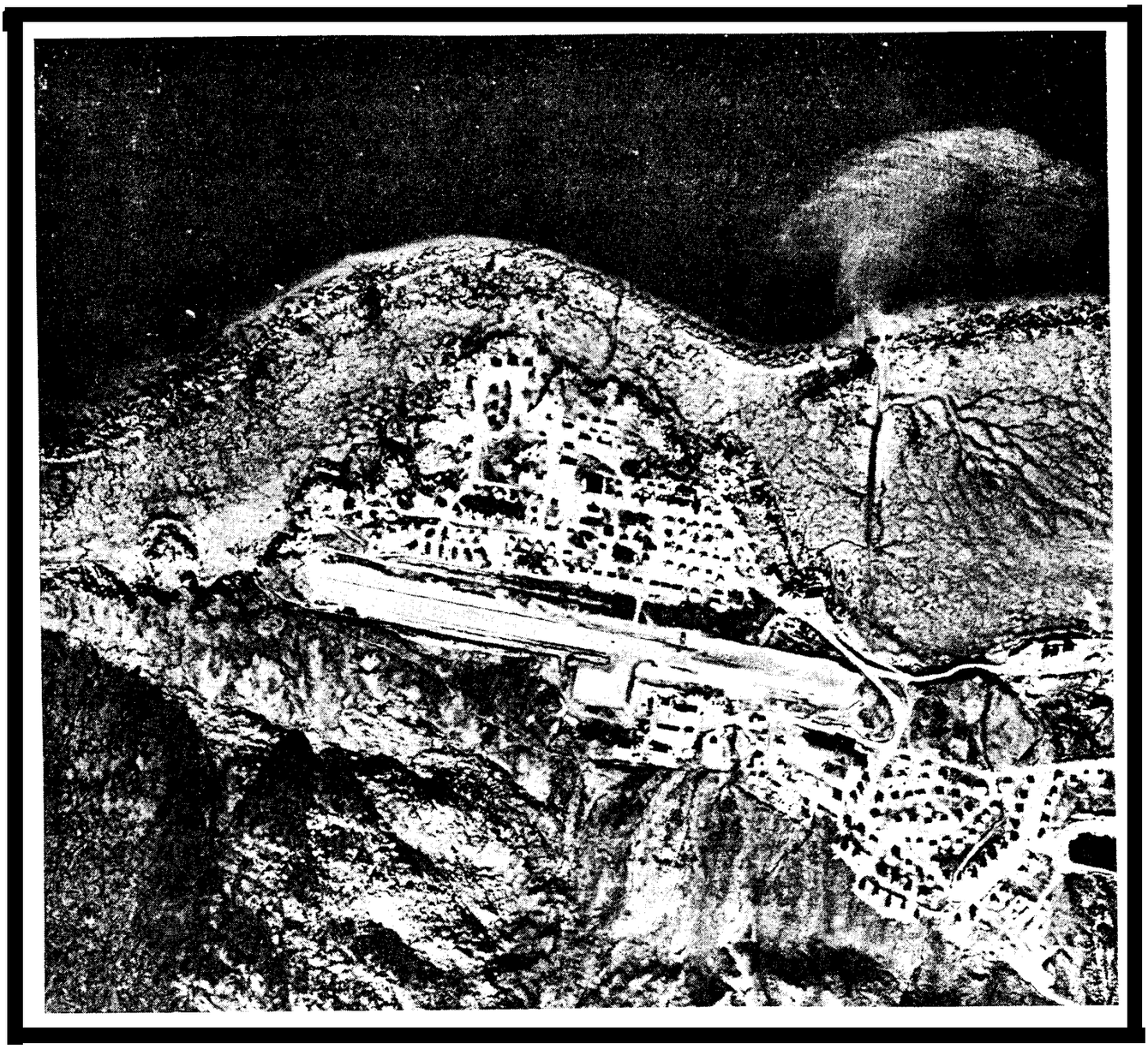
MARINE FACILITIES ASSESSMENT



PANGNIRTUNG HARBOUR

PANGNIRTUNG HARBOUR
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Hamlet of Pangnirtung Overview

The Hamlet of Pangnirtung is home to some 1,000 people and located 300 kilometres by air northeast of Iqaluit on the southern shore of Baffin Island's Cumberland Peninsula.

Having a long history, Pangnirtung now has become one of the better known communities in the Eastern Arctic and one of the Baffin Region's most popular tourist destinations. The hamlet is the access point for scenic Auyuittuq National Park and the local Inuit have become well known for their weaving and carving talents. Pangnirtung's local economy is dominated by marine mammal harvesting and tourism. Traditional pursuits such as fishing and hunting remain a strong part of the local social fabric.

Waterfront Utilization and Demand

As **with most Eastern Arctic communities, Pangnirtung has traditionally relied** on access to the sea for its livelihood and well being. These requirements are expected to continue and, in fact, to place increasing pressure on waterfront utilization and facilities.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Pangnirtung. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Pangnirtung during the open water season. Total dry cargo tonnages to the hamlet vary depending on local development projects **which are underway. A gradual and steady increase in dry cargo shipments to** Pangnirtung **is evident,** however, as demonstrated in the following table.

SEALIFT SHIPMENTS TO PANGNIRTUNG

1984-1989

(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	870	1,718	976	1,143	1,838	1,372
Petroleum Products (Bulk)	2,764	2,300	2,537	2,9S9	2,929	3,615

Bulk petroleum product shipments to the community are also growing steadily as evidenced in the above table. Population growth is forecast to increase steadily, which, with economic base growth, can be expected to generate higher volumes of inbound bulk petroleum products in the years ahead.

Both dry cargo and bulk petroleum product imports to Pangnirtung are expected to grow in relation to population base expansion. The hamlet has experienced one of the larger growth rates in the Northwest Territories (e.g. average of 12.9% per annum between 1966 and **1971,** 3.2% per annum between 1971 and 1976, and 4.5°A per annum between 1976 and **1986).** Population projections by the Northwest Territories Bureau of Statistics suggest a population growth for Pangnirtung of 2.8% per annum over the **10-year** period ending in 1996. This is more than double the **1.3%** per annum population growth expected for the Northwest Territories in total over the same period and will increase the hamlet's population base by about one-third over the next 10 years.

Our sealift shipment forecasts are based on these population growth expectations. Cargo volumes will **fluctuate annually as development projects occur.** However, steady growth in cargo throughput over the longer term is a trend which is supported both by past throughput expansion and the expected population base increase.

Sealift shipment levels to Pangnirtung are projected in the following table over the 1990 to 2000 period.

SEAL I FT SHIPMENT FORECASTS TO PANGNIRTUNG

1990 - 2000

(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
Dry Cargo	1,717	1,765	1,814	1,865	1,918	1,971
Petroleum Products (Bulk)	3,014	3,098	3,185	3,274	3,366	3,460

	1995	1996	1997	1998	1999	2000
Dry Cargo	2,026	2,083	2,141	2,201	2,263	2,326
Petroleum Products (Bulk)	3,557	3,657	3,759	3,864	3,973	4,084

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

Local Boating Activity

Residents of Pangnirtung make frequent use of the waterfront during the open water season. More than 80 boats are reported to be located in the community including both Lake Winnipeg boats and canoes. Three larger boats are currently used for commercial fishing and other purposes.

Local boating activity appears to be increasing. These activities include subsistence fishing and hunting, commercial fishing, guiding/outfitting and sightseeing. Traditional pursuits remain strong in Pangnirtung and can be expected to expand with the population base, increasing the need for basic marine facilities to accommodate local boating activity and to enhance safety. The hamlet indicates that rescue response is now dependent on tide levels (i.e. difficulty is experienced in responding at LWL). Community representatives also indicated that protection is required for local boats against the wind and waves that occur, particularly during high east wind conditions.

Local boats used to support subsistence hunting are reported to have difficulty unloading, some carrying loads of caribou or other animals or marine mammals. Clearly, some improvement in facilities which makes local boat unloading easier would be beneficial to Pangnirtung fishermen and hunters. Facilities which would assist in the haul-out of local boats was also mentioned as something that would help hamlet residents.

Finally, Pangnirtung representatives expect larger boats will become more popular in the future, especially with improved marine facilities. This demand is partially addressed below under "commercial fishing activity". **A** freight connection to Iqaluit is currently operational in season which local people **expect** will grow. Appropriate marine facilities would enable unloading at all tide levels. The twice seasonal service unloads only at HWL at the present time.

Commercial Fishing Activity

Currently commercial fishing activity in Pangnirtung is growing in importance. Local representatives believe that this activity will grow more readily as and when proper marine facilities are established. Locally based Cumberland Sound Fisheries employes up to 13 people at the present time.

Commercial fishing in Pangnirtung now focuses on shrimp and scallops in the summer and a sizeable turbot fishery during the winter. Off-loading of the catch in the summer can be difficult during bad weather since, for example, scallops are off-loaded into canoes and then pulled up the beach by all terrain vehicles.

The future of commercial fishing in Pangnirtung is uncertain, but we believe that current levels will be maintained and that some growth is likely. The community itself is optimistic. The growth will likely depend on the results of exploration fishing (e.g. for shrimp, turbot and cod) and the level of future subsidization of the fishery. Regardless, improved marine facilities which offer prOteCtiOn and proper moorings for the larger local boats, and which facilitate commercial fishing boat unloading, would clearly be advantageous to those local fishermen involved. Transporting fuel from shore to these larger boats is also a difficult task at present which could be improved with new marine facilities.

Tourism Activity

Tourism in Pangnirtung has evolved as an important economic activity responsible for local income and employment. Attractively located close to Auyuittuq National Park, having a reputation for quality arts and crafts produced locally and with good tourism support infrastructure (e.g. hotel, campground, stores... including The Weave Shop and The Print Shop, the new Interpretive Centre and local guides/outfitters), the community has purposely established itself as a tourism destination in the Eastern Arctic. Its popularity in this regard is expected to grow with tourists placing even greater demands on local boating activity for sightseeing, park access, hunting, fishing, wildlife tours, adventure tours and **guiding/outfitting. A number of fishing camps are located nearby including the** Inunguaruluk **Char Fishing Camp** which is a one hour boat ride from Pangnirtung on the shore of Cumberland Sound.

The main constraint to tourism development in Pangnirtung is accommodation capacity (approximately 40 in the hotel and 60 in the campground) and quality marine facilities which facilitate tourist use of the local boating capabilities. A number of conclusions from a recent tourism study(') of the Baffin Region are important to note as follows:

- the community generates the 3rd highest economic value from package tours in the Baffin Region (...after Resolute Bay and Pond Inlet);

- the hamlet is the 2nd most popular Baffin Region destination (...after Iqaluit...) and is significantly ahead of other Baffin communities; and

- Pangnirtung has the 4th highest facility rating in the Baffin Region at 3.9 next to Nanisivik (5.0), Clyde River (4.0) and **Resolute** (4.0).

Indeed, this study showed that Pangnirtung is a more popular "vacation destination" than even Iqaluit. It goes onto say, however "...that Pangnirtung has the ability to attract
tourists by virtue of its location, scenery, proximity to the park and so on. However, it does not have the facilities to encourage visitors to spend very much time there. This is exemplified by the fact that the average length of stay in Pangnirtung was only 5.4 nights, whereas the average length of stay in Iqaluit was 12.4 nights.

Tourism development potential in Pangnirtung is considerable, but facility development (...including marine facilities...) needs to take place and local/regional tours need to be expanded to capitalize on this important, but seasonal, economic opportunity.

Waterfront Utilization and Demand Summary

In summary, seasonal use of the Pangnirtung waterfront is important to the community for traditional pursuits, resupply and economic activity. Growth in all demand sectors is expected which can be encouraged in several areas by improved marine facilities. Waterfront development can also improve the quality of life for local residents and make marine activities safer for those who become involved. Hamlet Council has identified the need for breakwater construction, channel extension with a boat basin at the inner end and removable floats.

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(1) "Baffin Visitors Survey -1988"- Acres International - Prepared for G. N.W.T. - November, 1988.

Site and Harbour Profile

Relevant characteristics of Pangnirtung Harbour and the extent to which marine facility development has taken place to date are summarized below.

- **Tides**

Mean Tides	4.8M
Large Tides	7.7M
Mean Water Level	3.5M

- **Tidal Zone** From HWL, to 1/3 of the distance out to the LWL, the grade varies from 5% to 10%. From the 1/3 point out to LWL a very flat grade of about 2% is experienced.

- **Soil Condition** A large number of boulders are found within the tidal zone, up to 1 M in diameter. Soils consist of mixed clay/silt/sand. Rock outcrops were sighted at the inner end of the excavated channel. Boulders extend the full length of the settlement shore parallel with the LWL contour. Extensive tidal flats drop off sharply inshore **from the LWL** Above HWL, the shoreline rises steeply with rock outcrops to massive solid rock.

- **Site Topography** The settlement is located in a fiord on the north-east end of Cumberland Sound. The upland rises to medium/high mountains with an ice cap at the north-east end of the fiord. Severe winds blow down into the upper end of the fiord.

- **Ice** First year ice is typical with a possibility of some second year ice. No ice damage was observed and no information on this was provided. There will be a pile up in the spring within the tidal flat area, depending on wind/tidal conditions. Open water typically occurs from mid-July to the 3rd week in September.

- **Exposure** At LWL the main beaching area is exposed from the east and the west. Exposure from the west reduces progressively shoreward due to a rock point. Strong east summer storms cause problems in the main landing area.

- Littoral Drift — **Tidal currents and wave action pick** up some material from the tidal flats. Hamlet Council reports that the channel dug by bulldozer has little maintenance or infilling. It is likely there is a slow infill of the channel from littoral drift.

A channel has been excavated by the hamlet within the main beaching area. A bar can be seen across the outer end of the channel in line with boulders at LWL Inshore from the bar, the excavation is deeper with some shallow spots scattered along the channel.

The channel becomes shallower as it gets closer to the change in grade inshore and disappears entirely about 50 meters from it. There is a rock outcrop on the immediate west side of the projected line of the access channel.

Development Recommendations

Marine facility development recommendations prepared for Pangnirtung during the study are summarized in the following paragraphs according to their primary use.

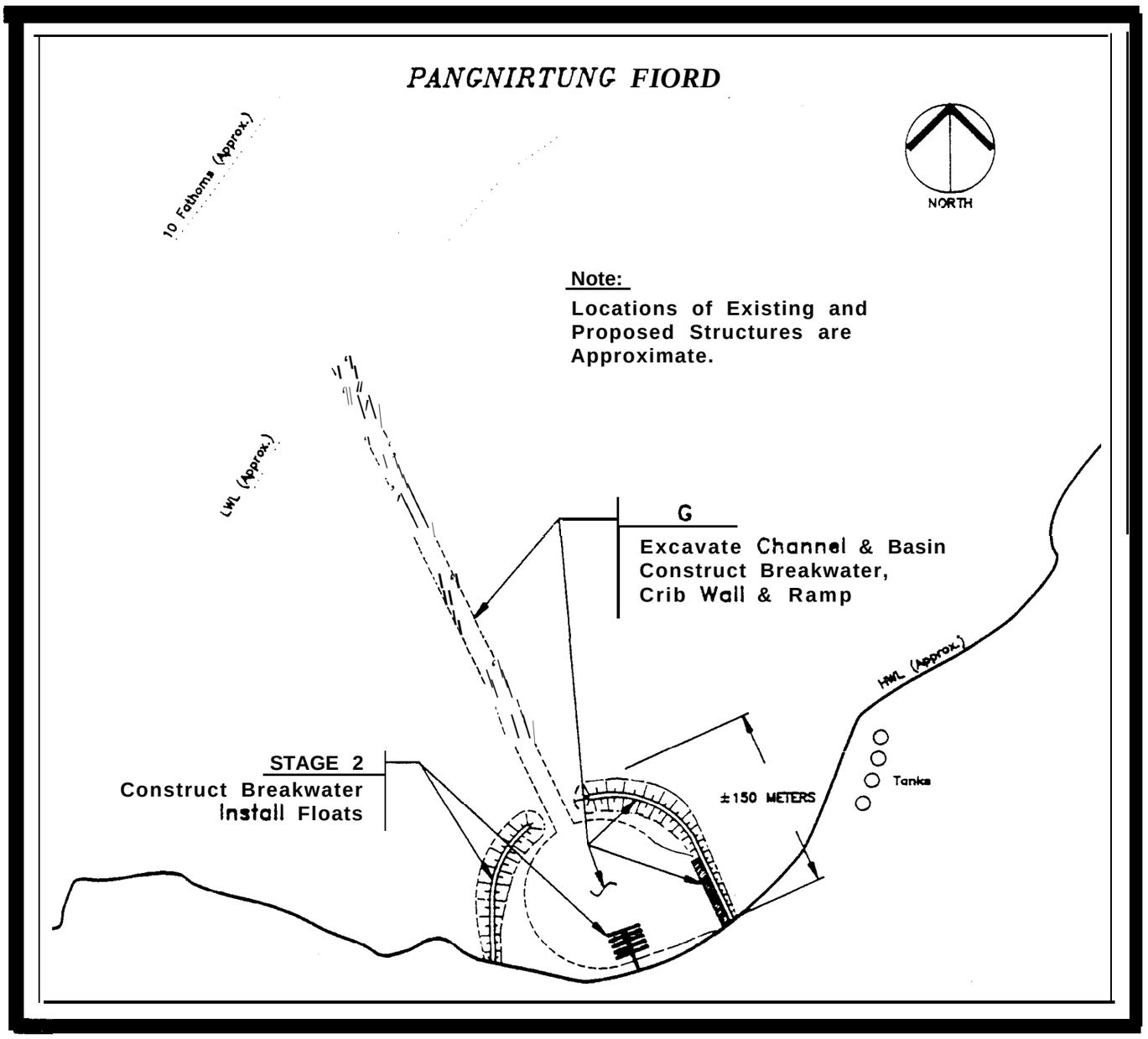
Local Community Use

Our evaluation of community needs and growth combined with our assessment of local conditions and marine development opportunities has enabled us to prepare a number of specific recommendations for marine facility development in Pangnirtung. Those which will benefit the community directly are outlined below.

