TAQPANGAJUK RELOCATION

A FEASIBILITY STUDY

VOLUME II

TECHNICAL STUDIES

SITE EVALUATION, COMMUNITY PLANNING AND COSTING
AIRPHOTO INTERPRETATION
ARCHEOLOGICAL SURVEY

Prepared for
Department of Indian Affairs and
Northern Development

By
Makivik Corporation
Kuujjuaq, Québec

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INTRODUCTION

In this, the second of a two-volume report on the feasibility of a relocation of the former residents of Killiniq to Taqpangajuk, the technical findings on the site and its development potential are set out. Three reports are included in this volume. The first report describes the conduct of, and findings from a major study on the site, infrastructure, community plan and projected cost of Taqpangajuk, that was carried out by the Municipal Technical Assistance Department of Kativik Regional Government. This report comprises the primary instruments for evaluating the site and developing a plan.

The work of the researchers that were responsible for the Kativik Regional Study was greatly facilitated by an aerial photographic interpretation that was carried out for the Makivik Research Department by a consultant. This interpretation was in turn, facilitated by an aerial photographic mission carried out by the Inuit of the Kangiqsujuaq Research Center. This mission resulted in a series of vertical and oblique color photographs taken at 5,000 feet and covering a 10 kilometer area around Taqpangajuk.

Finally, an archeological on-ground survey of the site was designed and carried out by personnel from Avataq Cultural Institute, an Inuit-run organization responsible for cultural development in Northern-Québec. This type of archeological survey was required by the Ministère des Affaires culturelles that issued the authorization and license. A full report with detailed maps and photographs has been submitted to the ministry by Avataq Cultural Institute.

All of the reports included in Volume II are organized and presented as separate units. Although there has been some editing and integration of material, there have been no substantial changes. Each of these reports contains an extensive series of large maps. In order to facilitate the use of these maps, they have been bound as a separate volume for use with either Volume I or Volume II.

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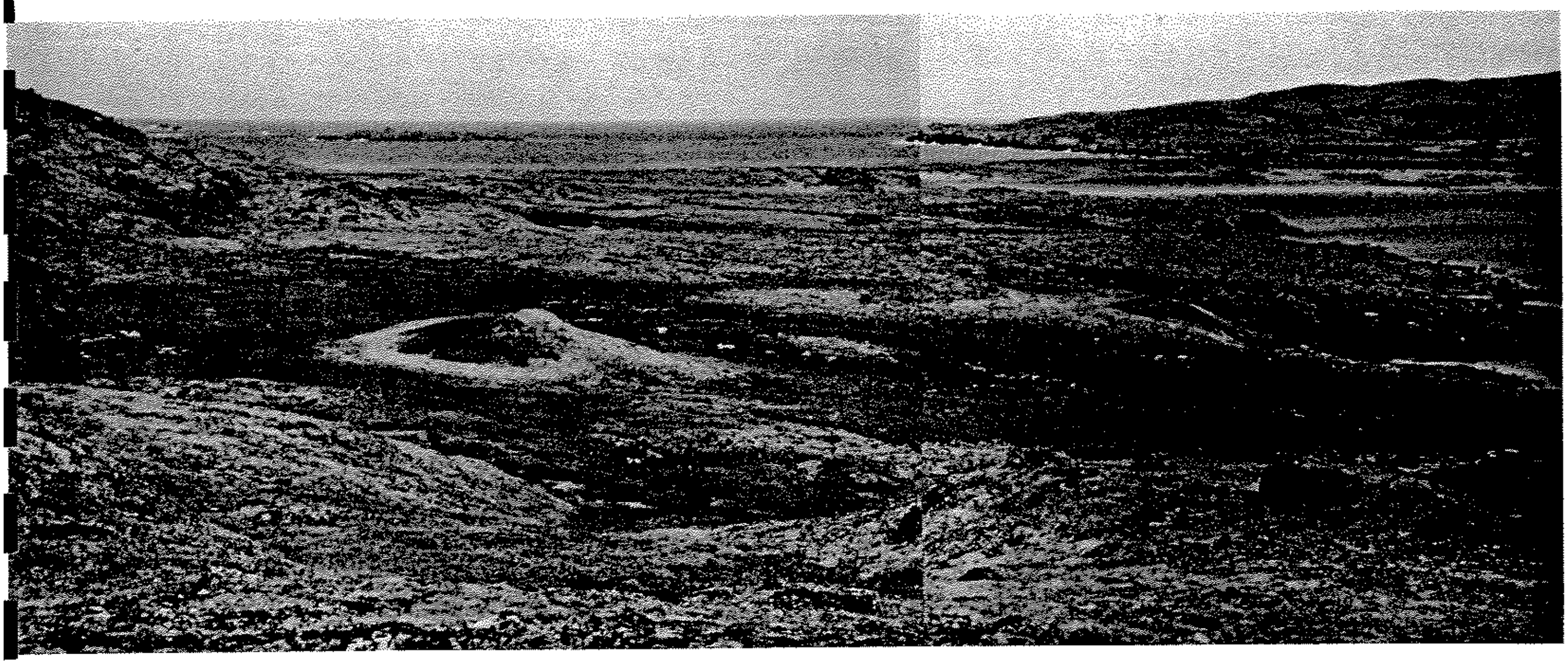
as seen from approximately 5,000 ft.

Taqpangajuk



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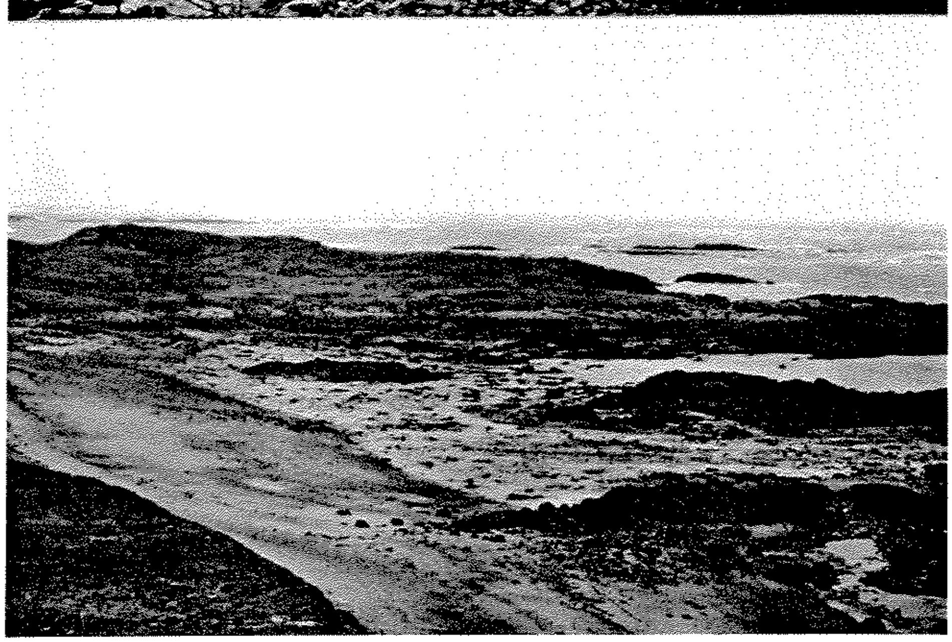

KATIVIK
REGIONAL
GOVERNMENT

MAKIVIK CORPORATION

TAQPANGAJUK FEASIBILITY STUDY

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Introduction

The Inuit who wish to relocate are former residents of Killiniq. This community was located on an island approximately 300 m from the Québec mainland and was under the jurisdiction of the Government of the Northwest Territories (GNWT) and the federal government. Under the James Bay and Northern Québec Agreement signed in 1975 the Inuit who were living at Killiniq were recognized as residents of Québec. In 1978, the federal government and the GNWT closed the community. Planes were brought in to take all of the people and some of their personal possessions to five host communities.

In 1982, the engineering firm Pluram Inc. was requested by Makivik Corporation to conduct a feasibility study for the relocation of Killiniq Inuit to Bell Inlet. Three different sites were investigated but none of them were considered adequate for the building of a new community, the major problems being poor foundations areas, bad drainage, the lack of drinking water, and difficulties of marine access.

A fourth site, on Singer Inlet, was then investigated by the consultants. After the study of the data gathered, it was considered the only feasible site, situated between Kangiqsualujjuaq and Killiniq, for the relocation of the Killiniq Inuit. This site is now refered to as Taqpangajuk.

In August 1985, in response to an invitation by Makivik Corporation, the Kativik Regional Government (KRG) made a formal proposal to undertake a feasibility study of the potential site at Taqpangajuk on Singer Inlet. The main objectives of the KRG study were:

1- to determine the capacity of the Taqpangajuk site to physically accommodate the infrastructure requirements for a new community with a base population of 205 individuals and to account for the expansion of the community for the following 25 years;

2- to establish planning scenarios for the development of the community infrastructures and to determine a realistic schedule and a critical path for the construction of the village;

3- to determine the cost of implementing each of the planning scenarios based on existing needs and the target population of 205.

The investigation began with a photographic survey. The analysis of these photographs indicated that another site with interesting potential could be found approximately 5 km to the east, at the head of Christopher Inlet, a site known by the Inuit as Uugalik.

Therefore, a decision was made by the Technical Committee to include the Uugalik site along with the Taqpangajuk site in the feasibility study conducted by KRG.

A field study was carried out in September 1985 by KRG's Municipal Technical Assistance Department along with Makivik's Research Department. Both potential sites were investigated and data were gathered and compared for each of them. An analysis of these data showed that the Taqpangajuk site was the best acceptable location because of its solid land base and its easier access to the sea.

At a meeting of the Technical Committee held in Montréal on October 17, 1985, Taqpangajuk was officially selected as the future site for the relocation of the Killiniqmiut.

The main purpose of this document is to demonstrate the feasibility of locating a new community at Taqpangajuk considering the type of infrastructures that must be built and the physical characteristics of the site. Taking into account the potentials and constraints of the site, and the concerns and preferences of the Inuit, three preliminary planning scenarios were prepared and their costs estimated. These preliminary options were then reviewed by the Inuit and by the Technical Committee at the Heads of Family meeting held in Kuujjuaq from December 9 to 13, 1985.

As a result of this review process, specific changes were made and additional information was obtained. In late January and February, all of the Inuit were once again consulted in their host community about the three planning scenarios. This information along with other changes and additions suggested by the Technical Committee in December 1985 were incorporated into the March 1986 Taqpangajuk Feasibility Study report. This report was then presented to the Technical Committee on March 25, 1986. During this meeting, certain modifications and corrections were suggested and some additional information was requested. All of these corrections were made and incorporated into the Final Report that was submitted to Makivik Corporation and the Technical Committee on May 9, 1986. The Final Report also contains the results of the winter site survey that was carried out on April 8, 1986. The findings and the planning scenarios were once again discussed and reviewed in a joint Heads of Family and Technical Committee meeting held in Kangiqsualujjuaq from April 23 to 25,1986. At this meeting a final planning scenario was presented and accepted by the community.

Acknowledgments

The study team wishes to thank all the people who participated in the study, especially:

- the people of Killiniq for their help on the land, their cooperation during the consultations, and their understanding;

- Makivik staff for their confidence and cooperation;

- the organizations and companies consulted for the information they provided;

- KRG staff for their collaboration regarding their specific fields.

The study team also wishes to thank the Department of Indian and Northern Affairs which made this important work possible and which provided valuable technical expertise through their representation on the Technical Committee.

Summary

The purpose of this study was to demonstrate the feasibility of constructing a new village at Taqpangajuk on Singer Inlet, 40 km southwest of Killiniq.

The geology, topography, soil, drainage and climatic conditions were investigated in depth to obtain a detailed evaluation of the site. The population to be accommodated was forecasted to reach 432 persons by the year 2010. This figure was used in order to plan adequate facilities.

The forecast and site characteristics were used to identify the population's needs in buildings, drinking water, wastewater treatment, municipal infrastructures, transportation, energy and communications.

Three planning scenarios were then prepared according to the needs determined and the potentials of the site.

A construction schedule was drawn up to coordinate the numerous activities needed to realize the project. The earliest possible completion date was determined to be the end of 1990. Detailed budgetary costs were also calculated.

It was found that the project was effectively feasible at an approximate cost of 34 000 000 $.

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List of abbreviations and symbols

BOD_5	:	biochemical oxygen demand after five days
Chap.	:	Chapter
CHU	:	Ungava Hospital Centre
cm	:	centimetre
CRTC	:	Canadian Radio-Television and Telecommunications Commission
°C	:	degree Celcius
DIAND	:	Department of Indian Affairs and Northern Development
E	:	east
FCNQ	:	Fédération des coopératives du Nouveau-Québec
Fig.	:	Figure
GNWT	:	Government of the Northwest Territories
g/pers. d	:	gram per person-day
h	:	hour
ha	:	hectare
JBNQA	:	James Bay and Northern Québec Agreement
kg	:	kilogram
Kg BOD_5/ha	:	kilogram of biochemical oxygen demand after 5 days per hectare
kg/ha. d	:	kilogram per heactare-day
km	:	kilometre
km/h	:	kilometre per hour
kPa	:	kilopascal
KRG	:	Kativik Regional Government
KSB	:	Kativik School Board

kw	:	kilowatt
L	:	litre
L/pers.d	:	liter per person-day
m	:	metre
m^2	:	square metre
m^3	:	cubic metre
MAS	:	Ministère des Affaires sociales
mg/L	:	milligram per litre
min	:	minute
MJ/m^2	:	megajoule per square metre
$MJ/m^{2 \cdot d}$	:	megajoule per square metre-day
ml	:	millilitre
MP	:	monthly mean precipitation
MW	:	megawatt
µg/L	:	microgram per litre
µmhos/cm	:	microhoms per centimetre
N	:	north
NE	:	northeast
NTU	:	nephelometric turbidity unit
NW	:	northwest
NWT	:	Northwest Territories
OPDQ	:	Office de planification et de développement du Québec
RBC	:	rotating biological contactor
S	:	south
S.D.	:	standard deviation
SE	:	southeast

Sec.	:	Section
SHQ	:	Société d'habitation du Québec
Subsec.	:	Subsection
SW	:	southwest
t	:	metric ton
Taq	:	Taqpangajuk
TP	:	total precipitation
Uu	:	Uugalik
W	:	west

1. PROJECT

1.1 MANDATE

In July 1985, the federal government's Department of Indian and Northern Affairs awarded the Makivik Corporation a grant to prepare a feasibility study for a village at Taqpangajuk to replace Killiniq.

Makivik's Research Department requested the services of KRG's Municipal Technical Assistance Department to take care of the engineering, planning and costing aspects of the feasibility study.

The mandate given to the Kativik Regional Government was to:

- verify the suitability of the Taqpangajuk site;
- carry out a physical investigation of the site;
- identify the population and estimate its growth over the next 25 years;
- identify the needs of the former residents of Killiniq regarding community infrastructures and services;
- adapt these needs to the standards presently applied in the Inuit villages of Northern Québec;
- determine the infrastructures to be provided considering the cost and impact of each option;
- identify the constraints and potentials of the site;
- prepare three planning scenarios showing the allocation of the land and the location of the main infrastructures for a period of 25 years;
- estimate the cost of implementation of the planning scenarios;
- prepare an implementation schedule;
- present the results in a preliminary report;
- prepare a final master plan based on the comments received from the future residents and the technical committee, concerning the the three options presented;
- finalize the cost estimates for all the infrastructures and the construction of the new village;
- present a summary of the results in a final report.

1.2 METHODOLOGY

1.2.1 Site selection

The most suitable of the three potential sites was determined by use of a selection chart evaluating the sites according to certain physical criteria. The selection criteria and evaluation were based on:

- bibliographical research;

- a study of a draft of the Lambert Rivard report entitled "Terrain Unit Characterization Forms"[1]* ;

- a study of the topographical maps and aerial photographs available at that time;

- a field survey made from September 10 to 19, 1985

Another field survey was made on October 10, 1985, in order to verify the data gathered. A winter site survey was made on April 8, 1986.

1.2.2 Determination of the characteristics and needs of the population

The heads of the families whishing to relocate to the new village were consulted from October 8 to 25, 1985. The results of this first consultation were used to determine:

- the population pyramid ;

- the needs in housing, support buildings, infrastructures and equipment;

- the location of these buildings and infrastructures.

A public meeting held on December 10 and 11, 1985 permitted a re-evaluation of the needs expressed earlier.

1.2.3 Drawing of maps

The site maps used in this report were drawn from two topographic maps at a scale of 1:2000 and 1:5000 produced by Photosur Inc., from aerial photographs taken by Aéro Photo Inc. (MTQ 85011).

The geological and physical maps were based on an air photo analysis by Lambert Rivard, prior to the field survey [2], on field survey data and on KRG interpretation of the aerial photographs after the field survey.

* Numbers in square brackets refer to the bibliography (pp. ** to **).

1.2.4 Selection of buildings, infrastructures and equipment

The selection of buildings, infrastructures and equipment was based on:

- the needs expressed by the future residents;

- the experience of the KRG Municipal Technical Assistance Department;

- a consultation of the public and private organizations working north of the 55th parallel;

- exhaustive bibliographical research;

- a compilation of the existing and planned equipment or infrastructure for the Inuit villages of Northern Québec;

- the natural constraints and potentials of the site.

1.2.5 Design of the planning scenarios

The different planning scenarios for the village were designed according to:

- the list of buildings and infrastructures and their space needs;

- a study of the constraints and potentials of the site;

- the results of the consultations with the Inuit in the host communities;

- the results of discussions with the Inuit at the two Heads of Family meetings;

- Formal and informal review by the Technical Committee as a group and with individual members.

1.2.6 Estimation of the costs

The costs were estimated using one or more of the following methods:

- use of the historical costs of projects which have already been realized;

- consultation of the organizations working north of the 55th parallel;

- breakdown of the project into its component steps and equipment and estimation of the related costs;

- consultation of the costs handbooks.

The historical costs were adjusted for 1985 using the average increase in the cost of living, while the projected costs for the following years were adjusted using an increase of 4 %.

2. SITE ANALYSIS

2.1 LOCATION

The sites that had to be examined for the relocation of the Killiniqmiut are located on the east coast of Ungava Bay some 40 km southwest of the former village of Killiniq (Fig. 2.1 and 2.2).

The sites are approximately 30 km from the Torngat Mountains, the range separating Québec from Labrador. The mountains rise as high as 600 m in this region but a pass with an elevation of only 120 m is located less than 10 km southeast of the sites, providing easy access to the Labrador coast along the Ikkudliayuk Fiord.

Taqpangajuk is located in a cove 40 km by air from Killiniq. Its exact location is 60°05'40" N latitude and 65°03'50" W longitude (Fig. 2.3).

"Taqpangajuk" is the Inuktitut name for Singer Inlet and means "a bay where there are many islands not touching each other". Many Inuit know the name of the place.

The village is to be built on a low terrace overlooking the cove and around a brackish lagoon that is separated from the cove by a raised beach. The site is surrounded by low, rocky hills on all sides except the side facing the cove.

Uugalik is located at the head of an inlet 38 km from Killiniq. Its exact location is 60°04'30" N latitude and 64°57'40" W longitude (Fig. 2.3).

"Uugalik" is the Inuktitut name for Christopher Inlet and means "a place where there are small cod".

The village would be built along the west bank of the inlet downstream from a river where Arctic char is said to be abundant. The mouth of the river is separated from Ungava Bay by a boulder barricade and tidal flats which limit access. The site is bordered on two sides by ridges rising to an altitude of approximately 100 m.

2.2 SITE SELECTION

At the August 20, 1985 Technical Committee meeting in Montréal, it was decided to include in the field survey, and also in the feasibility study, two potential development areas at Uugalik, following the identification of this possible alternative .

The field survey took place from September 10 to 19, 1985, and despite some weather problems, both sites were surveyed.

After analysis of the preliminary information, presented in Appendix II, the selection chart included in Appendix III was produced. This chart, together with 1:10 000 scale maps, demonstrated that the Taqpangajuk site was the most preferable one. To make this analysis more precise it was decided to draw up a selection chart that would include a weighted method of analysis. This chart is presented as Table 2.1.

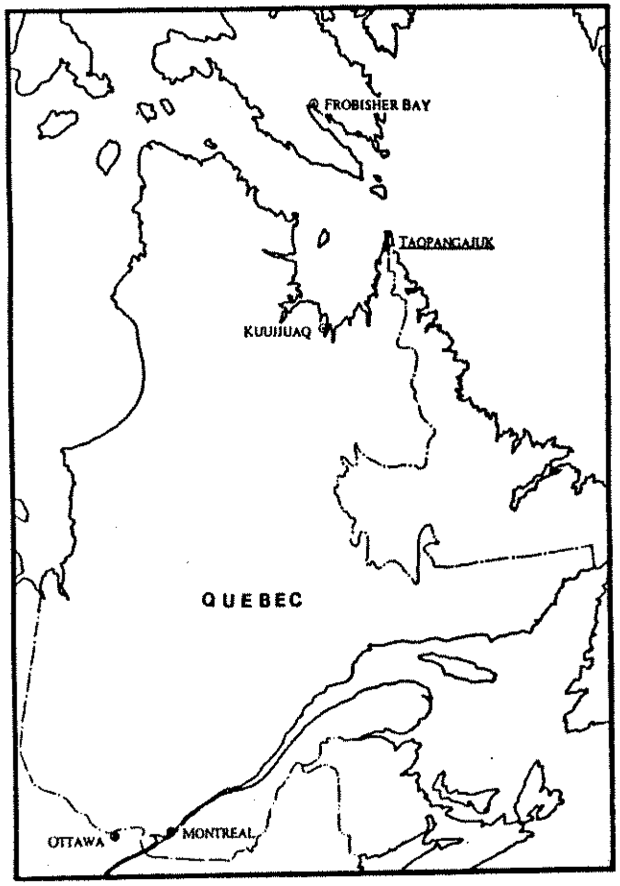

Figure 2.1
Location in Québec

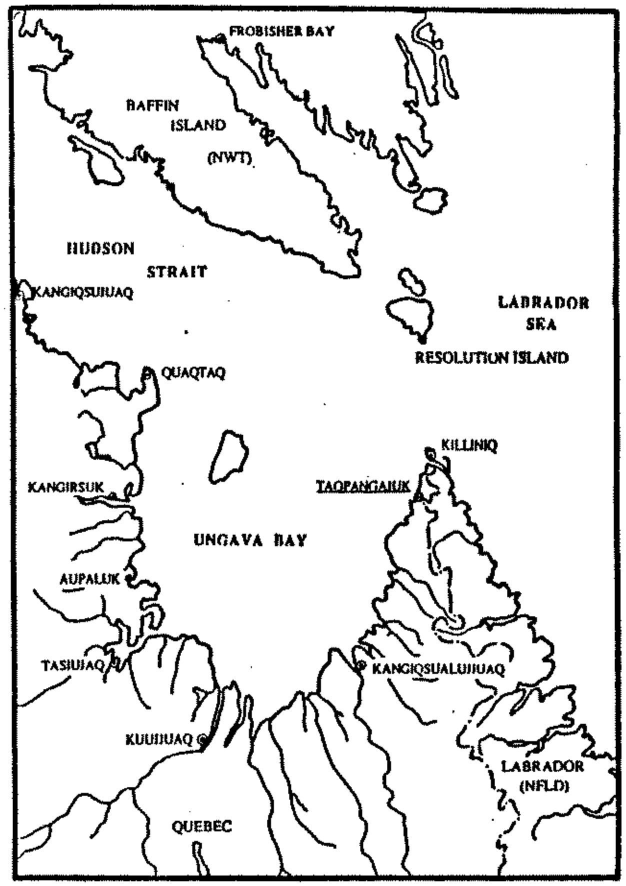

Figure 2.2
Location on Ungava Bay

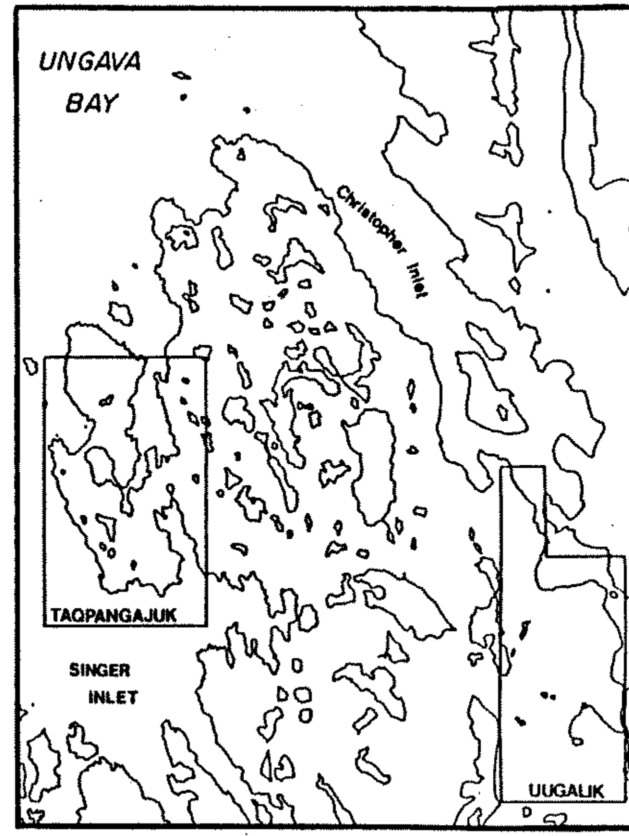

Figure 2.3
Location of the Sites

Table 2.1
Site Selection Chart

Criterion	Weight	Evaluation of the Options*			Weighted Value of the Options		
		Taq	Uu(1)	Uu(2)	Taq	Uu(1)	Uu(2)
Water access	20	9	5	3	180	100	60
Foundations	15	6	3	4	90	45	60
Drinking water	15	6	5	5	90	75	75
Available areas	10	2	3	5	20	30	50
Airstrip	10	3	7	5	30	70	50
Wastewater	10	8	5	5	80	50	50
Orientation	5	4	5	7	20	25	25
Topography	5	9	4	7	45	20	35
Port	5	5	3	1	25	15	5
Solid waste	5	5	2	2	25	10	10
Total	100	57	42	44	605**	440**	430**

* On a scale of 1-10; an average site would rate 5 points
** A perfect site would rate 1 000 points

From this analysis, it is clear that, although it is not a perfect site (1 000 points), Taqpangajuk is a better overall site (605 points) than either of the Uugalik sites (430 and 440 points). Therefore, as of October 7, 1985, Taqpangajuk was the only site studied. A field survey was carried out on October 10, 1985, to confirm this choice.

These results were presented to the Technical Commitee at a meeting held in Montréal on October 17, 1985. The report to the Technical Committee is presented in Appendix III.

2.3 GEOLOGY

2.3.1 Regional geology

The area planned for the relocation of the Killiniqmiut is on the Killiniq Plateau[1] in the Canadian Shield. It has the Torngat Mountains at its back to the southeast and faces Ungava Bay and Hudson Strait to the northwest (Fig. 2.4).

The Hudsonian orogeny (1 735 million years ago), which produced the Torngat Mountains, radically modified the oldest rocks in the world (Archean: 2 500 million years ago), transforming them from sedimentary rocks into the metamorphic rocks of granitic gneiss facies which are common in this part of the geological province of Churchill.

The glaciers of the Quaternary (from 20 000 to 9 000 years ago) then wrought great changes in the regional geology, transforming the substratum rock into moraines and other periglacial deposits. These deposits are nevertheless rather scattered and thin in this region

[1] Also known as the George Plateau

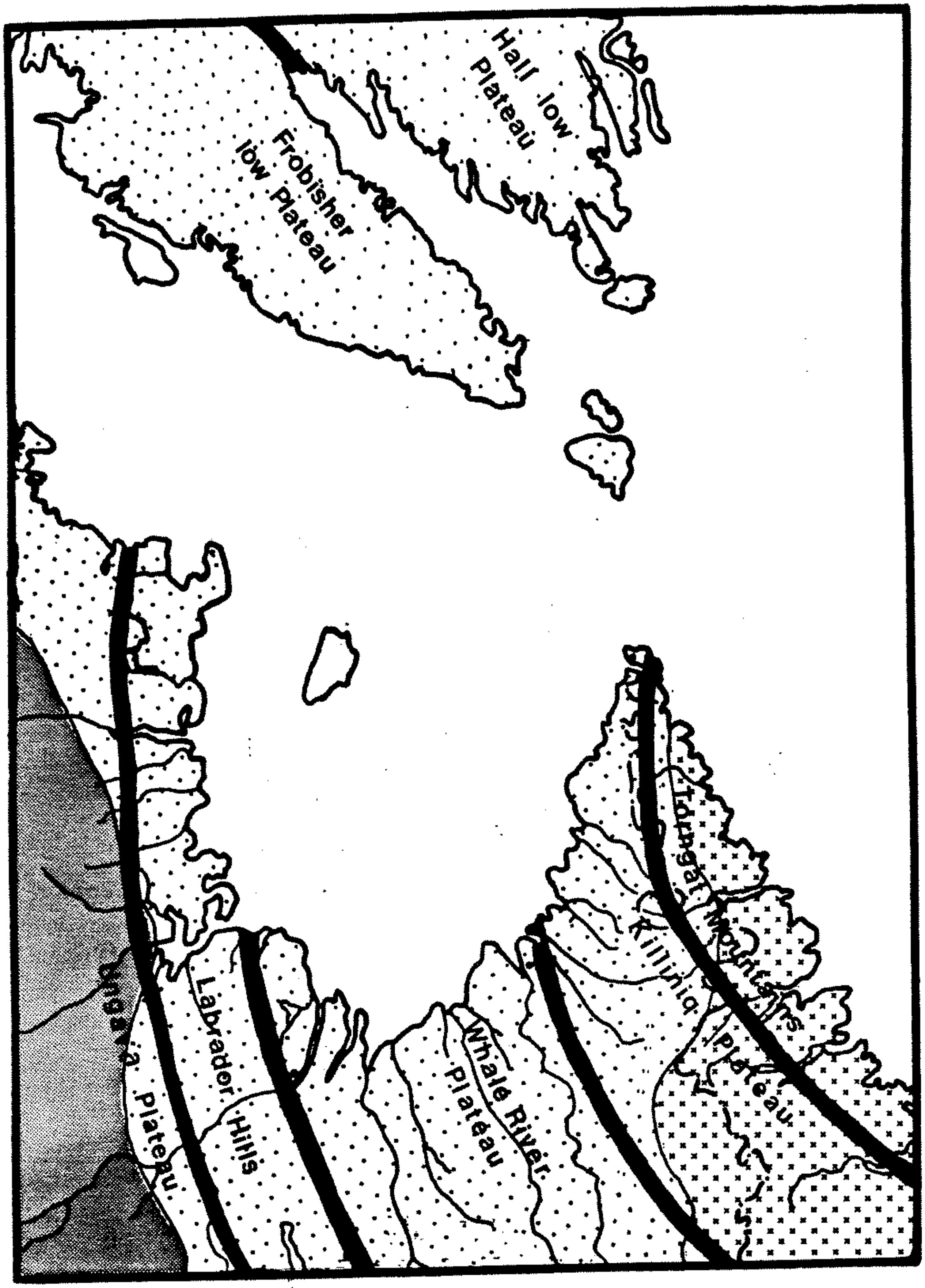

Figure 2.4
Regional Geology

Superior Province
Churchill Province
Nain Province

since the maximum extension of the glacial mass was much farther south, reaching into the northern United States.

The marine transgression which followed the melting of this ice mass rose approximately 15 m in this region. This makes it very unlikely that any granular materials from this source will be found at higher altitudes.

2.3.2 Site geology

The Taqpangajuk peninsula, located on the northeast side of Singer Inlet, is characterized by numerous rock outcrops, with occasional thin moraine deposits covering the bedrock. The northwest orientation of the rocky ridges, parallel to the Inlet, is a general feature of the regional glacial morphology.

The 2,6 km^2 peninsula is connected to the mainland by a 350 m wide isthmus. The peninsula surrounds a cove that is cut at midpoint by a sand bar extending between two rocky ridges and isolating a warmer lagoon.

Aside from this sand bar, the coast is composed of rock dipping into the sea, or blocks (taluses) which are covered above the waterline by thin moraine deposits and typical plant cover.

The rock is sound granitic gneiss with a few granitic intrusions of the pegmatite dike type. Where it is exposed to weathering, as in outcrops, it has been altered superficially by oxidation and one can note the effects of frost heaving since the rock is either broken or shattered. On steep slopes, this phenomenon has led to talus deposits, where the broken rock pieces have accumulated, or even to boulder pavements, which can be confused with those of fluvioglacial origin. The principal joint systems that affect the bedrock are, in order of importance:

- a northwest (310°-320°) system dipping 50° to 60° to the east, which is related to the gneissic foliation (in a parallel plane);

- a southwest (240°-250°) system with a sub-vertical dip which is subsidiary to the preceding system;

- a system striking north (360°) with a dip of 60° to the east, which is less regional and more local and is observed mainly on rock exposed at low tide or near the shoreline, which are also the strike and dip angles of the pegmatite dikes.

Granular deposits are limited to the sand and gravel of the raised beach, a washed-off sand strata overlying moraine near the tip of the west ridge, another one on the opposite side of the cove downstream of a round intermittent pond and also some scattered sand patches of a few cubic metres overlying moraine deposits that are caused by an erosion process in which fine particles are transported by rain run-off leaving sand. Another possible source of granular materials would be the two boulder barricades across the effluent of the lagoon that are the remnants of boulder-rich moraine deposits that have since been washed off by sea and water flow leaving behind only the biggest particles (20 cm or over).

Moraines, which are glacial deposits, are found mostly in five areas on the peninsula: northwest and northeast of the sand bar, where they were not touched by the marine transgression because of their elevation; southwest of the sand bar, out of reach of the marine transgression where, because of their impervious properties, they have formed swampy areas; on the northeast part of the peninsula where, because of the steeper angle of the slopes and also because of the oversaturated active layer that thaws during summer, they creep towards the sea in a slow process called gelifluction. Aside from these important morainic concentrations, a thin moraine or "glacial veneer" covers even small depressions in the bedrock except on steep rock faces.