The main factors affecting marine facility development at Pangnirtung are the relatively high tidal range (i.e. up to 8-metres) and the extent of the tidal flats. The distance from HWL to LWL is roughly 600 meters.

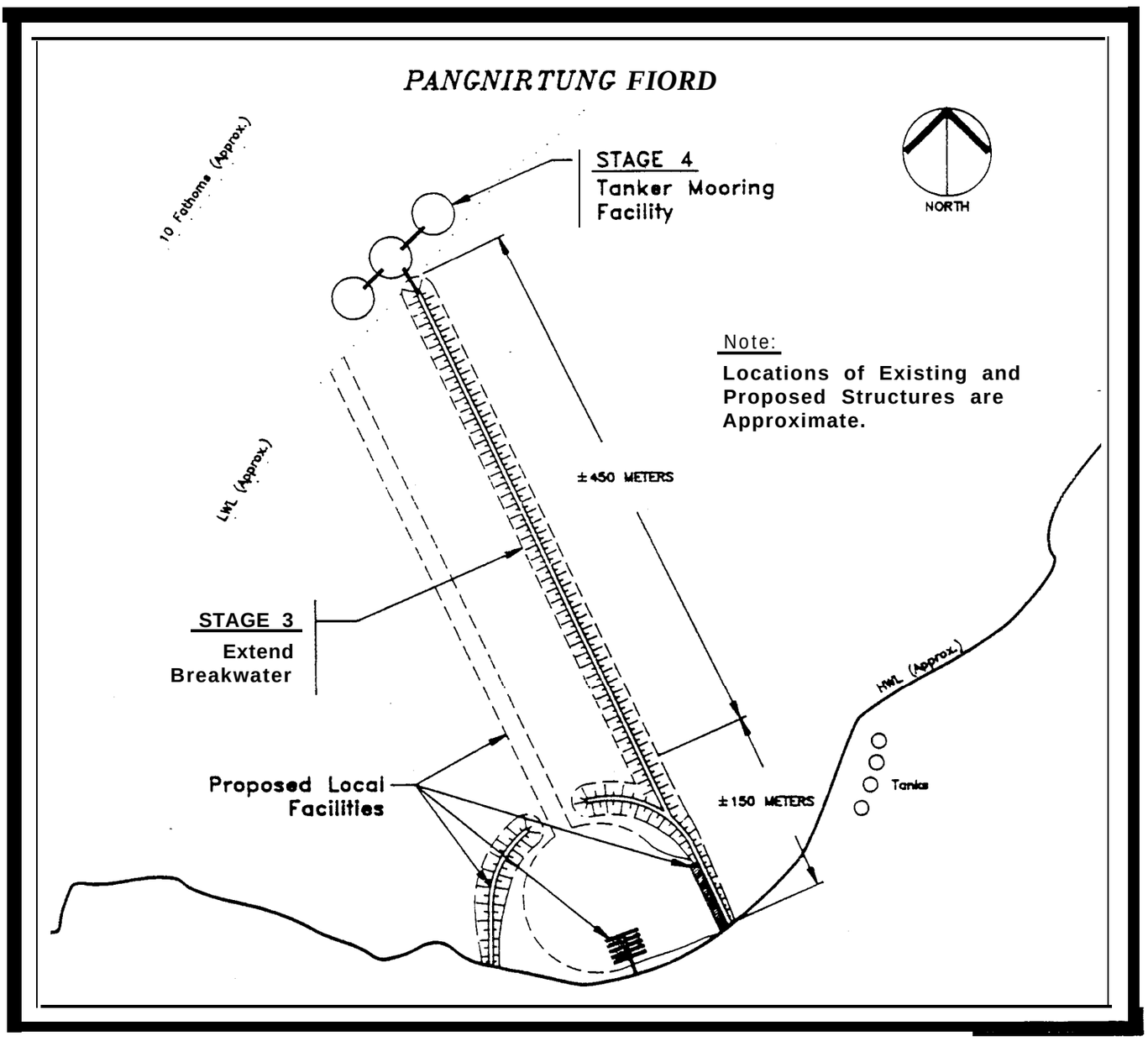
The current arrangement of using a channel for access at low water levels is a practical solution for smaller vessels. However, no protection is offered to these vessels, the channel is limited in its extent and is potentially vulnerable.

Pangnirtung is one community where adequate pre-engineering is essential. Concepts presented here involve extensive excavation of the existing channel and provision of an inner basin. The feasibility of excavation must be established prior to the adoption of this scheme.



Natural Scale **1:5000** **Soundings in Fathoms**

PANGNIRTUNG CONCEPTUAL PLAN LOCAL FACILITIES



Natural Scale 1:5000 **Soundings in Fathoms**

PANGNIRTUNG CONCEPTUAL PLAN SEALIFT FACILITIES

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We **recommend that marine facility development** in Pangnirtung incorporate **the following minimum** requirements during the initial phase:

- Excavation and extension of the existing channel to permit access at most tide conditions.

- **Excavation of a boat basin** at the south end of the completed channel.

- Construction of a rubble mound breakwater on the east side of the proposed channel and basin to provide the necessary protection to boats. The inner core of this structure could likely utilize material excavated from the basin. The breakwater would run approximately one-third of the way out from shore to LWL where the grade change occurs.

- Provision of a vertical face on the inside of the breakwater together with an adjacent sloped ramp which would permit the haul out and launching of boats. This would be constructed from timber cribs built in modular form and filled with suitable material, possibly that excavated from the channel and basin.

A plan view of Phase I marine facility development recommendations in Pangnirtung is provided in Figure PGI.

Future development in Pangnirtung Harbour is recommended to improve local community use once the initial phase of development is complete. This subsequent action is summarized as follows:

- Construction of a similar rubble mound breakwater on the west side of the basin.

- Provision of floats for use in the basin. It is envisaged that these floats would be of sturdy construction, but light enough to permit removal during the fall. Access arrangements by means of a gangway would also have to be provided to permit usage at all tide levels.

A plan view of this Phase II development recommendation is provided in Figure PG.2.

Sealift Dry Cargo

Current arrangements for the sealift involve beaching the barges and working the tides. This restricts times when unloading operations can be carried out to a few hours either side of high water, but otherwise the operation reportedly works reasonably well.

Improvement of the existing channel and provision of a sloped ramp adjacent to the breakwater would certainly benefit the sealift in that cargo could be unloaded at most of the tidal range. Protection would also be offered to the barge.

Improvement to the marshalling/storage area on shore is also recommended and would benefit the sealift operation.

Future development may justify the continuation of the breakwater out to the LWL, so that the sealift could unload directly to vehicles located on top of the structure. The present anchorage has poor holding and the area is subject to sudden gales.

Sealift Petroleum

For bulk oil delivery, tankers moor approximately 0.6 miles from the tank farm, with stern lines to the reef, and pump direct to the shore through 1,200 metres of floating hose. Stern lines can only be secured two hours either side of low water and hoses can be set or recovered one hour either side of high water.

In order to provide a mooring facility for oil delivery, major construction would be necessary. Certainly, the breakwater proposed for local community use would need to be extended out beyond the LWL to deep water. Effective mooring for the tanker could be provided by constructing circular sheet pile cells at the end of the causeway, which would then be backfilled with free-draining material. Such a structure would, however, be vulnerable to the actions of ice flows.

Marine Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Pangnirtung Harbour.

Development Cost Estimates

Preliminary cost estimates have been prepared, in 1990$, which reflect the development recommendations and possibilities described above. These are summarized below in the following paragraphs.

Pangnirtung is fairly well off as far as excavation type construction equipment is concerned. The community could probably, therefore, handle the construction of the local facility. Further stages of construction for the sealift, and especially a facility for tanker mooring, would require the use of outside labour resources as well.

Our cost estimates are based on community labour constructing the initial phase of development and, possibly, the first part of the sealift facility. An outside contractor would have to be mobilized to construct the tanker facility, which is the most difficult to estimate accurately.

The following is a summary of our preliminary cost estimates, in 1990 dollars, for marine facility development in Pangnirtung:

Local Facility

1st Stage

▪ excavation of channel and basin	$600,000
▪ construction of breakwater on east side	**550,000**
▪ construction of crib wall and ramp	**375,000**
▪ engineering and survey	150,000
▪ contingency	**300,000**
	$1,975,000

2nd Stage

▪ extend breakwater on west side	**$500,000**
▪ floating pontoons and ramp/gangway	**150,000**
▪ engineering and survey	**70,000**
▪ contingency	**:40,000**
	$910,000

Sealift Dry Cargo

▪	extend breakwater to deep water	$1,800,000
▪	engineering and survey	180,000
▪	contingency	360,000
		$2.340,000

Sealift Petroleum

(Assuming the causeway for sealift dry cargo is already built)

▪	mobilization	$500,000
▪	sheet pile cells and fill	1,400,000
▪	access **arrangements/connections**	**200,000**
▪	engineering and survey	**210,000**
▪	contingency	420,000
		$2,730,000

Clearly, the capital investment requirements increase significantly for the major facilities required to accommodate sealift operations. Local facility development recommendations are more reasonably priced, will provide local social and economic benefits and will also facilitate, to some extent, the dry cargo unloading operations associated with the annual sealift.

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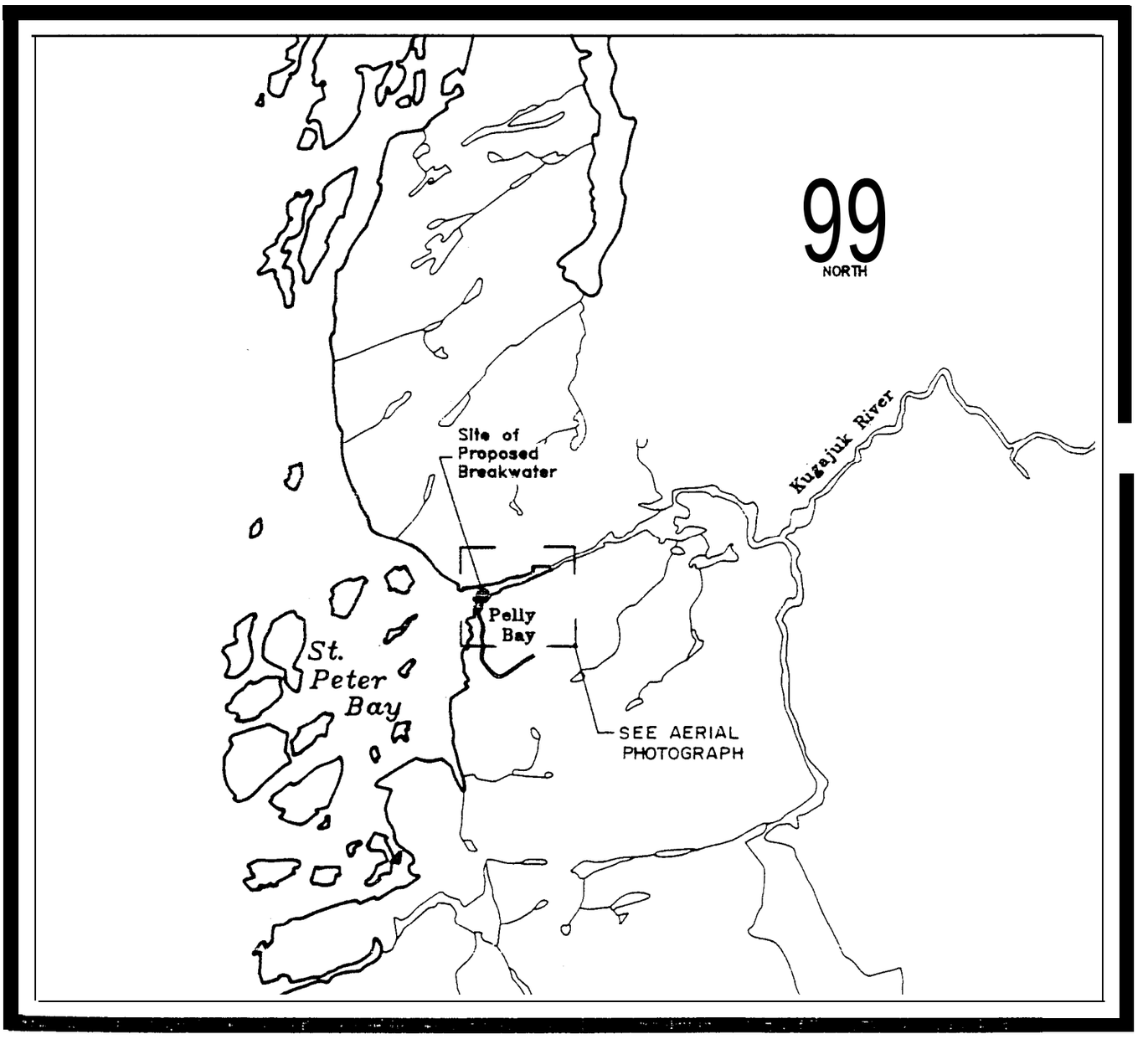
MARINE FACILITIES ASSESSMENT



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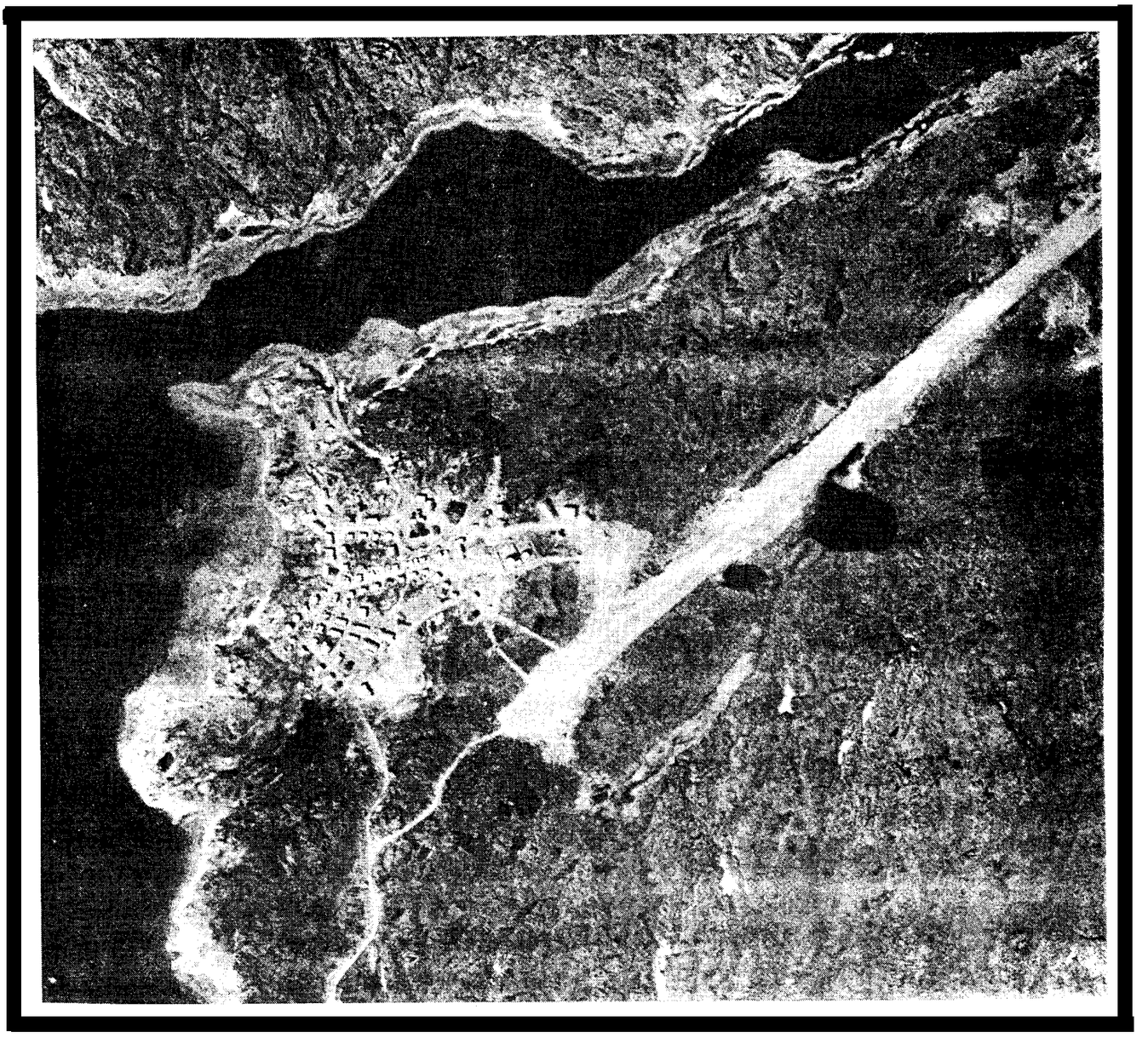
PELLY BAY

MARINE FACILITIES ASSESSMENT



PELLY BAY

PELLY BAY HARBOUR
MARINE FACILITIES ASSESSMENT

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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Hamlet of Pelly Bay Overview

Home to some 327 full-time residents, Pelly Bay is located on the mainland of the Northwest Territories on the west coast of Simpson Peninsula The community is 177 kilometres by air southeast of Spence Bay and 1,312 kilometres by air northeast of Yellowknife.

The Hamlet of Pelly Bay has a long history dating back centuries. In 1961, a school was built which was one of only three permanent buildings until a few years later. Since that time the community has evolved in both social and economic terms. Income has been generated in recent years by local carvings and a limited commercial fishery. Pelly Bay residents, however, continue to depend heavily on traditional hunting and trapping pursuits for their basic livelihood.

Pelly Bay is the only Eastern Arctic community not serviced directly by the sealift due primarily to ice conditions. As a result, the cost of living is reported to be one of the highest, or the highest, in the North.

Waterfront Utilization and Demand

Pelly Bay residents use their boats regularly during the **open water season, primarily** for marine mammal hunting. Other waterfront uses are limited with no sealift **operation, few tourists and limited commercial** fishing activity.

Cargo/Sealift Shipments

Neither government organized nor private sealift operations service the Hamlet of Pelly Bay. Ice conditions are so severe that only Ice Class Ill vessels are certified to operate in the area and only one such vessel with Canadian registry exists. Operational restrictions are severe, area navigation charts do not exist and, to date, it has been considered impractical and uneconomic to contract sealift operations into the community.

We do not expect this situation to change over the foreseeable future. The government subsidizes petroleum product shipments into the community out of Hall Beach by Hercules aircraft and GNWT dry cargo out of Spence Bay. Air resupply shipments to the Pelly Bay Co-op are transported out of Churchill - and NCPC resupply moves from a number of airports. Subsidization levels appear to be more economical than the major expenses that would be required to establish a relatively low" volume, high cost sealift operation.

Local Boating Activity

Local boats are relied on extensively, for hunting, during the open water season which lasts from the first week in August to the third week in September. This activity is crucial to the traditional customs of the local people and to their very livelihood. The local boats consist of canoes and small aluminum runabouts which are used for subsistence hunting and fishing and to reach and resupply the local outpost camp.

The population of Pelly Bay has increased consistently over the past 20 years (...averaging 3.7% annually between **1966** and 1976...and 1.9% per annum between 1976 and **1986).** The GNWT Bureau of Statistics projects that the local population base will grow at an average rate of 2.3% annually between 1989 and 2000, which is almost exactly the same as that projected for the Baffin Region in total.

Commercial Fishing Activity

Currently the only local commercial fishing is done during the winter using snowmobiles. The lack of larger boats in the community and the lack of road access to nearby lakes limits the possibility of commercial fishing.

Marine Tourism Activity

The level of tourist activity is severely limited by hotel capacity. The community is interest in expanding this activity.

Waterfront Utilization and Demand Summary

In summary, the local waterfront use is critical to the maintenance of the traditional activities of the local residents. Lack of other opportunities in Pelly Bay make the maintenance of traditional activities essential to the community. While the inner harbour area is well sheltered, users would benefit from improvement.

Site and Harbour Profile

Relevant characteristics of Pelly Bay Harbour and the extent to which marine facility development has taken place to date is summarized below.

- Tides

Mean Tides	**1.7M**
Large Tides	**2.9M**
Mean Water Level	**1.3M**

These tidal values are considered unreliable.

- Tidal Zone — The estimated beach grade is variable, from 3% on the unprotected seaward side to 10OA in the partially protected area.

- Soil Conditions — The surface is shingle/sand/boulders, but generally firm. Boulders are visible beyond low water on the unprotected shore. Above HWL, it is rocky upland. A road leads down to the beaching area between rock outcrops.

- Site Topography — The settlement is located in a bay near the lower end of the Gulf of Boothia. The gulf is often subject to pack ice during the summer, making it presently infeasible for sealift vessels to reach the settlement. The immediate area around the settlement is low rocky hilly terrain.

- Ice — First year, second year and older ice is probable. Small broken ice pans were observed in the bay about 25 kilometres from the settlement. Part of Committee Bay observed to have 90% ice pan cover. No reports of ice damage or ice pile-up. Ice pile-up could be expected along the unprotected shoreline but not around in the beaching area. The winter fast ice would extend out to the 2-metres *contour* above LWL.

Open water runs from first week in August to third week in September.

- Exposure — There appears to be a good protected anchorage on the north side of the settlement. Council reports there are problems with wind and waves from the northerly sector causing high wave conditions.

- Littoral Drift — No evidence of littoral drift was observed and it is not anticipated to be a problem.

The road to the docking area in the inner bay has been pushed out to form a minor breakwater. There is insufficient water at low tide to moor boats. The road is on a grade leading into the water and is used as a ramp for loading and unloading the boats although at low water the irregular bank makes this impractical.

Development Recommendations

Pelly Bay is not serviced by the sealift and is therefore resupplied by air. The primary reason given for this is the extent of pack ice during the summer season.

We have undertaken a preliminary review of the options for this community which appear to be:

- establishment of normal sealift operation;
- construction and use of a winter road to Gjoa Haven or Spence Bay;
- new surface technology such as Hovercraft;
- maintenance of existing airlift.

Sealift

No sealift can take place without adequate charts, navigation aids, ice breaker support and the availability of a suitable vessel. None of these presently exist. Correspondence indicates that charting will not take place prior to 1994. The necessary ice breaker support needs only scheduling to provide this service. The lack of a suitable cargo vessel is a more serious matter. Given the small volume of freight (estimated at 1000 tonnes of which 800 are petroleum products) it is unlikely that the only available Canadian registered vessel would be prepared to make a special voyage to the community 800 miles round trip from the entrance to Prince Regent Sound.

With the recent Treasury Board decision approving Coast Guard continuing the sealift operation, with the possibility of long term contracts with specific shippers it maybe possible to induce new ship construction, leading to the construction of a vessel designed for the traffic and capable of operating in this zone.

Winter Road to Gjoa Haven or Spence Bay

Both these communities have marine resupply now as part of the Western Arctic system. It is technically possible to construct a winter road between Pelly Bay and either community a distance of some 250 kilometres approximately half over sea ice and half over land. The costs of operating and maintaining such a system are very likely to exceed the airlift subsidization costs now incurred.

There are potentially two winter road systems.

- high powered bulldozers as tractors pulling specialized freight sleds and crew caboose traveling in convoy for security; and

- higher speed off highway rubber tired truck and trailer combinations, such as the Canadian Foremost Marauder type $350,000 per unit capable of 30 tonne pay loads, traveling in convoy with supporting road maintenance equipment.

Given the distance involved, the lengthy portion over sea ice, pressure ridging, isolation and lack of local support facilities either operation would require support in maintaining the route including the probable establishment of a temporary maintenance camp. While no detailed costing has been attempted it is likely that costs would exceed $3 million annually. The risk factors to the crew, equipment and cargo and the potential of an oil spill through loss of a tanker trailer through the ice make this option unattractive.

New Technology

While advanced surface technology systems such as Hovercraft and air foil vehicles do exist and have been more cost effective with increased carrying capacities and cheaper diesel engines, the necessity for specialized support systems, operating crew, etc. make it obviously impractical to provide a service primarily for Pelly Bay.

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Maintenance of Existing Airlift

This appears to be the only economic solution in the short term until the establishment of a normal sealift operation can occur.

Development concepts have only been considered in terms of local community use. Sealift dry cargo and petroleum needs have not been assessed in the context of local wharf facility requirements.

Local Community Use

The priority at Pelly Bay is to provide a dock structure which will allow access for small boats at low water.

Initial assessment indicates that extension to the existing road/breakwater structure with incorporation of timber cribs filled with rubble to provide a vertical wharf would be suitable.

The tide range at Pelly Bay is reported to be of the order of 2.9 meters. The study group felt that it could range to as high as 5 meters, and this would impact significantly on the choice of structure.

We recommend that marine facility development in Pelly Bay incorporate the following minimum requirements:

- Extension of existing road/breakwater structure using rock fill;
- Provision of verticai face wharf-type structure using rock-filled timber cribs.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Pelly Bay. They are summarized in sketch form in Figure PB. 1.

Development Cost Estimates

Preliminary cost estimates have been prepared in 1990 dollars which reflect the development recommendations described above.

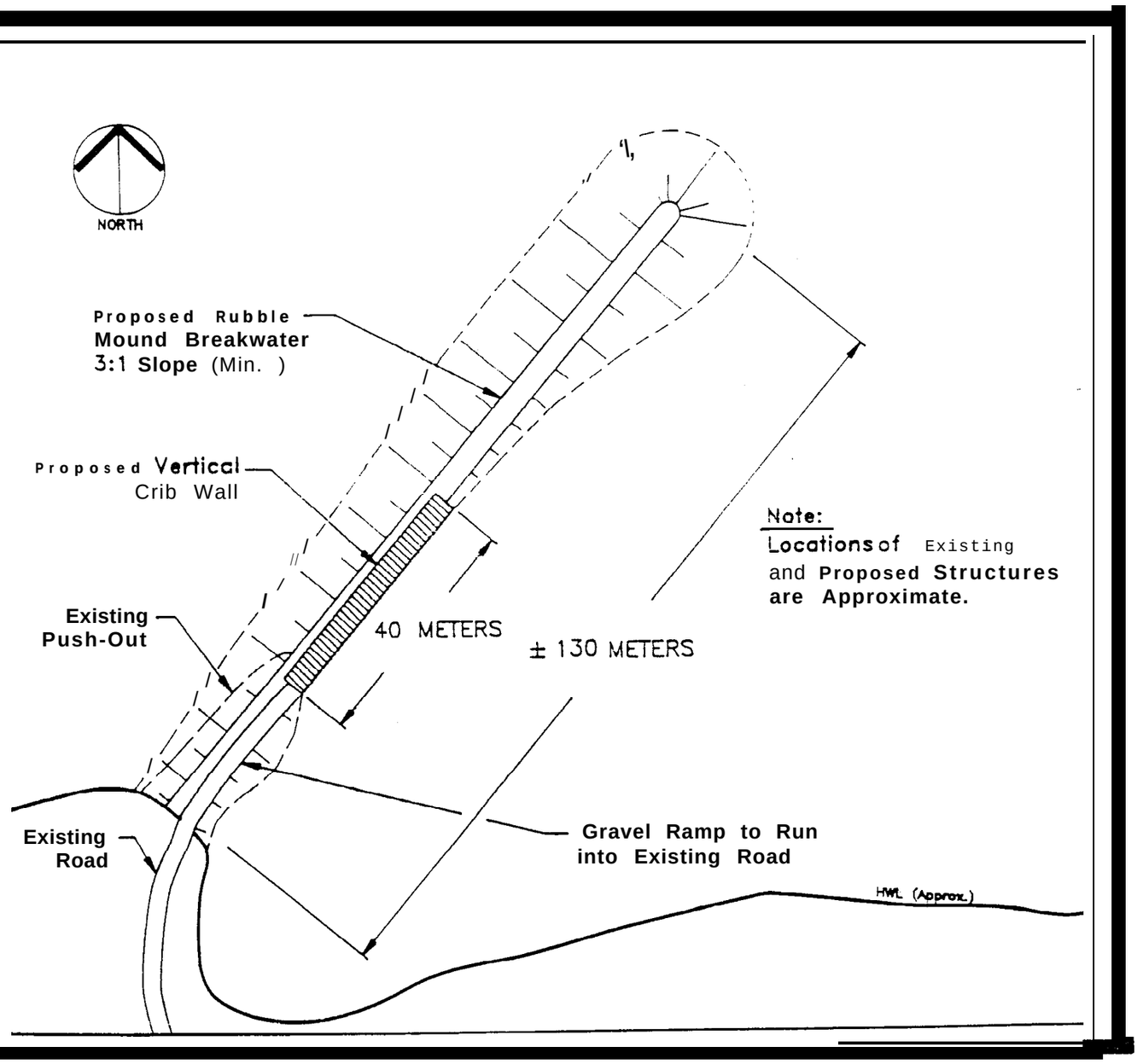
They are based on the maximum tidal range of 2.9 meters and assuming that lumber can be shipped to the community for timber crib construction.

Local Facility

▪ Excavation & Site Preparation	**$30,000**
▪ Extension of Breakwater	240,000
▪ Rock Filled Timber Cribs	80,000
▪ Construction of gravel ramp	**40,000**
▪ Survey and Engineering	**40,000**
▪ Contingency	**80,000**
	$510,000

Sealift Dry Cargo and Petroleum

Due to lack of sealift delivery to this site, no estimates were prepared for any possible structure.