On the geological maps (Plans 1.1 and 1.2) these translate into the following divisions:

R	rock
S	sand
Mo	moraine
B	boulders

To give greater detail these divisions are subdivided as follows:

R	rock outcrops where more than 90 % of the area is exposed rock;
Mo	moraine which is generally more than 1 m thick (2 m average);
Mo/R	thin moraine (less than 1 m, average 0,5 m) overlying bedrock and which has constructional topography reflecting the bedrock surface on which it lies;
R+Mo/R	thin moraine but where rock outcrops constitute at least 10 % of the area;
B	boulder accumulations;
B/R	thin boulder layer on rock;
S	sand deposits (may also include gravel);
S*	low sandy beach;
S/Mo	relatively large sand deposit overlying a moraine type deposit;
S+Mo/R	numerous sandy patches overlying a moraine type deposit;
W	organic mat with high water content generally on a saturated thin clayey material overlying poorly drained moraine on bedrock;
MoW	saturated moraine that generally has a thicker organic mat than Mo and that because of its poor drainage stays wet longer (in July it is not far from W); it may be considered somewhere between Mo and W;
MoSol	solifluction moraine or creeping soil.

The village itself will be located on the sand bar and around the lagoon on moraine and a few rock and muskeg (MoW,W) areas.

2.4 TOPOGRAPHY

The two most outstanding topographic features of the site of the future village are a sand bar connecting two ridges bordering the main development area, and a lagoon, almost at sea level, which is separated from the sea by the sand bar.

The village will be located in a semicircle around the lagoon on a sub-horizontal terrace rising from 4 m to 7 m above sea level (5 m being the average). This semicircular terrace begins on the northeast end of the sand bar where it consists of a raised beach set some 20 m back from the waterline of the lower beach on the Ungava Bay side and sloping gently down towards the lagoon on the other side (Plan 3). At the southwest end of the sand bar, the terrace continues along the shore of the lagoon where it consists of a moraine deposit with some rock outcrops rising as high as 9 m.

At the end of the terrace, this moraine zone dips noticeably at the midpoint of the lagoon to a low wetland area (from 2 m up).

The terrain then rises again to a reasonably flat rocky area at an altitude of 10 m to 12 m surrounding a bigger hill rising to 18 m. It then steps down across a small ridge to another wetland area at 8 m that could also be used for development purposes. This is the furthest point that development could extend in that direction.

Across the west ridge bordering the village area is another potential development area that would be ideal for industrial uses. Consisting primarily of a wetland at an altitude of 7 m, it extends to the south on rock foundations rising to an altitude of 12 m along the base of a steep rock face 20 m high.

It then continues around this ridge to connect with the wetland area which lies south of the lagoon and adjacent to the location planned for the wastewater disposal site.

South of this area is a freshwater lake which could be used for the drinking water intake point and to the east is the hilly isthmus connecting the Taqpangajuk peninsula to the mainland. An access road from the village would wind eastward through these hills up to the 30 m high plateau on the mainland where the airstrip would be located.

2.5 SOILS AND DRAINAGE

2.5.1 Materials and characteristics

There are three types of soils at the Taqpangajuk site: sand (pulverulent soil with excellent drainage), moraine (pulverulent or slightly cohesive soil with variable drainage) and wetland (more or less cohesive soil with poor drainage, characterized by its saturation and the abundance of vegetal matter and humus).

Sand is found mainly on the raised beach. It is generally a uniform, medium-grained sand with traces of silt and varying proportions of fine gravel. [2] The terrain is generally flat and well drained, and the permafrost should be quite deep. The processes affecting the active layer should not cause any problems considering the good drainage properties of this material.

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[2] The granulometric analyses of the test pits are available for consultation at KRG's offices.

However, the other processes influencing the behavior of this material should be noted. For example, there is a certain erosion of the seaward side of the raised beach. This process is slow and does not seem to have affected the structure of the beach over the last 35 years. The aerial photographs taken in 1949, 1960, 1979 and 1985 do not show any noticeable changes. It is also possible that this beach will be swept by waves during storms. Meteorological data show that the waves can be as high as 9 m in this region, although the mean height is 1 m and the frequency of a monthly average wave of 3 m is 1 month in 40. Since there is an absence of vegetation, there is some surface wind erosion. Also, subsidence occurs wherever the raised beach slopes steeply.

The lower beaches are also composed of sand.

There are two types of moraine: the thin moraine which is usually less than 1 m thick overlying bedrock (Mo/R), and the thicker moraine (Mo).

Moraine is a material composed of debris of crystalline rocks transported by advancing glaciers. This debris is heterogeneous and is generally fairly well sorted, ranging from blocks of approximately 1 m, to silt or clay. It can be divided into different categories with specific characteristics and properties according to where it occurs.

Thin moraine is a superficial covering less than 1 m thick associated with the presence of rock outcrops. When rock outcrops appear on over 10 % of the area, this is indicated by the use of the combined symbol R+ Mo/R. The topography is hilly and the micro-relief reflects the topography of the underlying bedrock. The composition of the thin moraine is rather sandy because of the segregation caused by the fine particles being washed away by the surface water and accumulating in other regions. The drainage is thus adequate and in general poses no problems.

Thick moraine is found at rather low elevations, especially in certain depressions in the rock. The topography is fairly flat. This deposit is 2 m deep on the average. Its composition is silty with surface pockets of sand characteristic of glacial retreat (S/Mo). It has an active layer more than 0,5 m thick with a rather high water content but generally shows no evidence of solifluction.

There are two other forms of moraine in transition to wetland: solifluction moraine (MoSol) and saturated moraine (MoW).

Solifluction moraine is found on medium to steep slopes where the oversaturation of the clayey active layer causes slow landslides during thawing (gelifluction). One of the characteristics of the surface of this material is the presence of lobes whose arrangement shows the direction of the flow. Mudboils of saturated clayey material and occasional nonsorted polygons or circles are also present. Solifluction moraine could pose serious stability problems during construction work (see Subsec. 2.5.2).

Saturated moraine is found in low-lying or gently sloping areas often next to wetland zones. This moraine is characterized by a high saturation level, a low clay content giving it a low plasticity, its grey color and the presence of vegetal matter which holds water. However, its drainage, which can be poor, is improved by the natural slope of the terrain. Once treated, this material is similar to thick moraine. Saturated moraine is more common during snowmelt and disappears gradually towards the end of the summer.

Wetland is found in flat, low-lying areas where fine particles have accumulated. The material underlying the thick, water-holding plant cover is clayey and very plastic, and under the humus layer its color is similar to that of gley. This material is poorly drained because of its composition and also because its location (usually in small depressions, where natural impermeable barriers prevent run-off) permits the accumulation of water. This foundation will require drainage work before it can be used, as well as backfilling because of its generally low elevation in relation to the neighboring areas.

2.5.2 Classes of construction materials

Physical characteristics maps (Plans 2.1 and 2.2) have been prepared to permit the evaluation of the soil for construction purposes. On these maps, the different types of soils were divided into five classes of materials according to the work that will be needed to make them suitable for construction. In increasing order of work required, they are:

Class 1: Sand and gravel, flat, good foundation

> This class includes sand (S) and sand on moraine (S/Mo). They are usually fairly flat, well drained soils requiring little or no excavation or backfilling.

Class 2: Uneven sand or moraine, good foundation

> This class includes Class 1 type materials as well as moraine (Mo) and saturated m oraine (MoW). In general, they are soils which are moderately well drained and which have slopes to be corrected. Drainage work and construction of gravel pads will be required.

Class 3: Uneven rock, good foundation

> This class is composed of rock outcrops (R). The different thin coverings of various materials (B, B/R, Mo/R and R + Mo/R) are also included since in preparing the rock, they will be removed completely. The rock is of good quality but must be levelled by excavation using explosives. It will provide excellent foundations for certain infrastructures as well as granular materials to be used for fill after excavation or crushing. Drainage and gravel pads will be required.

Class 4: Mostly wetland, fair foundation

> This class is composed of wetland (W). This moraine type soil is poorly drained and has boulders, thick humus material which could be mistaken for peat and swampy areas on an impermeable foundation including shallow rock. This foundation can be used as long as corrective work is done, for example, draining, excavation, backfilling, levelling and construction of gravel pads.

Class 5: Mostly creeping soil, poor foundation

This class is composed of solifluction moraines (MoSol). It is a moraine type soil which is generally oversaturated and shows signs of gelifluction. The plant cover is generally torn by slow landslides (30 cm/year) of the active layer, accentuated by rib and through patterns. There are mudboils present on the surface. If these areas are to be used then, at the very least large gravel pads must be built to raise the permafrost into the active layer to stabilize the soil. Studies would also eventually have to be carried out on the long-term stability of this construction method which would have to be accompanied by large-scale drainage work. This type of foundation is not planned for use at present.

Plans other than 2.1 and 2.2 may also be used to study the interrelation of these classes with the site of the village.

2.6 CLIMATIC CONDITIONS

No meteorological data are available regarding the climate of the site of Taqpangajuk itself. However, it is possible to obtain information from climatologists and individuals who are familiar with the area (Killiniq fisheries staff, etc.) and from Inuit who have set up camps there throughout the years. Information can also be found in documents of various types: statistics from the weather stations at Port Burwell (Killiniq), Resolution Island or Cape Hope's Advance (Quaqtaq), compilation maps [3,4] or a chapter from a study carried out by others [5].

The main climatological characteristics of the site can be summarized as follows:

Cimatic zone	boreal tundra continuous permafrost
Sunshine	ground level radiation: 10,3 MJ/m^2 (mean) hours of darkness: June 20 : 2,5 h December 20: 18,25 h
Temperature	annual mean: - 5,5° C January: - 20° C July: + 7° C
	frost-free season: 15 days (10-20 days) first fall frost: August 6 last spring frost: June 30 growing season: less than 40 days annual heat factor: 8 700 degree-days (° C)
Precipitation	annual mean: 400 mm variability (standard deviation): 25 % (100 mm) snowfall portion: 45 % annual run-off deficit: 140 mm (regional)
Waves	months of greatest combined wave amplitude (>10m): September, October

Winds	mean hourly wind:	30 km/h
	maximum hourly wind:	95 km/h
	mean summer hourly wind:	20 km/h
	mean winter hourly wind:	27 km/h
	gusts:	190 km/h
	dominant winds: annual	NW
	summer	SE + NW

Ice formation	lake ice-forming	November 10-20
	river ice freezing-up	after December 1
	river ice break-up	May 20-June 1
	lake ice-thawing	June 10-20

normal marine ice formation:

mid-June	compact ice
mid-July	dislocated ice
mid-August	iceberg
mid-September	iceberg
mid-October	clear
mid-November	clear
mid-December	compact ice

N.B. An automatic climate station was installed in Killiniq in August 1985.

2.6.1 Precipitation

The available precipitation data are incomplete. There are four sources for the total precipitation (TP) and four sources for the monthly means (MP):

Source	TP	MP	Station
Climat du Québec septentrional [3]	X (map)	X	Resolution Island
Marine Climatological Summaries [9]		X	Killiniq
H.G. Acres and Company Ltd. [5]		X	Killiniq
Permafrost Engineering [10]	X		map of Canada
Le Nord du Québec, profil régional [4]	X		map of Québec
Environment Canada [7]	X	X	Resolution Island
			Fort Chimo
			Resolution Island
			Frobisher Bay
			Quaqtaq

Table 2.2 summarizes the data obtained from these sources. As can be seen from the figures for total precipitation, there is a great variability among the sources (28 %); two of them even differ by a factor of 2,5. Even month by month, there is impressive variability, with some figures differing by as much as a factor of 9. It is therefore difficult to use these data to show anything other than the total precipitation. The average of the data from these different sources indicates a total precipitation of 400 mm (with snowfall converted to rainfall by multiplying it by a factor of 0,1). With a snowfall portion of 45 %, 220 mm of the precipitation would fall as rain and 180 mm as snow.

Table 2.2
Precipitation Data

Month	[7]	[3]	[7]	[9]		[5]	[7]	[10]	[7]	[4]	[7]	Mean	S.D.
JAN	19,1	15	12,7	53,3		58	26,1		33,1		15,3	29	18
FEB	13,3	14	11,7	0,0	(55)	70	23,3		33,3		7,3	25	23
MAR	12,5	15	15,9	*	(45)	32	23,3		26,0		8,3	22	12
APR	10,2	13	10,5	0,0	(30)	10	26,4		23,2		19,4	16	10
MAY	21,1	16	9,0	16,7		20	25,3		31,7		22,7	20	7
JUN	24,7	37	18,5	18,9		44	39,4		50,8		36,6	34	12
JUL	42,3	50	83,0	13,0		58	63,3		57,7		58,8	53	20
AUG	39,7	50	96,5	10,4		62	58,9		63,8		41,5	53	25
SEP	49,2	64	64,3	16,2		70	46,0		57,7		46,3	52	17
OCT	36,6	43	38,1	17,6		20	44,1		48,6		38,3	36	11
NOV	24,8	35	23,4	31,8		39	34,4		40,1		22,7	31	7
DEC	19,8	28	20,8	46,7		74	22,1		38,2		17,2	33	19
TOTAL	313,3	380	404,4	224,6	(355)	560	432,6	405	504,2	480	334,4	404	
S.D.	73,3		83,4								59,7		
%	23		21								18		
Snow %	50	45	32				56		48		51		

S.D.: Standard deviation
* No data available.
( ) Data generated by symmetry.
Average of the eleven totals : 399,4 mm S.D.: 94,3 mm

The variability of the annual precipitations is the ratio of the standard deviation (100 mm) to the mean precipitation (400 mm), expressed as a percentage (25 %). Statistically, it measures the spread of the values observed around the mean. An interval of 2 standard deviations (+/- S.D.) centred on the mean contains 68 % of the observations, while an interval of 4 standard deviations (+/- 2 S.D.) contains 95 % of the observations.

This means that for 95 % of the years (since it is an annual mean), the precipitation will be between 200 mm [3] and 600 mm[4]. For the other 5 % of the time, the precipitation values will be higher or lower in equal proportions. Thus, for 2,5 % of the years the precipitation will be less than 200 mm and for 2,5 % of the years it will be greater than 600 mm. This percentage of 2,5 translates as 2,5 years in every 100 years or 1 in every 40 years. Hence, for any given threshold it is possible to estimate the frequency at which it will not be reached.

A histogram of the distribution of the precipitation on a monthly basis is given in Fig. 2.5. It is based on the average of the nine samples obtained since there are no data available for the Taqpangajuk site itself. The data from Killiniq [5, 9] are too contradictory with the data from the neighboring stations for them to be used alone, despite the proximity of this station to Taqpangajuk (40 km).

[3] 200 mm = 400 mm - 2 x 100 mm (mean - 2 standard deviations).

[4] 600 mm = 400 mm + 2 x 100 mm (mean + 2 standard deviations).

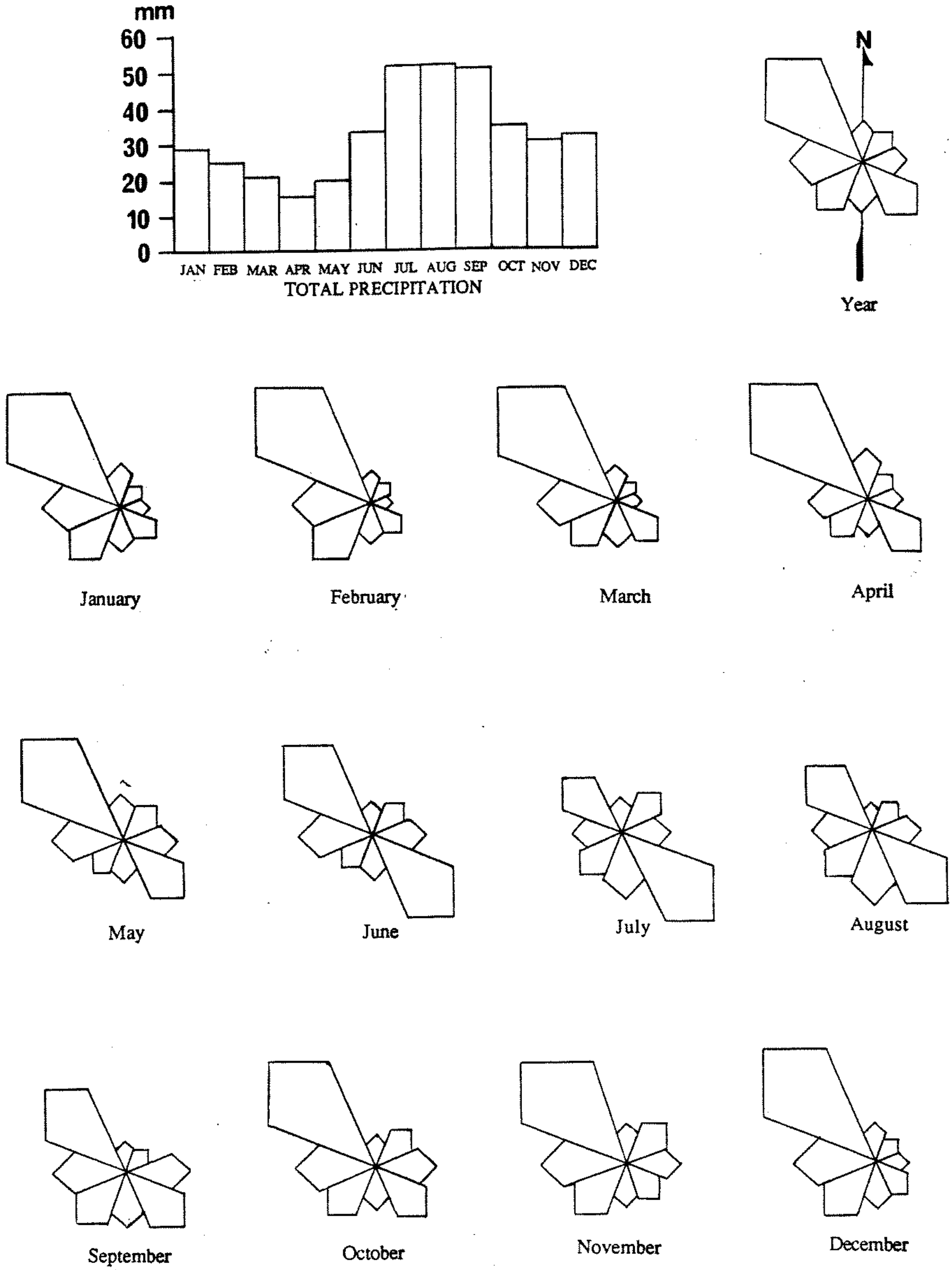


Figure 2.5
Monthly Precipitation and Wind Frequency

2.6.2 Winds

The available anemometric data are also incomplete. There are no data from Taqpangajuk, and the data from Killiniq are not reliable. It was impossible to obtain the data on which the summary in the Acres report [5] was based, and the data contained in the summary do not corroborate the data from the neighboring stations. Therefore, the winds were analysed using an average of the data from the Killiniq, Resolution Island, Frobisher Bay and Quaqtaq stations. These stations are all relatively close to the Taqpangajuk site and are also exposed to the same winds from Hudson Strait. The data from each of these stations are summarized in Tables 2.3 to 2.7.

Table 2.3
Wind Frequency Distribution - Killiniq 1930-1936 [5]

	N	NE	E	SE	S	SW	W	NW	Calm
JAN	6	4	4	10	3	21	13	26	13
FEB	3	5	2	11	4	22	13	23	17
MAR	8	5	4	20	7	17	9	14	16
APR	4	8	8	27	2	18	9	13	11
MAY	3	9	10	20	4	15	17	9	13
JUN	3	13	13	28	6	9	11	10	7
JUL	4	9	11	32	8	14	7	5	10
AUG	1	9	13	19	13	18	7	6	14
SEP	3	3	11	16	9	20	16	14	8
OCT	4	11	15	9	6	19	15	16	5
NOV	3	4	11	8	7	18	25	20	4
DEC	1	5	7	12	8	29	12	13	13
YEAR	3,6	7,1	9,1	17,7	6,4	18,3	12,8	14,1	10,9

NOTE: Percentage frequency of the winds according to the direction from which they blow (8 octants).

Table 2.4
Wind Frequency Distribution - Killiniq 1983 [6]

	N	NE	E	SE	S	SW	W	NW	Calm
JAN									
FEB									
MAR									
APR									
MAY									
JUN									
JUL	6	16	9	12	22	12	7	1	15
AUG	3	2	6	11	26	18	14	3	17
SEP	3	7	24	10	16	16	9	1	14
OCT									
NOV									
DEC									
YEAR									

NOTE: Data are available only for the above 3 months.

Table 2.5
Wind Frequency Distribution - Resolution Island 1963-1980 [7]

	N	NE	E	SE	S	SW	W	NW	Calm
JAN	14,3	7,2	2,6	5,7	6,6	15,4	21,0	25,9	1,3
FEB	13,2	6,3	2,8	6,9	7,5	18,2	22,6	20,6	1,9
MAR	15,6	7,3	2,5	4,1	4,5	11,6	23,0	28,7	2,7
APR	22,2	7,9	3,9	5,2	6,7	11,1	14,1	25,9	3,0
MAY	17,2	8,0	6,5	9,2	9,9	8,2	17,2	22,2	1,6
JUN	12,2	6,4	5,9	9,8	10,1	12,6	19,1	23,1	0,8
JUL	12,8	8,8	4,6	13,2	12,9	11,0	13,7	21,7	1,3
AUG	11,1	10,6	5,9	12,9	13,4	9,8	12,8	22,4	1,1
SEP	10,0	6,3	4,2	11,3	8,5	14,8	16,8	27,4	0,7
OCT	8,7	6,4	3,7	3,3	9,7	14,6	17,9	25,2	0,5
NOV	13,4	13,0	4,7	8,0	8,1	19,6	12,0	20,4	0,8
DEC	16,6	6,1	3,4	5,7	4,5	12,0	20,8	30,3	0,6
YEAR	13,9	7,9	4,2	8,8	8,5	13,2	17,6	24,5	1,4

NOTE: The prevailing wind blows from the northwest (NW) every month except February, when it blows from the west (W).

June, July, August	NW 22,6 %	W 15,2 %
December, January, February	NW 25,6 %	W 21,4 %

Table 2.6
Wind Frequency Distribution - Quaqtaq 1971-1980 [7]

	N	NE	E	SE	S	SW	W	NW	Calm
JAN	3,7	5,4	6,0	7,4	21,2	14,0	15,5	25,4	1,4
FEB	4,2	5,9	5,4	3,2	14,6	12,8	14,8	37,4	1,7
MAR	2,5	3,6	5,5	5,7	18,2	14,5	16,9	28,2	4,9
APR	6,0	5,3	7,1	6,5	12,7	7,6	12,7	39,4	2,7
MAY	7,0	11,8	12,8	5,4	8,5	7,4	9,7	36,7	0,7
JUN	6,1	10,7	11,3	9,8	8,7	8,1	14,2	30,6	0,5
JUL	6,6	10,3	13,5	15,1	10,4	11,4	9,5	22,8	0,4
AUG	2,8	8,9	13,3	14,8	10,0	10,1	11,0	28,8	0,3
SEP	5,5	6,9	8,1	10,8	10,1	10,7	14,2	33,3	0,4
OCT	2,3	9,1	7,4	11,4	10,8	13,7	15,3	29,8	0,2
NOV	3,8	13,3	10,1	7,4	13,4	11,9	14,1	25,7	0,3
DEC	3,2	4,8	5,6	5,5	20,9	10,5	16,6	31,3	1,6
YEAR	4,5	8,0	8,8	8,6	13,3	11,1	13,7	30,8	1,2

NOTE: The prevailing wind blows from the northwest (NW) every month of the year.

Table 2.7
Wind Frequency Distribution - Frobisher Bay A 1951-1952 [8]

	N	NE	E	SE	S	SW	W	NW	Calm
JAN	5,2	3,7	6,4	7,9	1,4	0,7	7,5	36,9	30,3
FEB	5,3	2,8	5,9	8,9	1,2	0,7	6,8	36,6	31,8
MAR	4,7	2,3	5,2	8,6	1,4	0,9	6,8	37,2	32,9
APR	4,7	2,9	5,6	13,9	2,9	0,9	6,7	40,1	22,3
MAY	5,4	5,0	7,6	24,8	5,3	2,0	6,5	34,0	9,4
JUN	4,4	3,7	5,7	32,8	6,3	3,0	7,1	27,1	9,9
JUL	2,4	3,2	5,6	40,1	6,5	2,8	5,6	17,5	16,3
AUG	3,5	3,3	5,5	35,5	6,1	2,5	6,4	20,8	16,4
SEP	5,5	5,2	8,5	24,3	3,6	2,5	8,3	29,0	13,1
OCT	6,3	7,6	14,8	14,9	2,5	1,3	7,3	36,6	8,7
NOV	7,6	9,1	14,1	10,0	3,1	1,5	6,8	35,6	12,2
DEC	5,7	3,7	7,6	7,7	1,3	0,6	8,9	39,7	24,8
YEAR	5,1	4,4	7,7	19,1	3,5	1,6	7,1	32,5	19,0

NOTE: The prevailing wind blows from the northwest (NW) for 9 months of the year.

Table 2.8 gives the average for the four stations, while this information is presented in graphic form in Fig. 2.5.

Table 2.8
Mean Wind Distribution
Killiniq, Resolution Island, Frobisher Bay, Quaqtaq

	N	NE	E	SE	S	SW	W	NW	Calm
JAN	7,3	5,1	4,8	7,8	8,1	12,8	14,3	28,6	11,5
FEB	6,4	5,0	4,0	7,5	6,8	13,4	14,3	29,4	13,1
MAR	7,7	4,6	4,6	9,6	7,8	11,0	13,9	27,0	14,1
APR	9,2	6,0	6,2	13,2	6,1	9,4	10,6	29,6	9,8
MAY	8,2	8,5	9,2	14,9	6,9	8,2	12,6	25,5	6,2
JUN	6,4	8,5	9,0	20,1	7,8	8,2	12,9	22,7	4,6
JUL	6,4	9,5	8,7	22,5	12,0	10,2	8,6	14,0	8,6
AUG	4,3	6,8	8,7	18,6	13,7	11,7	10,2	16,2	9,8
SEP	5,4	5,7	11,2	14,5	9,4	12,8	12,9	20,9	7,2
OCT	5,3	8,5	10,2	12,2	7,3	12,2	13,9	26,9	3,6
NOV	7,0	9,9	10,0	8,4	7,9	12,8	14,5	25,4	4,3
DEC	6,6	4,9	5,9	7,7	8,7	13,0	14,6	28,6	10,0
YEAR	6,7	6,9	7,7	13,1	8,5	11,3	12,8	25,0	8,5

Analysis of the summary in Table 2.8 above permits the following observations: on an annual basis, the prevailing winds blow from the northwest (25 %); the winds from the west (3 octants: NW, W and SW) account for over 50 % of the total winds. For 2 months in the summer (July and August), the prevailing winds blow from the southeast and for 6 months of the year (April to September) southeast winds have the highest or second highest frequency.

As regards wind speed, the data from Killiniq indicate mean wind speeds ranging from 15 km/h to 31,5 km/h, with maximum speeds from 46 km/h to 163 km/h. However, the neighboring stations record the following mean and maximum wind speeds:

Table 2.9
Mean and Maximum Wind Speeds (km/h)

Station	Mean Annual Wind	Mean Maximum Wind	Mean Minimum Wind	Maximum Wind
Resolution Island	35,3 NW	40,4 (Feb.)	28,2 (Jul.)	190 NE
Frobisher Bay	16,7 NW	19,7 (Oct.)	13,7 (Jul.)	156 *
Quaqtaq	21,9 NW	29,9 (Nov.)	18,1 (Jun.)	95 NE

* Wind direction not indicated.

2.6.3 Marine ice formation

Figs. 2.6 to 2.18 on the following pages illustrate the progressive formation of ice in Hudson Strait and Ungava Bay and along the coast of Labrador. These data were obtained from Le Nord du Québec, profil régional [4], an Environment Canada report [11] , a sealift report [12] and observations of the available aerial photographs.

In 1985, the following conditions were observed: on July 2, the compact winter ice was located 2 km from the coast, with dislocated ice 1,5 km from the coast and scattered clusters of floes (some measuring more than 100 m across) some of which had been blown right up against the shore. At the beginning of August, there were floes and clusters of floes blown by the wind against the shore and up to 1 km out from the shore. In mid-September, there were some isolated icebergs. In mid-October, only one iceberg was observed. In other words, normal conditions prevailed.

Figure 2.6

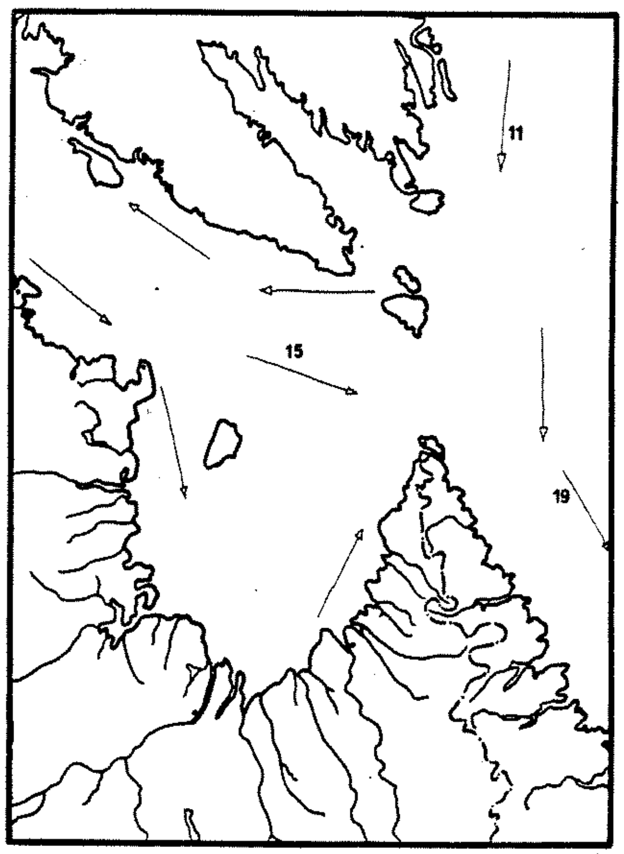


Figure 2.6
Direction and mean annual speed of marine currents (km/h)

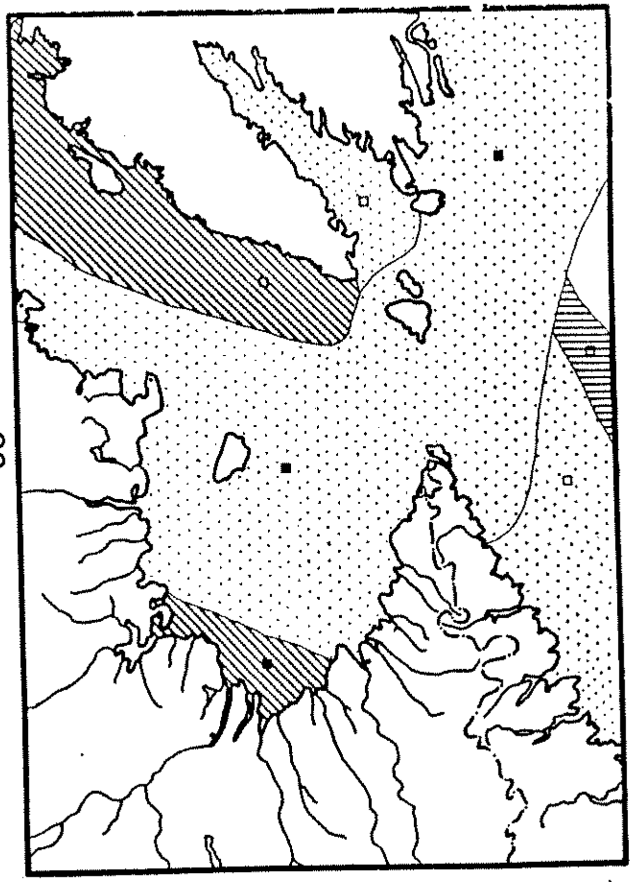


Figure 2.7
Marine ice formation - Mid-June Normal

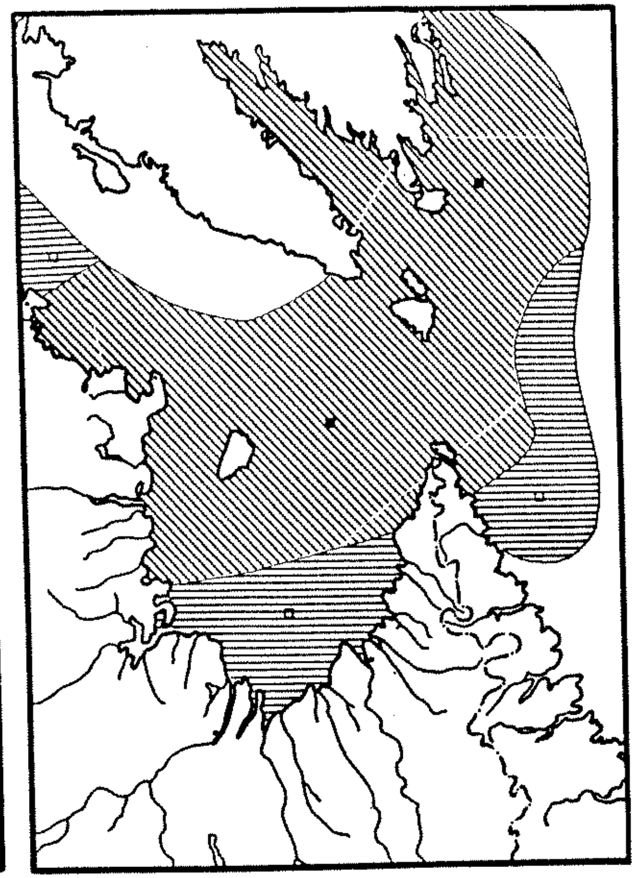


Figure 2.8
Marine ice formation - Mid-July Normal

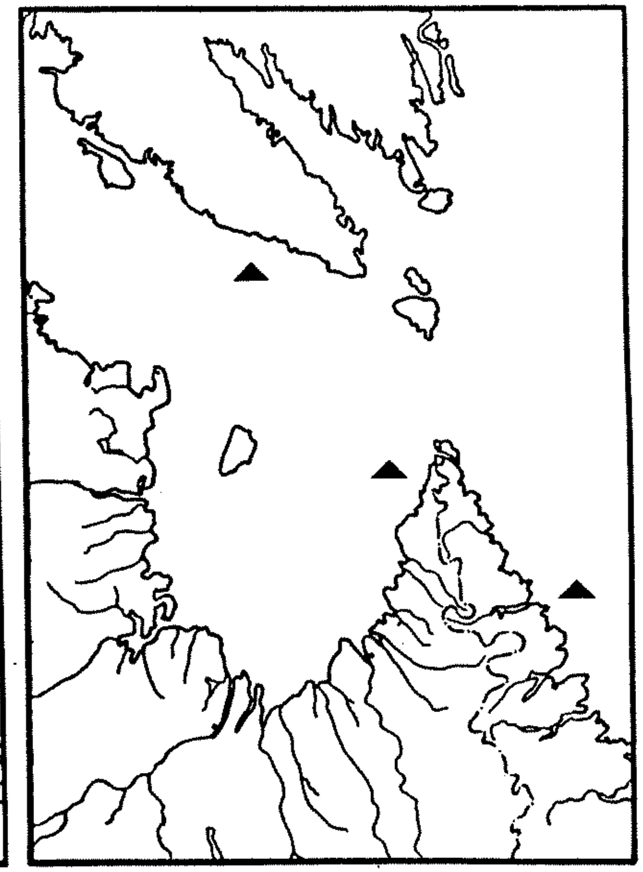


Figure 2.9
Marine ice formation - Mid-August Normal

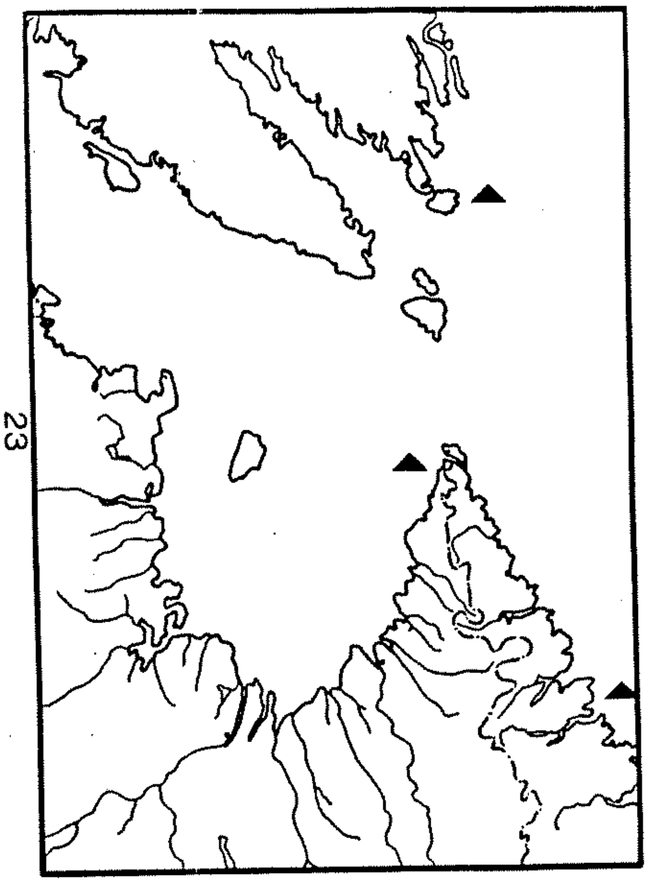


Figure 2.10
Marine ice formation - Mid-September Normal

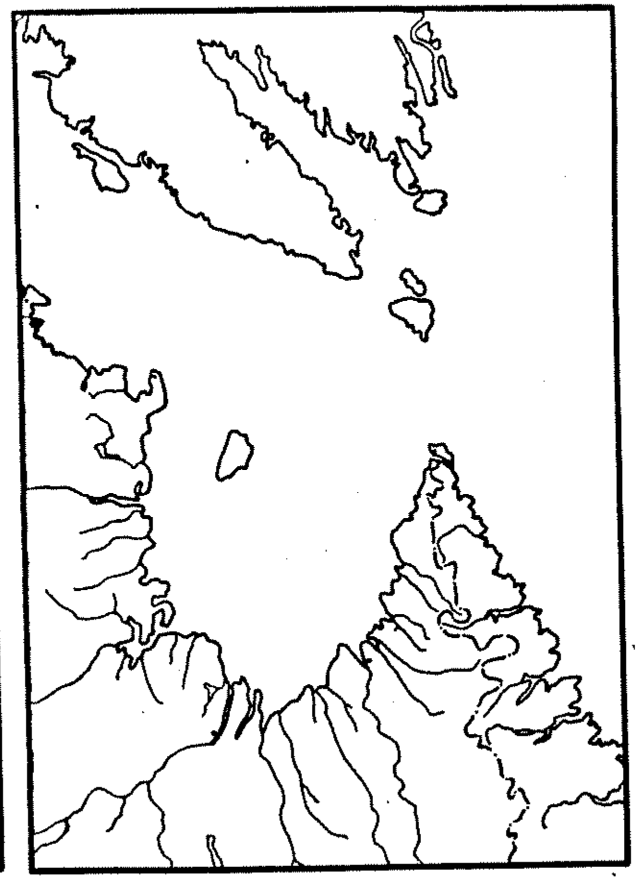


Figure 2.11
Marine ice formation - Mid-October Normal

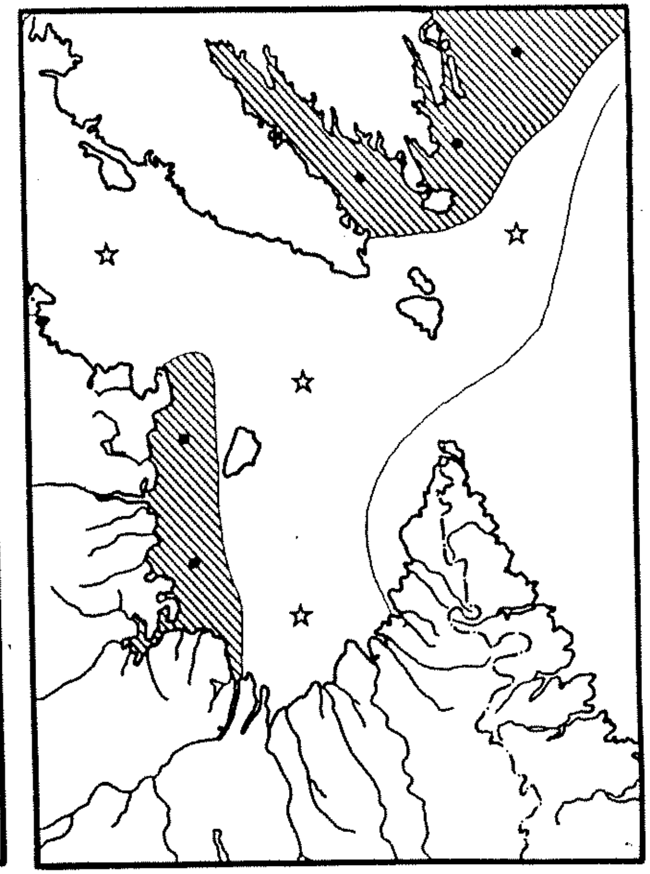


Figure 2.12
Marine ice formation - Mid-November Normal

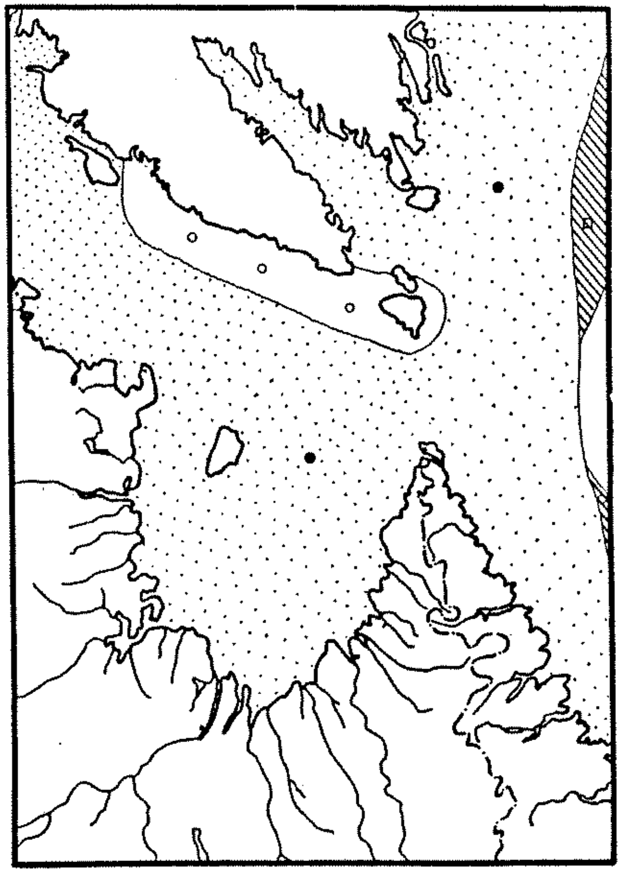


Figure 2.13
Marine ice formation - Mid-December Normal

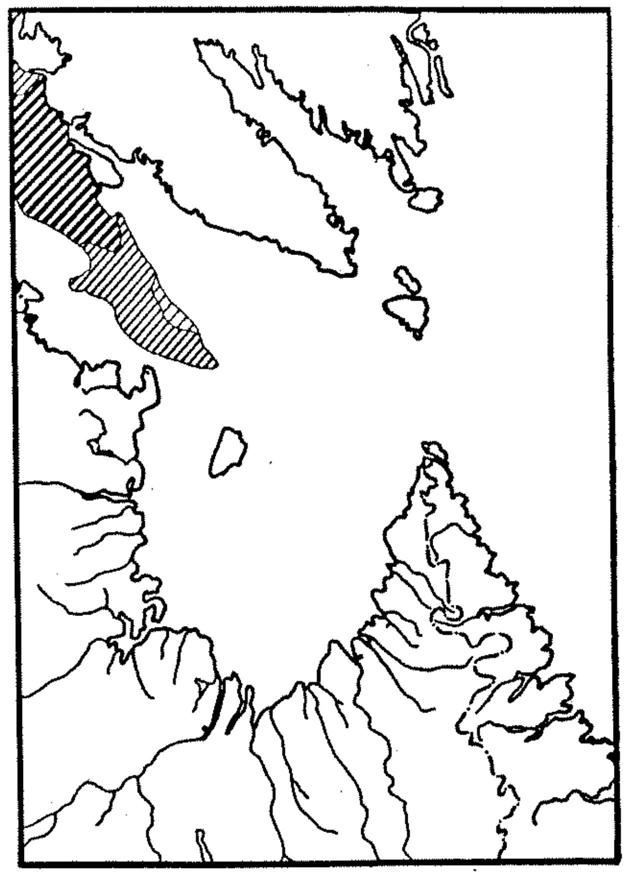


Figure 2.14
Marine ice distribution - July 19, 1981

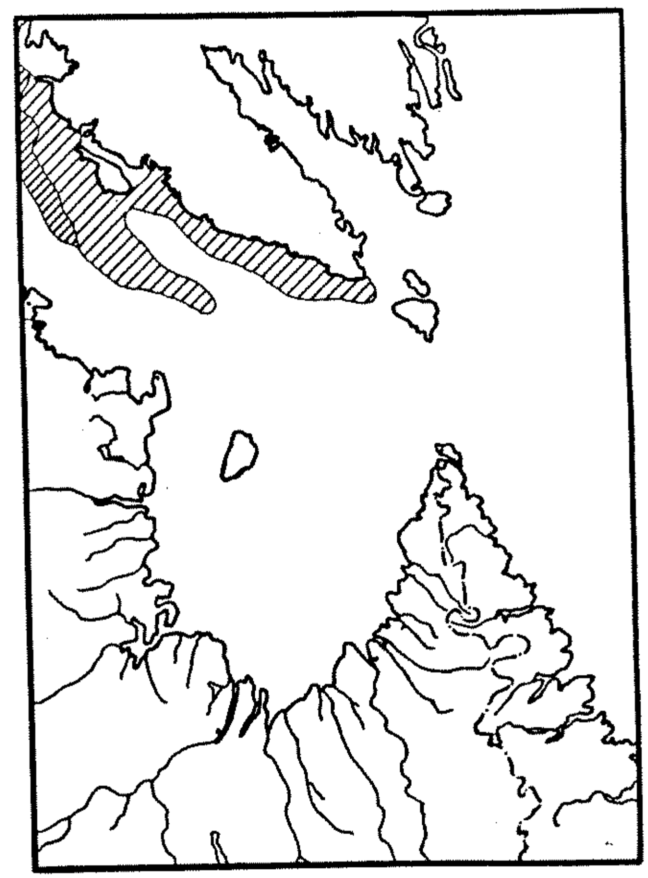


Figure 2.15
Marine ice distribution - July 26, 1981

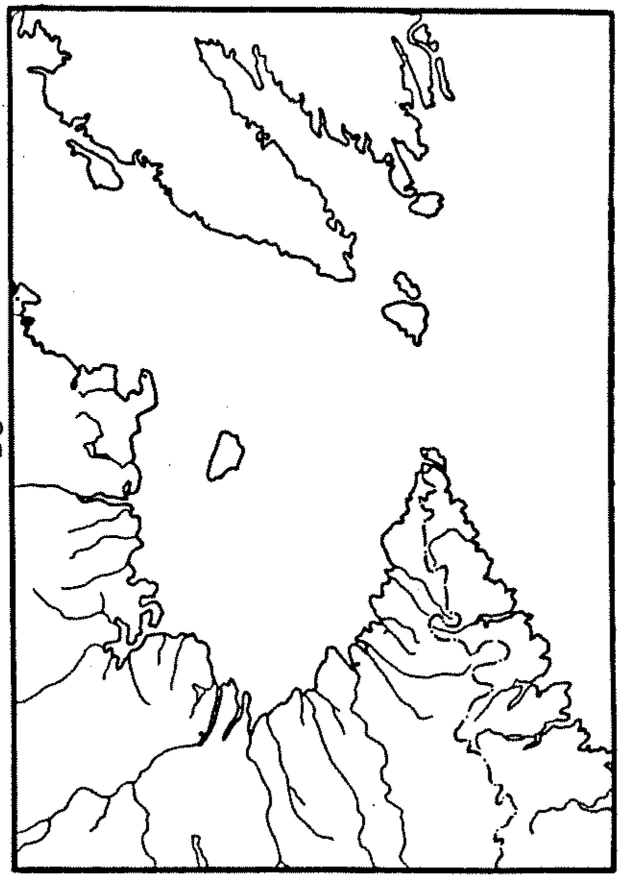


Figure 2.16
Marine ice distribution - August 2, 1981

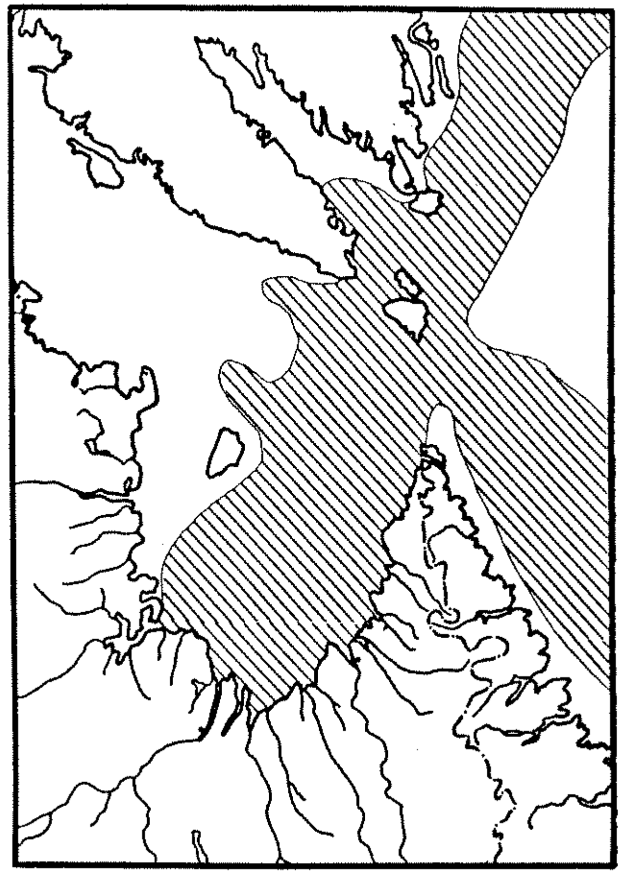


Figure 2.17
Marine ice distribution - August 2, 1983

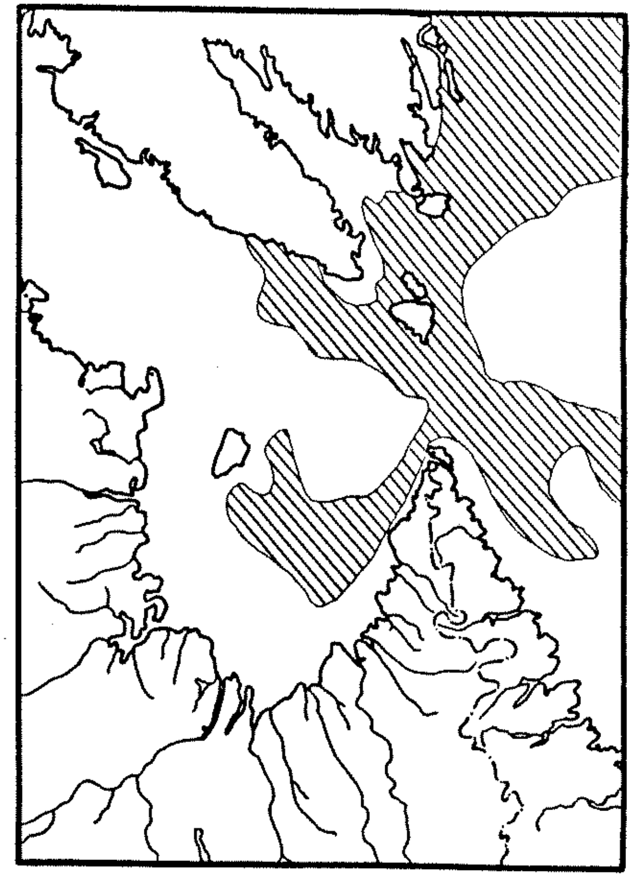


Figure 2.18
Marine ice distribution - August 16, 1983

2.7 SNOW ACCUMULATION

During the winter site survey, 18 snow accumulation samples were taken at the village site. Their location is shown in Fig 2.19.

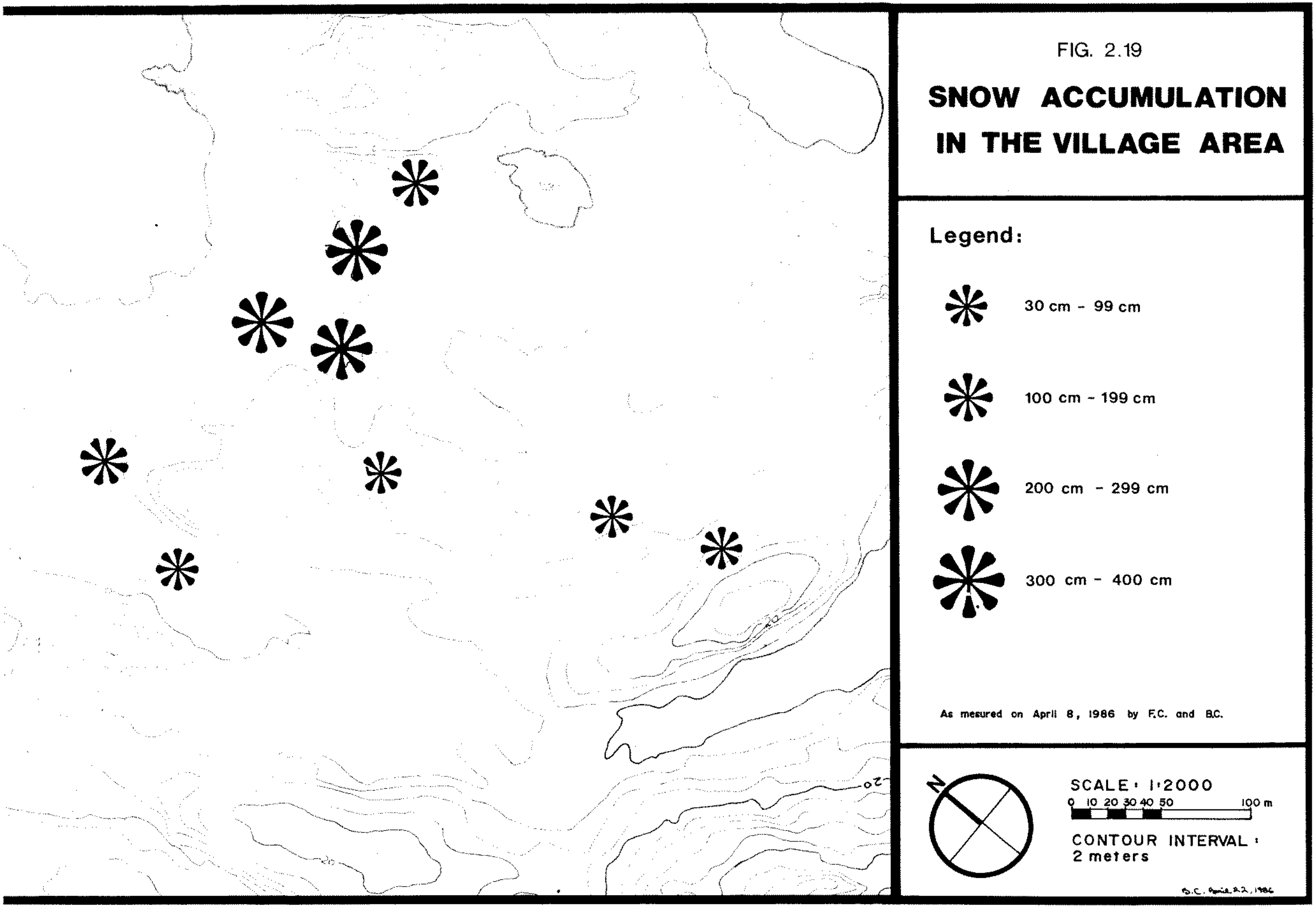
Two major areas of snow accumulation were observed. The area with the greatest accumulation was west of the village, close to the site planned for the powerhouse, and had a snowdrift 4 m deep. The road shown on Option 1, 2 and 3 of the master plan passes directly through it. The other area is along the east side of the small rocky hill which separates the village centre from the future development area to the southeast. At the time of the sampling, there was a snowdrift over 2 m deep in this area. It is in fact this hill, left intact in all three of the master plan options, which causes the snow to accumulate.

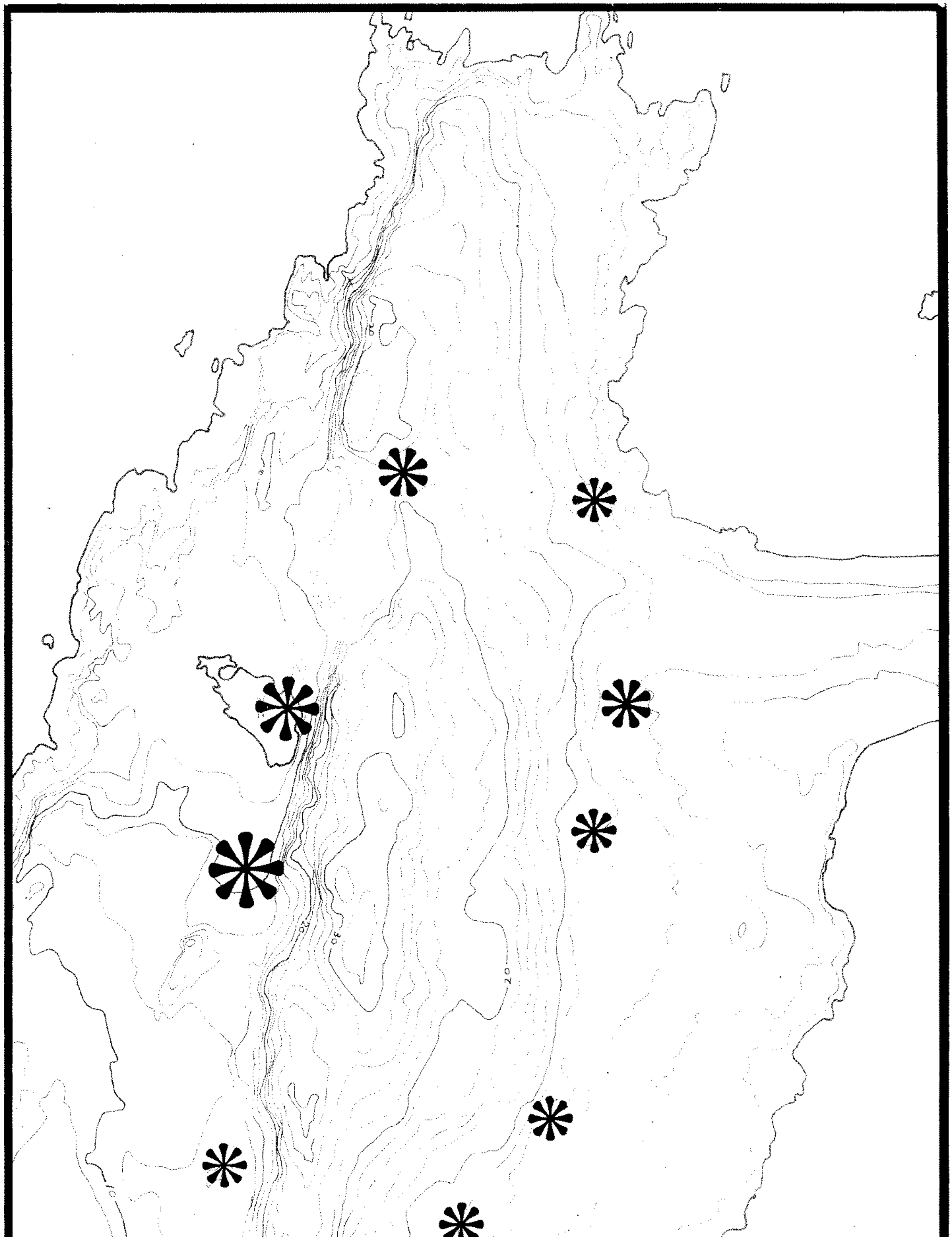
Except for three samples, a depth ranging from 40 cm to 70 cm was observed for the remainder of the village site.

According to a general concensus by many Inuit, this winter was one with some of the most heavy snowfalls and therefore of total accumulation in living memory. Consequently, no snow accumulation problem is foreseen for this site if the road does not pass through the major snowdrift area and if the small rocky hill is removed by blasting.

FIG. 2.19

SNOW ACCUMULATION IN THE VILLAGE AREA





3. SOCIAL CHARACTERISTICS

3.1 HISTORY

The Inuit who now wish to relocate to the Taqpangajuk site were originally residents of Killiniq. The village of Killiniq was located on an island approximately 300 m from the Québec mainland and was therefore under the jurisdiction of the Government of the Northwest Territories. Nevertheless, the Killiniqmiut were deemed to be residents of Québec under the James Bay and Northern Québec Agreement [15] when they were recognized as a signing party.

Prior to 1975, the Killiniqmiut had discussed the possibility of relocating as a group to the mainland of Québec. Concern with relocation was based on the fact that the Killiniqmiut realized that the programs initiated and administered by the GNWT would continue to deteriorate. It was also apparent that some of the vital infrastructures, especially an airstrip, would be difficult if not impossible to build at Killiniq. The concern stated by the Inuit is supported and details are provided in a large body of documentation.

In 1974, the Inuit considered Bell Inlet to be the most attractive area for relocation. This explains why the community selected approximately half of their Category I land under the James Bay and Northern Québec Agreement around Bell Inlet. An agreement has been reached with the Québec Government that will allow the Inuit to exchange the area covered by the Category I land at Bell Inlet for an equal area at Taqpangajuk, if the community is built. The Québec Government has agreed to cover the cost of the survey required for this exchange. The selection of Category I land north of Taqpangajuk will remain unchanged.

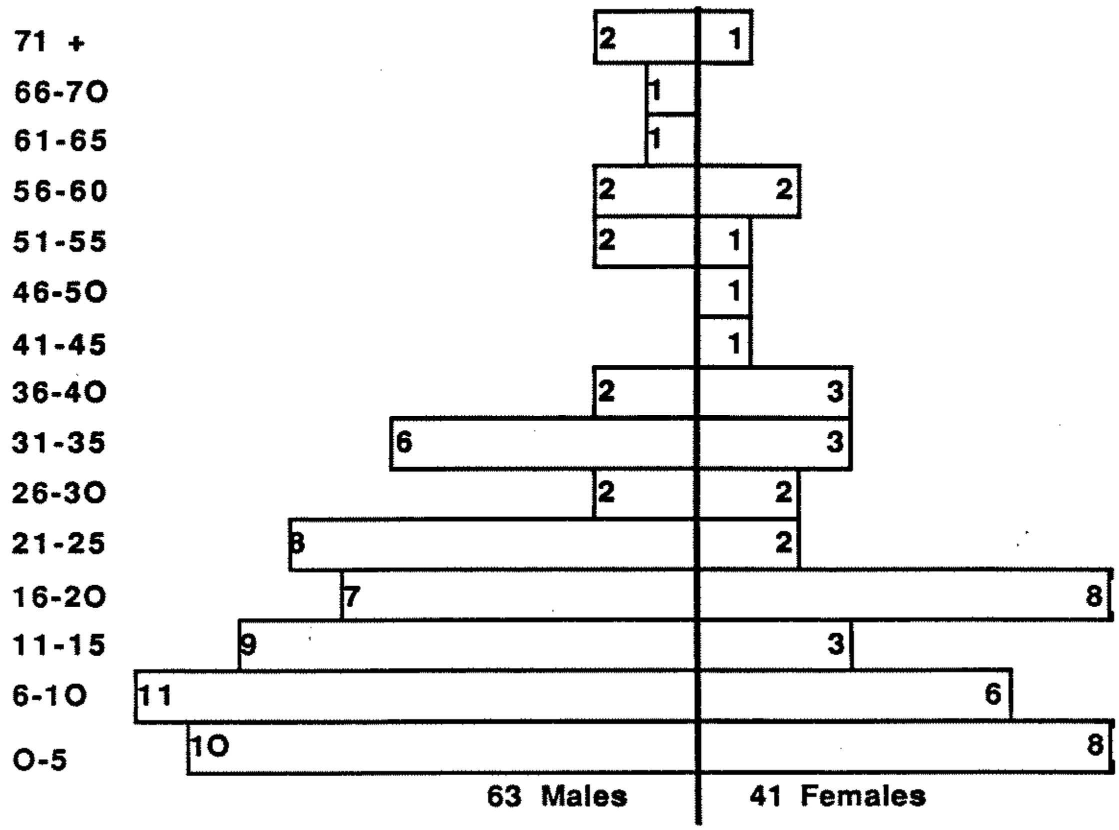
The original concern to relocate became urgent when the village of Killiniq was suddenly closed by the federal government and GNWT in February 1978, and the remaining families dispersed to five Ungava Bay villages. This major event was preceded by a gradual decline in government services between 1972 and 1978, which, in turn, created a deteriorating social climate. As a result, there was a gradual decline in the population as families felt compelled to move in search of better services, especially health services and transportation.

The Killiniqmiut continue to maintain their solidarity as a community, their landholding corporation is still active and they have started a commercial fisheries development project through Killiniq Fishermen Inc. In the fall of 1985, two families decided to leave the villages to which they had moved and to construct a winter camp for permanent residence at Taqpangajuk. Material supply and transportation problems, however, forced these two families to spend the winter at Killiniq. They are planning to move to Taqpangajuk in the summer of 1986. This activity is supported financially by the Outpost Camp Program of the Department of Indian and Northern Affairs.

3.2 POPULATION

Fig. 3.1 shows the population pyramid as of September, 1985, of the former residents of Killiniq who are to be relocated to Taqpangajuk. As can be seen, 69 % of this population is under 26 years of age, which means that there will probably be a large increase in the population in the coming years. One can also see a great imbalance between the sexes, with women accounting for only 39 % of the total population.

Figure 3.1
Population Pyramid of the Core Group to be Relocated



In addition to these 104 persons originally from Killiniq, 58 potential immigrants from different Inuit communities were also counted during the consultation. The total number of individuals who will make up the population of Taqpangajuk in 1985 is thus 162. This portion of the immigrant population is mainly composed of persons who had already lived in Killiniq before 1977 or who are related to the families from Killiniq.

When Killiniq was being closed down in 1977 and 1978, a large part of the population (47 %) decided to live in Kangiqsualujjuaq, the community closest to its hunting and fishing grounds.[1] This immigration caused a large increase in Kangiqsualujjuaq's demographic growth in the following years.

It should be noted that the population of Killiniq has always had close ties with that of Nain, Labrador (family ties, shared hunting and fishing grounds, etc.). It can be assumed that when the village of Taqpangajuk is opened, it will absorb part of the emigration from Nain which until now has been moving to Kangiqsualujjuaq.

[1] The remaining 53 % established itself in four other communities of the Ungava Coast, namely, Kuujjuaq, Tasiujaq, Quaqtaq and Kangiqsujuaq.

3.3 DEMOGRAPHY

In a feasibility study for the development of a new village, population forecasts are of the utmost importance. The evaluation of space requirements and the capacity of the basic infrastructures depend on these forecasts.

If successive censuses were available, they would constitute an excellent data base for forecasting population growth. With such data, there are many tested methods which can be used as models for forecasting. The most commonly used are:

- the arithmetic method;
- the constant-percentage growth rate method;
- the logistic method;
- the declining growth method;
- the ratio method;
- the graphical method.

However, since Taqpangajuk is a new village, census data is non-existent. The only data available is a 1985 census of the population wishing to be relocated to the new village. Consequently, most of the above-mentioned methods cannot be used directly in this study.

This problem can be overcome by using censuses from other villages in the territory which have a population of at least 162 persons. These villages include Akulivik, Kangiqsualujjuaq, Kangiqsujuaq and Kangirsuk.

The growth rate profile of these four villages was analysed using the constant-percentage growth rate method and the arithmetic method. Both of these methods result in growth rate models that are a good description of the reality in these villages. However, the constant-percentage growth rate method was chosen since the arithmetic method produces very pessimistic forecasts over 25 years which are more suited to villages that have reached a certain maturity, which is obviously not the case for Taqpangajuk.