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PELLY BAY
CONCEPTUAL PLAN

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POND INLET HARBOUR
MARINE FACILITIES ASSESSMENT

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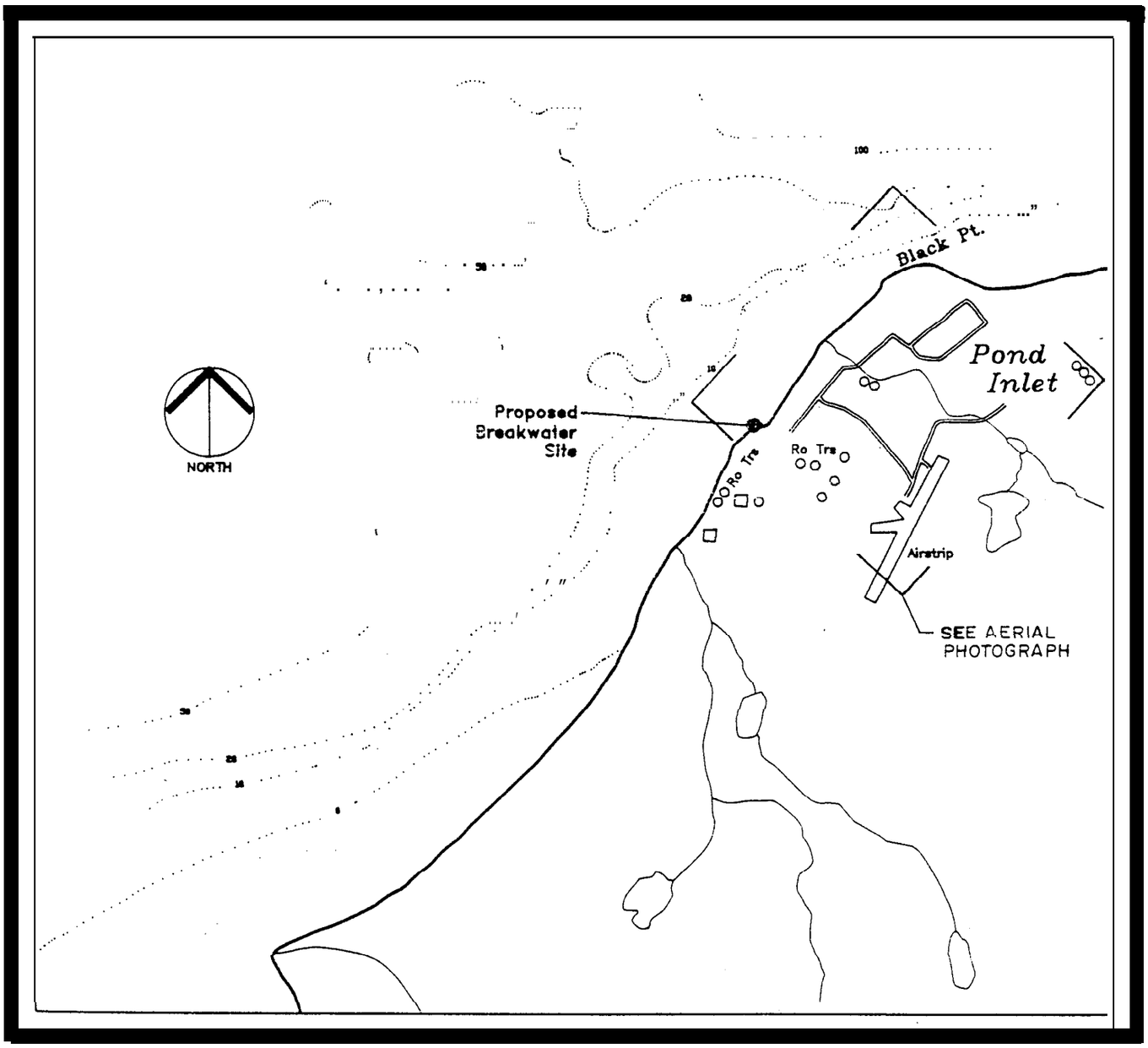

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Soundings in Meters

POND INLET HARBOUR

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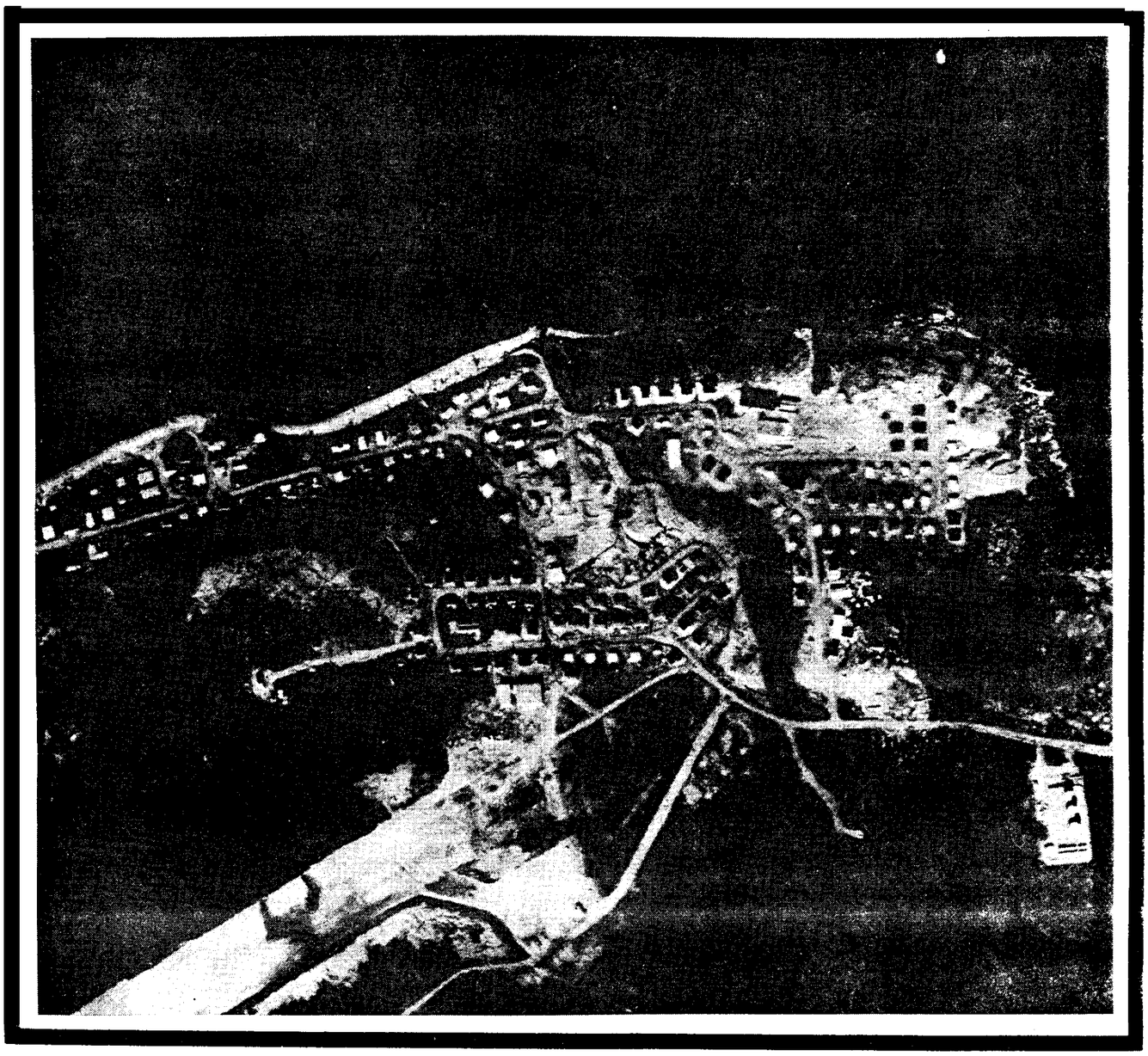
MARINE FACILITIES ASSESSMENT



POND INLET HARBOUR

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Pond Inlet Overview

Pond Inlet is a community of about 885 people situated on the northwestern end of Baffin Island, immediately opposite Bylet Island. The hamlet is 525 kilometres southeast of Resolute Bay by air and 1,883 kilometres northeast of Yellowknife.

The community is located in the ancestral homeland of the North Baffin Inuit and is a rich area for Thule culture archaeological sites. In the 1920's, an RCMP post was set up in Pond Inlet and Anglican and Roman Catholic missions were established. Until the 1960's most Inuit in the area continued to live off the land. Now traditional hunting and fishing are popular while a move towards a wage economy is becoming more predominant.

Waterfront Utilization and Demand

Traditional hunting and fishing pursuits in Pond Inlet are still very popular. With the hamlet expecting significant growth in the years ahead, both in the population base and the tourism industry, more activity in and reliance on the harbour is expected. Sealift operations cause concern locally as the temporary relocation of boats is necessary to enable barge access and unloading.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Pond Inlet. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Pond Inlet during the open water season. Dry cargo tonnages via sealift to the community, like in most other Eastern Arctic communities, vary from year-to-year based on construction/ development projects that are underway. Petroleum product shipments, in comparison, vary much less.

The following table summarizes both dry cargo and petroleum product shipments to Pond Inlet over the 1984 to 1989 period.

SEALIFT SHIPMENTS TO POND INLET
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	921	856	793	881	621	1,164
Petroleum Products (Bulk)	3,172	2,324	3,409	3,187	3,582	5,175

The dry cargo shipment trend over the last five years is down slightly except for 1989. This is inconsistent with the population base trend which is up over the same period. The petroleum product trend over the 1984 to 1988 period is upwards, more closely paralleling population and economic base growth.

The population growth in Pond Inlet has slowed less dramatically than in most Eastern Arctic communities (e.g. 10.8% annually between 1966 and 1976 vs 4.8% per annum between 1976 and 1986). Indeed, over the 1976 to 1986 period, significant growth was achieved. The GNWT Bureau of Statistics estimates that the hamlet will increase in size at a rate of 2.4% annually between 1989 and 2000, assuming a net migration rate of zero. in Pond Inlet's case, net in-migration is likely as the community takes steps to expand its economic base.

Our sealift shipment forecasts are based on revised population growth expectations of about 3% annually. These forecasts, for both dry cargo and bulk petroleum products, are summarized in the following table from 1990 to 2000.

SEAL I FT SHIPMENT FORECASTS TO PONO INLET

1990 - 2000

(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
■ Dry Cargo	642	661	681	701	722	744
m Petroleum Products (Bulk)	3,640	3,749	3,862	3,978	4,097	4 # 220

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	766	789	813	838	863,	889
■ Petroleum Products (Bulk)	4,346	4,477	4,611	4,749	4,892	5,039

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use our population forecast rate applied to the base year (1989).

The forecasts shown above donot account for annual variations which will, inevitably, result from specific and short-term construction projects. They do, however, demonstrate the upward trend in sealift shipments to Pond Inlet as the population base and the economic base expand.

It is important to note that Pond inlet is often exposed to strong currents and heavy swells. This has caused sealift unloading delays, particularly for bulk petroleum products from sealift tankers.

Local Boating Activity

Traditional hunting and fishing is important in Pond Inlet and regular use is made of local boats during the open water season. The importance of the waterfront in this regard is expected to continue and to increase more-or-less in parallel with the community's population and economic base.

Local representatives indicated clearly that improvements are required to the existing breakwater. Presently it is not large enough to provide the needed protection for local boats and, for example, hunters returning to the community during bad weather cannot always gain access to the shore. Boats and motors have also been lost when winds and waves from the northwest increase. Additionally, there is a reported demand for a method, or additional equipment, for hauling boats out of the water and a need for larger

beach storage areas for the growing number of fibreglass boats. There were 16 Lake Winnipeg boats, 35 fibreglass canoes and 1 Peterhead boat along the shoreline.

Commercial Fishing Activity

A limited amount of commercial fishing (... primarily Arctic Char...) currently takes place in Pond Inlet. The hamlet is interested in more activity in this area but, to the extent it occurs, will likely involve both Summer and Winter fisheries as well (N.B. 22 commercial fishing licences were issued during the 1987/1988 period to Pond Inlet fishermen and all of these were for the October through December period.) Exploratory permits have been issued and there is reported potential for clams.

We expect some commercial fishing expansion in Pond Inlet over the next five years, but this will likely be insufficient to significantly increase port demands. One of the greatest constraints to the industry will continue to be keeping the product competitive due to the high cost of shipping it out to market areas in the south.

Marine Tourism Activity

The Hamlet of Pond Inlet is interested in tourism development but considers it important that it is planned properly. Currently local boats and guides are used to provide visitors with tours for sightseeing. Local fibreglass boats and 7-metre canoes are used for this purpose.

With promotion, tourism activity which impacts on waterfront utilization will expand. As facilities are developed which are beneficial to local boaters, hunters and fishermen, the marine-related tourism business will also benefit and be encouraged.

Waterfront Utilization and Demand Summary

In summary, steady and noticeable growth is expected to continue the increase in demand locally for small boat facility improvements. Limited commercial fishing demand is expected while marine tourism activity would benefit from marine facility development.

Site and Harbour Profile

Relevant characteristics of Pond Inlet Harbour and the extent to which marine facility development has taken place to date are summarized below.

■ Tides	Mean Tides	1.5M
	Large Tides	2.5M
	Mean Water Level	1.OM

■ Tidal Zone — The estimated beach slope to LWL is 5%.

■ Soil Conditions — The surface is shingle/sand which is medium to firm. Above HWL very soft sand occurs within the indented shoreline east of the breakwater. West of the breakwater where the shoreline changes direction, the shore becomes low and has been cut down for beach access.

■ Site Topography — The settlement is located on the south shore of Pond Inlet. Within this area the terrain is hilly and leads down sharply to the shoreline. The uplands behind lead to mountainous terrain with glaciers emptying into the inlet. Pond Inlet is exposed to the tides of Baffin Bay and Lancaster Sound resulting in strong tidal activity. Katabatic winds (1) could be expected.

(1) Katabatic winds are locally generated, often very gusty blowing down a slope due to cooling, in this case due to the presence of glaciers and steep valley.

■ Ice — Ice is first year, second year and older. Two small growlers were observed in Pond Inlet opposite the settlement. No ice damage was reported although the existing breakwater has only been in place for one year. The winter fast ice would extend out from shore to roughly the.5 metre contour below LWL.
The open water period normally runs from the second week in July to the third week in September.

■ Exposure — At the breakwater site there are swells and waves from Baffin Bay refracting around the sharp bend in the shoreline to the east. Exposure from the northwest across the sound is 60 kilometres, and from the west it is 100 kilometres. Strong winds from the northwest are apparently more damaging during the open-water season than waves coming from the east through Pond Inlet.

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- Littoral Drift — There were conflicting reports as to the effect of the existing breakwater. Council feels that the breakwater has changed the beach line on both sides, whereas a local fisherman reports the sand is where it has always been. Further assessment should be made on this subject.

A one-year old, L-shaped rock breakwater has been placed at the easterly end of the small indenture in the coastline, west of the hamlet office. It was well constructed with blasted rock, which is in the 400-800 kilo range. Within the “L”, the protected area from Eclipse Sound can only shelter a maximum of 6 boats in the 6-8 metre range.

Development Recommendations

Preliminary cost estimates, in 1990 dollars, have been prepared which reflect the development recommendations described above. As with other communities, several assumptions have been made in preparing these cost estimates.

Local Community Use

The existing rock breakwater constructed at Pond Inlet has some limitations. Although well constructed, the community feels that the breakwater should have extended out further to deep water and possibly turned in the opposite direction. The cost of an alignment change to this structure would be prohibitive and is not proposed.

Several factors at Pond Inlet govern the design of future improvements to the local marine facility.

Firstly, the problem of littoral drift needs further evaluation and should be assessed in terms of the existing structure and future proposals.

Secondly, the exposure of the site suggests that protection is required to boats on the other side of the existing breakwater.

The most practical solution to improving the facility in Pond Inlet is to extend the existing rock breakwater out to deeper water and turn it around to the east to prevent swell and waves coming around the end of the structure.

Since this structure has only recently been constructed, it would probably be worthwhile to monitor its performance in terms of littoral drift and protection to boats prior to carrying through with further development.

We recommend that marine facility development in **Pond Inlet incorporate the following minimum requirement.**

- **Monitor the performance of the existing structure** in terms of littoral drift and provide input to future development concepts.

- Extend the existing breakwater out to deeper water and curve it around to the east to provide a protected area for small boats.

Sealift Dry Cargo

Vessels usually anchor about 0.3 to 0.5 miles off the settlement and there is a sandy beach in front of the Hudson's Bay post.

Anchorage is reasonable in Pond Inlet, but the community's exposure to winds from most directions means that vessels have to be ready to move immediately. There are strong tidal currents through the inlet. The area is also subject to large numbers of drifting ice flows.

In view of the site's exposure from all directions, it is difficult to develop an easy solution to help the sealift operation. Current arrangements for the sealift are reported to be satisfactory, and no proposals for improvement have been recommended. Extension of the existing rock breakwater structure may improve the protection of barges unloading at Pond Inlet.

Sealift Petroleum

The current unloading arrangements using a floating line require constant vigilance due to the presence of the strong currents and drifting ice.

Development Cost 'Estimates

Preliminary cost estimates have been prepared, in 1990 dollars, which reflect the development recommendations described above.

The following cost estimate has been prepared assuming seabed elevations and assuming that the breakwater structure can be constructed without problems from littoral drift.

Local Facility

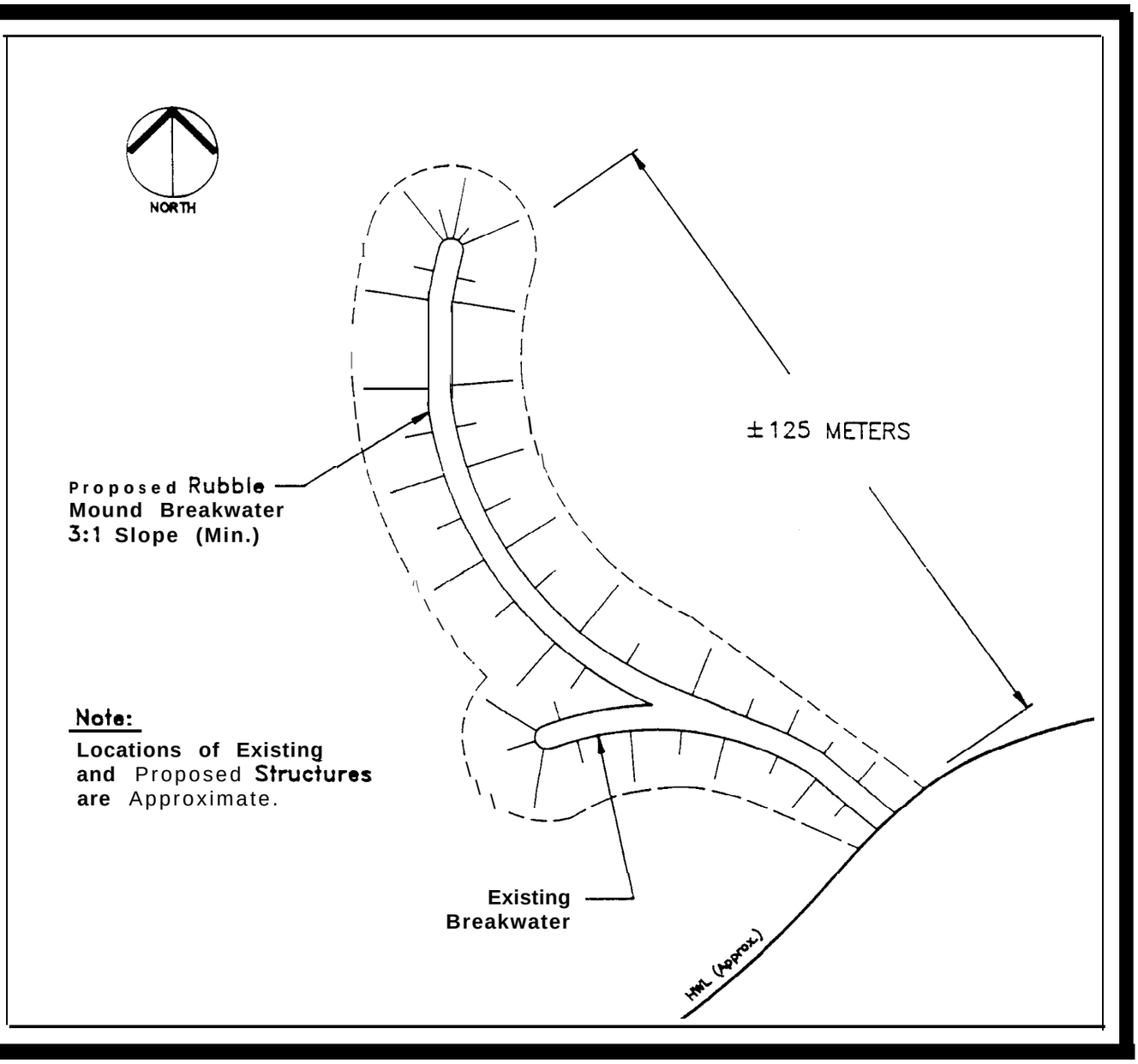
m	Excavation & Site Preparation	**$50,000**
■	Extension of Breakwater	**300,000**
■	Engineering & Survey	**35,000**
■	Contingency	**70.000**
		$455,000

Sealift Dry Cargo

No estimates have been prepared for improving the sealift operations other than grading and gravelling the marshaling area -$25,000.

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $4.2 million.



Natural Scale 1:1,000

POND INLET CONCEPTUAL PLAN

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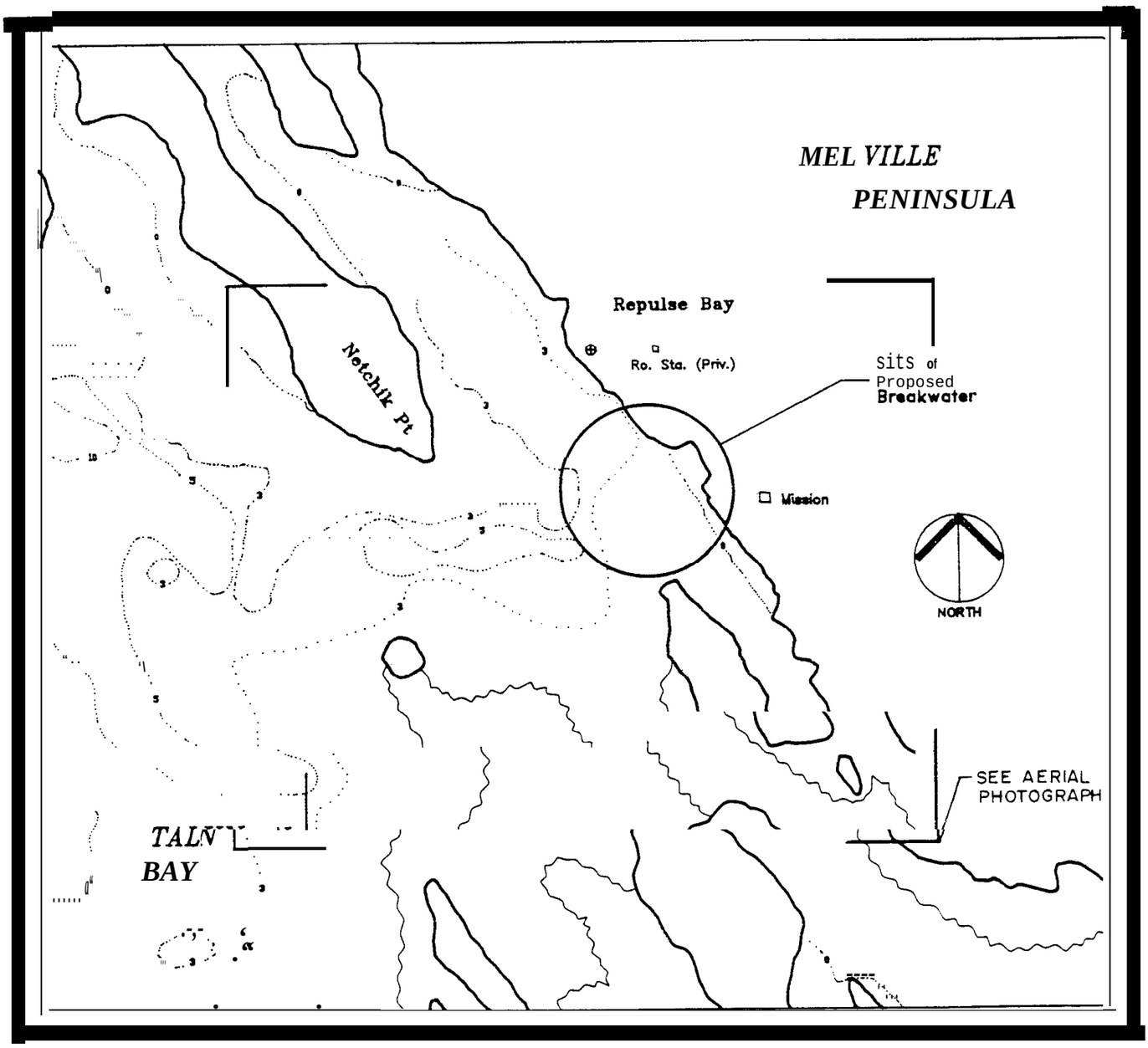
MARINE FACILITIES ASSESSMENT



Natural **Scale 1:12,000**

Soundings in Fathoms

REPULSE BAY HARBOUR

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MARINE FACILITIES ASSESSMENT

REPULSE BAY HARBOUR

REPULSE BAY HARBOUR
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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Repulse Bay Overview

Repulse Bay is a community of about 454 full-time residents located on the south shore of Rae isthmus at the southern end of Melville Peninsula. The hamlet is 443 kilometres by air southeast of Spence Bay and 1,424 kilometres by air northeast of Yellowknife.

The settlement's history dates back to the mid 1700's and local Inuit participating in the whaling industry in nearby Roes Welcome Sound, a centre for whaling in the mid-1 800's. In 1916, the Hudson's Bay Company developed a trading post in Repulse Bay and a Roman Catholic mission was established there in 1932.

The present permanent settlement began in the early 1960's. Construction took place, government personnel moved to the community and the Co-op was incorporated during the latter part of the 1960's, hunting and fishing community. More recently it has been recognized as a carving centre and as one of the most attractive settlements in the Eastern Arctic.

Waterfront Utilization and Demand

The people of Resolute Bay have traditionally relied on their boats for hunting and fishing in the Summer. This reliance, combined with sealift activity and some tourism, will continue to put pressure on the waterfront and increase the need for marine facility development.

Cur visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Repulse Bay. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Repulse Bay during the open water season. Shipment levels via the sealift have shown a gradual upward trend over the last six years as can be seen in the following summary between 1984 and 1989.

SEALIFT SHIPMENTS TO REPULSE BAY
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
▪ Dry Cargo	323	371	231	287	596	223
▪ Petroleum Products (Bulk)	945	1,010	1,487	1,497	1,106	1,376

Annual dry cargo shipment variations do, and will continue to, occur as construction projects generate peak demand levels in specific years.

Sealift shipment levels have increased as the population and economic base of Repulse Bay have grown. This relationship is expected to continue.

The community has experience steady growth over the past two decades as shown by census statistics (e.g. 6.1 % annually between 1966 and 1976...4.8% per annum between 1976 and 1986). These rates of growth are significantly higher than those experienced in other Eastern Arctic communities. The GNWT Bureau of Statistics projects that the community's population will expand at an annual average of 2.7% over the 1989 to 2000 period.

Recent growth rates in Repulse Bay, combined with our understanding of economic development initiatives and the fact that GNWT projections assume zero net migration, lead us to conclude that sealift shipment levels will increase at a rate higher than that shown above. For purposes of this analysis, we project sealift shipment growth at 5% annually between 1989 and 1992 and 4% annually thereafter.

Sealift shipment levels to Repulse Bay are projected in the following table over the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO REPULSE BAY
1990 - 2000
(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
■ Dry Cargo	500	525	551	579	602	626
■ Petroleum Products (Bulk)	1,452	1,524	1,600	1,681	1,748	1,818

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	651	677	704	733	762	792
■ Petroleum Products (Bulk)	1,890	1,966	2,045	2,126	2,211	2,300

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 our estimates of economic and population base growth applied to the base year (1989).

Variations to these sealift shipment forecasts on an annual basis as they respond to development project demand. The longer term upwards trench, however, is reflected in the projected levels shown in the above table.

Local Boating Activity

Residents of Repulse Bay rely heavily on the use of local boats for traditional hunting and fishing during the open water season. These levels of activity are expected to increase as the local population base expands. More and more pressure will be placed, therefore, on community marine facilities and the need to improve facilities will be come greater over the next several years. There are currently 2 Peterhead vessels, 4 Lake Winnipeg type and some 40 smaller canoes. These boats are used primarily for hunting and subsistence fishing.

Commercial Fishing Activity

The community indicated that while it had no specific plans as yet they felt that commercial fishing would become important to them.

Marine Tourism Activity

The lack of a hotel for this year precluded any tourism traffic. This is being remedied by the construction of new facilities. **There** has been limited tourist traffic to the community in the past and it is hoped to expand on this **for the future.**

Waterfront Utilization and Demand Summary

In summary, steady population and economic base growth in Repulse Bay is expected to result in sealift shipment expansion and increased local boating activity. These demand increases will place greater pressure on marine facilities and the need for improvements to these facilities.

Site and Harbour Profile

Relevant characteristics of Repulse Bay and the extent to which marine facility development has taken place to date is summarized below.

▪ Tides	Mean Tides	4.2M
	Large Tides	6.8M
	Mean Water Level	N/A
▪ Tidal Zone	The beach slope is approximately 8%.	
▪ Soil Conditions	The surface is shingle/boulder/sand and is generally firm. The back shore area is rocky upland except for the sealift site.	
▪ Site Topography	The settlement is located on the north shore of Repulse Bay at the base of Melville Peninsula. The terrain is rocky with low hills and mountains in the distant uplands. The settlement has rocky island and islets immediately offshore. The beach on the west turns north and loops back south to form a small inlet near the settlement.	
▪ Ice	Conditions are first year ice with a possibility of second year. **No** ice seen at time of inspection. Offshore islands prevent heavy ice pile-up. The winter fast ice would extend from shore to the 4-metres contour above LWL. Open water period runs from the first week in July to the end of September.	

- Exposure — **There is a long fetch** in a southerly direction which can come in between the island and the mainland. The fetch from the southwest and west would be over 16 to 20 kilometres.

- Littoral Drift — Littoral drift is not thought to be a problem at this site.

Some minor pushouts of boulders have been placed along the shoreline presumably to clear the beach. About 200 metres west of the Hamlet office at the mouth of the inlet, there are two pushouts of boulders which are covered at high tide.

Development Recommendations

Preliminary cost estimates, in 1990 dollars, have been prepared which reflect the development recommendations described above. As with other communities, several assumptions have been made in preparing these cost estimates.

Local Community Use

The main issue at Repulse Bay is to provide adequate protection for small boats by constructing a rock breakwater. A vertical face wharf-type structure would also be an asset, although this could prove to be fairly expensive in view of the high tide range.

There are two possible sites for a proposed breakwater.

The Council requested that a new breakwater be constructed to protect the community beach at the north end of the Hamlet, where some minor work has already been carried out.

An alternative site exists to the south of the community where the sealift unloads. This site is considered to be a better alternative as it is the more protected of the two. A breakwater could be constructed to partially close off the gap to the south of the community, creating a very large protected anchorage.

We recommend that marine facility development in Repulse Bay incorporate the following minimum requirement.

- Construction of rock mound breakwater in the area of the sealift beach to create a large protected anchorage area.

Sealift Dry Cargo

The inner harbour area at Repulse Bay provides good protected anchorage for vessels up to 50 metres with drafts of 3-metres. Larger vessels must anchor to the west of Netchik Point which can become very exposed and has only fair holding ground.

Construction of the breakwater proposed for local community use would help the sealift in terms of offering protection to barges unloading.

The sealift operation could also be improved by carrying out some work on the beach and perhaps providing a ramp structure.

Sealift Petroleum

Tankers currently discharge through a floating hose from a berth west of the point situated 0.5 miles NW of Netchik Point.

In view of the high tide range and the draft required for a tanker, a mooring facility would require major construction which would be very difficult to justify.

Marine Facility Development Summary

The recommendation and development possibilities described above provide sound direction for marine facility development in Repulse Bay. They are summarized in sketch form in Figure RB.1.

Development Cost Estimates

Preliminary cost estimates have been prepared in 1990 dollars which reflect the development recommendation describe above.

The cost estimates are based on constructing a rock mound breakwater in the vicinity of the sealift landing beach to the south of the community.

These first stage estimates have been prepared making basic assumptions for seabed elevations and available materials and equipment.

Local Facility

▪ Site Preparation & Excavation	$150)000
▪ Construction of Rock Mound Breakwater	1,250,000
▪ Engineering & Survey	140,000
▪ Contingency	280,000
	$1,820,000

Sealift Dry Cargo

The cost of improving the sealift beach and providing an unloading ramp is estimated at $100,000.

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $5.3 million.