The following growth rates were calculated using the constant- percentage growth rate method:

- Akulivik	8,6 %
- Kangiqsualujjuaq	4,1 %
- Kangiqsujuaq	3,8 %
- Kangirsuk	3,2 %

If these growth rates are applied to an initial population of 162 persons in 1985, the population forecasts for these villages in 2010 are as follows:

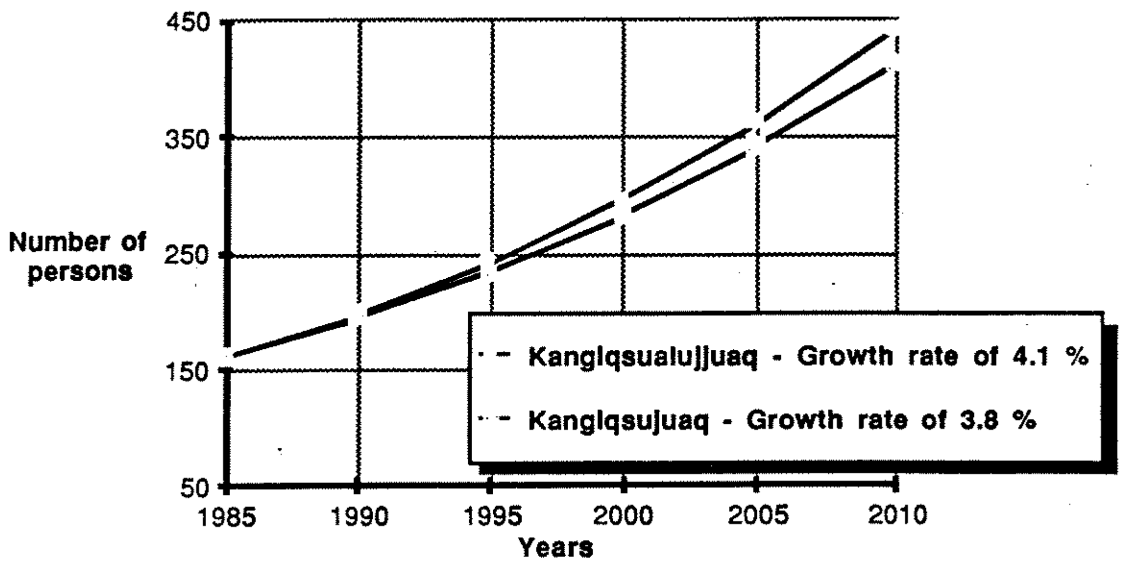
- Akulivik model	1 274 persons
- Kangiqsualujjuaq model	442 persons
- Kangiqsujuaq model	412 persons
- Kangirsuk model	356 persons

The 8,6 % growth rate used in the Akulivik model was calculated on data gathered over a period of only 8 years. This gives a description which is valid for the period studied but does not permit a realistic estimate of the population growth over a 25-year period. The Akulivik model can also be rejected at the outset based on other references [4, 13].

If other censuses are artificially generated based on the 1985 census of the population from Killiniq wishing to be relocated, a growth rate of 3,2 % is obtained. Of course, this is only a rough estimate and cannot be used for population forecasts, especially since immigration is not taken into account. This rate of 3,2 % thus seems too low for the population in question. For this reason, the Kangirsuk model will not be used.

The remaining two models are shown in Fig. 3.2. The Kangiqsualujjuaq model, with its growth rate of 4,1 %, clearly shows the phenomenon of the waves of immigration from Killiniq and Nain over the last 10 years.

Figure 3.2
Growth Rate Models for Kangiqsualujjuaq and Kangiqsujuaq



Although some immigration should be forecast for the new village, Kangiqsualujjuaq's rate of 4,1 % seems rather high since it includes the forced immigration from Killiniq and Nain. Moreover, it seems likely that the birth rate will decrease in the coming years.

Thus, it would seem that a rate of 3,8 %, like that calculated for Kangiqsujuaq, would give a realistic model for the new village of Taqpangajuk. This growth rate would take into account the phenomenon of immigration, since people are attracted to a new village, as well as the phenomenon of natural population growth, while providing an acceptable safety factor for projections covering a 25-year period (see Table 3.1).

Table 3.1
Population Forecasts for Taqpangajuk

Year	Natives	Non-Natives	Total
1985	162	10	172
1986	168	10	178
1987	175	10	185
1988	181	10	191
1989	188	10	198
1990	195	10	205
1991	203	10	213
1992	210	10	220
1993	218	10	228
1994	227	11	238
1995	235	11	246
1996	244	11	255
1997	253	12	265
1998	263	12	275
1999	273	13	286
2000	283	13	296
2001	294	14	308
2002	305	14	319
2003	317	15	332
2004	329	15	344
2005	342	16	358
2006	355	17	372
2007	368	17	385
2008	382	18	400
2009	397	19	416
2010	412	20	432

4. COMMUNITY INFRASTRUCTURE AND BUILDING NEEDS

4.1 HOUSING*

4.1.1 Houses

In Killiniq, the people were living in DIAND Northern houses of the single-family 3-bedroom type. The core group of 104 people consulted who are now scattered in other villages, are presently living in SHQ single-family, 3-bedroom dwellings in 94 % of the cases. Fifty percent of the people are living in renovated houses, 44 % in non-renovated houses and 1 household is living in a shed.

The present distribution of SHQ housing in Inuit Northern Québec is shown below.

Table 4.1
SHQ Housing Distribution in Northern Québec (February 1986)

Type	%
1-bedroom	7,9
2-bedroom	2,7
3-bedroom	57,2
4-bedroom	31,4
5-bedroom	0,8

There is a high concentration of the 3-bedroom and 4-bedroom types. This can be explained by the fact that since the SHQ took over housing in Northern Québec in 1981, 52 4-bedroom units have been built and 76 3-bedroom units have been renovated per year in the Northern villages. The SHQ 5-year program is presently under review but the recommendations have not yet been made public.

In planning the housing for Taqpangajuk, it would be possible to implement the recommendations contained in the Inuit Housing Study report [14]. This study, financed by the Department of Indian and Northern Affairs, was aimed at involving the Inuit of Northern Québec in the decision-making process concerning housing. The comments received in the second consultation tour of the Inuit Housing Study show that:[1]

-dwelling on one floor is preferred because it is easier to escape in case of fire and because it is more convenient for the handicapped and the elderly;

-the single-family dwelling is what the Inuit truly want. The duplex models, even with added improvements, were clearly and firmly rejected. We could expect the most satisfaction from the Inuit concerning their housing if this need was met.

* A more detailed breakdown of costs is presented in Appendix I for all buildings and infrastructures. The same section titles and numbers are used in order to facilitate cross referencing.

[1] P. 64.

The major recommendations of the Inuit Housing Committee are:[2]

- houses in the future to be single-family, one-storey dwellings;
- that there be consultation with the village people about the design and location of their houses.

The core group of 104 people were consulted regarding the house plans recommended in the Inuit Housing Study. Their needs are:

Type of single-family dwellings	Number of households	(%)
2-bedroom	5	21,7
3-bedroom	11	47,9
4-bedroom	2	8,7
5-bedroom	5	21,7
Total :	23	100,0

There is an increase in the number of households[3] since:

- the people expressed their desires for the next 5 years;
- present conditions are overcrowded, with more than 1 family often living in the same house;
- there are unmarried adults and single parents still living in their parents' home who want to have their own home;
- the birth rate is higher in Northern Québec than in the rest of Canada.

There are 4,52 persons/household for the core group.

The method used to estimate the needs for the next 25 years is to determine the number of households according to the population forecasts (see Sec. 3.3), plan a housing unit for each household, and then calculate the space requirements to suit the needs.

The estimate was made for two periods: 1990 (the beginning of the village) and 2010 (the design period requested in the mandate).

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[2] Ibid., p.65.

[3] See Appendix I.

The calculation was based on a rate of:

- 4,7 persons / household for Natives;
- 1,6 persons / household for non-Natives.[4]

The needs in housing units are therefore:

Native (1990): $\frac{\text{195 persons x 1 housing unit / household}}{\text{4,7 persons / household}}$ = 42 housing units

non-Native (1990): $\frac{\text{10 persons x 1 housing unit / household}}{\text{1,6 persons / household}}$ = 6 housing units

Native (2010): $\frac{\text{412 persons x 1 housing unit / houshold}}{\text{4,7 persons / household}}$ = 88 housing units

non-Native (2010): $\frac{\text{20 persons x 1 housing unit / household}}{\text{1,6 persons / household}}$ = 12 housing units

Since the number of persons per household is expected to increase, the houses will have to have more bedrooms. The projected Native housing distribution for 1990 is given in Table 4.2.

Table 4.2
Native Housing Distribution (1990)

Type of single-family dwelling	Number of units	%
2-bedrooms	6	14
3-bedrooms	16	38
4-bedrooms	13	31
5-bedrooms	7	17
Total:	42	100

The non-Native population will need 6 housing units in 1990. They will live in duplexes since this is the type of dwelling provided by the employers (Kativik School Board, CHU).

To avoid scattering the community in distant development areas, it seems preferable to build some duplexes for Native people in the second stage of construction starting in 1991.

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[4] The rate of 4,7 is used since it is expected that the size of the households will increase once there is adequate housing space provided. Unmarried adults living with their parents would move out and start having families of their own, and it is likely that family size will increase when the households are not overcrowded. The rate of 1,6 is normal for the non-Natives because the employers hire more single people than people with families.

The recommendations of the Inuit Housing Study will therefore not be fully implemented in Taqpangajuk. Three options for the master plan are presented in Chapter 6. Options 1 and 3 have a potential of 101 housing units and Option 2 has a potential of 100 housing units.

Table 4.3 presents a summary of the number and types of housing units per option.

Table 4.3
Taqpangajuk Housing Distribution (2010)

	Single-family dwellings	Two-family dwellings	Total
Option 1	57 units	44 units	101 units
Option 2	50 units	50 units	100 units
Option 3	73 units	28 units	101 units

The size of the lot for a single-family dwelling is 33 m x 26 m (858 m^2). This allows a clearance of 14,4 m between 5-bedroom units. Single-family dwellings with 2, 3 or 4 bedrooms will be built on the same sized lot since these models can all be enlarged to contain 5 bedrooms. This will avoid any unnecessary building moves in the future providing that the houses are placed with this expansion in mind. The size of the lot is the same for the duplexes, which allows a clearance of 15,24 m between two duplexes. These clearance standards are usually applied in Northern Québec for fire safety reasons and to permit the delivery of services by trucks.

Table 4.4 shows the space needs according to the option and the type of the dwelling.

Table 4.4
Space Needs for Housing (2010)

	Single-family dwellings	Two-family dwellings	Total
Option 1	48 906 m^2	18 876 m^2	67 782 m^2
Option 2	42 900 m^2	21 450 m^2	64 350 m^2
Option 3	62 634 m^2	12 012 m^2	74 646 m^2

The costs of housing construction up to 1990 will be:

6 single-family dwellings with 2 bedrooms:	600 000 $
16 single-family dwellings with 3 bedrooms:	1 840 000 $
13 single-family dwellings with 4 bedrooms:	1 690 000 $
7 single-family dwellings with 5 bedrooms:	1 015 000 $
3 two-family dwellings :	690 000 $
Total:	5 835 000 $

4.1.2 Housing warehouse

Even if houses are well built, they still need regular maintenance. This maintenance will start as soon as the family moves into the new house. The necessary tools, parts and materials are stored in the housing warehouse, which also serves as a workshop for the maintenance man who takes care of the heating, plumbing, carpentry, electricity and insulation in the houses. This warehouse must be relatively large since 70 % of the materials arrive on the annual sealift.

The space needs and cost determined by KRG are:

Building size	Lot size	Lot area	Cost
12 m x 9 m	26 m x 25 m	650 m^2	385 000 $

The maintenance man will also need a vehicle for summer and another one for winter, with the appropriate trailers to carry his tools and materials.

- materials		50 000 $
- tools		15 000 $
- vehicles		9 000 $
- trailers		1 000 $
	Total	75 000 $

4.2 COMMUNITY SERVICES

4.2.1 Office building and fire hall

Under the James Bay and Northern Québec Agreement [15] Northern communities have the right to be established as municipalities and as such need premises for their administrative functions [16]. Based on the results of the consultations, it was also decided to include other services, such as the Landholding Corporation and Post Office, in the same building and also to have a fire hall attached to the office.

Therefore, the office building will include the following:

- the Mayor's office;
- the Secretary-Treasurer's office;
- the Municipal Manager's office;
- the Housing Manager's office;
- the Fire Chief's office;
- the Landholding Corporation office;
- the Post Office;
- the Québec Government office (Welfare, Manpower, etc.);
- a conference room.

The fire hall attached to the office will include:

- a garage for the firetruck;
- a storage room for firefighting equipment;
- a mezzanine to be used as a classroom and meeting room;
- a water pump to clean the firetruck.

The building should be centrally located in the village because of the nature of the services, and also in order to allow a fast answer from the fire brigade since it will be composed of volunteer firemen scattered all over the village. The firetruck will be kept full of water so it can answer the calls as fast as possible.

The space needs and cost determined by KRG are:

Building size	Lot size	Lot area	Cost
15,9 m x 23,5 m	40 m x 31 m	1 240 m^2	650 000 $

4.2.2 School and playground

Education is a basic right in Canada. Children in Taqpangajuk must therefore have access to adequate educational facilities. Since the nearest school is located in Kangiqsualujjuaq, young children cannot be expected to stay so far from home. All Northern villages have a school. The Kativik School Board recommends that Taqpangajuk have a school to provide education from kindergarten through Secondary III in Inuktitut, English and French. For Secondary IV and V, the students will have to go to Jaanimmarik School in Kuujjuaq. If they want to continue their education further they will have to go outside the territory since there are no post-secondary institutions in Northern Québec.

A single gymnasium is included in the school plans. The playground, which should be located beside the school, will include playground equipment, a 60 m x 25 m skating rink and a baseball field.

The space needs and cost determined by KSB are:

Building size	Lot size[5]	Lot area	Cost
40 m x 21 m	70 m x 131 m	9 200 m^2	2 200 000 $

4.2.3 Nursing station

Health services have been one of the main concerns expressed by the Killiniqmiut over the past 15 years. Because of the isolated character of Northern villages, access to medical facilities is limited. A nursing station in the village is therefore necessary to provide three types of services to the community: community health (prevention), nursing and social services. Two nurses and a local assistant will give front-line services in nursing and community health, and a local social worker will take care of the social services. They will be assisted periodically by visiting doctors and social workers from the Ungava Hospital Centre in Kuujjuaq. A dentist will also come to the village periodically.

[5] Includes the playground.

If a case is too serious to be dealt with locally, the patient will be evacuated by airplane to Kuujjuaq. If the Ungava Hospital Centre cannot provide the necessary treatment, the patient will be evacuated to the Centre Hospitalier de l'Université Laval in Québec City or to the Montréal General Hospital.

To fulfill its local mandate, the nursing station will include:

- 2 examination rooms;
- a waiting room;
- a pharmacy;
- a consultation office;
- a social services office;
- a conference room (Local Health Committee);
- showers, bathroom, etc.

Le Ministère des Affaires sociales du Québec (MAS) recommends that the nursing station be built in a central location in the community use area.

The space needs determined by the MAS are:

Building size	Lot size	Lot area	Cost
18,8 m x 14,4 m	30 m x 30 m	900 m^2	725 000$

4.2.4 Community centre

Municipal Services in Inuit Territory [16], also known as the Jolicoeur Report, states:

> Recreation plays an important role in the life of any Québec citizen. Since most of the year the Inuit now live in organized communities, they should be provided with facilities to ensure their full development. The community centre is the ideal place for social, cultural and recreational activities.

The community centre (or recreation hall) will be smaller and not as high as the school gymnasium and will be used for social and cultural activities such as bingo, dances, parties, shows, holiday celebrations (Christmas, New Year's, etc.), and also for community activities such as public meetings and travelling court sessions.

The building will also house the local FM station,[6] which is the main source of information on local and regional matters, and will include a television room if the community installs a satellite antenna.

The space needs and cost determined by KRG are:

Building size	Lot size	Lot area	Cost
7,6 m x 24,4 m	23 m x 37 m	851 m^2	385 000 $

[6] See Subsec. 4.5.4.

4.2.5 Religious facilities

4.2.5.1 Church

The heads of family want an Anglican church. However, they are willing to welcome another religion in the same building.

The church will have enough space to permit all of the members of the community to attend regular religious services, baptisms, weddings and funerals. The Arctic Diocese of the Anglican Church of Canada recommends that the church be centrally located in relation to the residential areas.

Building size	Lot size	Lot area	Cost
14,6 m x 6,1 m	33 m x 26 m	858 m^2	385 000 $

4.2.5.2 Cemetery

A cemetery is of course needed at Taqpangajuk. During the first consultation (Appendix I) it was indicated that the north end of the peninsula would be an appropriate site for the community's cemetery (C 2 on Plan 3). This site selection was made when it was planned to have two future development areas in this region to accommodate part of the community. However, during the development of the master plan options these future development areas were discarded in favor of a single area around the lagoon. The cost of building a single use road 1,3 km in length in very hilly topography leading to a now remote cemetery seemed prohibitive.

An alternative site (C 1 on Plan 3) was selected on the west shore of the south cove at 500 m from the drinking water intake point on suitable and relatively flat terrain. The space needed for the road leading to the new site is 4 000 m^2 at a cost of 20 000 $. No space needs or cost for the cemetery is foreseen as this will be left up to the people of Taqpangajuk.

4.2.6 Police station

The police station will be part of the Sûreté du Québec network, until the Kativik Regional Police Force is created, and must respect standards established for Northern Québec communities. There will be 1 local police officer to maintain peace and order and to carry out prevention programs on a 24-hours-a-day, 7-days-a-week basis. There may be an auxiliary officer to help him. In complicated cases such as murder, the Sûreté du Québec will send officers from Kuujjuaq to give technical assistance to the local police officer and also to investigate cases which are under provincial or federal jurisdiction.

The building itself will have to be detached from any other building because of the nature of police activities. These activities are detention, incarceration, conservation of exhibits, investigation and answering calls of complaint.

The building will be a 4,3 m x 12,8 m (14 foot x 42 foot) trailer divided into two sections: a 4,3 m x 4,3 m section to be made into a 1-bedroom apartment for the visiting officers and a 4,3 m x 8,5 m section to be used as a police station.

The police station will include:

- an office (for complaints and investigations);
- 2 cells (for detention and incarceration);
- an exhibits room (for evidence, fingerprints, etc.);
- a bathroom.

There should also be a shed to store a snowmobile and an all-terrain vehicle.

Building size	Lot size	Lot area	Cost
12,8 m x 4,3 m	28 m x 26 m	728 m^2	130 000 $

4.2.7 Freezers

It is an Inuit tradition to share the food with everybody. Therefore meat and fish brought back by the hunters are stored and distributed in an informal manner, for free, to all the members of the community. Provincial regulations [17, 18] stipulate that:

> The operator of a cold storage depot who receives, for purposes of preservation, carcasses, meat or meat products intended for human consumption must keep them in the frozen state at a temperature not higher than minus 18° C.
>
> Rooms in which frozen fish is stored shall be maintained at a temperature of minus 23° C or colder.

Therefore, Taqpangajuk must have a freezer. Usually 1 freezer is enough for a community. However, Taqpangajuk will need 2 freezers since 1 will be used by Killiniq Fishermen Inc. and will be subject to commercial regulations.

The space needs and cost are:

Freezer size	Lot size	Lot area	Cost
4,1 m x 4,7 m	26 m x 20,2 m	525 m^2	200 000 $

4.3 COMMERCIAL FACILITIES

4.3.1 Store and warehouse

A general store will sell clothing, food, hunting and fishing equipment and hardware, and will also be the major outlet for local products such as fur, carvings and handmade clothing.

It will need a warehouse with a 365-day storage capacity since the supply ship comes only once a year. The store should be located in the village centre.

The space needs and cost determined by the Fédération des coopératives du Nouveau-Québec (FCNQ) are:

	Building size	Lot size	Lot area	Cost
Store	9,1 m x 15,2 m	35 m x 35 m	1 250 m^2	125 000 $
Warehouse[7]	9,1 m x 15,2 m			75 000 $

4.3.2 Commercial services building

A commercial services building is needed to contain the eiderdown project facilities, the sewing shop, research and office space for Killiniq Fishermen Inc. and other resource-related activities or potential local development projects.

The space needs and the cost are:

Building size	Lot size	Lot area	Cost
371,6 m^2 (2 storeys)	30 m x 30 m	900 m^2	600 000 $

4.3.3 Hotel

Since housing is limited and many people will be travelling to Taqpangajuk for administrative and business purposes as well as tourist activities, accommodation must be provided. A hotel is the only tourist facility planned at present. It is not a Southern-type hotel, but rather a 5-bedroom transit house with a common bathroom and living room and also a fully equipped kitchen so that the guests may cook their own meals since this is the normal procedure in Northern Québec communities of this size. This small hotel can be enlarged if required.

It was pointed out in the consultation tour that the hotel should be located on the road leading to the airstrip to make it easier for travellers and it was also suggested that it be located on a site where it would have a view of the village and the surrounding countryside.

The space needs and cost are:

Building size	Lot size[8]	Lot area	Cost
18,6 m x 10,8 m	50 m x 22 m	1 100 m^2	200 000 $

[7] The warehouse will be located on the same lot as the store.

[8] This lot is planned to accommodate expansion of the hotel.

4.4 MUNICIPAL SERVICES

4.4.1 Drinking water

4.4.1.1 Design criteria

The design criteria for identifying the needs of the population are as follows:

Design period:	25 years
Population:	435 persons
Average consumption:	120 L/pers· d
Average daily consumption:	52 m^3
Institutional daily consumption: (all public and commercial buildings)	7 m^3
Total daily consumption:	59 m^3
Total yearly consumption:	21 535 m^3

These criteria are based on the findings of the consulting engineering firm Vézina, Fortier et Associés [19] and on Environment Canada's Cold Climate Utilities Delivery Design Manual (CCUDM) [20] for houses and buildings equipped with various water conservation fixtures including the toilet system.

4.4.1.2 Water sources

Generally water sources are groundwater, snow and ice, seawater or brackish water and surface waters (lakes or rivers).

Groundwater

According to the CCUDM "the subpermafrost groundwater is the most reliable and satisfactory groundwater source. However, this type of groundwater occurs beneath large rivers and lakes which recharge the subpermafrost aquifers."[9] In the general Taqpangajuk area, there are no large rivers or lakes close at hand. Also, a geological survey found that the region is characterized by rock foundations. Trying to find a reliable groundwater source under the permafrost, in rock, would be expensive and most probably unsuccessful.

Snow and ice

This option is not practical unless the need is temporary and the population to be served is small. Large volumes of snow are required to obtain even small quantities of water. It has been estimated that about 1 L of Arctic diesel fuel is required to produce 70 L of water from snow. This means that more than 840 L of fuel per day would be needed for Taqpangajuk. In addition to fuel costs and construction costs for the snow melters, labor for operating snow melters and snow harvest equipment must be considered.

[9] Pp. 3-6.

Seawater or brackish water

According to the CCUDM]:

> Desalinated seawater has been used for domestic supply but the associated problems are considerable. Intakes in the ocean or on the beach are subject to ice forces of phenomenal magnitude. Ice scour of beaches at all times during the year must be considered because of combinations of wind and sea ice. During the winter months, shore-fast ice and frozen beaches pose special problems. The largest drawback is that there are no economical (from an operating and management standpoint) methods to desalinate seawater on the scale necessary for a small community or camp.
>
> Brackish waters... may be treated by reverse osmosis or distillation but significant problems must be anticipated at small installations.[10]

Surface waters

Water sources that are suitable for continuous supply are large rivers and large lakes. In the Taqpangajuk area there are no rivers close to the village, so lakes are the only source that may be available.

Three lakes have been identified as possible water sources. One lake is near the village (DW 1) while the other two are 2,3 km (DW 2) and 2,6 km (DW 3) away (see Plan 3).

Because of the distance between the farther lakes and the village, the intake point at the lake and the filling station for the distribution trucks cannot be contained in the same building. As in all the other villages of Northern Québec, if the supply lake is more than 1 km from the centre of the village, the truck filling station is not located with the intake point but has to be located in the village. This would require the installation of a double pipe, mostly in rock, between the supply lake and the filling station, with boilers and heat exchangers at each end of the circuit. Recirculation pumps would also have to be installed so that the water would be constantly in movement between the intake point at the lake and the filling station for the trucks in the village.

The cost of the recirculation pipes is estimated at more than 1 840 000 $ for lake DW 2 2,3 km away and at 2 080 000 $ for lake DW 3 which is 2,6 km away. These costs are only for a double pipe system laid in loose soil; they do not include the price of blasting trenches in rock nor the cost of the two buildings, the boilers, the heat exchangers, the recirculation pumps, the secondary reservoir at the filling station and the access road to the lake.

It is clear that lake DW 1, located 350 m from the village centre, is the only logical and economical choice for water supply.

4.4.1.3 Lake DW 1 reservoir

Lake DW1 is located between rocky ridges. The area of this natural lake is about 17 400 m^2 and its estimated volume is 29 900 m^3. Information concerning the depth of the lake was a single measurement of 3,6 m at the centre. According to aerial photographs, the lake can

[10] Pp. 3-10.

be divided into two depth ranges: one section 1,5 m deep for the whole area of the lake and a pool 2,1 m deeper for an area of 4 570 m^2. The volume of this pool was calculated based on an assumed conical shape.

Winter conditions affect the availability of water because of the ice cover on the lake. The estimated ice thickness is about 2 m. Raising the level of the lake by 2,5 m to create a deeper reservoir will provide for ice cover and prevent disturbing the bottom sediments. The area of this reservoir becomes 37 540 m^2 and the estimated volume becomes 123 750 m^3. In winter the available amount of water would be 48 685 m^3 .

Three small earthen dikes will be needed to raise the water level by 2,5 m. The total length of the dikes is 120 m, for a total volume of materials of about 2 000 m^3. A weir will be installed in a channel at the south end of the lake to evacuate the overflow to the sea to avoid overtopping the dikes. The winter survey of water availability indicated that it may be necessary to raise the water to 3.5 m (See Section 4.4.1.7).

4.4.1.4 Hydrology

Using the meteorological data available, precipitation is estimated to be about 400 mm annually (see Table 2.2). Usually, in Northern Québec, water loss is assumed to be between 25 % and 50 % of the precipitation value. However, in this study, the water loss in the watershed and the reservoir will be determined more precisely.

General considerations

Precipitation and water loss are events that occur throughout the year and are closely related. To obtain precise figures, ideally numerous types of daily measurements over a minimum period of 30 years are needed and the characteristics of each and every rainfall or snowfall must be recorded. This data is not available, so estimates will be made to simulate the most pessimistic scenario.

Of the precipitation which falls upon the catchment area of the DW 1 reservoir, some runs off immediately to appear in the reservoir; some evaporates from land and water surfaces; some, the snow, remains where it falls with possibly some evaporation until it melts; some, known as interception, is caught on leaves of vegetation and evaporates; some, called depression storage, is held in low-lying areas; and some, termed infiltration, seeps into the ground.

As regards the infiltration, part of it is taken up by vegetation and transpired through the leaves; some percolates through the soil to emerge again; part of it is held by capillarity of the soil; another part is held in the soil particles by molecular action; while a small portion, termed underground seepage, may penetrate into deep porous underground strata and be lost so far as the catchment area is concerned.

To rationalize these components a water budget equation may be written. The yield of the area may be expressed as:

$$Y = P - E - I - D_s - T - C_m - U_s$$

Where Y: yield
P: precipitation
E: evaporation
I : interception
D_s : depression storage
T : transpiration
C_m : capillarity and binding
U_s : underground seepage

Some components of the equation are readily evaluated, others are more complex to compute. Precipitation data is available. Evaporation has to be estimated for the lake, the snow and the soil. Because of the barren and rather smooth surface of the general area, depression storage will be considered as negligible. Interception and transpiration cannot be measured from an appreciable area under natural conditions. Capillarity, molecular binding and underground seepage are also considered negligible because of the rock foundations and constantly frozen state of the underlying strata.

It is extremely difficult to evaluate soil evaporation, interception and transpiration. However, in studying the hydrological balance for a catchment area, one is usually concerned only with the total evaporation: the evaporation from all water, soil, snow, ice, vegetation and other surfaces plus transpiration. This total evaporation is usually termed "evapotranspiration". [11]

Since field determinations of evapotranspiration are impractical, a concept of potential evapotranspiration is widely used. By definition, it is "the water loss which will occur if at no time there is a deficiency of water in the soil for the use of vegetation provided the surface is fully covered by green vegetation" [21].[12] This definition is generally satisfactory, but it becomes meaningless during winter in Northern latitudes. Some authors recommend that potential evapotranspiration be taken as being equal to that of an equivalent free water surface with negligible heat storage capacity.

This approximation will be used in this analysis but will greatly overestimate the real evapotranspiration because the rate of evaporation from soil surfaces is limited by the availability of water. Eventually, evaporation ceases since there is no effective mechanism for transporting water from an appreciable depth. Moreover, since the foundations of the area are rock, there are no water transportation mechanisms through this strata even at shallow depths.

This method of evaluating water loss will be applied during the summer (July to October) when water surfaces and the active layer of the area are not frozen. For the catchment area considered the evapotranspiration value obtained will be multiplied by a corrective factor taking into account the percentage of the area covered by vegetation according to an interpretation of aerial photographs. The rest of the area being rock, there is virtually no soil moisture evaporation or transpiration.

In winter (November to May), only evaporation of the snow will be considered since no other mechanisms of water loss are taking place.

During the spring (June), evaporation will again be the major water-loss mechanism as interception, infiltration and transpiration are not possible because of the frozen ground.

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[11] $E_t = E+I+D_s+T$

[12] P. 177.

For each season the continuity equation becomes:

Summer: $Y = P - E_t$ where E_t: evapotranspiration

Winter and Spring: $Y = P - E$

Summer losses

In the area under study there are two systems: the DW 1 reservoir and the catchment area. Each will be treated separately in the text.

As mentioned above, the potential evapotranspiration will be estimated using the free water surface with negligible heat storage capacity model. The model used requires the following data: mean daily air temperature (°C), solar radiation ($MJ/m^2 \cdot d$), mean daily dew point temperature (°C), wind movement 0,15 m above ground or water level (nautical miles/d). Wind values have been taken at an estimated height of 10 m. To convert wind values to 0,15 m above ground or water level, the following formula is used:

$$V / V_1 = (\ln((Z / Z_o) + 1)) / (\ln((Z_1 / Z_o) + 1))$$

where
V : mean wind speed at some height Z
V_1: mean wind speed at some standard height Z_1
Z_o: roughness factor

In summer, Z_o will represent a desert surface for the catchment area and open water for the lake. In winter the roughness factor will represent smooth snow on short grass for both areas.

Since the vegetation cover accounts for less than 10% of the area, the values computed have to be reduced by at least 90%. Thus, the total water losses for the catchment area for the summer period are, by month:

July:	5,9 mm
August:	4,7 mm
September:	3,0 mm
October:	3,5 mm
Total	17,1 mm

Evaporation from the reservoir for the same period is 127 mm. This value has also been corrected by the percentage of occurrence of wind direction when no ridges protect the water surface. For the rest of the time, evaporation in calm conditions has been computed.

Winter loss

Snow evaporation can occur only when the vapor pressure of the air is less than that of the snow surface or when the dew point is lower than the temperature of the snow surface.

No data on snow surface temperature is available; however, it is reasonable to assume that the surface snow temperature is likely to be close to that of the air. When the above-mentioned condition was verified for the winter months, it was found that the dew point temperature is always higher than the air or snow surface temperature.

There is thus no effective evaporation of the snow during winter.

Spring loss

Evaporation for the entire area from melting snow is a special problem. It is related to the snowmelt rate and consequent run-off. To estimate the snowmelt rate, one must first consider that the energy for snowmelt is derived from:

- net radiation;
- conduction and convective transfer of sensible heat from the overlying air;
- condensation of water vapor from the overlying air;
- conduction from the underlying soil;
- heat supplied by incident rainfall.

With the available data, such computations are impossible. For the purpose of the study, it will be assumed that the snowmelt rate is constant and that melting takes place during the whole month of June.

As for run-off evaporation, it is reasonable to assume that run-off will be within snow layers or over frozen ground with negligible losses.

To precisely estimate the real rate of evaporation of the surface film on melting snow more data would be required. However, a maximum rate of evaporation may be computed. This maximum rate of evaporation is about 25 % of that of a water surface at 26,7°C when the dew point is 7,2°C under the same wind condition. [13]

This maximum rate will overestimate the real loss since it assumes that temperatures are well above freezing while the mean daily temperature in June is only 2°C in the Taqpangajuk area. It also assumes clear sky conditions throughout the month.

After wind speeds are corrected for height and surface roughness, the total water loss during snowmelt is 51 mm over the entire area including the reservoir.

Total losses

The catchment area loses a total of 68,1 mm of water annually while the reservoir loses 178 mm. These values result from pessimistic scenarios and are considered to be slightly higher than the real losses.

Water yield

For the catchment area, subtracting the loss from the precipitation gives 331,9 mm of water that runs to the reservoir. The area of the catchment basin without the reservoir is 92 460 m^2 which yields an annual volume of water of 30 685 m^3.

[13] Maximum possible air-to-snow vapor-pressure difference under evaporating conditions.

For the reservoir area, subtracting the losses from the precipitation gives 222 mm of water. The area of the reservoir being 37 540 m^2, a net gain of 8 330 m^3 of water is achieved annually.

The total volume of water entering the reservoir annually is thus 39 015 m^3. This is almost double the volume of 21 535 m^3 that will be withdrawn annually by the population of the village in the year 2010.

When spread over the entire area, the total yield represents 300,1 mm so that the weighted average loss for the area is 99,9 mm, which represents 25 % of the precipitation. As mentioned before, a percentage of loss ranging from 25 % to 50 % is usually used without verification in Northern Québec.

4.4.1.5 Recurrence of drought periods

The maximum design need is 21 535 m^3 of water per year. This means that a yield of at least 165 mm over the catchment area is needed or, adding the losses, precipitation in the order of 265 mm is needed.

The variability of the precipitation data is around 25 %. Assuming that the data follow a normal distribution, with a mean of 400 mm and a standard deviation of 100 mm, its associated curve is given in Fig.4.1. It is thus possible to compute the recurrence period of the event of the yield being less than the withdrawal from the reservoir. The probability of having less than 265 mm of precipitation in a given year is 8,9 %.

Expressed as a frequency, this means that in 1 out of every 11,3 years the precipitation will be less than 265 mm so that the village, with a population of 435, will take more water from the reservoir than the catchment area is able to yield.

To better illustrate this concept, Table 4.5 gives the recurrence period for precipitation values from 260 mm to 160 mm.

Figure 4.1
Normal Distribution Curve for Taqpangajuk Precipitation

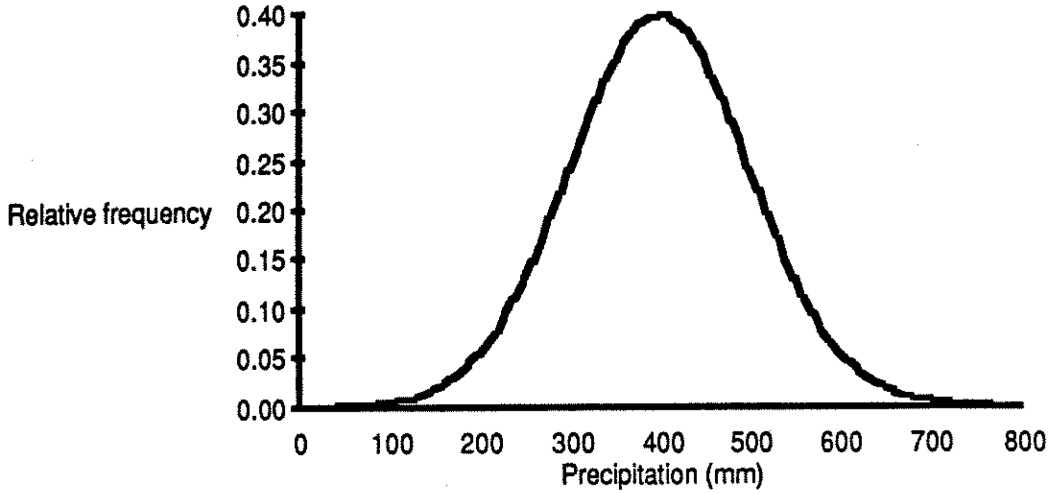

Table 4.5
Recurrence Periods for Precipitation

Precipitation (mm)	Recurrence period (years)
260	12,5
240	18,2
220	27,9
200	43,9
180	72,0
160	121,9

When the village is built, for example, it will have a population of 205. The demand for water will be 8 980 m^3 which represents, including losses, a need for 169 mm of precipitation . The recurrence period of precipitation lower than 169 mm is about 109 years.

There is no practical way of inducing the minimum precipitation required every year. The only other variable that can be controlled to ensure that the residents do not run out of drinking water is the storage capacity of the reservoir.

4.4.1.6 Storage capacity

The estimated volume of the reservoir with its level raised by 2,5 m is 123 750 m^3. Assuming that there is average precipitation in the 3 years following the completion of the reservoir (yield of 39 015 m^3), the reservoir will have filled up and have a storage capacity 5,7 times the demand of the population of 435 in the year 2010. This means that even if there is no precipitation for 5 consecutive years, the reservoir would be able to supply the amount of water needed. The probability of such an event occurring is infinitely small. As long as over a period of 5 consecutive years the cumulative yield of the catchment area is at least equal to or greater than the cumulative demand, the reservoir will stay full.

To compute the required capacity of the reservoir, mass diagram or sequent peak analyses can be used.

Better still, a stochastic simulation would provide further insight into the frequency of failure to meet the target of providing enough water for the residents.This is done by generating synthetic data that represent one possible sequence using a uniform random number generator and converting these numbers into random variables through a statistical distribution function such as the normal distribution described above. This generated time series is said to be one realization of a stochastic process. Generating numerous time series would allow a complete stochastic simulation. However, this approach is quite sophisticated and definitely beyond the scope of this study.

Nonetheless, one time series has been generated so that the sequent peak analysis may be carried out. Forty-three random numbers are needed to represent the desired distribution (mean=400, standard deviation=100) with an error on the mean of 10 % within a 95 % confidence interval. The characteristics of the generated series are a mean of 362 mm of precipitation with a standard deviation of 115 mm, which falls within the limits stated. This realization of a stochastic process is pessisimistic as regards the mean.

From this series of 43 years, the first 20 years were submitted to a sequent peak analysis, producing the following results :

Table 4.6
Sequent Peak Analysis for DW 1 Reservoir

Period	[Release - (m^3)	Inflow + (m^3)	Previous required capacity] (m^3)	=	Current required capacity (m^3)
1990	15907	453	0		15454
1991	16267	23290	15454		8430
1992	16582	31335	8430		0
1993	16942	4799	0		12143
1994	17392	20979	12143		8556
1995	17752	33646	8556		0
1996	18157	29948	0		0
1997	18607	28838	0		0
1998	19507	32444	0		0
1999	19552	28561	0		0
2000	20002	14322	0		5680
2001	20542	40858	5680		0
2002	21037	11826	0		9211
2003	21622	26619	9211		4214
2004	22162	7295	4214		19081
2005	22792	21626	19081		20247
2006	23422	23476	20247		20193
2007	24007	35218	20193		8982
2008	24682	20887	8982		12777
2009	25402	33184	12777		4995
2010	26122	33276	4995		0

In this analysis, the release is the annual demand of the population plus the annual evaporation from the reservoir. The inflow is the precipitation minus the catchment area's losses, multiplied by the area. There is no need to continue the analysis further than the design period. Moreover, the critical sequence of flows occurs at the end of the record.

The maximum value for the current required capacity is the required storage capacity for the specified releases. Because of winter conditions, an extra capacity of at least 15 000 m^3 must be planned for a total capacity of 35 247 m^3.

Since the capacity of reservoir DW 1 is 123 750 m^3, it is sure to be able to meet the village's needs for the next 20 years, without fear of drought or lower than average precipitation.

The above analysis suggests that raising the reservoir by 2,5 m, as discussed previously, is not necessary. However, this is justified for the following reasons:

- it will permit the installation of the overflow weir at the south end of the reservoir;

- it will provide a minimum volume of water in winter to dilute the mineral concentration when the ice cover forms;

- It will prevent disturbing the bottom sediments and putting them back into suspension.

4.4.1.7 Drinking water

During the winter site visit, five boreholes were drilled to determine ice thickness and the depth of free water available. The positions of the boreholes are indicated in Fig. 4.2 along with the characteristics of each borehole. It can be seen that the thickness of the ice cover is only 95 cm on the average. The depth of available water is, however, quite small (0 cm, 115 cm and 175 cm). It is clear that a complete depth survey of the lake is required to determine its exact bottom profile and the available storage. If storage is not sufficient with the proposed diking of the lake, there would be no problem in raising the level of the lake by an additional 0,5 m to 1 m (see Section 4.4.1.3).

4.4.1.8 Distribution system

It has been shown by the consulting firm of Dupont, Desmeules et Associés Inc.[22] that, for economic reasons, a population of at least 500 persons is needed to even begin considering distributing water to consumers by means of a pipe system. The Taqpangajuk design population is only 435 persons. Moreover, because of the rock foundations of the area, trenches in which to lay the pipes would have to be blasted in rock over most of the required length. This mode of distribution is to be rejected because of the costs and more complex operation.

A trucked distribution system will prove to be the most satisfactory, while at the same time providing employment for the residents of the village. Since the truck filling station is only 570 m from the village centre, the service to the consumer could be excellent.

For fire protection considerations, 2 drinking water distribution trucks of 6 750 L will be available from the start so that the village will have vehicles which can deliver enough water to supply the firetruck at the scene of a fire.

Auxiliary work will include a water intake, pumping station, disinfection station and truck filling station. These facilities will all be located in a heated building next to the lake.

Building size	Lot size	Lot area	Total area[14]	Cost
5 m x 5 m	30 m x 30 m	900 m^2	38 440 m^2	300 000 $

[14] Total area includes reservoir.

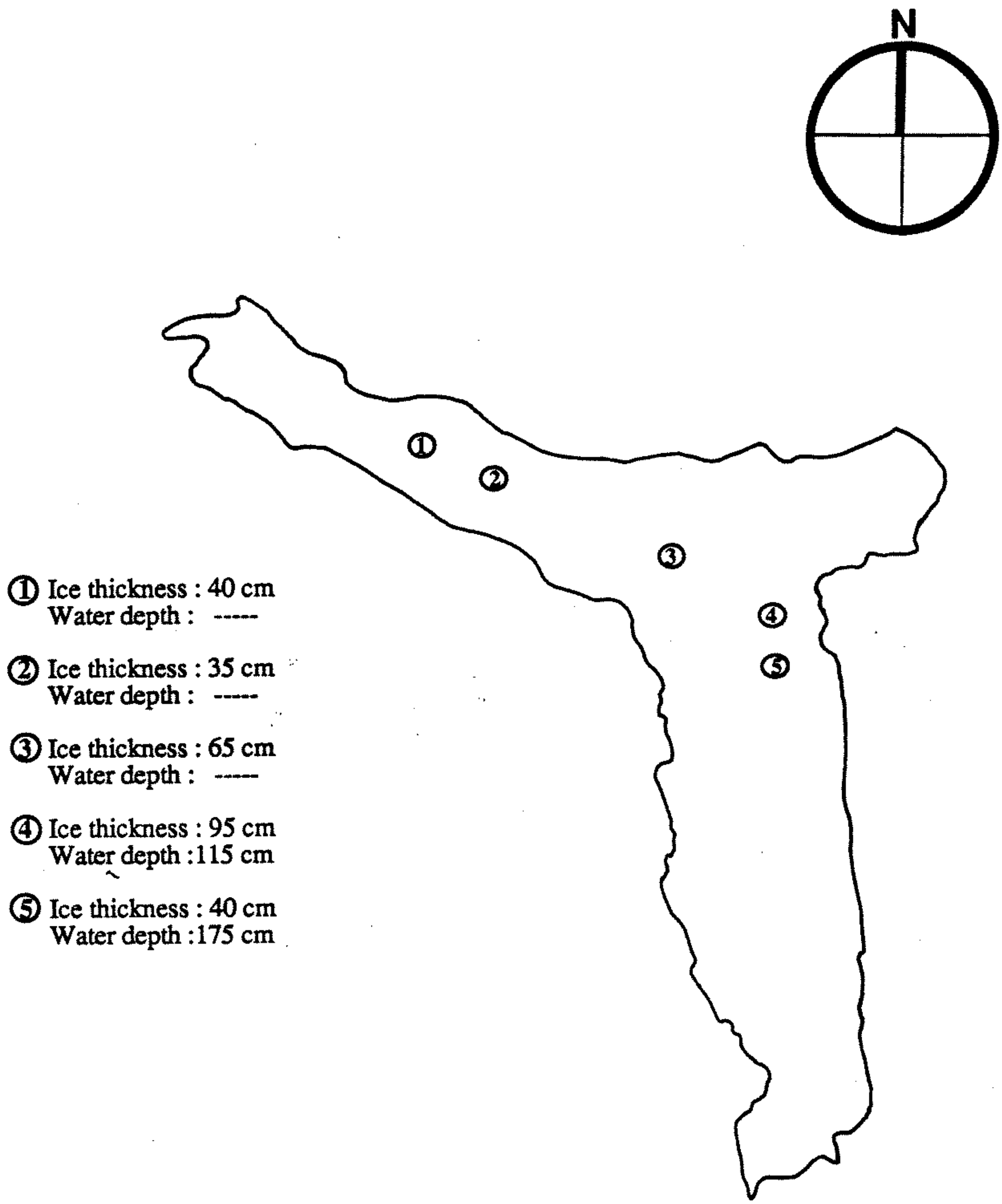

Figure 2.2
Location of Boreholes
in DW 1 Lake

4.4.1.9 Water Quality

During the fall field survey a lake near Uugalik was sampled for a complete physico-chemical analysis of its water. Lake DW 1 was only sampled for bacterial analysis. However, considering the similarities of the two lakes, it is reasonable to believe that the water quality of Lake DW 1 is similar if not identical to that of the sampled lake. Table 4.8 gives the results of this analysis.

A sample was also taken to determine the quality of winter water in Lake DW1 for drinking purposes; the results are presented in Table 4.7 along with the results of the sample taken by Pluram Inc. in August, 1982.

Table 4.7
Water Quality of Lake DW-1

Parameter	Results		Maximum Acceptable
	August 5, 1982[31]	April 8, 1986	Concentration[23,24]
pH7	7,3	6,2	6,5-8,5
Color	20	8	15
Turbidity (NTU)	0	0,44	5
Alkalinity (mg/L $CaCO_3$)	14	31	-
Total hardness (mg/L $CaCO_3$)	60,6	39	-
Conductivity (µmhos/cm)	-	200	-
Total solids (mg/L)	75	166	-
Dissolved solids (mg/L)	74	152	-
Iron (mg/L)	0,10	0,36	0,3
Manganese (mg/L)	<0,01	0,04	0,05
Sulfates (mg/L)	4,5	6,5	500
Nitrites and nitrates (mg/L N)	0,005	1,303	10
Chlorides (mg/L)	1,2	22	250
Ammonia (mg/L)	0,53	0,2	-
Silver (mg/L)	-	<0,005	0,05
Arsenic (mg/L)	-	<0,003	0,005
Barium (mg/L)	-	0,02	1
Boron (mg/L)	-	0,07	5
Cadmium (mg/L)	-	<0,002	0,005
Chromium (mg/L)	-	<0,01	0,05
Cyanides (mg/L)	-	<0,01	0,2
Fluorides (mg/L)	-	<0,1	1,5
Mercury (mg/L)	-	<0,002	0,001
Lead (mg/L)	-	0,02	0,05
Uranium (µg/L)	-	<0,001	0,02
Selenium (mg/L)	-	<0,002	0,01
Phenols (mg/L)	-	<0,002	0,002
Total coliforms / 100 ml	0	0	10
Fecal coliforms / 100 ml	0	0	0
Fecal streptococci / 100 ml	0	0	0

All of the parameter values for the lakes tested are under the recommended limits except for iron. The iron limit has been established on the basis of aesthetic considerations. At levels above 0,3 mg/L, iron stains laundry and plumbing fixtures, and causes undesirable tastes in beverages. However, there are no health risks. The sample slightly exceeds the iron limit but it must not be forgotten that it was taken after eight months of ice cover. Because of the lack of dissolved oxygen and the lower pH, ferric iron is reduced to ferrous iron which is readily soluble in water, and this accounts for the higher values. Removal of iron is not recommended since the excess is slight, the situation is temporary and the depth of the lake will be augmented, thus counterbalancing the depletion of dissolved oxygen during winter.

The quality of the water is excellent and does not require any treatment other than disinfection to prevent waterborne diseases.

Table 4.8
Water Quality of a Lake near Uugalik

Parameter	Results	Maximum Acceptable Concentration [23, 24]
pH	5,4	6,5-8,5
Color	6	15
Turbidity (NTU)	0,36	5
Alkalinity (mg/L $CaCO_3$)	8	-
Total Hardness (mg/L $CaCO_3$)	10	-
Conductivity (µmhos/cm)	40	-
Total solids (mg/L)	32	-
Dissolved solids (mg/L)	31	-
Iron (mg/L)	0,06	0,3
Manganese (mg/L)	<0,03	0,05
Sulfates (mg/L)	2,5	500
Nitrites and nitrates (mg/L N)	<0,1	10
Chlorides (mg/L)	7	250
Ammonia (mg/L)	<0,1	-
Silver (mg/L)	<0,005	0,05
Arsenic (mg/L)	<0,003	0,05
Barium (mg/L)	<0,2	1
Boron (mg/L)	<0,05	5
Cadmium (mg/L)	<0,002	0,005
Chromium (mg/L)	<0,02	0,05
Cyanides (mg/L)	*	0,2
Fluorides (mg/L)	0,19	1,5
Mercury (mg/L)	<0,0005	0,001
Lead (mg/L)	<0,02	0,05
Uranium (µg/L)	<1	20
Selenium (mg/L)	0,002	0,01
Phenols (mg/L)	<0,002	0,002
Total coliforms / 100 ml	0	10
Fecal coliforms / 100 ml	0	0
Fecal streptococci / 100 ml	0	0

* Not available

4.4.2 Wastewater

4.4.2.1 Design criteria

Design period:	25 years
Population:	435 persons
Daily hydraulic loading	59 m^3
Yearly hydraulic loading:	21 535 m^3
Total BOD_5:	70 g/pers·d
Total suspended solids:	50 g/pers·d
Total BOD_5/soluble BOD_5:	1,4

These criteria are based on the study by Vézina Fortier et Associés [19] for the James Bay area Hydro-Québec camps. They have been used for the design of all wastewater treatment systems in Northern Québec and are accepted by Environnement Québec.

4.4.2.2 Selection of wastewater treatment system

One option is direct discharge of untreated wastewater into the sea. This method is simple enough and economical, although deep-sea diffusers would have to be built. However, since the Inuit depend on the sea for their subsistence (seals, whales, fish, etc.) and bacteria and viruses have a high survival rate in cold water, this solution is less attractive. Moreover, the Québec Government will be constructing secondary wastewater systems for all villages of Northern Québec. For these reasons, untreated discharge into the sea is not a recommended solution.

General considerations of wastewater treatment

Wastewater contains varying quantities of floating and suspended solids. Materials such as rags, metal, plastic, or rubber will reach the treatment plant.

Preliminary treatment systems are designed to remove large floating solids, grit and perhaps grease because their presence would interfere with subsequent treatment processes or mechanical equipment.

Primary treatment has traditionally meant a sedimentation process intended to remove suspended organic solids. Chemicals are sometimes added in primary clarifiers to assist in the removal of finely divided and colloidal solids.

Secondary treatment systems are intended to remove the soluble and colloidal organic matter which remains after primary treatment. The removal of this material can be effected by physico-chemical means or by a biological treatment process. Because of the high cost of chemicals, difficulty of handling, transportation costs and lack of laboratory facilities and specialized technical personnel for operating the equipment, the different physico-chemical means of secondary treatment will not be discussed and are rejected out of hand.

Wastewater, in addition to containing organic matter, also carries a large number of microorganisms which are able to stabilize the waste in a natural purification process. Biological treatment consists of the application of a controlled natural process in which microorganisms first remove soluble and colloidal organic matter from the waste and are then in turn removed themselves. Biological treatment systems are designed to maintain a large active mass of bacteria within the system confines. While the basic principles remain the same in all secondary processes, the techniques used in their application may vary widely, but may be broadly classified as either attached growth or suspended growth processes.

Attached growth process

This process utilizes a solid medium upon which bacterial solids are accumulated in order to maintain a high population. The area available for such growth is an important design parameter. Surface growth processes include: intermittent sand filters, trickling filters and rotating biological contactors.

Intermittent sand filters would have to be enclosed in a heated building to permit year-round operation at Taqpangajuk. The area required for our purposes is approximately 550 m^2 with a depth of sand varying from 460 mm to 760 mm. The sand used normally has an effective size of 0,2 mm to 0,5 mm. The sand is underlaid by approximately 300 mm of graded gravel in which perforated pipes or unjointed drain tiles are placed to collect the treated waste. The upper layer of the sand will eventually become clogged. When this occurs, 50 mm to 75 mm of the sand is removed and replaced with clean material.

This solution is not attractive because of the large area required, the building size and heating costs, the need to have graded sand and gravel that would have to be shipped from the South, the mode of application of the wastewater (once or twice a day), which is not compatible with a trucked system and the general operating procedures which are difficult to carry out within an enclosed area.

Trickling filters use a bacterial growth medium such as rock or formed plastic shapes. The wastewater is applied to the surface, usually in an intermittent fashion, and percolates through the filter, flowing over the biological growth in a thin film. An underdrain system serves to carry away the liquid effluent and sloughed biological solids and to distribute air through the bed. This system usually performs better when part of the effluent is recirculated.The wastewater is distributed over the filter by either rotary or fixed nozzles, the latter being possible with artificial media.

This option is not recommended because of the mechanical equipment involved and the bulk of the system (100 m^3 to 300 m^3). These systems are also very sensitive in cold weather operation and their efficiency is reduced by approximately 30 % for every 10° C drop in temperature. This type of system is an ideal breeding ground for flies and other insects. Flooding the filter for 24 hours and the application of insecticides are effective techniques of filter fly control but the filter must be designed to permit it.

A rotating biological contactor (RBC) consists of a basin containing mechanically driven rotors which provide a large surface area for biological growth. It is a continuous flow process and the rotating mechanism is covered with a slime film similar to that of trickling filters. The film is rotated through the wastewaster and through the air above the liquid. RBCs are generally more reliable than other attached growth processes because of the large amount of biological mass present. This also permits them to withstand hydraulic and organic surges more effectively, a major advantage of a trucked system. The RBC units are usually prefabricated and can be moved to the site already assembled. This type of system can operate efficiently in the 10°C to 25°C temperature range.

This system is a possible option for wastewater treatment in Taqpangajuk.

Suspended growth process

Suspended growth processes maintain an adequate biological mass in suspension within a reactor by employing either natural or mechanical mixing. In most such processes the volume required is reduced by returning bacteria from the secondary clarifier to the head of the system to maintain a high bacteria concentration. Suspended growth processes include activated sludge and its numerous modifications and oxidation ponds.

The basic factor in design, control and operation of activated sludge systems is the mean cell residence time or sludge age. Aeration is also critical in this process. Most installations need a sludge recirculation system and compressors or surface aerators for oxygen requirements. The plant is thus highly mechanized and requires constant surveillance by qualified personnel. Operational problems of activated sludge generally stem from the inability to maintain the desired sludge age. The problems that result are floating sludge, bulking sludge and poorly settling bacterial suspensions. The efficiency of the plant is therefore affected and fine tuning is constantly required. It is also a known fact that operation and maintenance costs for the activated sludge process are two to three times higher than those of attached growth processes.

For these reasons, all activated sludge processes are rejected for wastewater treatment in Taqpangajuk.

Oxidation or stabilization ponds are a relatively low-cost treatment system which has been widely used. The ponds may be considered to be completely mixed biological reactors without recirculation of solids. The mixing is usually provided by natural processes but may be augmented by mechanical or diffused aeration.

Ponds are usually classified as aerobic (high-rate, low-rate and tertiary), facultative and anaerobic (without oxygen) or a combination of all three. To reduce operating costs and mechanical problems due to freezing or equipment breakdown, aerated ponds are rejected and will not be considered further. Anaerobic ponds are not a practical option for Taqpangajuk because of the very high organic loadings (200 kg to 500 kg BOD_5/ha) and relatively large depth (2,5 m to 5 m) needed to keep the pond anaerobic.

The facultative pond is a possible option for wastewater treatment in Taqpangajuk.

Choice between an RBC and a facultative pond system

Facultative oxidation ponds are always the preferred option for small communities. However, specific site and design constraint analyses must be made before choosing this type of treatment.

For the population to be served, two ponds with a total area of 14 400 m^2 would be required for a total retention time of 365 days. The depth of the ponds should not exceed 1,5 m. Since in winter no treatment, and thus no discharge, is possible, a 365 day retention time is required to store the wastewater in the winter months and to provide enough time for the treatment to be completed in the summer months. With an area of 14 400 m^2, the organic loading is 21,1 kg/ha·d of BOD_5 which falls between the recommended limits of 11 kg to 22 kg/ha·d BOD_5. However, a lower organic loading is preferable. The selected loading is 15 kg/ha·d of BOD_5. The pond area needed thus becomes 20 000 m^2. The first pond will have to be able to store the winter production of wastewater.

There is no existing lake system with the required area in the vicinity that could be used as oxidation ponds. The ponds would therefore have to be constructed. Because proper impervious materials for the dikes are lacking on the site, a membrane would have to be used to line the dikes of the ponds. The area of membrane necessary would be 7 800 m^2 including a 20 % overlap. The cost of the membrane alone, when transported and installed, would be 468 000 $ (60 $/$m^2$). Including the cost of blasting for a smooth bottom and the cost of constructing the dikes, the total cost for the ponds would be approximately 900 000 $.

For safety reasons, and since odors would develop in the spring, the ponds would have to be at least 1 km from the edge of the living area. The topography of the region makes it virtually impossible to construct 20 000 m^2 of ponds so that they would discharge into the sea.

For these reasons, the pond system must be rejected at this stage of the study.

The rotating biological contactor seems to be the only practical and economical (700 000 $) solution to the wastewater treatment problem.

The system will be housed in a heated building and will include the following equipment: screens as preliminary and primary treatment, an equalization basin to spread the flow of the trucks' discharge over a 24-hour period, three stages of disks to provide secondary treatment, a secondary settling tank, an ultraviolet light disinfection system for the effluent and an aerobic digester to stabilize the excess sludge coming from the screens and secondary clarifier. No odors would develop from this system and the aerobically stabilized sludge would be deposited in a special area beside the solid waste disposal site. The operation could be carried out by the residents with minimal training.

In Northern Québec, eight of the thirteen villages will be equipped with RBCs through Environnement Québec's wastewater treatment investment program.

4.4.2.3 Site selection

In selecting the site of an RBC, the following considerations must be taken into account:

- public protection;
- discharge into a diluting environment;
- protection of the receiving ecosystem;
- protection of adjacent wastersheds or ecosystems;
- proximity to wastewater source.

In response to the concern expressed by the people that the RBC site WW 3 on Plan 3 seemed too close to the village, two other potential sites were identified; one near the southern cove of the peninsula (WW 1) and a second site beside the solid waste disposal site (WW 2). Each site will be analysed according to the above-mentioned criteria.

Site 1- WW 1

The effluent would be discharged into the cove. As a result of the gently sloping bottom of the cove, it is very likely that this area will be used as a canoe beaching site. It is already planned for the fishing boat haul-out facility to be located in this area. The wharf may also be constructed on the shores of the cove. It is clear that some human activity will take place in and around this easily accessible site. The effluent, although disinfected, could disturb the potential users and could present a small risk if ever the disinfection equipment fails. In the spring, the accumulated frozen effluent would probably melt on the spot, producing higher local concentrations. The degree of public protection would thus not be ideal.

Dilution of the effluent would pose no problems considering that the receiving environment would be the sea. Although the cove is quite deep and the height of the tides varies seasonally, it is reasonable to consider dilution factors in the range of 50 000 to 500 000 for neap tide conditions. These dilution factors were taken from a study done on Salluit's RBC through a finite element simulation of the discharge in the receiving bay. These results have been confirmed by actual sampling of the bay. Because the WW 1 site at Taqpangajuk opens directly into the sea, the dilution values would probably be much higher there than in Salluit.

The receiving ecosystem (the sea) would benefit from the discharge which contains nutrients that are usually lacking in cold water oceans, mainly nitrogen and phosphorus. These nutrients would increase the productivity of these waters.

Adjacent watersheds and ecosystems could not be harmed by the presence of the RBC and its discharge.

The unit would be located approximately 540 m by road from the edge of the village. This distance is reasonable considering that the road would provide access to multiple services and that power lines would pass near the area to supply the airstrip with electricity.

Site 2- WW 2

This area is not planned to support many human activities. The solid waste disposal site would from the start discourage potential sightseers. However, as regards public protection, there is a possibility that the discharge would be carried back into the lagoon near the village centre at high tide. The effluent, although disinfected, could present a small risk if the disinfection equipment fails. In the spring, the accumulated frozen effluent would probably melt on the spot, producing higher local concentrations. The degree of public protection would thus not be ideal.

Dilution is expected to be as high as that of Site 1. Similarly, the RBC and its discharge should not pose any risk to the adjacent watersheds and ecosystems, and the productivity of the receiving ecosystem should actually be increased by the discharge.

The unit would be approximately 940 m by road from the edge of the village. This distance is reasonable considering that the road would provide access to multiple services and that power lines would pass near the area in order to service the airstrip.

Site 3- WW 3

The effluent from the system would flow into a tertiary or polishing pond and then through a shallow peatland. These two extra steps would ensure a more complete treatment and a higher removal rate than would be possible at the other sites. It is clear that the area would have to be declared off-limits to the residents. A fence might have to be put up to discourage exploration of the area. However, as in the other two sites, the only risk involved would be in the case of a failure of the effluent disinfection equipment. If the equipment works properly, there would be no risk of contamination to any people or animals who come into contact with the effluent. The discharge would flow directly to the sea and would not risk being transported back towards the village. The site that would receive the discharge is not planned to support human activity. This site would thus provide more public protection than the other two sites.

Dilution is expected to be higher than at the other two sites since the effluent would discharge directly into the sea, not through an inlet or cove.

The receiving ecosystems would be a small shallow lake, a peatland and then the sea, in that order. The lake could not be protected and would be part of the treatment process. The peatland would not suffer from the effluent flowing through it. This has been demonstrated by three studies [25, 26, 27] which the Ecole Polytechnique de Montréal carried out for the James Bay Energy Corporation on the capacity of peatlands to purify wastewater in the James Bay area.

If the residents indicate that they would prefer to preserve the lake and peatland, a longer, overland discharge pipe to the sea would have to be built and kept heated. The additional pipe required is estimated to be 100 m, which would add 40 000 $ to the cost.

Adjacent watersheds, including the watershed of the reservoir, and other ecosystems would not be harmed by the presence of the RBC and its discharge. The unit would be approximately 150 m from the edge of the village. This distance respects all existing regulations for this type of treatment. The proximity of the system would mean less trouble in winter for wastewater trucks to reach the facility. It also would involve less wear and tear on the trucks. Power lines pass near the area to service the drinking water treatment plant and the airstrip. However, people expressed concern about this site.

Although all three sites are of equal value for a properly functioning system, Site 3 offers more protection should a component of the system fail. It also would permit a more complete treatment of the wastewater. For these reasons, this site is recommended for the construction of the rotating biological contactor of Taqpangajuk.

Building size	Lot size	Lot area	Total area[15]	Cost
21 m x 18 m	25 m x 30 m	750 m^2	12 540 m^2	700 000 $

[15] Includes the receiving lake and peatland.

4.4.3 Solid waste

4.4.3.1 Regulation

The solid waste disposal site must follow the provincial regulation respecting solid waste [28] which states:

Siting: A waste disposal site in the North must be placed at least:

a) 100 metres from a lake or watercourse;
b) 300 metres from a dwelling, school, place of worship, cemetery or hospital;
c) 500 metres from a well or spring supplying water for human consumption.

Fence and gate: A waste disposal site in the North must be surrounded by a fence and gate to prevent access to the site. They must be at least 2,5 metres high, angled inward at the top, and be made of square mesh wire with spacing not exceeding 10 centimetres. The gate must remain closed at all times except for the passage of vehicles or employees.

Preparation: Before any solid waste is deposited in a waste disposal site in the North, unconsolidated materials must be removed to a depth of one metre, the permafrost line or to 30 centimetres above the underground water level, whichever is encountered first. Such excavated material must be deposited on the periphery of the site and will be used subsequently to cover the waste.

Burning of waste: In a waste disposal site in the North, solid waste must be burned at least once a month. It must also be burned before final burial.

Final burial: At the closure or the discontinuation of operation of a waste disposal site in the North, residual solid waste must be covered to a depth of at least 30 centimetres by unconsolidated material.

Toxic waste: Hydro-Québec has a new policy that all used oil generated by the production of electricity and all transformers no longer in service will be automatically shipped down South for disposal. The solid waste disposal site will thus be used for domestic wastes, which will not include "honey bags". The leachate from such a site will have a very minor effect on the receiving environment.

4.4.3.2 Space needs

The area required for the solid waste disposal site is computed based on an average of 2,6 m^3/pers·year of non-compacted waste after burning and allows a maximum depth of waste on the site of 1 m. The space needs are:

Year	Population	Waste (m^3)	Cumulative waste (m^3)	Cumulative area (m^2)
1988	126	328	328	328
1989	164	426	754	754
1990	205	533	1 287	1 287
1991	213	554	1 841	1 841
1992	220	572	2 413	2 413
1993	228	593	3 006	3 006
1994	238	619	3 625	3 625
1995	246	640	4 265	4 265
1996	255	663	4 928	4 928
1997	265	689	5 617	5 617
1998	275	715	6 332	6 332
1999	286	744	7 076	7 076
2000	296	770	7 846	7 846
2001	308	801	8 647	8 647
2002	319	829	9 476	9 476
2003	332	863	10 339	10 339
2004	344	894	11 233	11 233
2005	358	931	12 164	12 164
2006	372	967	13 131	13 131
2007	385	1 001	14 132	14 132

4.4.3.3 Site selection

The following considerations must be taken into account in the selection of the site:

- odor problem;
- smoke from burning;
- wind direction;
- leachate flow;
- visibility from the living area.

The living area must never be downwind of the site. This eliminates all possible sites north, south and west of the central lagoon because of prevailing wind directions. The site may be northeast or southeast of the lagoon. Northeast sites, although adequate, would not be easily accessible and an extra road would have to be built. Southeast sites would be easily accessible by the road that leads to the airstrip. However, these sites would preferably have to be at least 1 km from the edge of the living area.

The selection of the site also has to take into account the presence of the airstrip. It is not recommended that an extra road be built to locate the solid waste disposal site east of the airstrip. The distance becomes too great to ensure uninterrupted service all year round.

The solid waste disposal site (SW on Plan 3) thus has to be located between the eastern edge of the lagoon and the airstrip. The site will be far enough from the village and far enough east to protect the population from odors and smoke. The site will not be visible from the village and the leachate will flow into the sea without having much impact on the receiving body of water due to the very small quantity of leachate. It is important to note that there will be no "honey bags" deposited at the site creating a health hazard from leachate.

Two adjacent areas will be provided, one for RBC sludge drying and disposal and the other for metallic wastes. Strong incentives will be provided for the population to recycle metal parts.

4.4.3.4 Life span

The total area of 15 200 m^2 provided for the solid waste disposal site will have an approximate life of 20 years. All these computations are made on estimated quantities that have not yet been verified. However, it is felt that these quantities incorporate an adequate margin of error.

4.4.4 Municipal equipment

As the Jolicoeur Report [16] so justly states:

> If this minimum infrastructure is to be built and maintained [airplane runway, streets, access roads],[17] it is essential to be able to rely on adequate equipment. Private firms cannot locate here; from an economic point of view it would not be practical: the population is small, there are no links with Québec's highway system, and there is no local road network. Each community, then, must have its own basic equipment.[18]

In Northern communities, the municipality also provides a large number of services related to sanitation (drinking water distribution, wastewater and garbage removal) and fire protection. Appropriate equipment is needed to provide these services. Some of this municipal equipment, if bought during the early construction phase, could also be used during construction, resulting in substantial savings.