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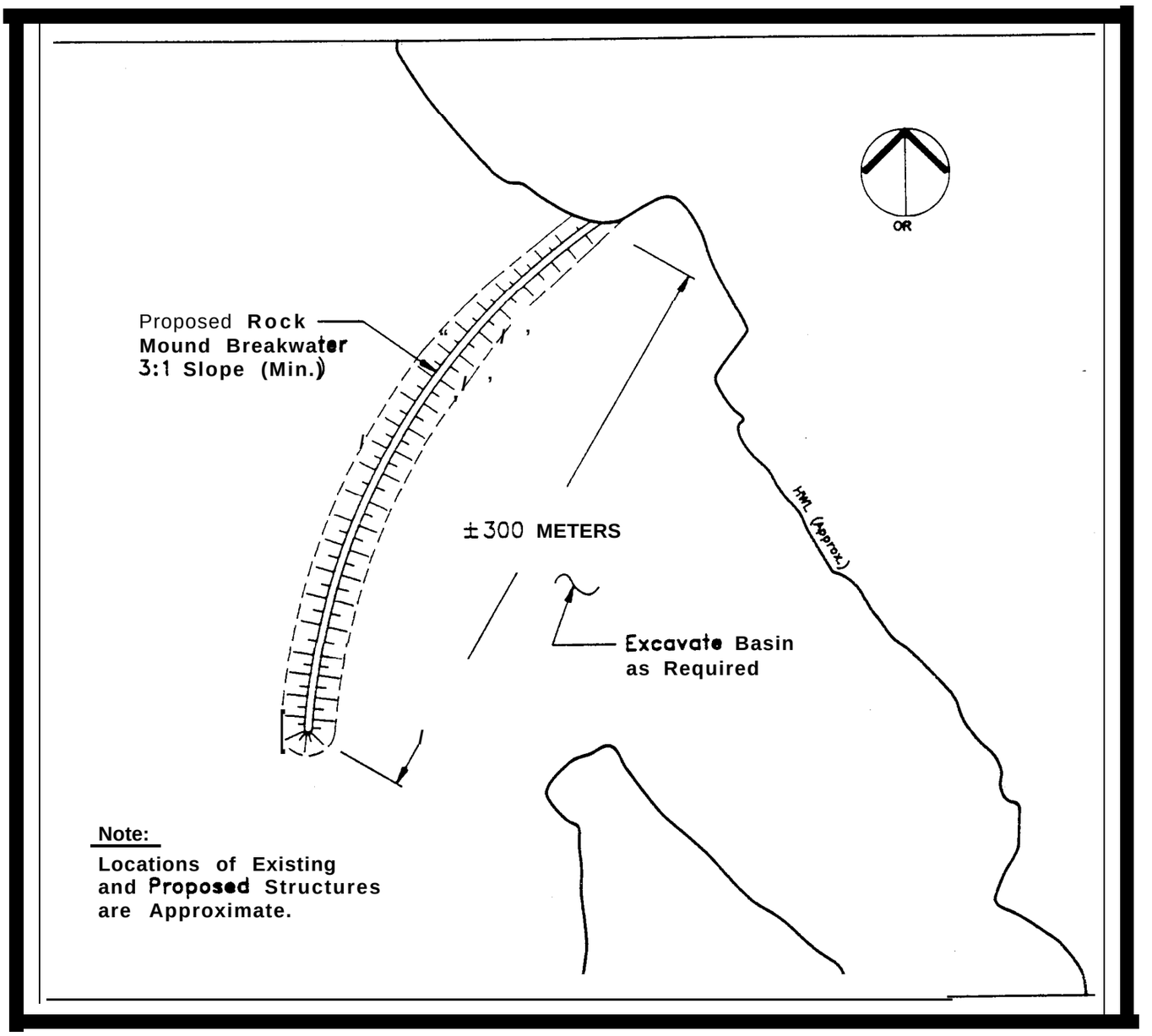

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REPULSE BAY
CONCEPTUAL PLAN

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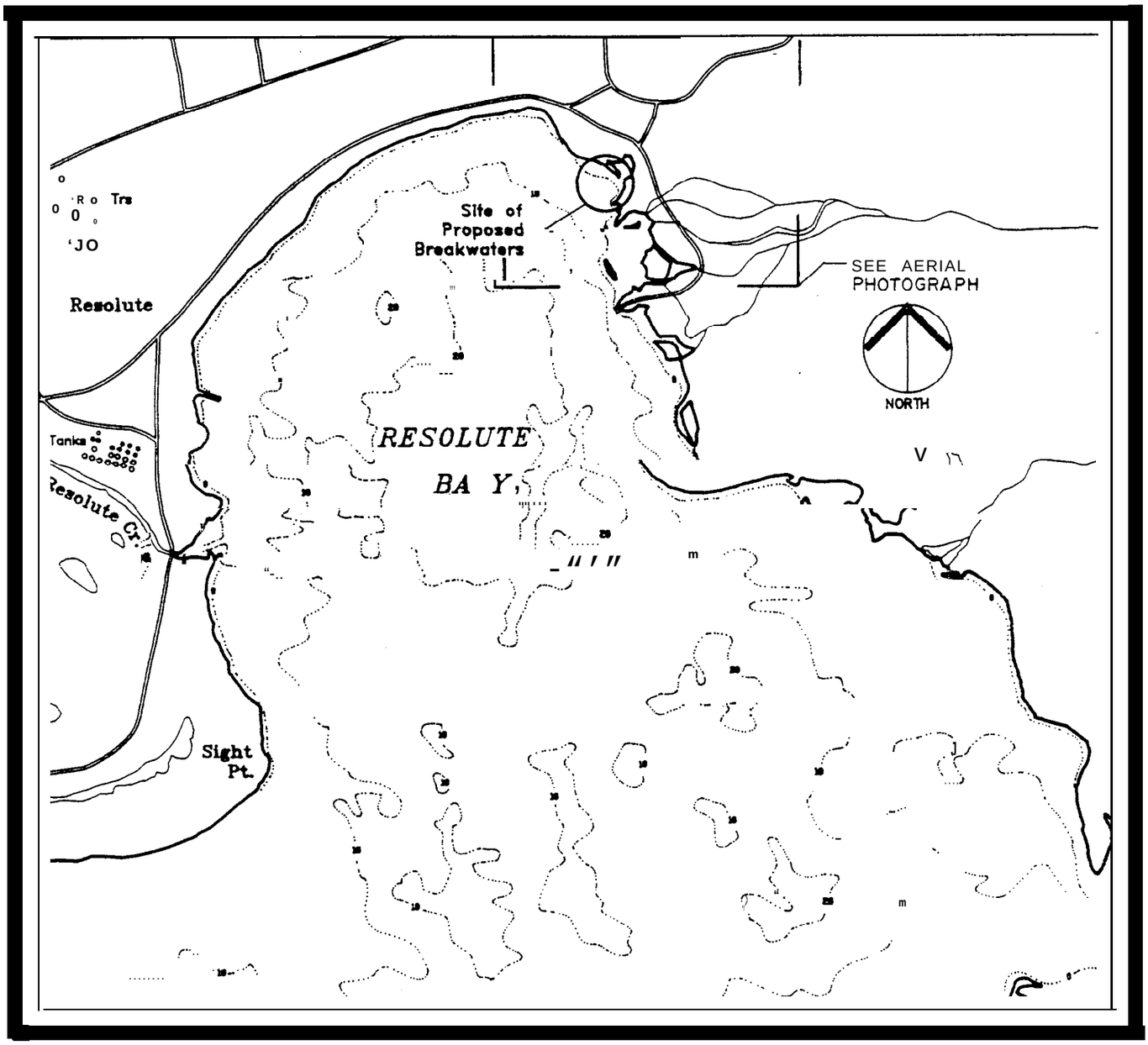
MARINE FACILITIES ASSESSMENT



Natural Scale 1:20,000 **Soundings in Meters**

RESOLUTE BAY HARBOUR

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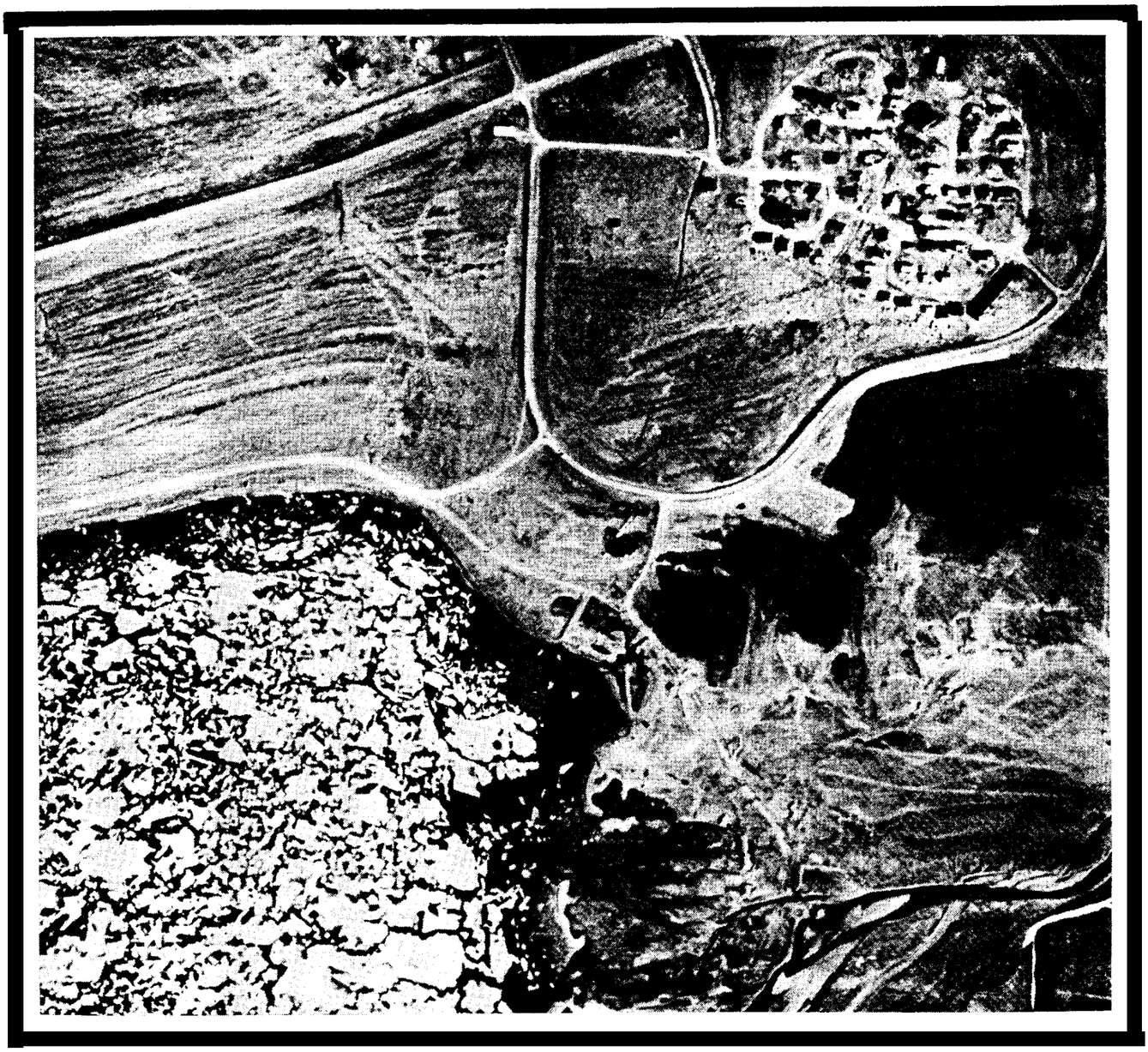
MARINE FACILITIES ASSESSMENT



RESOLUTE BAY HARBOUR

RESOLUTE BAY HARBOUR
MARINE FACILITIES ASSESSMENT

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Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting inc. on behalf of the Governments of the Northwest Territories and Canada in 1989.

Hamlet of Resolute Bay Overview

Resolute Bay is a community of about 166 people located on the southwest coast of Cornwallis Island on Barrow Strait. It is some 1,561 air miles northeast of Yellowknife, 3,444 kilometres by air northwest of Montreal and situated in the Queen Elizabeth Islands.

The impetus for development in Resolute Bay came from airfield construction in 1947 as part of a joint U. S.-Canadian weather station. In 1953, Inuit from Port Harrison (Quebec) and Pond Inlet were relocated to Resolute to take advantage of the island's superior game resources. A number of relatives followed in 1955 and, since that time, the community has developed as an important transportation, communications and administrative centre. A new townsite was completed in 1977. Oil and gas exploration in the 1980's and Cominco's Polaris mine on Little Cornwallis Island have contributed to Resolute Bay's economy.

Waterfront Utilization and Demand

The shoreline in Resolute Bay sees proportionately more activity than most other Eastern Arctic communities. Local hunting and fishing, tourism, sealift operations and a Fisheries and Oceans Canada base all contribute to activity levels during the open water season.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand in Resolute Bay. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Resolute Bay during the open water season. Because of the community's strategic position as a staging area for both freight and tourists, sealift shipment levels are considerably higher than they are for other hamlets of similar size in the Eastern Arctic.

The following table summarizes sealift shipment levels to Resolute Bay over the 1984 to 1989 period.

SEALIFT SHIPMENTS TO RESOLUTE BAY
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
Dry Cargo	853	995	667	1,368	1,599	670
Petroleum Products (Bulk)(1)	N/A	N/A	N/A	N/A	N/A	N/A

(1) Petroleum products are shipped in bulk to Resolute Bay by Imperial Oil, not the sealift, and are not, therefore, included in this table.

A consistent and steady growth in dry cargo shipments has been experienced as the local economic base has strengthened through 1988. The recovery follows a slow period after intense activity took place during the late 1960's and early 1970's, fueled primarily by oil and gas exploration in the islands. During that period six or seven supply ships would arrive in Resolute Bay annually and in 1973/74, 13 drilling rigs were operating in the region. This activity started to decrease rapidly after the mid-1970's. By 1980 only four rigs were operating which decreased to two in 1982 and none by 1986. Good potential for gas production in the area still exists.

Until the time that oil and/or gas activity returns to the Queen Elizabeth Islands area, Resolute Bay is expected to continue to slowly increase its population and economic base. Census statistics show that the hamlet's population declined at an average rate of 3.9% annually between 1966 and 1976. Over the ten year period ending in 1986, some nominal recovery had occurred as the number of residents increased by 0.7% per year, on the average... although the GNWT Bureau of Statistics estimates a slight drop since that time as some people have relocated to other communities.

Population forecasts prepared by GNWT suggest a growth for Resolute Bay of close to 2% annually between 1989 and 2000, assuming zero net migration. We expect that the current out migration will turn around over the next few years as economic development initiatives create new opportunities. Major expansion or growth, however, is not expected unless oil and gas prices encourage oil companies to return to the area.

Our sealift shipment forecasts are based on population and economic growth/decline expectations. These suggest a decline (...of 3% annually...) in movements over the 1990 through 1992 period followed by a recovery and growth (...of 5°A annually...) thereafter. Sealift shipment levels to Resolute Bay are projected in the following table over the 1990 to 2000 period.

SEALIFT SHIPMENT FORECASTS TO RESOLUTE BAY

1990 - 2000

(Metric Tonnes)

	1989(1)	1990	1991	1992	1993	1994
Dry Cargo	1,656	1,606	1,558	1,511	1,587	1,666
Petroleum Products (Bulk)(2)	N/A	N/A	N/A	N/A	N/A	N/A

	1995	1996	1997	1998	1999	2000
Dry Cargo	1,750	1,837	1,929	2,025	2,127	2,233
Petroleum Products (Bulk)(2)	N/A	N/A	N/A	N/A	N/A	N/A

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population and economic base forecast rate applied to the base year (1989).

(2) Petroleum products shipped in bulk to Resolute Bay are carried by Imperial Oil, not the sealift. This is expected to continue and, therefore, these forecasts are not included in the above tale.

The dry cargo forecast will vary to the extent that development projects generate peak demand levels. All of the forecasts will increase if and when renewed oil and gas exploration and/or production activity occurs.

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Local Boating Activity

Traditional hunting and fishing activities are popular in Resolute Bay and local boats are utilized frequently during the Summer. Marine mammal hunting during the open water season is critical to the livelihood of local Inuit. Privately owned local boats vary in size from traditional canoes to three 7-metre Lake Winnipeg yawls and one 8-metre boat. The community repotted that about 11 boats are used in the Summer for hunting... primarily for Beluga Whales, Narwhals and seals.

Operations of local boats are often difficult according to community representatives. The principal local requirement is protection of boats from wind, waves and ice. Because of the current lack of protection, boats have to be moved frequently (...sometimes daily). A protected basin which enables the larger boats to anchor safely would be beneficial due to the problems of hauling these onto shore.