A list of the necessary equipment can be drawn up based on the services to be provided in Taqpangajuk:

Services	Equipment
1. water distribution	1 water truck and 1 backup unit
2. wastewater collection	1 wastewater truck and 1 backup unit[19]
3. garbage collection	1 garbage truck
4. fire protection	1 firetruck and 2 water trucks to provide enough water for firefighting
5. snow removal (airstrip, roads, village)	1 loader 2 trucks with snowplow equipment 1 snowblower
6. airstrip and road maintenance	1grader 1 truck 1 loader with backhoe equipment

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[17] See Section 4.7

[18] p. 153.

[19] For services that must be provided on a regular basis, backup units are needed. Depending on the services, these backup units could be trailers or self-contained units.

	1 bulldozer
7. solid waste disposal	1 bulldozer
8. fishing boat haul-out	1 winch (acc. equip. on bulldozer)
9. handling of cargo	1 forklift (acc. equip. on loader)
10. transportation to airport	1 pickup (crewcab type)
11. coordination and repairs	1 pickup
	1 tool box

Based on these requirements, the following equipment can be acquired based on the standards now applied by KRG when buying municipal equipment:

Quantity	Type of equipment	Total cost ($) [20]
2	water trucks (4x4; 6 700 L)	115 000
1	wastewater truck (4x4; 6 700 L)	52 000
1	wastewater trailer (4x4; 2 700 L)	33 000
1	garbage truck (4x4; 5 m^3)	25 000
1	firetruck (4x4; 6 700 L)	150 000
1	loader (110 kW; 2,5 m^3) with backhoe and forklift equipment	200 000
2	trucks (4x4; 10,5 t) with snowplow equipment	116 000
1	snowblower (55 kW)	165 000
1	grader (130 kW; 4 m)	200 000
1	bulldozer (105 kW; 14 t) with winch	185 000
1	pickup (4x4; crewcab)	22 000
1	pickup (4x4)	18 000
1	tool kit	35 000
	Total	1 315 000 $

The costs quoted do not include spare parts.

4.4.5 Municipal garage

In Northern communities, a municipal garage serves a double purpose, which is recognized in the Jolicoeur Report [16]: "If these villages are supplied with this equipment, warehouse and repair space will have to be allowed for."[21] The warehouse space is needed to store equipment that cannot be left outside during winter nights.

The building itself will be a 5-door unit, separated into 2 doors for long-term repairs and general maintenance, 2 doors for the water trucks since they are stored full of water at night for fire protection purposes and 1 door providing a separate, enclosed area for the wastewater truck.

The building will be constructed on a concrete slab poured over a rock foundation to avoid any settling problems. Appropriate locations for the municipal garage have been identified

[20] Costs are estimated from historical costs in Northern Québec.

[21] P. 155.

on sites MG 1, MG 2, MG 3 and MG 4 on Plan 3.These locations adjacent to the powerhouse could possibly have the added benefit of the cooling equipment of the powerhouse generators being used to provide adequate heating for the garage through heat exchangers using a liquid medium.

From the point of view of proximity to the village, sites MG 3 and MG 4 are less desirable. Site MG 2, because of the buffer zone that should surround the powerhouse, takes up housing space and must therefore be rejected. MG 1 is the recommended site.

For such a building, the space needs and cost are:

Building size	Lot size	Lot area	Cost
20 m x 17 m or 24 m x 12 m	40 m x 45 m	1 800 m^2	905 000 $

4.5 ENERGY AND COMMUNICATIONS

4.5.1 Electricity

4.5.1.1 Powerhouse

Of the thirteen Inuit villages of Northern Québec, none are connected to the Hydro-Québec network. In these villages, electricity is produced by diesel generators with a capacity of 50 kw to 800 kw depending on the local needs. The cost of such an operation is extremely high but Hydro-Québec has standardized domestic rates across the province. Electricity is distributed by high-tension lines, as is the case throughout Québec.

There are various possibilities for producing hydro-electric power in Northern Québec, but at present there are no plans for developing this potential in such remote areas. There are also projects for adding wind-driven generators to existing facilities for network studies in the region.[2] Taqpangajuk's exposure to the winds from Hudson Strait could results in it being an ideal site for such an installation. However, this type of facility will be experimental for some time. As far as other means of energy production are concerned, there are projects on the drawing board. These include solar power to be used partly for heating but mostly for the production of electricity, and nuclear reactors. A Slowpoke-3 [23] could be used to produce 2 mw to 20 mw of heat, while a Super-Slowpoke could even be used to produce 0,2 mw to 2 mw of electricity.

Except for hydro-electricity, all of these alternative methods of energy production would still require a diesel-powered backup generator. For this reason, the diesel generator is the only viable option for Taqpangajuk.[24]

As agreed in the terms of reference for this study, the standards used by Hydro-Québec have been applied. Since Hydro-Québec took over the Northern Québec communities' electrical generating equipment in 1981 there has been a continuous upgrading and

[23] For "safe low-power critical (k) experiment".

[24] This choice would also satisfy the general public which tends to be against some of the other methods which it considers to be unreliable or even dangerous.

standardization of equipment. The present 5-year program ending in 1990 will have the majority of Northern villages enjoying new or upgraded facilities. Consequently, it has been assumed that this will also apply to Taqpangajuk.

Space needs

Hydro-Québec has indicated that a 100 m x 120 m lot would be adequate for its installations (including the powerhouse, garage and substation). The lot should be located near the tank farm and away from the community so the residents will not be bothered by the noise from the generators. The installations should also be on sound rock foundations where there is no possibility of permafrost action.

Such a site (PH 1 on Plan 3) has been identified on the western side of the rocky ridge in a rock outcrop zone near the planned tank farm site. The ridge will act as a natural sound barrier between the Hydro-Québec installations and the residential areas. This site will have to be checked during the summer of 1986 by Hydro-Québec representatives.Sites PH 2, PH 3 and PH 4 have been rejected for the reasons stated for sites MG 2, MG 3 and MG 4 in Subsec. 4.4.5.

	Building size	Lot size	Lot area	Cost
Powerhouse	19,5 m x 12,2 m	100 m x 120 m	12 000 m^2	3 350 000 $
Transit house[25]	4,3 m x 12,8 m	30 m x 60 m	1 800 m^2	

4.5.1.2. Distribution network

There are two options for distribution: underground cables or overhead lines. As underground water distribution pipes have already been eliminate,[26] it would be prohibitively expensive to bury the electric cables. Consequently, it has been assumed that poles would be used in conjunction with overhead lines.

Space needs

There is no specific space requirement for the poles and power lines but a 3 m right of way must be kept under the lines.

Cost

In 1985, the cost of a three-phase line on wooden poles was 75 000 $ per km and 60 000 $ per km for a single-phase line.

[25] Hydro Québec has indicated that it will need a transit house for its staff. Its cost is included in the cost of the powerhouse.

[26] See Subsec. 4.4.1

The cost of an overhead network for Taqpangajuk has therefore been estimated at:

	Network length	Cost
Option 1	5,35 km	401 000 $
Option 2	5,46 km	410 000 $
Option 3	5,44 km	408 000 $

4.5.2 Tank farm

As has been previously discussed in Subsec. 4.5.1, fossil fuels are an absolute necessity in the North for the production of electricity. They are also necessary for heating, transportation by airplane, truck, boat, all-terrain vehicle or snowmobile.

Supplying the Northern villages with fossil fuels is a costly and difficult operation. Since there are no means of overland transportation, the fuels have to be shipped by sea. Due to climatic conditions, this can be done only during the annual sealift.

In all of the Northern villages, it is a private firm that supplies the fuels. As a result of the high transportation costs and additional storage costs, the price of fuels is much higher than in the South.[27]

It is foreseen that a private company will supply and install the required number of tanks to meet Taqpangajuk's fuel needs. The design period for a tank farm is 5 years but there is usually a minimum size required which for small communities already incorporates some overdesign.

Heating fuel will be delivered to the different buildings by the company's truck. All other fuel distribution will take place at the tank farm site, so there will be no distribution station in the village or at the airport.

The FCNQ, and to a lesser degree, Shell Canada Ltd. have already indicated that they would be interested in building and operating such a tank farm.

Space needs

Based on the estimates by the FCNQ and Shell Canada Ltd., two tanks will be needed, with a capacity of 1 600 m^3 and 320 m^3 (1 600 000 L and 320 000 L) surrounded by a dike to prevent spills.

They would be circular, straight-sided tanks, with a diameter of 14,6 m for the larger one and 7,6 m for the smaller one. They would be installed on a 70 m x70 m lot on rock foundation close to the sea, occupying 4 900 m^2 of special use area possibly near the wharf (W 1 on Plan 3) on the far side of the ridge from the village (TF 1). An alternative site (TF 2) near the south cove was considered but found less attractive because of difficult access by sea.

[27] The price is currently 1,5 times higher in the Northern villages than in Southern Québec.

Based on recent construction of the same type and information given by representatives of the two organizations, the costs to be assumed by these commercial organizations would range from 700 000 $ to 1 000 000 $, including the cost of 1 fuel delivery truck.

4.5.3 Telephone system

As a result of the large distances separating the Northern communities and the absence of roads between them, there is a vital need for telecommunications, which should be viewed as an important tool for development and regional integration.

There is presently a telephone system available in each of the Northern villages and it is therefore taken for granted as a normal service. However, when this service was lacking it was a constant preoccupation of the residents, who were concerned about health services, coordination of transportation, and commercial and administrative needs. Telephone service must be viewed as an absolute necessity.

In Taqpangajuk, the service will be provided by Bell Canada, via the Anik B satellite communication system which is the responsibility of Telesat Canada.

The CRTC requires that normal telephone service be available to every home in every community that meets the criteria of having an initial demand of 25 telephone lines in addition to containing 35 dwellings or having a population nucleus of at least 100 people. This type of service is called an exchange.[28] The village of Taqpangajuk should thus have an exchange since in the first year after the relocation of the original population, there will be 31 dwellings and a population of 191 people. It is important that residents request a telephone in their homes so that the village will meet the criterion of an initial demand of 25 lines.

Bell Canada will build a substation and install telephone wires on the poles already erected for the power lines to ensure that normal telephone service is available to every home. Telesat Canada will install a satellite earth station on one of the lots on the west ridge (see master plans).

Space needs

The earth station will require a 37 m x 37 m (1 400 m^2) lot. The substation will require a lot measuring at least 18 m x 23 m (420 m^2) but a 45 m x 45 m (2 025 m^2) lot would be better. No space needs have been calculated for the telephone wires and poles since the wires will be installed on the power poles.

Cost

There will be no cost to the community for the installation and upkeep of the telephone system. Bell Canada will, of course, bill its customers for their service on a monthly basis.

[28] The alternative, if these criteria are not met, is the "toll station", which must be provided for communities of at least 10 dwellings or a population of 50 people. This is a minimal service whose conditions and cost would have to be ascertained.

4.5.4 Radio and television facilities

The inhabitants of the vast and sparsely populated region of Northern Québec are very concerned about communications. This is less obvious these days since for the past 10 years most of the Northern villages' communications need[29] have been met. However, a quick look at the book "The Northerners" [30] published in 1974 shows the importance accorded to these facilities when they are lacking.

At the time this book was published, CBC's Northern Service was only available on short wave and the people, although they were interested in listening to it, complained that most of the time they were not even able to find the station on the dial and that when they did the words were often unintelligible.

All of the Northern villages now have radio and television and it would be unthinkable for Taqpangajuk not to have the same facilities. Sites have therefore been planned for the installation of a satellite antenna on the ridge to the west of the village. The transmitters could be located close to the village centre where a small broadcasting station could be set up.

The CRTC's criterion for obtaining CBC radio and television services is that the community have a population of 500 people. Even in the next 25 years, Taqpangajuk's population will not reach this figure. Only five of the Northern villages are able to meet this criterion. Since 1978, the other villages have provided themselves with community radio and television facilities at their own expense.

The former residents of Killiniq would thus have helped to pay for the cost of installing these facilities in the villages to which they had moved. In leaving these villages, they will also leave behind their radio and television services. Since it would be unfair for them to have to pay for them twice, the costs of radio and television facilities are included in this report.

Space needs

A 1 400 m^2 site (see master plans) on the rocky ridge to the west of the village has been planned for the installation of a satellite antenna to be used for radio and television services.

Cost

According to the Taqramiut Nipingat Inc. (TNI), the cost of establishing a community radio station would be approximately 10 000 $ for a 1-watt facility or 30 000 $ for a 6-watt facility.

[29] Short wave radio, telephone, radio and television.

4.6 TRANSPORTATION

4.6.1 Airport facilities

For Taqpangajuk, as for all communities in Northern Québec, the only real year-round link with suppliers, medical facilities, other professional services and the outside world in general is by airplane. The airplane normally used for local service in Northern Québec by Air Inuit, a subsidiary of Makivik, is the Twin Otter , a short take-off and landing airplane built in Canada by de Havilland. These airplanes are still using runways ranging from 350 m to 850 m in length, with the average length being 500 m. However, a federal-provincial airstrip program to upgrade existing facilities is presently being carried out in Northern Québec. The new runways are planned to be at least 1 070 m long, with airport terminal facilities, runway lights and a radio beacon. Such runways could permit the use of more cargo-efficient airplanes such as the Hawker-Siddeley HS-748, McDonnell-Douglas DC-3 or Gulfstream G-159.

Although a shorter runway and less sophisticated equipment are alternatives in Taqpangajuk, the recommended option is that the airport facilities be planned according to the federal-provincial airstrip program.[30] This program is aimed at correcting the inadequacies pointed out in the Jolicoeur Report [16] so as to standardize air transportation services throughout Northern Québec.

According to Transport Canada's survey of the area, a suitable location (see Plan 3) for the construction of a 1 070 m runway including all support facilities has been found some 2 km from the village.

The foundations consist of rock so construction will require blasting and crushing of materials. This would have been necessary whatever the length of the runway.

Based on another airport of the same type, the space needed to accommodate these facilities would be as follows:

	Size of facility	Lot size	Lot area
Airstrip	30 m x 1 070 m	300 m x 1 790 m	537 000 m^2
Parking(vehicles)	50 m x 100 m		
Apron (airplanes)	55 m x 75 m	100 m x 350 m	35 000 m^2
Equipment	------	140 m x 175 m	25 000 m^2
		Total area:	597 000 m^2

Transport Canada has estimated that such airport facilities will cost 12 000 000 $, based on other projects of the same scope. No breakdown of the cost of the project is available yet. The cost of the airport is therefore not included in the cost of the village. It is instead kept as a separate cost which is then added to the village cost to indicate the total cost.

30 At their 1983 meeting, the mayors of the eleven communities concerned by this program established a priority list for the airstrips to be improved, and indicated that the future community of Taqpangajuk would have to be included in this list once relocation agreements are signed and additional funding is provided.

Information from various sources would indicate that the 12 000 000 $ cost includes 3 000 000 $ for roads (as is the case for the Salluit airport) which will be accounted for in Subsec. 4.7.3.

The cost of the airport facilities excluding roads will thus be 9 000 000 $. This amount is believed to include: mobilization costs (including equipment and crusher), temporary camp or lodging of construction workers, airfare for workers, etc. As most of these costs are already included in the construction costs for each of the buildings, there is no need to estimate them for the airport facilities. The camp built to house construction workers for the airport project would be adequate for a larger project spread over more years. Therefore, separate estimates have not been made for costs specific to the construction period (including fuel and electricity).

4.6.2 Wharf

Most of the materials sent to Northern Québec are transported by ship, although this is a somewhat adventurous undertaking due to climatic conditions in the North. However, the advantage of this means of transportation is its capacity to carry large quantities of very heavy or very bulky goods. It is also the only economical link with the South.

In all villages, when sealift time is approaching, there is a feeling of eagerness and expectancy as new supplies are coming to the village. The Hudson's Bay Company uses this means of transportation to restock its stores across Northern Québec. It is also the only way to bring construction equipment and materials, goods and fuel to the communities.

It is proposed to build a wharf in Taqpangajuk to facilitate the sealift. The docking facilities should be adjacent to a large open storage area where the supplies could be stored during unloading without impeding the operations. This area would also be used for temporary storage of merchandise prior to its distribution in the village and, in certain cases, for year-round storage.

There are no real docking facilities as yet in any of the Northern villages, although such facilities have been planned for certain communities.[31] However, the funds available for such infrastructures have never been equal to the task at hand, and any improvements made have thus been merely cosmetic. A program to improve docking facilities in the Northern villages is under discussion at the present time.

Although not having a wharf is an option, there is a need for improvement in this field and as such the planned docking facilities at Taqpangajuk must be seen as a small step towards better facilities. Needless to say, better facilities would lower the cost of the sealift because of more efficient unloading and less loss of materials due to difficult handling.

The wharf proposed for Taqpangajuk would consist of a permanent bulkhead which could be used as a side docking wharf under certain conditions and a floating assembly which would be removed during winter or as necessary. The bulkhead would consist of a rock-filled wooden crib with a protective covering of metal plate.[32]

31 In a recent relocation project, a floating wharf is planned. The community is still under construction and the wharf has not been used yet since the natural facilities are exceptional.

32 Multi-plate culvert parts would be an excellent material.

The floating assembly would be composed of 8 hollow steel pontoons measuring 6 m x 3 m x 2 m and would extend 24 m into the water.[33] The whole assembly would be covered with a wooden deck and a mobile ramp attached to the bulkhead would allow access to the wharf at all times.[34] All metal parts would have to be treated against saltwater corrosion.

Such a wharf is not intended for docking large vessels in the 3 000 t range, but is intended to permit unloading of barges and docking of fishing boats. Four potential sites have been studied (see Plan 3). A cove to the northeast was considered early in the study but was rejected since the narrow point of entry, which was narrowed even further by tidal flats, made access difficult.

The other three sites need further study. Site W 1 is the best site for the fishing boat because of the protection it offers from winds. At this site, anchorage for the sealift vessel has to be found and depths have to be ascertained. There is the possibility of a high rock bottom in the middle of the cove. In addition, a moderate slope at the shoreline could require a longer wharf structure. Site W 2 is an alternative location near the tank farm site (TF 1) and closer to the village. It would permit the boats to be docked in deeper water but wind protection seems less adequate. Again depths have to be ascertained and wind protection needs further analysis. This site would facilitate unloading of fuel. At a preliminary meeting it was indicated as an adequate site for larger vessels. Site W 3 is a last option. It offers better protection than Site W 2 but it is in the village and the depth of water may be inadequate.

Further studies need to be carried out to determine the best location for the wharf but it is estimated that a budget price of 500 000 $ would cover the cost of its construction if no dredging is required.

The space needed for the storage area would be in the order of 7 500 m^2 at a cost of 150 000 $.

4.6.3 Fishing boat haul-out facility

The Killiniq community already owns and operates a fishing vessel for the Killiniq fisheries project. This boat, the Aiviq, is 42 feet (12,8 m) long and weighs 28 000 pounds (12,7 t). It is presently planned to bring the fishing boat back to Taqpangajuk from Killiniq each winter. The boat will be kept in the south cove (see master plans) where it will be protected from the winds.

As freeze-up starts, the boat will have to be hauled out of the water to protect it from ice pressure.

A simple haul-out device consisting of a cradle made of wide flange metal beams mounted on the rear axles and wheels from a truck would be suitable. It would also provide a

[34] Alternatively, the wharf could be made of preserved wood with additional flotation provided by foam or steel floats.

reliability in Northern conditions that almost no other systems, such as a cradle travelling on rails[35] or a hoist, could offer.

This wheeled haul-out cradle would roll down a ramp extending well into the water. The natural slope at site W 1 on Plan 3 is estimated at 5 % based on tide surveys made during the September field survey. This slope could be covered with coarse gravel and cobbles, and corrected to make a ramp with an acceptable surface for the haul-out device to roll on. Once the boat has been floated onto the cradle and tied down, the whole unit would be hauled out of the water using the winch on the bulldozer.

The space needs, above the waterline, would be 10 m x 60 m (600 m^2). No preliminary design of such a device has been made. However, used metal parts would cost approximately 1 000 $. With the costs of labor for soldering these parts, the purchase of used truck axles and wheels and transportation to Taqpangajuk, the total cost of the unit should be less than 15 000 $. It is estimated that it will cost 35 000 $ to prepare the gravel ramp and storage area which makes a total cost of 50 000 $ for the haul-out facility.

4.7 EARTHWORK

The Jolicoeur Report [16] states that: "Each village in Québec's far north should have an airplane runway with a road leading to it ... and access roads leading to the drinking water point and the waste disposal site".[36]

This is more than a mere wish; it is a statement of certain basic needs of the Northern population.

In order to examine these needs, this section has been divided into four parts, the first two dealing with the foundations and drainage of the village, the third with the road network and the last with the airstrip.[37]

4.7.1 Foundations

Foundations can be divided into two different categories: the foundations of the individual buildings and the foundations of the village itself.

Each building will be built on a particular type of foundation: on a gravel pad or else on piles for certain infrastructures such as the school, nursing station, etc. The buildings which use a concrete slab will be built on a gravel pad or on levelled rock.

As regards the foundations of the village itself, they include the earthwork (excavation and backfilling or cut and fill) but not the drainage works, which will be dealt with in the following subsection.

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[35] Such a system is currently being used to haul out 55-foot yachts in the 50 000 to 60 000 pound range near Québec City.

[36] P. 153.

[37] The need for an airstrip has been justified in the previous section; the aim here is to deal with the construction process itself.

The ideal foundations would be a level gravel terrace requiring minimal work. However, this is not the case at the Taqpangajuk site, and the potentials and constraints maps (Plans 4.1 and 4.2) identify the work that will have to be carried out: excavation of organic or clayey materials, if required, in the wetlands, excavation of the rock to eliminate humps or steep slopes, filling in of areas which are lower than the surrounding areas, and general levelling of the surface. All of this work must be carried out to ensure proper subfoundations for the buildings and roads.

The volume of fill required and the volume of excavated materials have been estimated and compiled below for each of the master plan options in order to indicate what work would be necessary. The excavated materials are divided into two classes: Class 1 for rock and Class 2 for soil (granular or common). Class 2 is subdivided into materials that can be reused as Class A fill (sand) or Class B fill (moraine) and materials, such as vegetal, organic or clayey matter, which cannot be reused (common). Class 1 excavated materials can be reused in two forms: as is and crushed.

		Option 1	Option 2	Option 3
Volume of excavated materials (m^3)				
	Class 1 rock	15 000	43 000	22 000
	Class 2 granular	7 000	33 000	22 000
	common	1 000	1 000	3 000
Volume of fill (m^3):				
	Granular (A or B)	7 000	33 000	22 000
	Crushed rock	93 000	47 000	48 000

	Option 1	Option 2	Option 3
Total cost ($):	2 465 000	1 855 000	1 800 000

Space needs

No space needs have been determined for this work.

4.7.2 Drainage works

4.7.2.1 Trenches, interceptor drains and ditches

Before constructing sound foundations for the buildings, it is important to make sure that run-off from heavy rain or spring thaw will not erode them.

The purpose of drainage works is thus twofold. Firstly, work will be carried out to drain wetland areas prior to backfilling them with well-draining material such as blasted and crushed rock. This will be done by digging trenches in wetland that will drain into the lagoon opening into the sea. During construction, these trenches will be left open for as long as possible[38] to allow rain to run off and also to provide continuous maximum drainage.

Secondly, major interceptor drains will be dug at the bottom of steep slopes upstream of living areas to divert run-off from heavy rains and possibly spring thaw away from these areas.

These drains will be connected to the trenches described above, so that the run-off will be discharged into the lagoon or sea.

Prior to the backfilling of foundations, all underlying trenches will be filled with coarse material to permit continuous drainage and minimize surface streams, erosion and deterioration of foundation quality over the years.

Where advisable, ditches will be dug and left open on the final surface of the foundations to provide normal surface drainage and minimize road and foundation erosion.

No space needs have been identified for trenches as they will be under the foundations. The space needs of open ditches are usually included in road right-of-ways. In the case of interceptor drains where buildings are located at the bottom of slopes, 1 km of these drains are required, for a total space need of 4 000 m^2.

A total cost of 100 000 $ will cover digging and backfilling 1 km of trenches and 1 km of interceptor drains. No cost is foreseen for ditches as they are included in road costs.

4.7.2.2 Dikes

The previously described drainage process will also be helped by the diking of lake DW 1 for drinking water purposes. These dikes will cut off its discharge and keep the lower lands drier. Three dikes will occupy approximately 1 500 m^2. Their location is indicated on the master plans. No preliminary design has been prepared for these dikes but a run of the pit core structure with an upstream blanket of sand covered by an impervious geomembrane anchored at the toe of the dike[39] with a total volume of 2 000 m^3 at a cost of 150 000 $ has been foreseen.

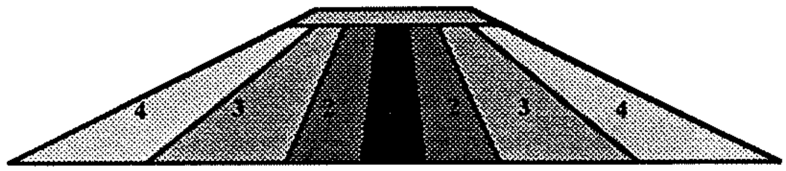
It would also be possible to use concrete or impervious core earthen dikes.
Concrete dikes would require 260 m^3 of concrete and 520 m^2 of formwork at a cost of 260,000 $. the concrete would have to be very well mixed and carefully controlled because of the severe freezing and thawing cycles that the dikes would have to withstand.

Earthen dikes with four different zones, including an impervious core, (see Fig. 4.3) would require 255 m^2 of filter sand that would have to be ordered from the South; the other materials could be found at the Taqpangajuk site. The total cost for this type of dike would be 190 000 $.

38 If any stability problems occur, the trenches would have to be backfilled immediately.

39 Alternatively, if impervious moraine is available at the site, an upstream blanket of such materials could be used at a lower total cost.

Figure 4.3
Typical Section of Earthen Dikes with Impervious Core
(not to scale)



1: Impervious moraine

2: Filter sand (imported)

3: Crushed material

4: Run of the crusher

The technique for this type of construction involves careful compacting and placing of materials. Construction is complex and is not recommended for small dikes such as those required for Taqpangajuk. For these reasons and in the interest of economy, the use of dikes along with an impervious membrane is recommended.

4.7.3 Road network

In order to permit communication, access to service areas, delivery of water and fuel and fire protection, it must be ensured that an adequate road network can be built in Taqpangajuk.

The roads of this network can be divided into two types: the streets within the village and the access road going from the village as far as the airport.

Since traffic will be more or less limited to the vehicles ensuring municipal services, there is no need to design a road network with a complex structure. On granular foundations, simple roads with a 7 m wide roadway covered with a layer of gravel 150 mm thick would be suitable. On other foundations (bedrock, MoW, etc.) a base of run of the crusher materials 300 mm to 600 mm thick would be required.

As regards the access road, the two routes considered would both require some excavation work (10 000 m^3 to 15 000 m^3 of material) to minimize the long hills or steep slopes (more than 10 %). However, all of the excavated material could be used to fill in the adjacent hollows, none of which would require the material to be transported any farther than 200 m. The excavation and fill work could thus be done by a bulldozer without any need to move the material by truck. If there is any rock that requires blasting, the blastholes could be made by the track-mounted drills on their way to the airport site, so that the infrastructure of the road could be constructed from the very beginning. A 300 mm gravel base could later be laid to support the top layer of gravel 7 m wide and 150 mm thick.

The two potential routes for the access road are indicated on the master plan options, and the corresponding profiles of the roads are shown in Fig. 4.4.

The streets within the village will have a right of way 15 m wide with a roadway 7 m wide. The excess right of way will permit the parking of vehicles, piling up of snow and digging of ditches if necessary.

The access road will have the same dimensions. In areas where there is much cut and fill work required (2 m deep), the right of way could be wider. However, 15 m could be the typical width.

The space needed and the costs are:

	Length of road system	Area	Cost
Option 1	5,35 km	80 250 m^2	1 108 000 $
Option 2	5,46 km	81 900 m^2	1 123 000 $
Option 3	5,44 km	81 600 m^2	1 103 000 $

The cost of the roads includes ditches where required.

4.7.4 Airstrip

The need for an airstrip and airport facilities has been justified in Sec. 4.6. What will be discussed in this section is the interaction of the airstrip construction with the village construction.

As has already been mentioned in Subsec. 4.6.1, the construction of an airstrip at Taqpangajuk will require the blasting and crushing of materials since the foundations of the site surveyed and selected by Transport Canada are rock (R) or bedrock thinly covered by moraine (Mo/R).[40] The depth of this deposit bears no relation to the depth of rock that will have to be excavated to provide the foundation for the airstrip and thus may be ignored.

What is evident in the Taqpangajuk project is the fact that the airstrip must not be considered as a project on its own. It must be seen in a more global perspective and be considered as part of the Taqpangajuk community. In previous projects carried out under the federal-provincial program to improve airport facilities, the airstrip has always been viewed as a separate, self-contained project since the village already existed. This would also have been the case in Taqpangajuk if sand and gravel had been abundant. With no shortage of materials, each project could have been carried out separately, at least from the point of view of balancing cut and fill.

However, since there is a severe shortage of sand and gravel at Taqpangajuk, rock will have to be crushed and used instead. This type of work is being carried out extensively in the North for the airstrip program and also for road surfacing when there is no gravel available. What is different in the case of Taqpangajuk is the fact that crushed rock, or even natural blasted rock, could be put to good use for the village construction if there is insufficient rock available in the immediate area. Thus, instead of balancing cut and fill for the village and cut and fill for the airstrip, the total cut and fill balance for the two should be

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[40] See Plan 1.2.

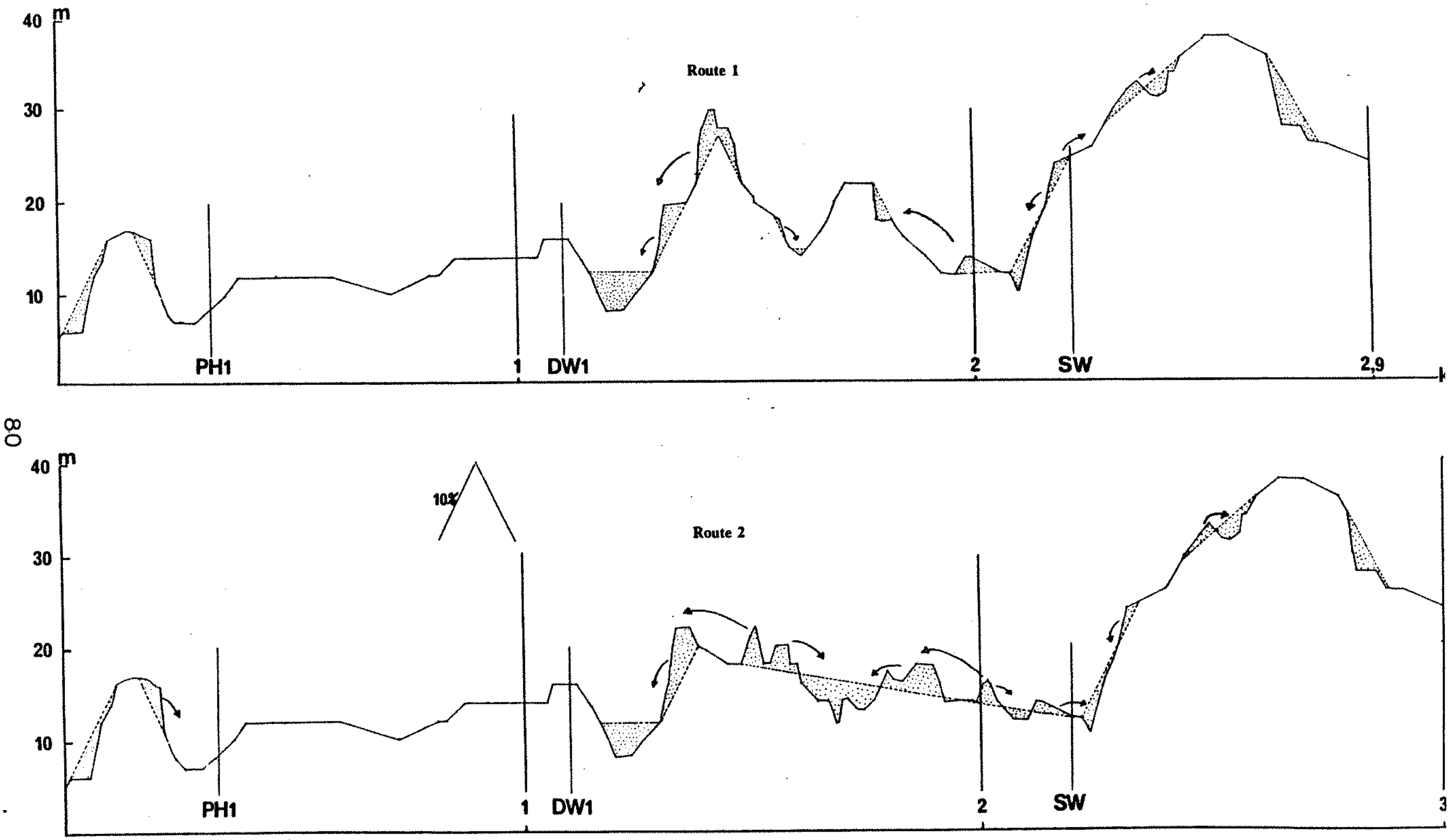


Figure 4.4
Cut and Fill of Potential Routes for the Access Road

considered. This could also lower the total cost for the whole project, although it could mean a higher cost for the airstrip.

Once the level required to balance cut and fill quantities for the whole project is known, drilling and blasting operations would proceed. The blasted rock material obtained would then be divided into natural fill and material to be crushed. The natural fill would be placed where needed, while the rest of the material would be processed by crushers to obtain the different granulometric classes needed to provide transitional stability in the building up of the foundations of the airstrip, village and roads.

Such an integrated process would greatly simplify the whole operation as there would be one single source of fill material instead of the many sources which would be needed if sand and gravel pits were used or in the case of non-integrated projects. It would also cause less damage to the environment.

The space needs and cost have already been discussed in Subsec. 4.6.1.

4.8 TOTAL COSTS PER OPTION FOR BUILDINGS AND INFRASTRUCTURES

The cost of all the buildings and infrastructures discussed in Subsecs. 4.1 to 4.7 are summarized below. Table 4.9 presents the costs of the buildings and infrastructures which remain constant in the three master plan options.[41] All of these costs are broken down into six elements: plans and specifications, construction, supervision, loan, project management and contingencies. The cost of plans and specifications includes architects' fees, engineering fees and the cost of soil studies and surveying. The construction costs include materials, labor, transportation (including packaging and insurance) and the cost of the foundations (gravel pads, piles or concrete slabs). Supervision costs include the cost of giving the architects and engineers the additional mandate of supervising some aspects of the construction. Laboratory fees (soils and concrete) and supervision of the site by an inspector mandated by the promoter are also included under supervision. The other three costs are indirect costs. A short-term loan will have to be contracted to provide funds between the allocation and actual receipt of the funding. The cost of this loan includes the interest, bonds, brokerage fees, notices of tender and printing of tender documents, legal fees, etc. Incidental special costs such as electrical hook-up for buildings, equipment rental, a reserve, etc., are included under contingencies.

Since these costs are mostly based on historical costs for single projects and there should be an economy of scale considering the size of this project, a savings of approximately 10 % is forecast.

41 The cost of the airport facilities, which remains constant in the three options, is however not included in this table since Transport Canada has not supplied a cost breakdown (see Subsec. 4.6.1).

Table 4.9
Cost Summary for Buildings and Infrastructures
(Constant in all Options ($))

Building or Infrastructure	Space needs (m^2)	Plans and Specifications (9,6 %)	Construction (73,50 %)	Supervision (4,15 %)	Loan (8,74 %)	Management (3,5 %)	Contingencies (0,50 %)	Total Costs
48 houses	38 610	561 000	4 289 000	242 000	510 000	204 000	29 000	5 835 000
Warehouse	650	44 000	338 000	19 000	40 000	16 000	3 000	460 000
Office building	1 240	62 000	478 000	27 000	57 000	23 000	3 000	650 000
School and playground	9 200	211 000	1 617 000	91 000	192 000	77 000	12 000	2 200 000
Nursing station	900	70 000	533 000	30 000	63 000	25 000	4 000	725 000
Community centre	851	37 000	283 000	16 000	34 000	13 000	2 000	385 000
Church	858	37 000	283 000	16 000	34 000	13 000	2 000	385 000
Cemetery	4 000	2 000	15 000	1 000	2 000	0	0	20 000
Freezers	525	19 000	147 000	8 000	17 000	7 000	2 000	200 000
Police station	728	12 000	96 000	5 000	11 000	5 000	1 000	130 000
Store	1 250	19 000	147 000	8 000	17 000	7 000	2 000	200 000
Commercial services building	900	58 000	441 000	25 000	52 000	21 000	3 000	600 000
Hotel	1 100	19 000	147 000	8 000	17 000	7 000	2 000	200 000
Drinking water plant & reservoir	38 440	29 000	221 000	12 000	26 000	11 000	1 000	300 000
Wastewater	12 540	67 000	515 000	29 000	61 000	25 000	3 000	700 000
Solid waste	15 200	10 000	74 000	4 000	9 000	3 000	0	100 000
Municipal equipment	0	126 000	967 000	55 000	115 000	46 000	6 000	1 315 000
Municipal garage	1 800	87 000	665 000	38 000	79 000	32 000	4 000	905 000
Powerhouse	13 800	322 000	2 462 000	139 000	293 000	117 000	17 000	3 350 000
Tank farm	4 900	67 000	515 000	29 000	61 000	25 000	3 000	700 000
Telephone	3 425	0	0	0	0	0	0	0
Radio station	1 400	1 000	8 000	0	1 000	0	0	10 000
Wharf & unloading area	7 500	62 000	478 000	27 000	57 000	23 000	3 000	650 000
Fishing boat haul-out	600	5 000	37 000	2 000	4 000	2 000	0	50 000
Drainage works	4 000	10 000	74 000	4 000	9 000	3 000	0	100 000
Dikes	1 500	14 000	110 000	6 000	13 000	5 000	2 000	150 000
Subtotal		1 951 000	14 940 000	841 000	1 774 000	710 000	104 000	20 320 000

Table 4.10 presents these costs along with the costs of the infrastructures which vary according to the options in order to show the cost per option.

Table 4.10
Cost Summary for all Buildings and Infrastructures (Excluding Airport Facilities ($))

Option & Infrastructure	Space Needs (m²)	Plans and Specifications (9,6 %)	Construction (73,50 %)	Supervision (4,15 %)	Loan (8,74 %)	Management (3,5 %)	Contingencies (0,50 %)	Total Costs
<u>Option 1</u>								
Subtotal (Table 4.9)		1 951 000	14 940 000	841 000	1 774 000	710 000	104 000	20 320 000
Power Lines	0	39 000	295 000	17 000	35 000	14 000	1 000	401 000
Foundations	0	237 000	1 811 000	102 000	215 000	86 000	14 000	2 465 000
Roads	80 250	106 000	814 000	46 000	97 000	39 000	6 000	1 108 000
TOTAL COST OPTION 1		2 333 000	17 860 000	1 006 000	2 121 000	849 000	125 000	24 294 000
<u>Option 2</u>								
Subtotal (Table 4.9)		1 951 000	14 940 000	841 000	1 774 000	710 000	104 000	20 320 000
Power Lines	0	39 000	301 000	17 000	36 000	14 000	3 000	410 000
Foundations	0	178 000	1 363 000	77 000	162 000	65 000	10 000	1 855 000
Roads	81 900	108 000	825 000	47 000	98 000	39 000	6 000	1 123 000
TOTAL COST OPTION 2		2 276 000	17 429 000	982 000	2 070 000	828 000	123 000	23 708 000
<u>Option 3</u>								
Subtotal (Table 4.9)		1 951 000	14 940 000	841 000	1 774 000	710 000	104 000	20 320 000
Power Lines	0	39 000	300 000	17 000	36 000	14 000	2 000	408 000
Foundations	0	173 000	1 323 000	75 000	157 000	63 000	9 000	1 800 000
Roads	81 600	106 000	811 000	46 000	96 000	39 000	5 000	1 103 000
TOTAL COST OPTION 3		2 269 000	17 374 000	979 000	2 063 000	826 000	120 000	23 631 000

The cost of the airport facilities excluding the access road, which was included in the cost of the total road network (see Subsec.4.7.3), is 9 000 000 $. This cost added to the cost of each master plan option produces a total cost per option of :

	Option 1 ($)	Option 2 ($)	Option 3 ($)
Subtotal Table 4.10	24 294 000	23 708 000	23 631 000
Airport facilities	9 000 000	9 000 000	9 000 000
TOTAL COST*	**33 294 000**	**32 708 000**	**32 631 000**

* Total costs for the master plan can be found on pp. 102-103.

5. POTENTIALS AND CONSTRAINTS

This chapter presents a summary of the potentials and constraints of the Taqpangajuk site, based on the results of the soil studies and the determination of the space requirements described above. It should be noted that depending on the use that is made of it, the same feature could constitute either a potential or a constraint.

Plan 4.1, at a scale of 1:2000, and Plan 4.2, at a scale of 1:5000, both illustrating the potentials and constraints, were drawn independently from each other using different sets of aerial photographs. Since there is a difference in the scale, there is not the same degree of detail on the two maps. Thus, the 1:2000 scale map covering the immediate area of the village site indicates the rock outcrops, while the 1:5000 scale map covering the whole of the region shows the bedrock to a depth of 2 m.

As can be seen on these maps, there are three potential development areas, which together offer a total available space of 33,8 ha. However, this study is confined to the most southerly site since it alone has an area of 24 ha and can thus accommodate a village large enough for 432 inhabitants if the density is increased, since this is the population forecast for Taqpangajuk in the year 2010.[1]

The Taqpangajuk site offers exceptionally beautiful views on all sides, as a result of its location overlooking Ungava Bay, its hilly terrain and its proximity to the Torngat Mountains.

The potential development area is located at the base of a rocky ridge which could serve as a natural barrier between the village and infrastructures such as the powerhouse, tank farm and municipal garage which could be a nuisance to the residents. The area's elongated shape oriented in a northwest-southeast direction would permit the roads to be aligned with the prevailing winds in order to avoid snow buildup.The rocky ridges which limit the size of the development area also protect it from the northerly and southwesterly winds. The many small rocky hills on the site could be used for producing some of the crushed material needed to fill in the numerous wetlands. Moreover, once these hills are levelled, they would provide a good foundation for infrastructures and buildings.

The wetlands are caused by many streams and creeks draining from lake DW 1 near the development area. This lake is the area's most interesting potential source of drinking water, although it would have to be diked to increase its volume. However, this would have the added benefit of drying up the wetlands.

The sandy beach would provide direct access to the sea for canoes inside the village site. The south cove offers an area protected from the waves of Ungava Bay, which would be an ideal location for unloading the barges used in the sealift and mooring the Aiviq and the canoes. The access road which would have to be built from the site of the village to the airstrip site farther east could also service this unloading area as well as the solid waste disposal site, gravel stockpile and cemetery.

Except for the raised beach north of the development area, there are almost no granular materials available. Crushed rock would thus have to be produced on site. Because of the hilly topography of the Taqpangajuk peninsula and the large area required, the airport must

[1] See Sec. 3.3.

be located east of the isthmus connecting the peninsula to the mainland, at a distance of 2,5 km from the centre of the development area.

It should also be noted that apart from a section of the raised beach, none of the available area is suitable for construction without prior cut and fill work. With the exception of certain rock outcrops, the slopes of the development area range between 1 % and 20 %.

The main potentials and constraints of the Taqpangajuk site are listed below.

5.1 POTENTIALS

- proximity to the sea and the fishing and hunting grounds;

- natural cove for mooring boats, barges and canoes;

- elongated shape of the site in the same direction as the prevailing winds;

- rocky ridges protecting the site from the northerly and southwesterly winds;

- rocky surfaces for supporting certain infrastructures;

- beautiful scenery with good tourist potential;

- proximity of a lake for obtaining drinking water;

- continuous area of 24 ha including one future development area;

- two other development areas providing an additional 9,8 ha;

- rocky ridge for isolating infrastructures or installations which could be bothersome to the residents;

- possibility of building one access road from the village to all services.

5.2 CONSTRAINTS

- site exposed to prevailing northwesterly winds;

- some very hilly terrain with slopes of over 20 %;

- numerous wetlands;

- drinking water source which would require diking;

- extreme lack of granular materials;

- small rocky hill within the development area which could cause snow buildup shown by the winter site survey;

- slopes generally facing northeast limiting sunshine in the houses;

- two future development areas separated from the 24 ha main development area.

6. MASTER PLAN OPTIONS

The different options for the Taqpangajuk master plans proposed in this report and illustrated on Plans 5.1, 5.2 and 5.3 are based on the results of the consultations of the population to be relocated, the community infrastructure and building needs and the study of the potentials and constraints of the site.[1] The town planning standards in effect in the other Northern villages were also taken into consideration.

Since the planning possibilities were limited by the physical features of the site, a certain number of the proposals had no alternative and thus remain constant in the three master plan options.

6.1 GENERAL OBJECTIVES

The following general objectives guided the design of the master plan options:

- provide access to Ungava Bay;

- maximize the use of the seashore;

- preserve the natural features of the site;

- align the roads with the prevailing winds;

- isolate polluting infrastructures from the village;

- locate the school, playground and community centre so that they are isolated from the houses and yet not too far away;

- keep a reasonable distance between the houses;

- locate the buildings in such a way as to maximize sunlight inside the houses;

- locate the residential areas around a central core of community, commercial and administrative uses.

6.2 GENERAL DESIGN

The site of the village is in an elongated shape running in a northwest-southeast direction from Ungava Bay to lake DW 1, and is bordered by a rocky ridge to the west and the lagoon to the northeast.This zone, with a total area of 24 ha, includes the village centre, all of the residential areas and the future development area. In order to minimize the distance between the houses and the village centre and to reduce the length of road needed, the future development area chosen is located close to the central core in all of the options proposed. This choice has been made to avoid creating a suburb. Therefore, in order to accommodate a fixed number of dwelling units within a limited space, certain options present more lots reserved for duplexes.

[1] See Sec.1.2, Chapters 4 and 5.

In order to avoid snow buildup, the road network within the development area is always designed so as to maximize the alignment of the roads with the prevailing winds.

The temporary construction camp is located at the north end of the raised beach bordering the village site. Due to its proximity to the sea and its bearing capacity, this is a good location to support heavy equipment with only minimal preparatory work having to be done. The lower beach facing Ungava bay is an ideal location for mooring and beaching canoes within the village and is thus reserved for this use in all of the options.

The telecommunications antennae are located on the crest of the rocky ridge and are reached by an access trail up the northwest end of the ridge. At the foot of this road is a two-storey building planned for different community and commercial uses, such as the office of Killiniq Fishermen Inc., the sewing shop, etc. On the west side of the ridge are located the telephone substation,the powerhouse, tank farm, garages and warehouses. This zone permits the polluting infrastructures to be completely isolated from the houses and yet in close proximity to the village.

The duplexes are located to the northeast of the development area in all of the options so as not to cut off the sunlight from the other houses. A small rocky hill is left in the centre of the development area and partly separates the future residential area from the area developed in the first phase.

At the south end of the development area is the drinking water reservoir and to the west of the reservoir is the wastewater treatment plant. This plant is located at least 150 m from the nearest house.

The airstrip is located 2,5 km east of the village centre. The road leading to it also provides access to the cemetery, solid waste disposal site, sand and gravel stockpile and the fishing boat haul-out facility.

6.3 OPTION 1

In this option, the grouping together of residential uses is sacrificed to permit a greater centralization of administrative, community and commercial uses. In the first implementation phase, the 4,1 hectare space planned for residential use is located at the far end of the development area. The village centre surrounds the school and the playground so as to separate them from the neighboring residential areas.

The church is located a bit farther to the east in the village centre. The community centre, hotel and Hydro-Québec transit house are on the south edge of the central core.

The area reserved for future residential development surrounds the southeast residential core located on the airstrip access road. The northeast part of the raised beach is also reserved for future residential development.

The wharf and the unloading area are located between the powerhouse and the tank farm on the west side of the rocky ridge facing Ungava Bay.

The road from the village to the airstrip detours slightly to give access to the south cove where the canoes can be moored in bad weather.

This option provides a total of 57 lots for single-family dwellings, 22 lots for two-family dwellings, 4,3 km of main roads and 2,4 km of secondary roads.

6.4 OPTION 2

Option 2 is characterized by a greater concentration of houses in the first implementation phase and by the preservation of the raised beach in its natural state. The road network maximizes the alignment of the roads with the prevailing winds. One main road crosses the whole development area in a straight line. The secondary roads are parallel to it, and most of the side roads intersect on a 35° to 60° angle, which permits the houses to be separated so as not to obstruct each other's view.

The village centre is more spread out than in Option 1 but is more centrally located in relation to the development area as a whole. The school and playground are at the foot of the rocky ridge on slightly sloping ground which will require some levelling work. The office building, with the attached fire hall, is in the same location as in Option 1, on rocky ground at the edge of the lake in the centre of the village. The police station and the church are adjacent to it. The nursing station is across the road from the police station. The retail store and the freezers are located on the main road at the edge of the central core in the direction of the wharf and airstrip. The community centre is always somewhat isolated; in this option it is on the road to the powerhouse.

The wharf and the unloading area are located on the south cove, midway between the village and the airstrip, in order to protect the port activities from the strong winds and waves on Ungava Bay.

Option 2 provides a total of 50 lots for single-family dwellings, 25 lots for two-family dwellings, 4,2 km of main roads and 2,3 km of secondary roads.

6.5 OPTION 3

Option 3 is characterized by a separation of certain uses from the village centre and by a greater respect for the local topography. The future development area is designed so as to avoid any construction in a zone which is subject to flooding and which otherwise would require major fill work. This design also gives a greater unity to the road network. The secondary roads intersect with the main road and each other at right angles.

The school and the playground are isolated at the northeast part of the raised beach as was suggested during the first consultation. This provides much more space for residential uses. It should be noted that this does not at all change the location of the temporary camp planned for the same spot. The temporary camp only needs to be there during the first few months of the first implementation phase and it will then be moved farther away.

The community, commercial and administrative uses are more concentrated in the village centre than in the other two options. The office building, fire hall, nursing station and police station are in a row along the east side of the main road, while the retail store, freezers, community centre and church are on the west side.

The airstrip access road is shorter and straighter than in the other two options. Although the road does not pass as close to the south cove where the fishing boat haul-out facility and wharf are located, the unloading area has a better quality foundation than in Option 2. It is also located closer to the village.

The solid waste disposal site is located farther from the gravel stockpile than in the other two options.

Option 3 provides a total of 73 lots for single-family dwellings, 14 lots for two-family dwellings, 4,4 km of main roads and 2,2 km of secondary roads.

Table 6.1
Comparative Table of Space Allocation (m^2) per Option

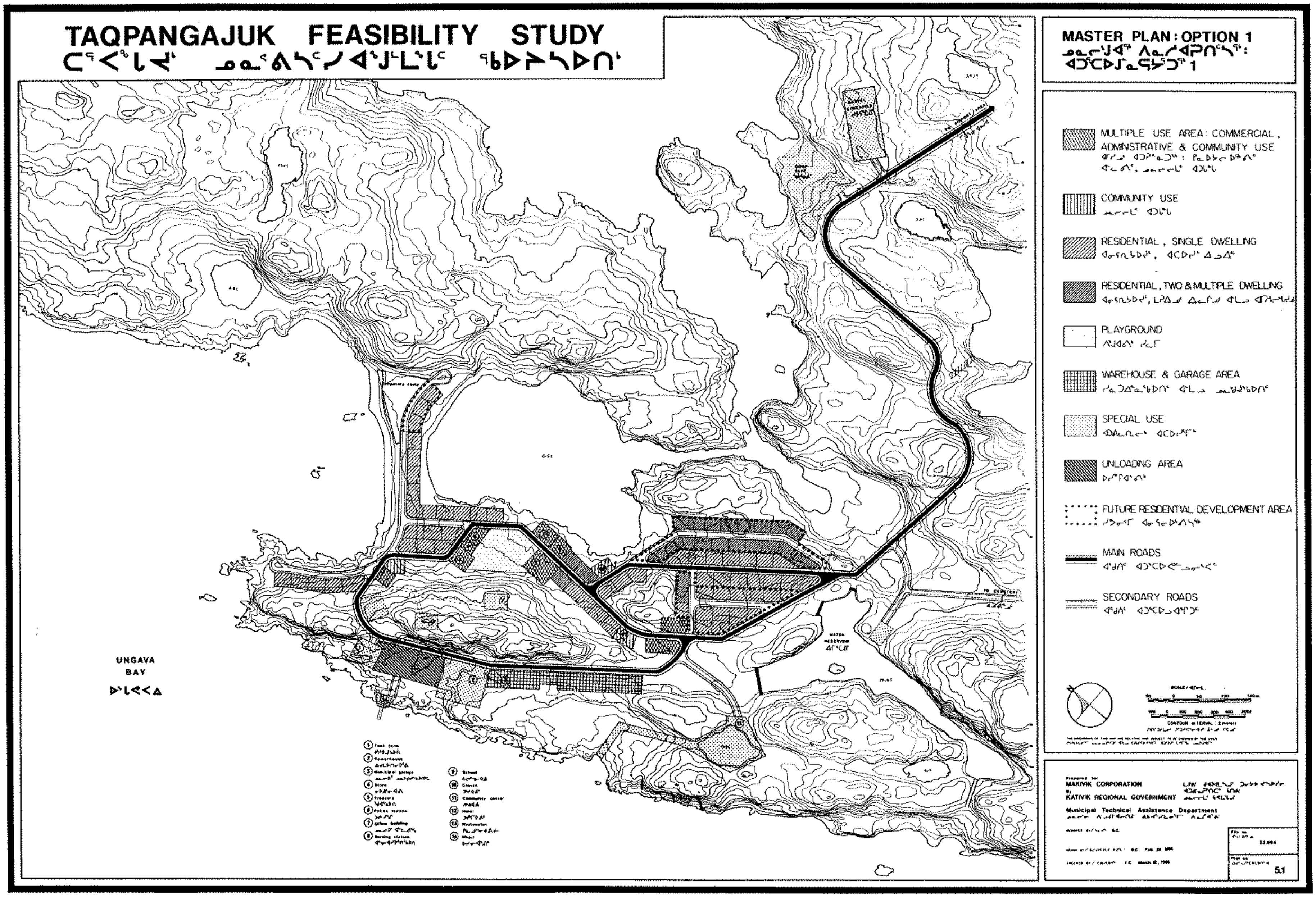
Uses	Option 1	Option 2	Option 3
Single-family dwellings	48 906	42 900	62 634
Two-family dwellings	18 876	21 450	12 012
Multiple use	11 555	11 555	11 555
Community use	2 960	2 960	2 960
Playground	8 363	8 288	7 039
Special use	76 085	76 085	76 085
Warehouse and garage area	10 980	10 980	10 980
Unloading area	7 500	7 500	7 500
Road network	96 250	94 300	94 600
Subtotal	281 475	276018	285 365
Airport area	597 000	597 000	597 000
Total area (ha)	87,85	87,30	88,24

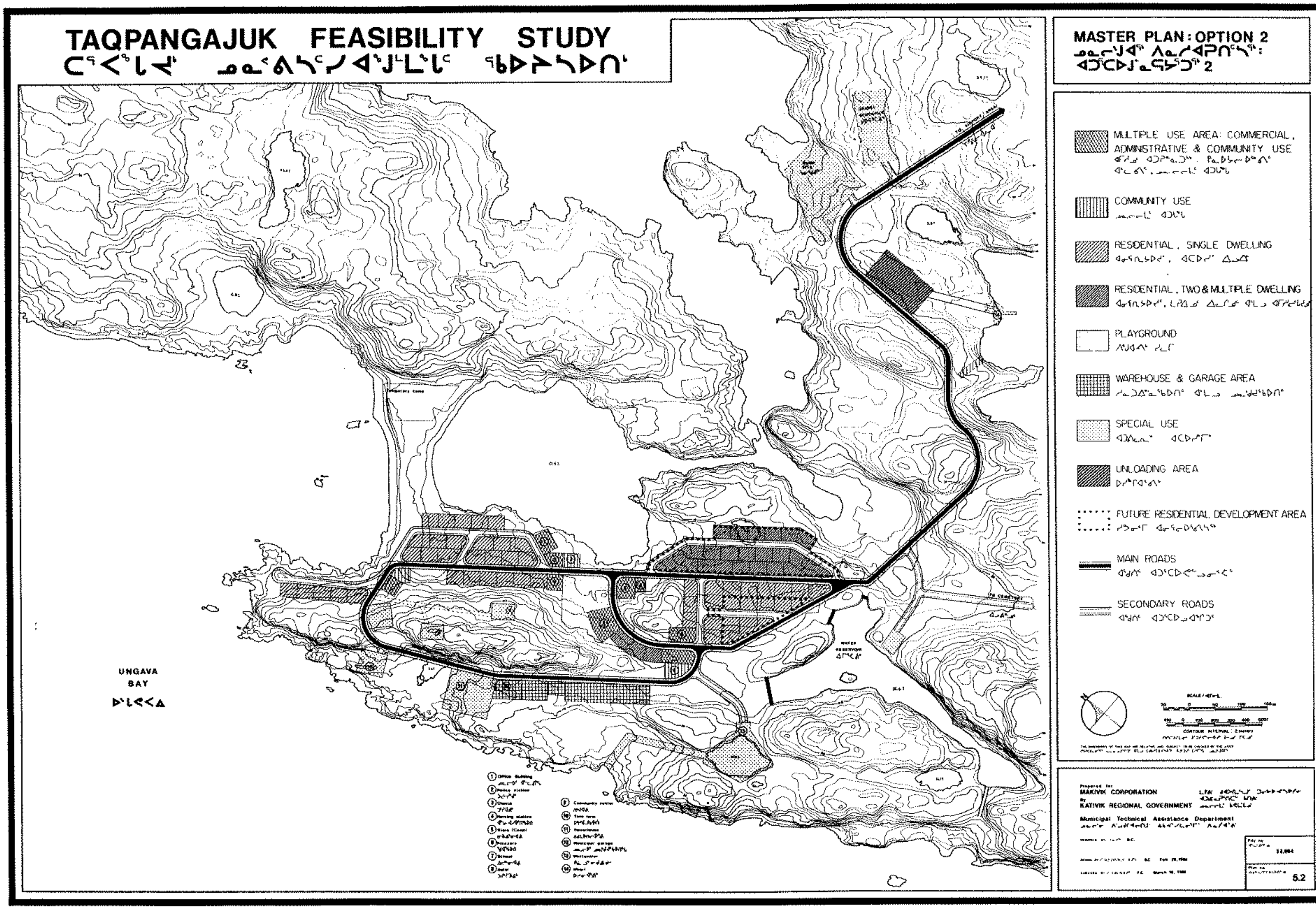
6.6. RESULTS OF THE CONSULTATION CONCERNING THE THREE MASTER PLAN OPTIONS

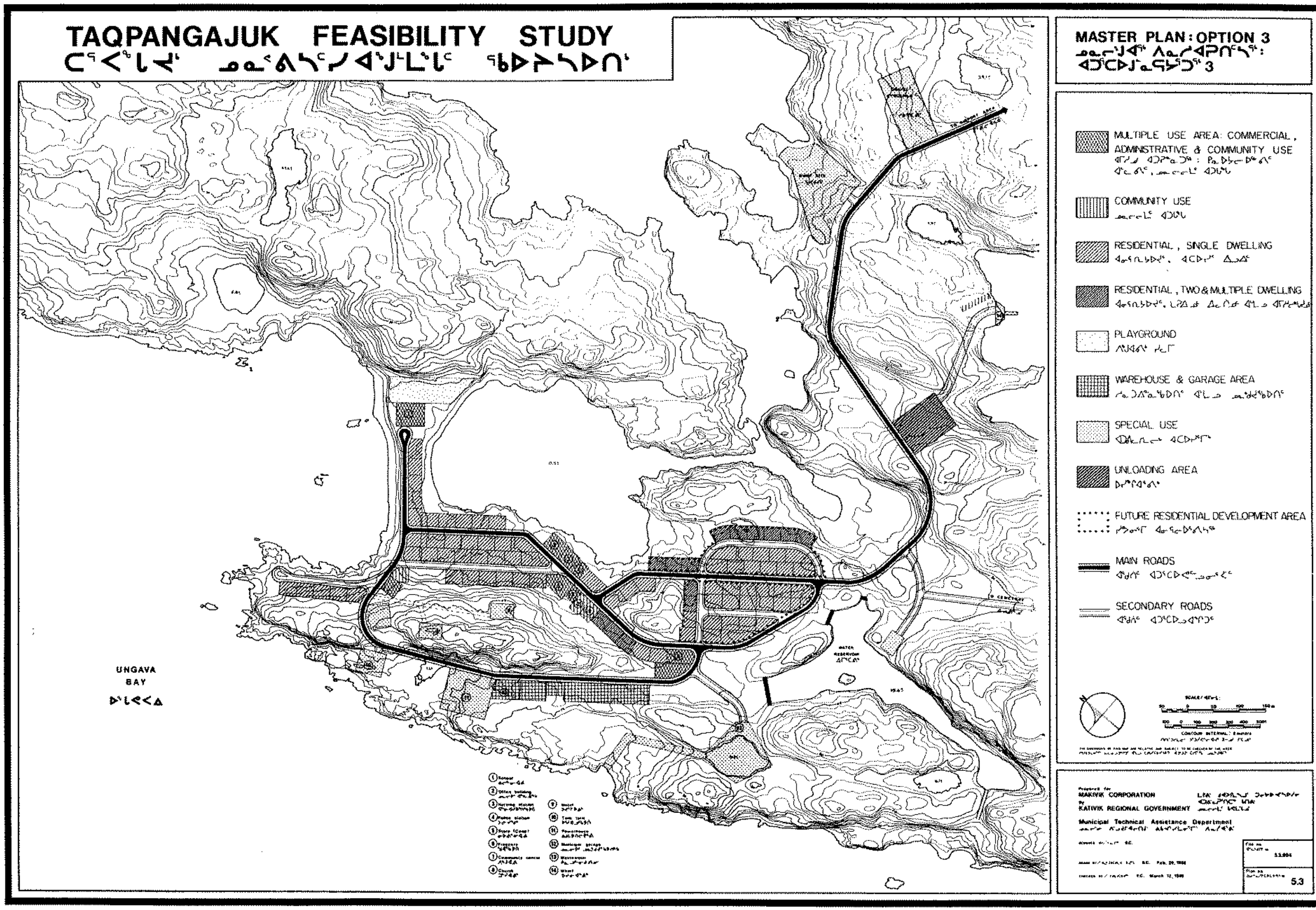
In order to design the master plan for Taqpangajuk, a consultation of the Killiniqmiut concerning the three master plan options was conducted from February 4 to February 18, 1986, in the villages of Kangiqsualujjuaq, Quaqtaq, Kangiqsujuaq, Tasiujaq and Kuujjuaq.

Every family was visited; this included 35 persons and 100 % of the heads of family. Thus all of the families had the opportunity to obtain the information on the three master plan options and had enough time to give their personal feedback. Following this, a public meeting was held in each of the villages with the Killiniqmiut living there in order to complete the community input. Only two families (9 people) did not attend these meetings, for a participation rate of 74 %.

The three master plan options proposed to the population are shown on the following pages (Plans 5.1, 5.2, 5.3). It was clearly explained that the purpose of the consultation was not merely to choose the best proposals from the three master plan options, but that the options were to be used for reference purposes in the people's discussions. Other alternatives or proposals were thus welcome. However, since the master plan options had been designed based on the results of the first meetings, the majority of the choices made by the people were from among the different options presented.


TAQPANGAJUK FEASIBILITY STUDY
MASTER PLAN: OPTION 1
MULTIPLE USE AREA: COMMERCIAL, ADMINISTRATIVE & COMMUNITY USE
COMMUNITY USE
RESIDENTIAL, SINGLE DWELLING
RESIDENTIAL, TWO & MULTIPLE DWELLING
PLAYGROUND
WAREHOUSE & GARAGE AREA
SPECIAL USE
UNLOADING AREA
FUTURE RESIDENTIAL DEVELOPMENT AREA
MAIN ROADS
SECONDARY ROADS
CONTOUR INTERVAL: 2 meters
UNGAVA BAY
WATER RESERVOIR
TO CEMETERY
1 Tank farm
2 Powerhouse
3 Municipal garage
4 Store
5 Freezers
6 Police station
7 Office building
8 Nursing station
9 School
10 Church
11 Community center
12 Hotel
13 Wastewater
14 Wharf
Prepared for
MAKIVIK CORPORATION
By
KATIVIK REGIONAL GOVERNMENT
Municipal Technical Assistance Department
File no. 33.004
Map no. 5.1


TAQPANGAJUK FEASIBILITY STUDY
MASTER PLAN: OPTION 2
MULTIPLE USE AREA: COMMERCIAL, ADMINISTRATIVE & COMMUNITY USE
COMMUNITY USE
RESIDENTIAL, SINGLE DWELLING
RESIDENTIAL, TWO & MULTIPLE DWELLING
PLAYGROUND
WAREHOUSE & GARAGE AREA
SPECIAL USE
UNLOADING AREA
FUTURE RESIDENTIAL DEVELOPMENT AREA
MAIN ROADS
SECONDARY ROADS
UNGAVA BAY
WATER RESERVOIR
1 Office Building
2 Police station
3 Church
7 School
8 Hotel
Prepared for: MAKIVIK CORPORATION
By KATIVIK REGIONAL GOVERNMENT
Municipal Technical Assistance Department
5.2


TAQPANGAJUK FEASIBILITY STUDY
MASTER PLAN: OPTION 3
MULTIPLE USE AREA: COMMERCIAL, ADMINISTRATIVE & COMMUNITY USE
COMMUNITY USE
RESIDENTIAL, SINGLE DWELLING
RESIDENTIAL, TWO & MULTIPLE DWELLING
PLAYGROUND
WAREHOUSE & GARAGE AREA
SPECIAL USE
UNLOADING AREA
FUTURE RESIDENTIAL DEVELOPMENT AREA
MAIN ROADS
SECONDARY ROADS
UNGAVA BAY
WATER RESERVOIR
CONTOUR INTERVAL: 5 meters
Prepared for
MAKIVIK CORPORATION
by
KATIVIK REGIONAL GOVERNMENT
Municipal Technical Assistance Department
5.3

Except for three components of the master plan, the people were able to reach a consensus. In the consultation process, any proposals put forth by the people during the meeting in one village were included in the subsequent meetings in the other villages.

Table 6.2 presents the results of the consultation.

Table 6.2
Results of the Consultation Concerning the Three Master Plan Options

Village components	Options 1	2	3	Any of the options	Other proposals
School		26 (100 %)			
Playground		26 (100 %)			
Roads (Phase1)		26 (100 %)			
Roads (Phase2)			25 (96 %)	1 (4 %)	
Road to airstrip			26 (100 %)		
Office building		9 (35 %)		17 (65 %)	
Nursing station		26 (100 %)			
Police station		26 (100 %)			
Store		25 (96 %)		1 (4 %)	
Freezers		25 (96 %)		1 (4 %)	
Church		12 (46 %)			14 (54 %)[1]
Community Centre					26 (100 %)[2]
Single-family dwelling (Phase1)		21 (81 %)		5 (19 %)	
Single-family dwelling (Phase2)			21 (81 %)	5 (19 %)	
Duplexes			21 (81 %)	5 (19 %)	
Hotel		22 (85 %)	4 (15 %)		
Antennae				26 (100 %)	
Tank farm				26 (100 %)	
Powerhouse				26 (100 %)	
Municipal garage					26 (100 %)[3]
Wharf			26 (100 %)		
Unloading area			26 (100 %)		
Solid waste			13 (50 %)	13 (50 %)	
Gravel stockpile			13 (50 %)	13 (50 %)	
Boat haul-out		26 (100 %)			
Cemetery					26 (100 %)[4]
Wastewater				24 (92 %)	2 (8 %)[5]
Water reservoir				26 (100 %)	
Airstrip				26 (100 %)	

[1] The church should be located on the main road that crosses the village, at the edge of the village centre, beside the future residential area. This would permit relative isolation from the community centre and the major public buildings.

[2] In Kangiqsualujjuaq, 12 persons indicated that they would like to have the community centre located at the northeast end of the beach. The remaining 14 persons consulted in the other communities pointed out that this location would be too far from the village and that the costs associated with it (for a powerline, road and municipal services) would be too high for only one building. An alternative site was proposed across from the school and playground area, on the site occupied by the church in Option 2.