As the local economy and population base recovers, we anticipate that current difficulties with local boating activity will be amplified as more activity occurs. The community itself is optimistic with respect to future opportunities and growth.

Commercial Fishing Activity

Resolute Bay commercial fishing activity is almost non-existent. Only two commercial fishing licences were issued over the 1987/88 period. The hamlet suggests that local clams could be harvested commercially, but that they would likely be sold only on an inter-settlement basis.

We believe that little impact on marine facilities will evolve over the foreseeable future from commercial fishing activity. Some subsistence fishing is expected to continue... primarily dominated by land-locked Char.

Fisheries and Oceans Canada

Tine Federal Department of Fisheries and Oceans (DFO) operates a research centre and laboratory in Resolute Bay. The Department's research during the open water season involves waterfront use. Two 7-**metre inboard/outboard boats and one 14-metre research vessel make continued use of the** harbour **and** DFO's small dock structure. The operation employes up to 20 people during the Summer and is resupplied via the sealift.

DFO's operations would benefit from improved marine facilities... perhaps in combination with local marine facility development. Difficulties are experienced now loading the research vessel which would be relieved with a proper dock. It also most be moved to Nanisivik for hauling out because suitable facilities are not available in Resolute Bay. There are reportedly, some safety concerns with the DFO vessel which could be relieved with a suitably protected harbour/boat basin area.

Marine Tourism Activity

Tourism industry development in Resolute Bay is more encouraging. While limited numbers of tourists venture this far north, it appears that opportunities exist to generate local income from specific, high value market segments. Local boat tours by these visitors would place increased demands on waterfront facilities.

One of the principal generators of tourism activity, now and in the future, is the cruise industry. "Society Expeditions Cruises" of Seattle uses Resolute Bay as their "turnaround" point for the 140-passenger M/S World Discoverer. The company expect to continue its visits to the community but have requested improved dock facilities for the embarkation and disembarkation of passengers and their luggage. The vessel only calls once in Resolute Bay at the present time. While limited in the number of vessel port calls, the cruise industry and other tours have shown their importance to the local economy as evidenced by the following findings from a package tour analysis carried out in the Baffin Region in 1988:

- 14 tour packages generated 462 tourist visits to Resolute Bay;
- 104 tourists were passengers from a cruise ship who purchased local tours;
- 4 tours consisting of 72 tourists and generating over $750,000 used Resolute Bay as a staging point for expeditions to the North Pole; and
- total value (... including non-consumptive and consumptive value. ..) for these package tours to Resolute Bay was estimated at close to $1.1 million (...78% of this representing non-consumptive value).

These values, although not accruing to Resolute Bay businesses alone, were the highest of all Baffin Region package tours by community in 1987. Statistics such as these reinforce our conclusion that tourism opportunities can be capitalized on in the future. The hamlet expects that two cruise ships will call at Resolute Bay annually in future years. It is also reported that six to eight vessels transiting the Northwest Passage stopped in the community in 1988.

A **variety of attractions and opportunities** for tourists exist in Resolute Bay including hiking/walking tours, whale watching, sport hunting, skidoo and boat trips, outfitting and the like. Promotion and local tour arrangements will be required to capitalize on tourism opportunities. It is evident, however, that harbour protection and loading/unloading facilities on the waterfront could encourage tourism industry expansion. The cruise industry has requested improvements and local tour operators/outfitters recognize the need for development. The community reports that at least one 12-metre boat for visitor tours is being considered but is impractical unless protection from the sea and ice is available.

The Hamlet of Resolute Bay acknowledges tourism opportunities and supports the industry's expansion.

Waterfront Utilization and Demand Summary

Improvements are needed in Resolute Bay to protect local boaters from wind, seas and ice. Sealift operations function well and are expected to increase nominally over the next decade. Principal waterfront growth opportunities arise from the tourism and cruise industries both of which would benefit and/or be secured by marine facility development.

Site and Harbour Profile

Relevant characteristics of Resolute Harbour and the extent to which marine facility development has taken place to date are summarized below.

■ Tides	Mean Tides	1.3M
	Large Tides	2.1M
	Mean Water Level	1.oM
■ Tidal Zone	The beach gradient is approximately 10% in the area near the Fisheries and Ocean lab pushout. There is a very steep drop off at the sealift site. The area by the old community dock is relatively flat.	
■ Soil Conditions	Surface is shingle/sand/boulders, mostly firm. Above HWL it is basically flat with a small berm at HWL. The flat area extends inland roughly 300 metres and then rises to 20 **rnetres above** sea level with steep escarpments inland.	

- Site Topography

The harbour is located within a medium size bay on the south end of Cornwallis Island. It is on the north side of Parry Channel at the narrowest section of the channel. The immediate area is relatively low-lying. Resolute Bay is strategically placed to serve as a staging area for the High Arctic.

- Ice — First year, second year and older ice is probable. Ice pans and one small growler were seen in the bay. No damage was reported to the existing D.F.O. pushout at the head of the bay indicating that pile-up does not occur. Winter fast ice would extend out from shore to the LWL

  Open water runs from the first week in August to the third week in September.

- Exposure — At the DFO site wave exposure is from the south or southwest. Strong winds from the north have also been a problem.

- Littoral Drift — Littoral drift is not a problem at this site.

At the D.F.O. laboratory site a small building has been erected on a pushout. The community and the sealift site are located east of this in the northeast corner of the bay. The community site consists of a pushout protected on the exposed side with barrels filled with shingle and sand and tied together with wire rope.

Development Recommendations

Preliminary cost estimates, in 1990 dollars, have been prepared which reflect the development recommendation described above. As with other communities, several assumptions have been made in preparing our cost estimates.

Local Community Use

The main priority for the local community at Resolute Bay is to provide a safe, sheltered area for small boats. An unloading berth for local boats and to embark cruise ship passengers is also required.

This goal could be achieved by extending and improving the existing pushout and constructing a second breakwater on the opposite shore to create a protected area. The gap between the two structures could be left relatively small to prevent ice pans packing into the bay.

One problem with this scheme is that the hamlet's sewer outfall empties directly into the protected area. It may be possible to place culverts during construction of the breakwater or relocate the sewer outfall. Certainly, this problem should be given consideration prior to adoption of any scheme.

We recommend that marine facility development in Resolute Bay incorporate the following minimum requirements.

- Relocation or extension of the existing sewer outfall.
- Improvement and extension of the existing pushout structure.
- Construction of timber crib vertical faced unloading wharf.
- Construction of a second breakwater structure to create a protected bay.

Sealift Dry Cargo

The current arrangement for unloading the sealift involves floating steel pontoons and a ramp pontoon in place to give the necessary depth of water and then placing a gravel ramp from the shore. The pontoons are winched in shore using anchors on the shore. The gravel ramp erodes after the ship has left. There is a steep drop off where the ship is anchored, but it must be moored out into the bay for safety during periods of high winds.

The system for sealift unloading seems to work fairly well at present, although some improvement to the onshore anchoring system should be made by providing secure deadman anchors for bow and stern lines.

Sealift Petroleum

Tankers currently moor east of the tank farm about 250 meters off shore with stern lines to bollards on the shore. Oil is pumped direct to the shore through two 6-inch rubber pipelines, each about 250 meters long.

A permanent unloading facility for tankers could involve construction of a rock causeway out to deep water with sheet pile dolphins installed for mooring the vessels.

Preliminary evaluations indicate that this type of structure is feasible, but wouid involve the use of specialized construction equipment and would need to be carried out by an outside contractor.

Marine **Facility Development Summary**

The recommendations and development possibilities described above provide sound direction for marine facility development in Resolute Bay Harbour. They are summarized in sketch form in Figure RS.1.

Development Cost Estimates

Our cost estimates are provided below, in 1990 dollars, according to the principal use of the recommendation involved.

Local Facility

▪ Site Preparation & Excavation	$50,000
▪ Breakwater Construction & Improvement	380,000
▪ Rock Filled Timber Cribs	35,000
▪ Engineering & Survey	45,000
▪ Contingency	90.000
	$600,000

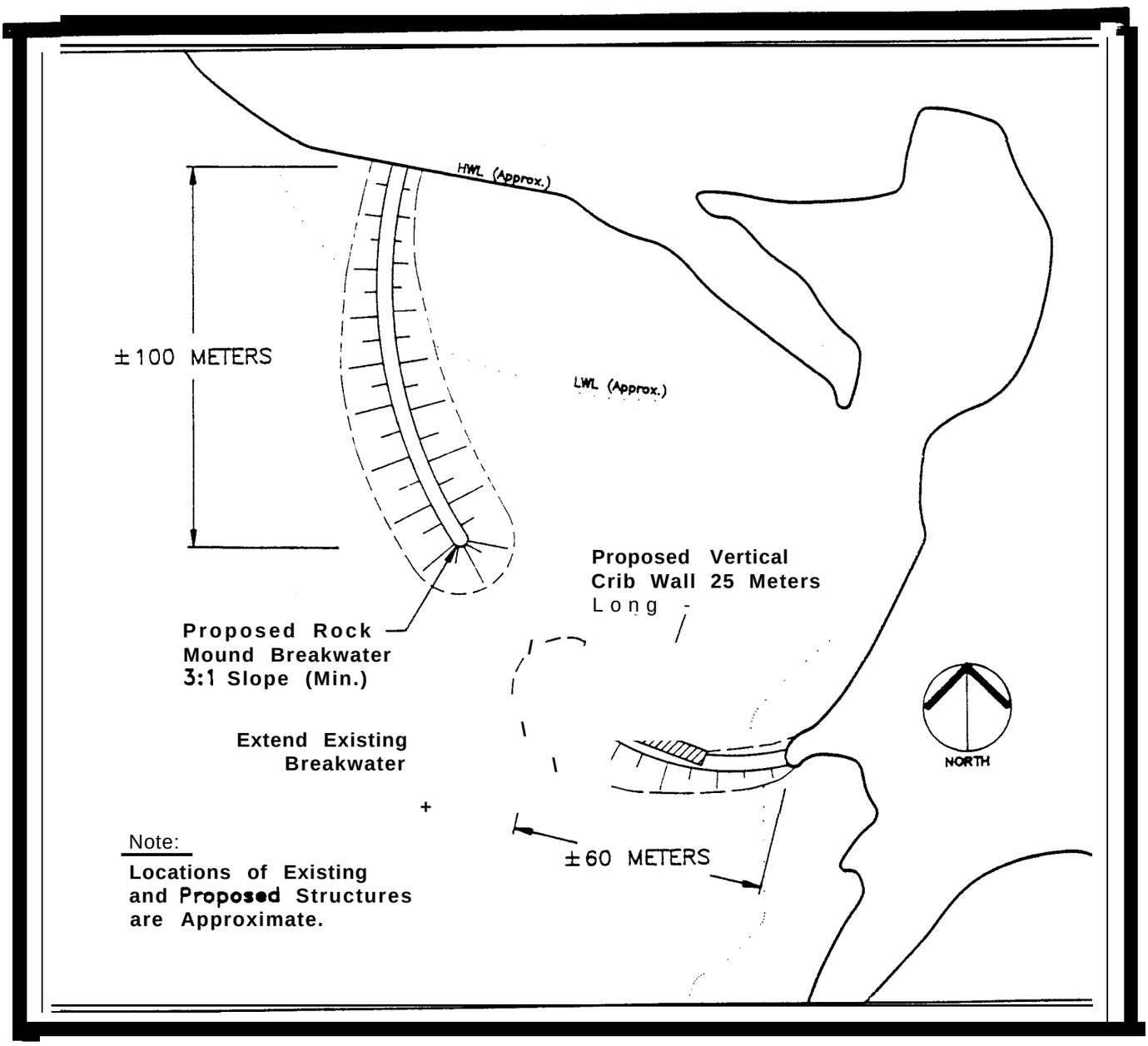
Note: This cost estimate does not include any provision for relocating or extending the existing sewer outfall.

Sealift Dry Cargo

m Improvement of Existing Anchoring System	$20,000

Sealift Bulk Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $3.2 million.



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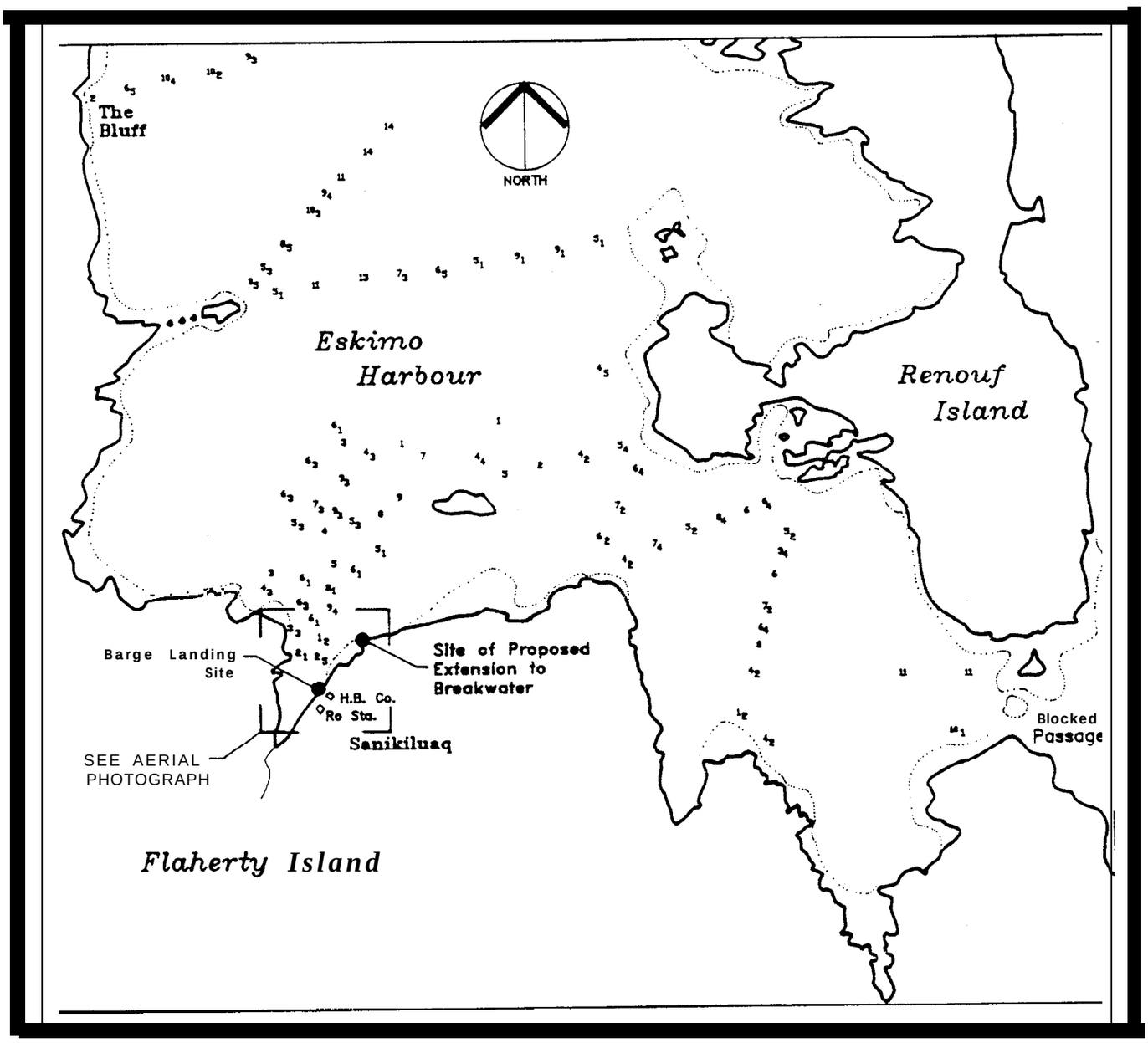
RESOLUTE BAY
CONCEPTUAL PLAN

Reid Crowther

MARINE FACILITIES ASSESSMENT



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Soundings in Fathoms

SANIKILUAQ
ESKIMO HARBOUR

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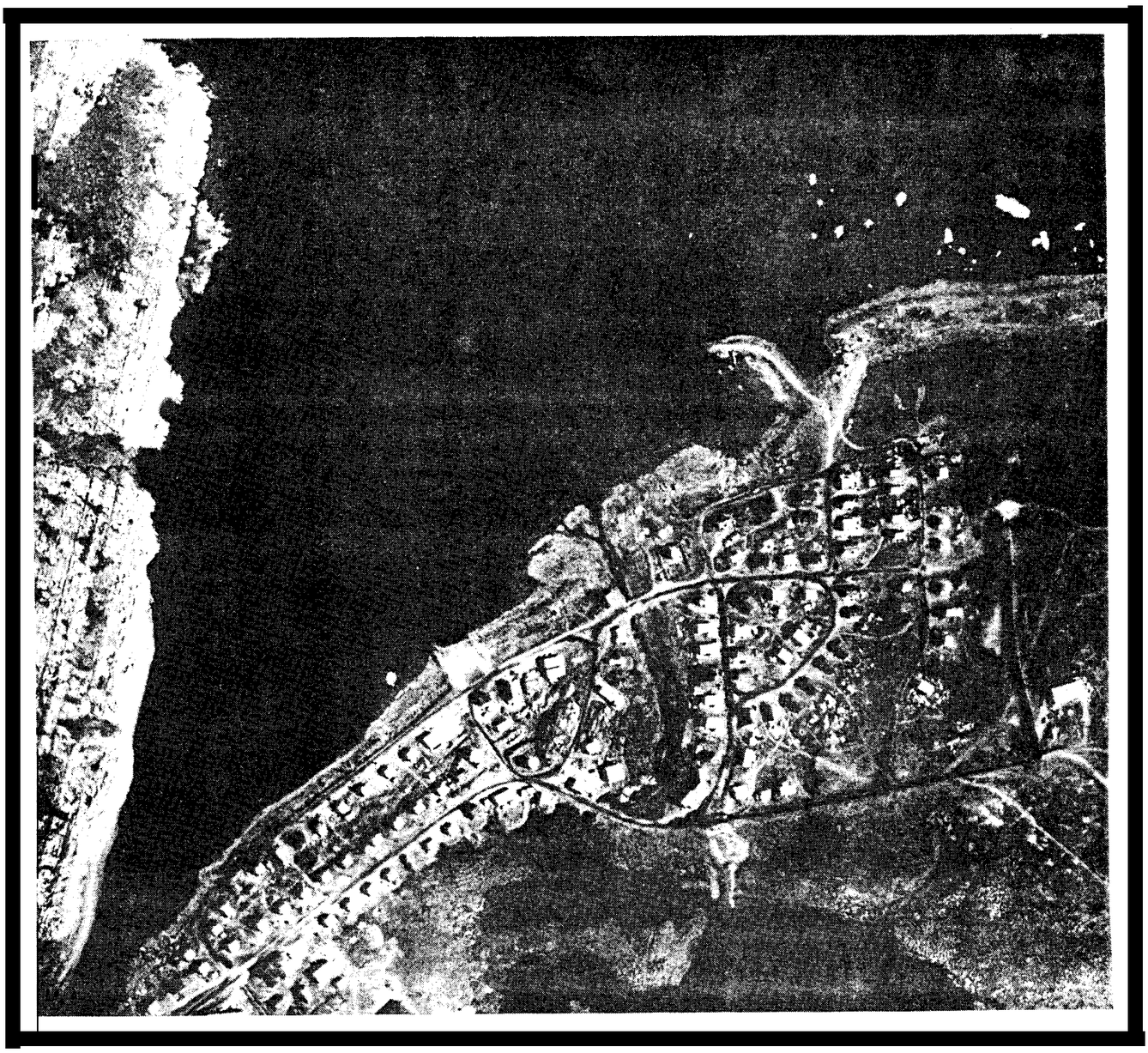
MARINE FACILITIES ASSESSMENT



SANIKILUAQ
ESKIMO HARBOUR

SANIKILUAQ HARBOUR
MARINE FACILITIES ASSESSMENT

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Reid Crowther

Introduction

This short report summarizes the findings of a study of Eastern Arctic marine facilities undertaken by Reid Crowther & Partners Ltd. and Novacorp Consulting Inc. on behalf of the Governments of the Northwest Territories and Canada.

Hamlet of Sanikiluaq Overview

Sanikiluaq is home to some 457 people. It is located within the defined Eastern Arctic geographic area but is some distance from other communities in the area at the southeastern corner of Hudson Bay. On the North end of Flaherty Island, part of the Belcher Islands group, the community is 1,024 kilometres by air southwest of Iqaluit and 1,282 kilometres northwest of Montreal.

The present community of Sanikiluaq evolved primarily over the last three decades, although inhabitants of the Belcher Islands date back thousands of years. Today local residents are known for their creation of distinctive soapstone carvings while their economy and livelihood is based principally on domestic fishing and trapping. Some soapstone quarrying is also carried out locally for export to carvers in other communities.

Waterfront Utilization and Demand

Waterfront activities in Sanikiluaq include local boat use for subsistence fishing, marine mammal hunting and trapping and the annual sealift operation. Little tourism activity takes place and the commercial fishing industry has not evolved to date.

Our visit to the hamlet, combined with our discussions locally and our research of marine demands, has enabled us to develop a number of conclusions on waterfront utilization and demand is Sanikiluaq. These findings and conclusions are summarized in the following paragraphs.

Cargo/Sealift Shipments

Annual sealift operations bring dry cargo and petroleum products, in bulk, to Sanikiluaq during the open water season (...normally June to September). The following table profiles sealift shipments to the community between 1984 and 1989.

SEALIFT SHIPMENTS TO SANIKILUAQ
1984-1989
(Metric Tonnes)

	1984	1985	1986	1987	1988	1989
▪ Dry Cargo	251	448	335	184	224	425
▪ Petroleum Products (Bulk)(1)	N/A	N/A	N/A	N/A	N/A	N/A

(1) Petroleum products are not shipped in bulk to Sanikiluaq via the sealift and are not, therefore, included in this table.

Dry cargo shipments moved via the sealift to Sanikiluaq vary because of construction projects in the community. If they were normalized to exclude peak construction-generated demand, it is likely the totals would vary only nominally and reflect population and economic base changes.

We believe that sealift shipments to Sanikiluaq will not change dramatically over the foreseeable future, other than the occasional, annual peaking of dty cargo movements responding to development activity. Our forecasts sealift shipment levels to the community over the 1990 to 2000 period are summarized in the following table.

SEALIFT SHIPMENT FORECASTS TO SANIKILUAQ
1990 - 2000
(Metric Tonnes)

	1989[1]	1990	1991	1992	1993	1994
■ Dry Cargo	193	197	201	205	209	213
■ Petroleum Products (Bulk)[2]	N/A	N/A	N/A	N/A	N/A	N/A

	1995	1996	1997	1998	1999	2000
■ Dry Cargo	217	222	226	231	235	240
■ Petroleum Products (Bulk)[2]	N/A	N/A	N/A	N/A	N/A	N/A

(1) 1989 estimates are based on a trend line analysis of 1984 - 1988 statistics. Projections after 1989 use the population forecast rate applied to the base year (1989).

(2) Petroleum products are not shipped in bulk to Sanikiluaq via the sealift now, are are not expected to be over the forseeable future and are not, therefore, included in this table.

Local Boating Activity

Residents of Sanikiluaq make frequent use of the waterfront during the open season, primarily for subsistence hunting and fishing and the collection of carving rock. The local boats are small 5-metre to 7-metre aluminum and fibreglass. There is one 12-metre Cape Islander boat in the community. We do not anticipate major increases in boating activity.

The Hamlet has requested an extension to their breakwater, which is too small and have requested an unloading wharf.

There were 230 domestic fishermen registered.

It was reported that 28 Beluga Whale and 10 Walrus were harvested in 1987/1988.

Commercial Fishing Activity

There has been no commercial fishing activity in this area.

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Marine Tourism Activity

There is no significant tourist traffic in the area although the community is in favour of encouraging it. The community is well known for its carvings.

Waterfront Utilization and Demand Summary

In summary, seasonal use of the Sanikiluaq waterfront is critical to the traditional activities of local residents. Nominal expansion in sealift throughput and in local use if anticipated. The existing breakwater needs improvement to meet the current demand.

Site and Harbour Profile

Relevant characteristics of Sanikiluaq Harbour and the extent to which marine facility development has taken place to date is summarized below.

■ Tides	Mean Tides	1.oM
	Large Tides	1.5M
	Mean Water Level	**0.9M**

■ Tidal Zone — The beach gradient is estimated at 5% to LWL.

■ Soil Conditions — The surface is shingle/small boulders, medium to firm from high tide to mid-tide. Mud and clay were reported near low water contour. the terrain is generally flat above HWL followed by low relief rocky terrain.

■ Site Topography — Sanikiluaq is located on one of the islands within the Belcher Island group located in the southeast corner of Hudson Bay. The islands have low level bare rocky terrain and the region is exposed to wind conditions over 360°.

❑ ice — First year ice with only a slight possibility of second year ice. The sea is relatively shallow which breaks up ice movements on shore. There may be some pile-up above high water. The winter fast ice would extend out from shore to roughly the LWL.

Open water period is probably from mid-June to the end of October, although council reported it to be six months.

- Exposure — **From** the north, it is exposed over roughly 15 kilometres. Low rocky islets prevent deep water waves from reaching the beach. Council reports that very strong N.W. winds have sunk boats.

- Littoral Drift — Littoral drift could be expected to be a factor at this site. Probable drift in north-south direction along the shore.

A ten year old L-shaped breakwater is located on the northwest side of the beaching area. It is built up of shingle/boulders with a slope of about 6:1 on the exposed side. Bars could be seen 80 to 100 metres off the breakwater. The area inside the "L" is reported to be too shallow.

Development Recommendations

Marine facility development recommendations prepared during the study are summarized in the following paragraphs according to their primary use.

Local Community Use

The main priority for Sanikiluaq is improvement to the existing breakwater structure and excavation to provide a deeper area behind it.

Council requested that the extension to the breakwater should run to the east of the existing structure and curve around to the south to create a basin. In view of the problems of littoral drift, it is not recommended that the breakwater extension should run on the east side as the protected area would probably fill^ that 2-3 years. The preferred solution would be to increase the height of the existing structure with a thick layer of boulders and extend it out to a deeper water. The area behind the breakwater should also be excavated to provide more water.

The second priority at Sanikiluaq is provision of a vertical face wharf-type structure which could also be used by the sealift barges during unloading. It would therefore be logical to incorporate this crib in the breakwater extension at this location.

We recommend that marine facility development in Sanikiluaq incorporate the following minimum requirements:

- **extension of existing breakwater structure;**
- **excavation behind new breakwater**
- **provision of vertical face wharf structure** using timber cribs (optional).

Sealift Dry Cargo

As outlined in the section for local community use, the priority for improving the sealift operation is provision of a vertical face structure which could be built from timber cribs and incorporated in the new breakwater structure.

The sealift marshaling area could be improved by the grading and gravelling of an area at the inshore end of the breakwater.

Should cargo barge service (Moosenee Transportation) begin here then a separate crib structure and unloading area should be built to the west of the breakwater site near the remains of the old pushout.

Sealift Petroleum

No details were available of unloading operations or how far off shore tankers must anchor to deliver oil. In any event, provision of a tanker facility would require construction of a large rock causeway out to deep water and probably sheet pile cells to be used as mooring dolphins. The first stage for a major structure of this type would be pre-engineering and survey investigation to select a suitable site.

Marine Facility Development Summary

The recommendations and development possibilities described above provide sound direction for marine facility development in Sanikiluaq Harbour. They are summarized in Figure SK.1.

Development Cost Estimates

Preliminary cost estimates have been prepared in 1990 dollars which reflect the development recommendations described above.

Local Facility

The following estimate has been prepared without detailed sounding information, which would impact on the cost of the proposed facility. It has been assumed that the timber crib wharf is included in the local facility.

■ Excavation & Site Preparation	**$50,000**
■ Improvement & Extension to Breakwater	**180,000**
■ Construction of Timber Crib Wharf	**40,000**
■ Engineering & Survey	**27,000**
■ Contingency	**54.000**
	$351,000

Sealift Dry Cargo

Improve marshaling area $20,000.

Provision of a separate barge facility for 2-metre draft at LWL

■ Excavation & Preparation	$25,000
m Rock Mound Causeway	150,000
■ Vertical Timber Crib Landing Face	50,000
■ Engineering & Survey	25,000
■ Contingency	50,000
	$300,000

Sealift Petroleum

The cost of providing a deep water mooring facility for tankers is estimated at $4.0 million.

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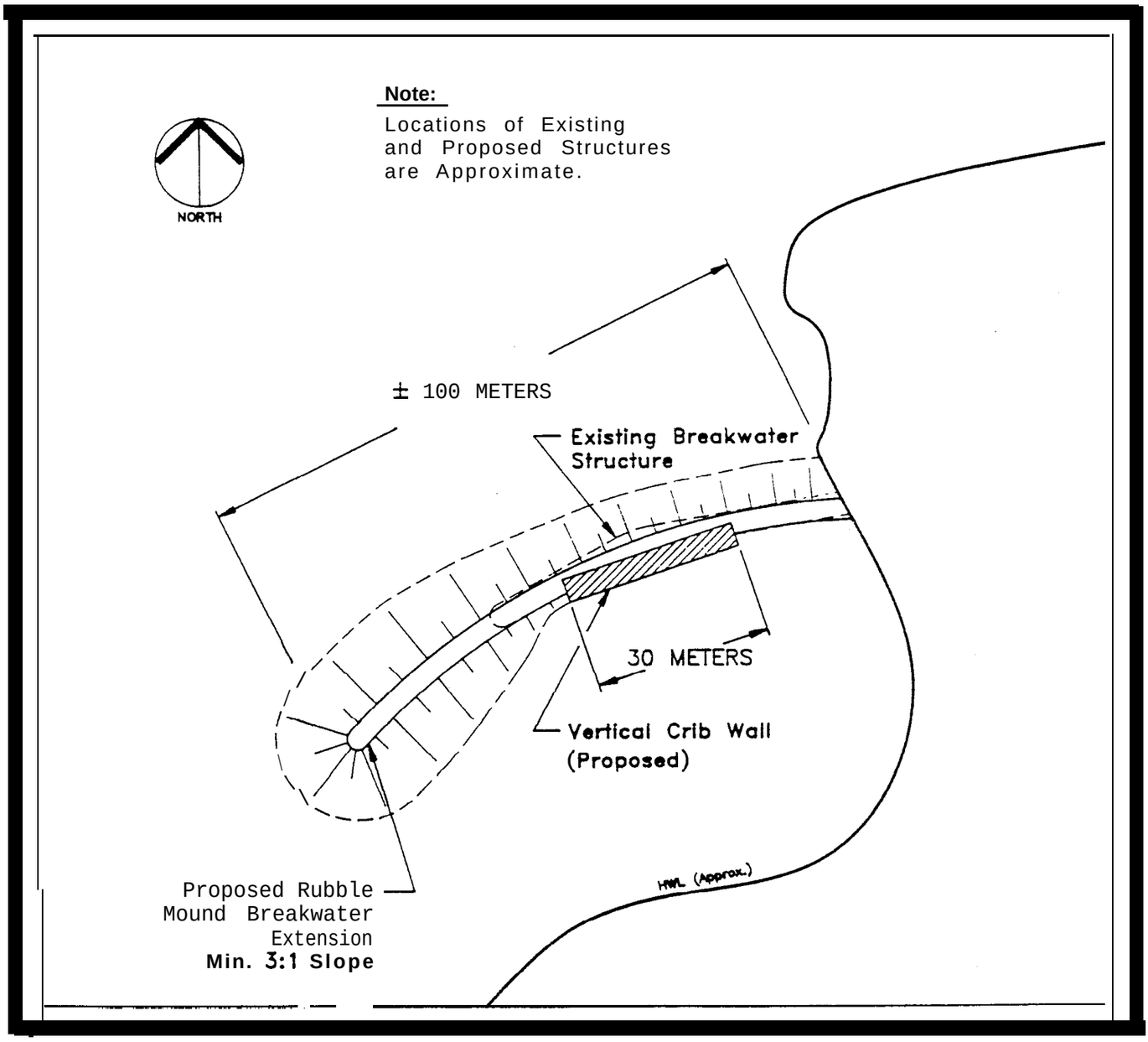

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SANIKILUAQ
CONCEPTUAL PLAN