[3] The municipal garage should be a bit farther from the powerhouse in case of fire.

[4] The cemetery should be at the north end of the peninsula without any road leading to it.

[5] Two heads of family felt that the wastewater treatment plant was too close to the village. They would prefer another site. The majority of the people expressed the same concerns but nevertheless agreed with the site since it would be too expensive to have another one located farther away.

The following comments were also made by the Killiniqmiut during the consultation:

- the wastewater plant should be surrounded by a fence to ensure the children's safety;
- the community centre should not be too close to the church and residences;
- the hotel should not be too close to the residences;
- the duplexes for non-Natives should not be grouped together so as to avoid creating a segregated neighborhood (12 people);
- everyone agreed that the small rocky hill in the middle of the village should be removed by blasting to avoid snow accumulation in the area and to allow continuity in the development of the village.

As shown on Table 6.2, Options 2 and 3 were the most favored by the people consulted. When the people said "any of the options", it was because the components had the same location in each of the options and they agreed with the location.

Based on this consultation, a new master plan was designed taking into account the proposals which the people favored in Options 2 and 3 and the new proposals they had put forth during the meetings.

6.7 MASTER PLAN

The master plan illustrated on Plan No. 6 is based on the results of the consultation of the population to be relocated concerning the three master plan options (Plans 5.1, 5.2, 5.3), the observations made during the winter site visit, the community infrastructure and building needs[2] and the study of the potentials and constraints of the site[3]. The town planning standards in effect in the other Northern villages were also taken into consideration.

At a meeting of the heads of family held on April 23, 1986, a vote was held concerning the master plan (as shown on Plan No. 6) and it was unanimously approved by 37 persons.

Objectives

The following objectives guided the design of the master plan:

- provide access to Ungava Bay;
- maximize the use of the seashore;
- preserve the natural features of the site;
- align the roads with the prevailing winds;
- isolate polluting infrastructures from the village;
- locate the school, playground and community centre so that they are isolated from the houses and yet not too far away;
- keep a reasonable distance between the houses;
- locate the buildings in such a way as to maximize sunlight inside the houses;
- locate the residential areas around a central core of community, commercial and administrative uses;
- avoid snow accumulation;
- maximize the land use inside the development area;
- carry out all major earthwork during the first phase of development so as to avoid this kind of activity when the people are living in the village.

Road network

In order to avoid snow accumulation, the road network within the village is designed so as to maximize the alignment of the roads with the prevailing winds.

The roads within the village will have a right of way 15 m wide with a roadway 7 m wide. The excess right of way will permit the parking of vehicles, piling up of snow, digging of ditches if necessary and installation of the poles for the power lines and telephone lines. The access road serving the tank farm, powerhouse, municipal garage and housing warehouse has been moved to the southwest to avoid the snow accumulation area identified during the winter site visit.

The road network shown in the master plan ensures direct access to each building and has a total length of 6 km. The roads built during the first construction phase will account for

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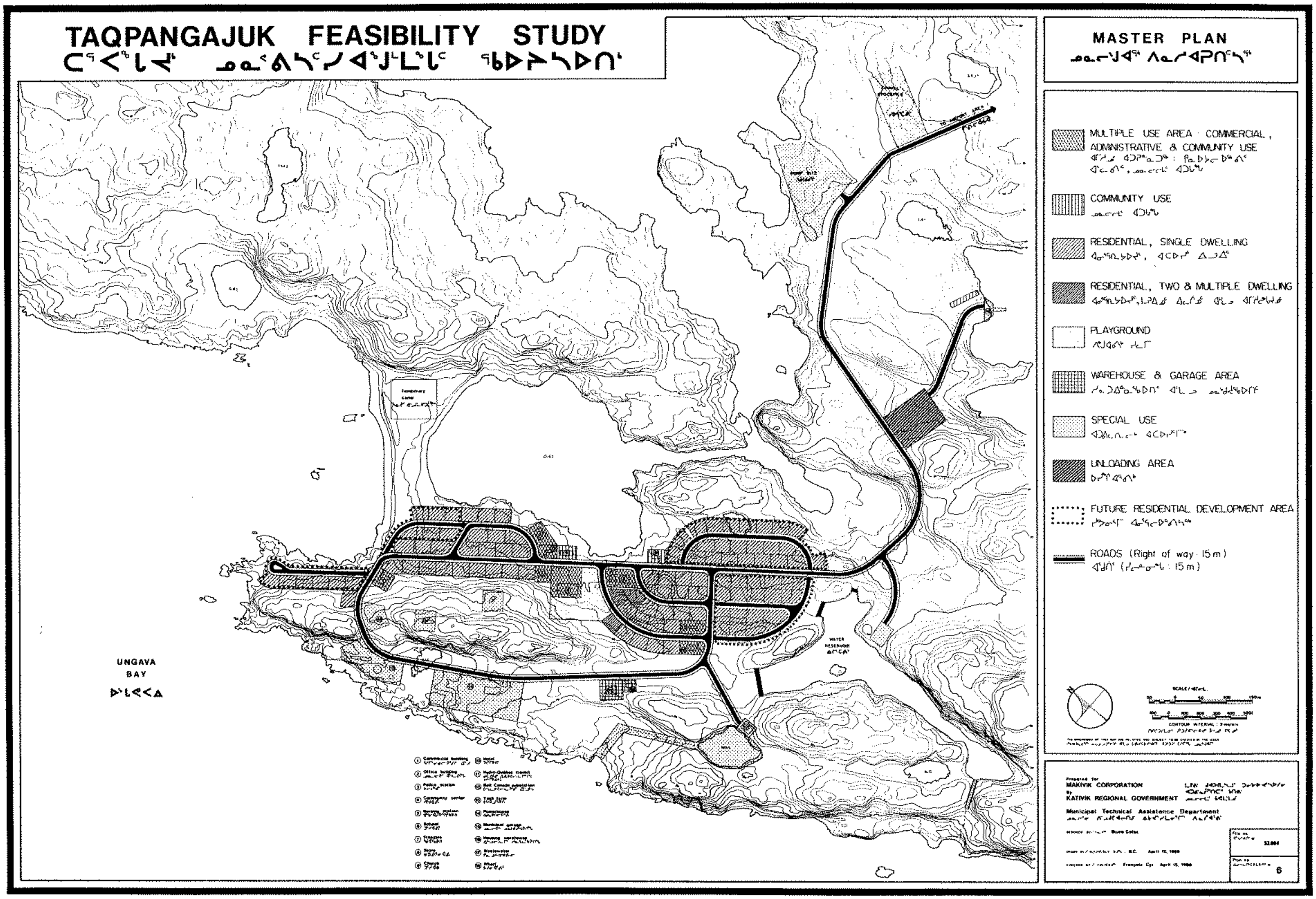
[2] See March 1986 Taqpangajuk Feasibility Study report, Chapter 4.

[3] See March 1986 Taqpangajuk Feasibility Study report, Chapter 5.


TAQPANGAJUK FEASIBILITY STUDY
MASTER PLAN
MULTIPLE USE AREA : COMMERCIAL, ADMINISTRATIVE & COMMUNITY USE
COMMUNITY USE
RESIDENTIAL, SINGLE DWELLING
RESIDENTIAL, TWO & MULTIPLE DWELLING
PLAYGROUND
WAREHOUSE & GARAGE AREA
SPECIAL USE
UNLOADING AREA
FUTURE RESIDENTIAL DEVELOPMENT AREA
ROADS (Right of way : 15 m)
UNGAVA BAY
WATER RESERVOIR
Prepared for
MAKIVIK CORPORATION
By
KATIVIK REGIONAL GOVERNMENT
Municipal Technical Assistance Department
File no.
Plan no.
6

4,9 km of the total length. The ground area covered by the road network is 73 500 m^2 for Phase 1 and 16 500 m^2 for Phase 2, for a total area of 90 000 m^2.

Land use

Village centre (Multiple use area, playground and community use)

The village centre groups together a variety of community-interest activities. It is located in the central core of the village and the main road passes through it.

The school (6)[4] and the playground are located in the middle of the village at the foot of the west ridge. The site of the school consists of rock foundation. The community centre is located across from the school and is surrounded by a number of public buildings which isolate it from the residential areas.

The police station is at the north side of the community centre. The nursing station is located across from the police station, close to the school. This location will allow a quick response if children are hurt while playing in the playground or the gymnasium and is also central to the residential areas. The office building, with the attached fire hall, is on rocky ground at the edge of the lake.This location allows a quick response to fire emergency calls and the proximity of the lake will enable the firefighters to use it as a source of water to fill the firetruck in summer.

The freezers and the store are located on the main road east of the playground, from which they are separated by another road. A pedestrian path crosses behind these buildings in order to accommodate the circulation of children between the residential areas and the school and playground area. As proposed during the consultation, the church is located at the southeast edge of the village centre in order to keep it relatively isolated from the other activities.

This concentration of services in several buildings minimizes the distances to be travelled by the residents and thus creates a lively village centre.

Residential areas (Phase 1)

Two residential areas are located adjacent to the village centre to the northwest and to the southeast. This type of planning minimizes the distance between the residential areas and community-interest activities. The majority of the houses are single-family dwellings. The duplexes are located north of the single-family dwellings in the southeast sector to allow maximum exposure to sunlight for all of the houses. The houses planned for the non-Native residents are located in the same areas as Native housing to avoid any kind of spatial segregation. The houses are interspaced so that each row of houses does not block the view of the row of houses immediately behind it. This arrangement also discourages vehicles from passing between the buildings, especially in the southeast sector where there are curved roads beside the playground area. Finally, it should be noted that the residential areas are designed to follow the projected contour lines (see Fig. 6.1).

There are two multiple use areas located outside the village centre. One is at the far end of the northwest residential area and contains the commercial services building (1).

[4] The number in parentheses is the number identifying the component on Plan No. 6.

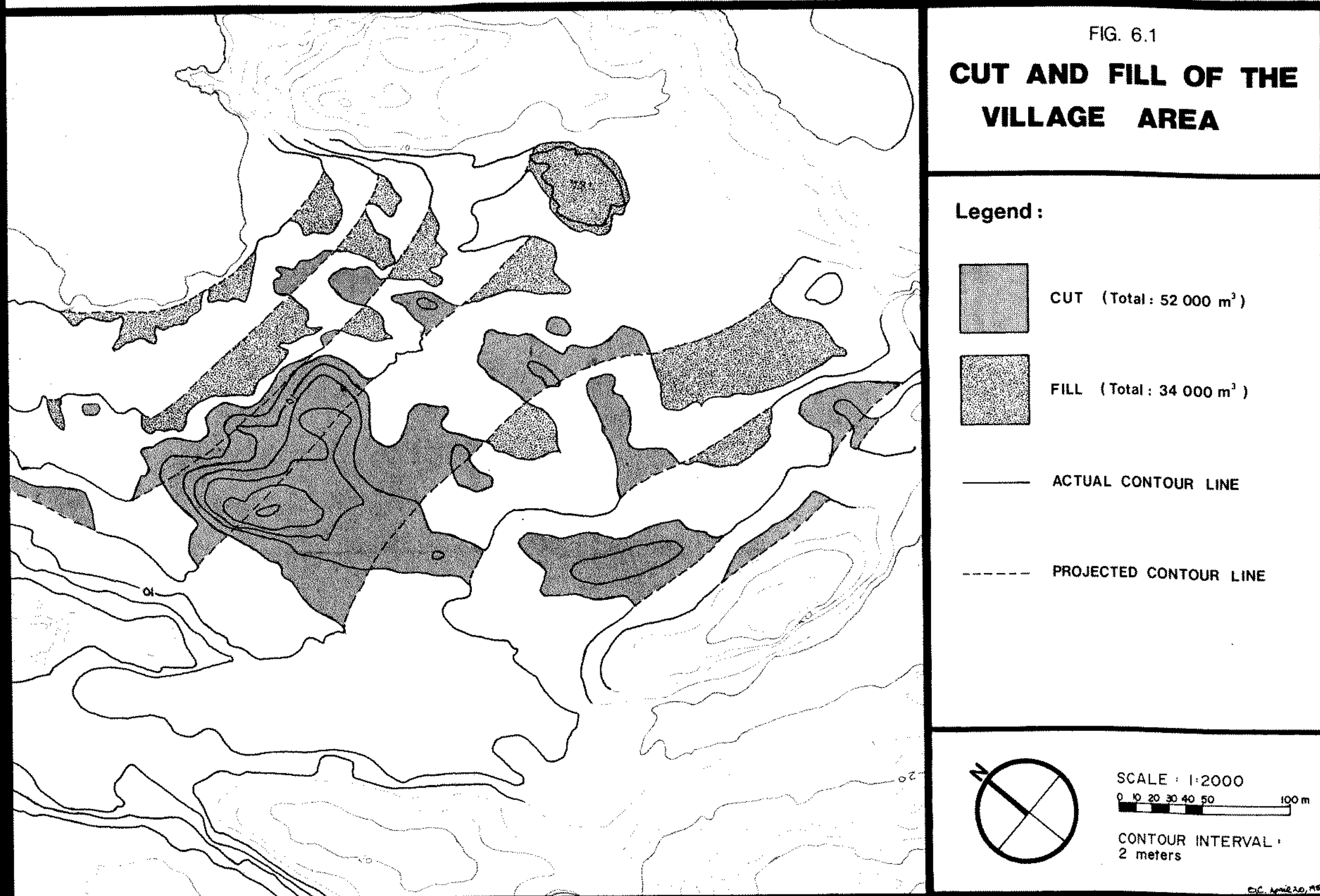


FIG. 6.1

CUT AND FILL OF THE VILLAGE AREA

This two-storey building, which will house the sewing shop and research and office space for Killiniq Fishermen Inc., is located facing Ungava Bay as requested by the promoter. This location will maximize the sunlight received by the neighboring houses. The building is on the south side of the road so that it will not cause snow to accumulate on the road.

The other multiple use area is at the far end of the southeast residential area and includes the hotel (10) and the Hydro-Québec transit house (11). This location allows the transit house to be close to the powerhouse, and provides a good view from the hotel for the tourists.

Special use area

The satellite antenna for television and Telesat Canada's satellite earth station for the telephone service are located on the crest of the rocky ridge bordering the areas described above. This location was chosen since there are no adjacent buildings to block reception and it is far from where the children would play. The telephone substation (12) is located at the northwest end of the rocky ridge on the road leading from the village to the powerhouse. On the west side of the ridge are located the tank farm (13) and, 60 m to the south, the powerhouse (14). This special use area permits the polluting infrastructures to be completely isolated from the residential areas and the village centre and yet to be in close proximity to the village. The foundations are rock, which is necessary for these types of infrastructures.

Warehouse and garage area

The municipal garage (15) and the housing warehouse (16) are located 210 m east of the powerhouse. They are isolated from the village so that the traffic they generate will not constitute a safety hazard for the children.

Wastewater

The wastewater treatment plant (17) is reached by a road leading south from the road to the warehouse and garage area. It is located 150 m from the nearest building. The site includes the natural pond and sloping ground that will be used as a discharge for the wastewater after its treatment in the rotating biological contactor.

Water reservoir

From the main road, a road to the southwest leads to the drinking water truck filling station 570 m from the village centre. This filling station is part of a building which also includes the pumping station and disinfection station. Next to it is the water reservoir which will be fenced off to avoid any contamination.

Unloading area and wharf

The unloading area is located on the road to the airport. The wharf (18) is located in the south cove because of the protection it offers from the winds. In the same cove, 20 m farther north, is the fishing boat haul-out facility which will be used to remove the boat belonging to Killiniq Fishermen Inc. from the water during the winter. A road joins the wharf to the unloading area.

Solid waste disposal site

The solid waste disposal site is located on the north shore of the isthmus joining the Taqpangajuk peninsula to the mainland. South of the disposal site is the road leading to the airport. This site will be far enough from the village and far enough east to protect the population from odors and smoke, and it will not be visible from the village.

Gravel stockpile

The gravel stockpile is located 130 m east of the disposal site. This site was chosen because of its proximity to the airport where most of the crushed materials will be produced.

Future residential development areas

The two future residential development areas are located at the far ends of the northwest and southeast residential areas developed during Phase 1. The area past the northwest residential development area, just before the raised beach, was set aside as a future development area because of the presence of archaeological sites. Residential development is thus delayed until 1991 in this area to allow the archaeologist enough time for the discovery and removal of artifacts.

Future development should proceed by opening one street at a time, working outward from the village centre.

Table 6.3 presents a summary of the areas allotted to each type of use.

Table 6.3
Space Allocation for the Master Plan

Uses	Area (m^2)
Single-family dwellings	80 652
Two-family dwellings	2 574
Multiple use	12 680
Community use	2 310
Playground	7 280
Special use	83 755
Warehouse and garage area	2 450
Unloading area	7 500
Road network	90 000
Subtotal	289 201
Airport area	597 000
Total area (ha)	88,62

Summary of cut and fill

As seen in Section 4.71, the volume of fill needed varied from 70 000 m^3 to 100 000 m^3 depending on the option. These volumes were based on the average levels of platforms varying from 4 m (raised beach) to 10 m (near lake DW 1).

Cut and fill operations were deemed necessary to provide level development areas and minimize the excavation of rock at the site. However, during the last consultation, it became evident that the future residents were in favor of rock excavation to provide more space. This introduced two new phenomena to the analysis. Instead of a lack of fill materials at the site, it was possible to have a surplus of fill. Furthermore, instead of building platforms or terraces, it was possible to build on slightly sloping ground providing better drainage and a better view of the lagoon from every house.

This program was adopted and by blasting the small rocky hill in the middle of the village, the following quantities of cut and fill are obtained:

Volume of excavated materials		
	Class 1 rock	66 000 m^3
	Class 2 granular	2 000 m^3
	common	3 000 m^3
Volume of fill		
	Granular (A or B)	2 000 m^3
	Crushed rock	32 000 m^3

The total quantity of excavated materials is thus 71 000 m^3. From this, 19 000 m^3 of solid rock or 25 000 m^2 of crushed rock must be reserved to build the pads of 48 houses. This leaves a balance of 52 000 m^3 of cut and 34 000 m^3 of fill (see Fig. 6.1). If 32 000 m^3 of crushed rock is used for fill, this leaves a balance of 22 000 m^3 of rock to build roads, etc.

Cost summary

In Table 4.9, a total cost was determined for all of the components which remained constant in the three options. This total cost is 20 320 000 $. Since then, the cost for a cemetery has been dropped since the road, which accounted for the total cost of the cemetery, is no longer needed. This represents a saving of 20 000 $. However, as mentioned previously, no cost was allowed for a television station. Thus if 20 000 $ is included for a television station, the total cost of the buildings and infrastructures which remain constant in all options is still 20 320 000 $.

Based on the choices made in the master plan, costs have been determined for the infrastructures whose cost varied according to the option (see Table 4.10):

Subtotal (Table 4.8)	20 320 000 $
Powerlines	368 000 $
Foundations	1 014 000 $
Roads	1 026 000 $
Total cost	22 728 000 $

If 9 000 000 $ is added to this amount to cover the cost of building the airport, a total cost of 31 728 000 $ is obtained. Finally, if 730 000 $ is added to cover special costs, the total cost of the project is 32 458 000 $. This cost compares favorably with the figures produced for the preliminary planning scenarios, Table 4.10.

7. CONSTRUCTION SCHEDULE AND COSTS

7.1 CONSTRUCTION SCHEDULE

The construction schedule, presented in Fig. 7.1, shows the work in the order that it must be done to construct the village at the Taqpangajuk site. It is possible to refer to it to see what work will be carried out each year.

It is a realistic yet optimistic schedule in that there is no extra time allowed so that there can be no delays in the completion of each phase. The schedule is also based on the presumption that all necessary approvals will be received on time to permit the realization of the work in question. However, the schedule allows sufficient time to obtain these approvals.

7.2 COSTS SCHEDULING

For the purposes of this schedule, the most expensive option (Option 1) is not included and an average of the other two options is used.The total costs appear on the construction schedule in budget form. The schedule shows the cost of the work to be carried out each year in 1985 dollars. The cost adjusted for the actual year of construction assuming an annual inflation rate of 4 % is indicated below this figure in parentheses.

The construction costs for each year were calculated by first determining the construction costs for each element. These were obtained by subtracting the costs of the preliminary studies and engineering and architectural work from the total cost of the element. The remaining cost was then attributed to the year in which the element will be realized. The construction costs of all of the elements in a particular year were then added together to give the total construction cost for that year. The costs of the preliminary studies, engineering and architectural work were attributed to 1986, the year in which they will be carried out.

7.3 SPECIAL COSTS

7.3.1 Construction camp

Most of the costs related to the construction work, for the temporary camp, temporary airstrip, fuel, etc., have not been estimated separately since the costs used for each element are the real construction costs. The cost of building the airport includes the costs of setting up a camp and providing all of the services needed to feed and house approximately fifty workers for one year. The camp will be built on the beach at the beginning of construction in 1987 and will require a space of approximately 6 000 m^2. No other structure will be needed during the 4-year construction period. However, an additional amount of 500 000 $ has been allowed to cover contingencies such as temporary drinking water supply, temporary wastewater disposal, etc. In case a temporary telephone system is needed during the construction phase before the families are installed in 1988, an additional cost of 300 000 $ should be foreseen, based on an 8-month period of use. This cost is not included in any of the calculations since there is some possibility that a radio communications system would be adequate for this purpose.

7.3.2 Moving

The cost of moving the families' personal effects to Taqpangajuk by boat is estimated at 200 000 $. This figure is based on the costs of providing 1 container for each of the 23 families that were counted in the 1985 survey and insuring each container for 20 000 $. This amount was then increased by 25 % since the sealift rates at that time and the exact quantity of personal goods to be moved are not known.

The move will take place in September 1988. Although the houses will not be completely finished by then, this was considered to be an appropriate time since it would allow the community to be reunited sooner and would also avoid having the people decide to move to the village on their own with no coordination. Most of the heavy construction work should be finished by then and any remaining work should not pose safety problems for the residents, especially the children.

7.4 TOTAL COST OF PROJECT PER OPTION

Thus, if the costs of the construction camp (500 000 $) and moving (200 000 $), as well as the cost of an archeological study (30 000 $),[1] and of the impact assessment study (56 000$) are added to the total cost for the buildings and infrastructures, the total cost of the project per option is:

	Option 1 ($)	Option 2 ($)	Option 3 ($)
Total cost for buildings and infrastructures:	33 294 000	32 708 000	32 631 000
Special costs:	786 000	786 000	786 000
Total cost of project	**34 080 000**	**33 194 000**	**33 417 000**

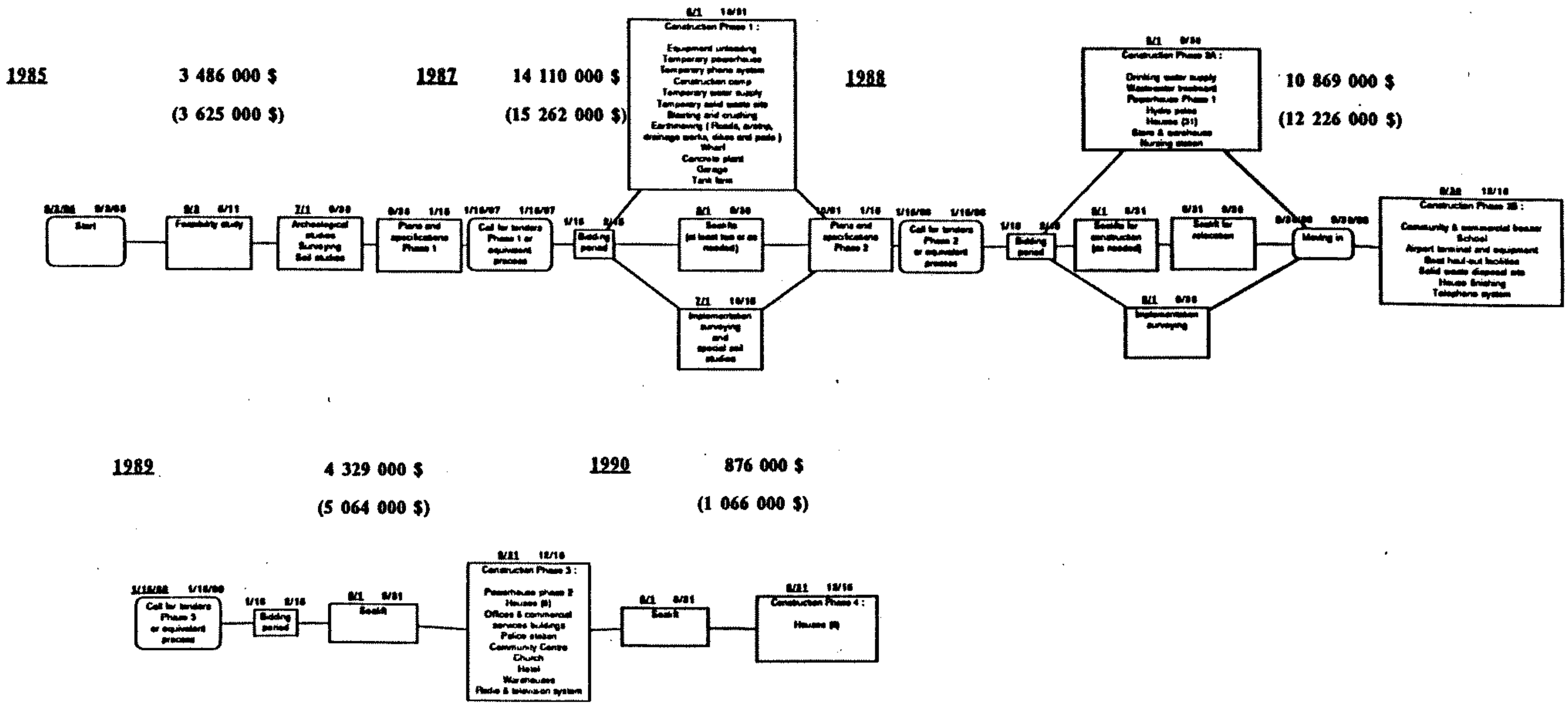
[1] This preliminary study cost is not normally included in building or infrastructure costs.

Figure 7.1

Taqpangajuk Construction Schedule

March 1984

N.B. : Inflation rate is estimated to be 4 %/year



7.5. RECOMMENDATIONS

It is strongly recommended that the following measures be taken in order to respect the proposed construction schedule and to fully exploit the potential of the site.

1. A complete topographic survey of all development areas should be done in the summer of 1986 in order to obtain more precise topographic data and implement a reference system for future needs.

2. Soil studies including geological mapping, pedology, soil analyses and depth of overburden over rock should be done in the summer of 1986.

3. Archaeological studies should be done in the summer of 1986 in order to obtain data on the site before any artifacts are removed.

4. A bathymetric study of the waters surrounding the peninsula should be done in the summer of 1986 in order to determine the best potential site for a wharf.

5. An ice study should be done as soon as possible to give further insight into the best location for the wharf and to permit the evaluation of year-round resource-related potentials.

6. A bathymetric study of lake DW 1 should be done in the summer of 1986 in order to determine its exact capacity for use as a reservoir, the depth of water required and the resulting height of the dikes to be built.

7. A weather station should be set up as early as possible so that data may be collected and analyzed regularly to permit correlation of on-site observations with the averaged data used in the report.

8. The impact study to be submitted to the Kativik Environmental Quality Commission should be finished before January 1987 and should take into account the results of all impact studies made by other organizations.

9. Each family contacted during the feasibility study should be consulted in order to clearly identify their housing needs in terms of the number of bedrooms required. The location of each of the houses should be decided by the Killiniqmiut themselves since a large majority of them would prefer to have the houses grouped according to the family relationships. A plan showing the location of each family in the village should then be drafted and sent to all of the heads of family for approval. A study on immigration should be conducted (who, in what number, types of houses needed, location of the houses, etc.) in order to integrate this information into the consultation.

10. All organizations which could be involved in projects in Taqpangajuk (Hydro-Québec, Transport Canada, Shell Canada Ltd, FCNQ, MAS, KSB, etc.) should be given the information needed to permit them to carry out their own special studies in the summer of 1986 or 1987.

11. Discussions should be undertaken with these organizations in order to determine their involvement in the project from the point of view of capital invested.

12. Mandates should be given to consultant firms for the preparation of plans and specifications for the houses in 1986. This should also be done for the buildings and facilities which are not the responsibility of a specific organization.

13. All plans and specifications, any subsequent modifications to them and the final master plan should be submitted to KRG for approval as required by law (section 244 of the Kativik Act).

14. All modifications recommended either by the impact study or the consultant firms should be submitted to the Killiniqmiut in a continuous consultation process.

15. All heavy equipment should be purchased in time for the 1987 construction season and be made available to the contractors in order to reduce mobilization costs and demobilization costs.

16. In hiring people to work on the construction of Taqpangajuk, priority should be given first to qualified Killiniqmiut and then to qualified Inuit from the other villages before considering any other qualified workers. In order to ensure that the Inuit will be properly qualified, a training program should be started as soon as possible.

17. The temporary camp and temporary airstrip (if needed), as well as their support facilities, should be built early in the 1987 construction season. Any land use conflicts between the two should be settled as soon as they arise.

18. Blasting and crushing operations should proceed from the village to the airstrip and the two projects should be integrated so as to avoid duplication.

19. All earthwork should be done one year before the actual buildings are constructed in order to avoid storage problems or land use conflicts.

20. The phases of housing construction should follow a logical order progressing outward from the village centre. The first houses should be built simultaneously in the southeast and northwest residential areas adjacent to the village centre. This will minimize the distances from the residences to the village centre in the event that only the 48 houses planned for the first phase are built in the middle or long term. After the opening of the village, planned for 1990, the second phase of construction should continue in the same way, developing one street at a time in each of the future development areas and working progressively outward. This will minimize the distances to be travelled to service the outlying homes. Fig. 7.2 shows the recommended method of proceeding with the development of the village, as well as the method which is not recommended.

21. Each house should be placed on its lot in such a way that in the event of an addition being built, the house will not have to be repositioned (see Fig. 7.3).

22. The host villages should be advised well in advance of the date of departure of the Killiniqmiut so that all claims may be settled beforehand.

23. It would be preferable that the Killiniqmiut not move to Taqpangajuk ahead of their scheduled moving date so as to prevent any land use conflicts. If any families actually do move before this date, they should establish their camp in a location that will not cause any such conflicts. However, it is recommended that the people move only when their houses are ready, which should be as soon as possible.

24. Until the village is incorporated as a Northern village corporation, KRG has the obligation to act as the municipality as described in the Kativik Act. All decisions, approvals, by-laws, etc. normally effected by a municipal corporation will have to be submitted to KRG for it to vote on them and make them official.

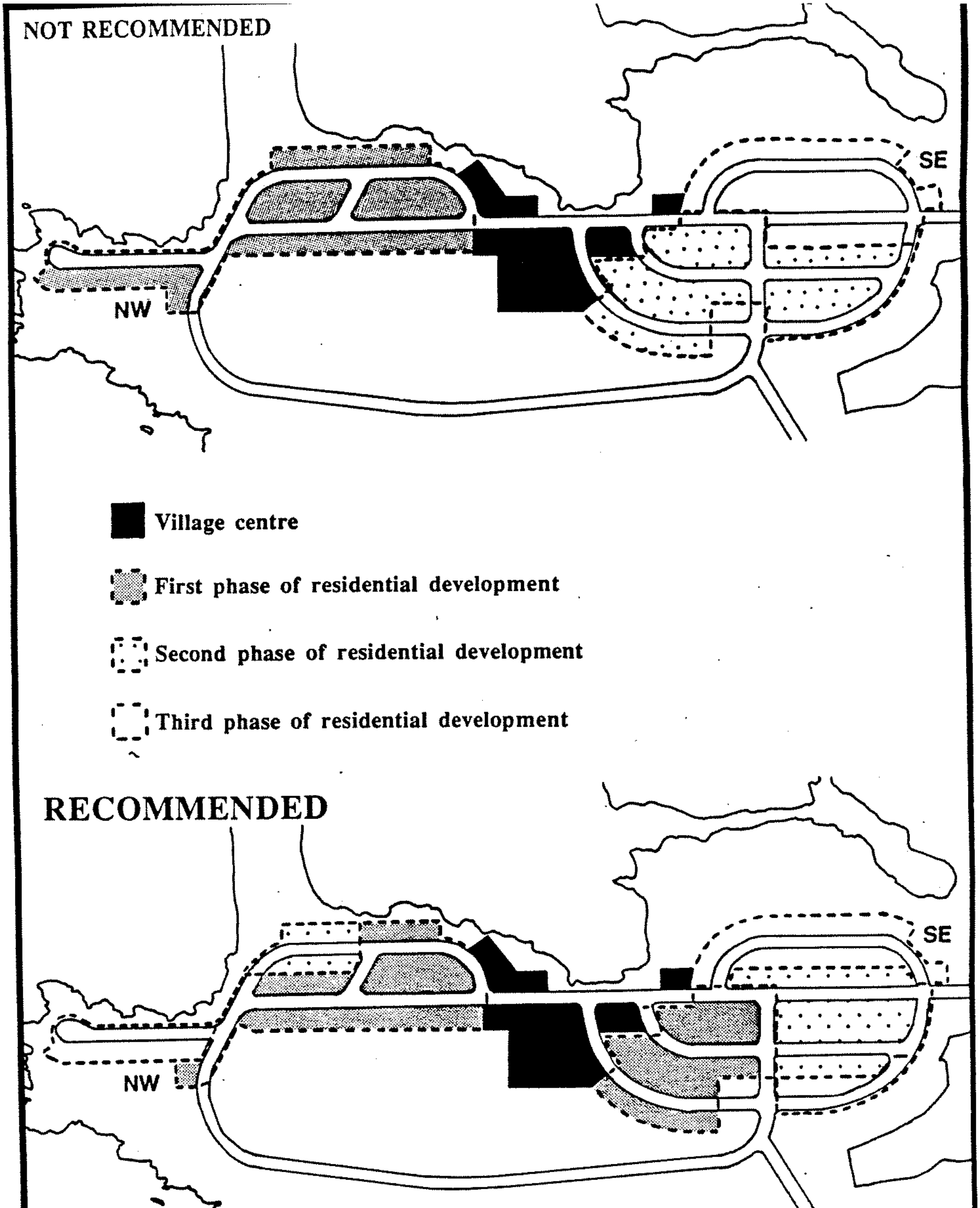


Figure 6.1
Recommended Phases of Residential Development

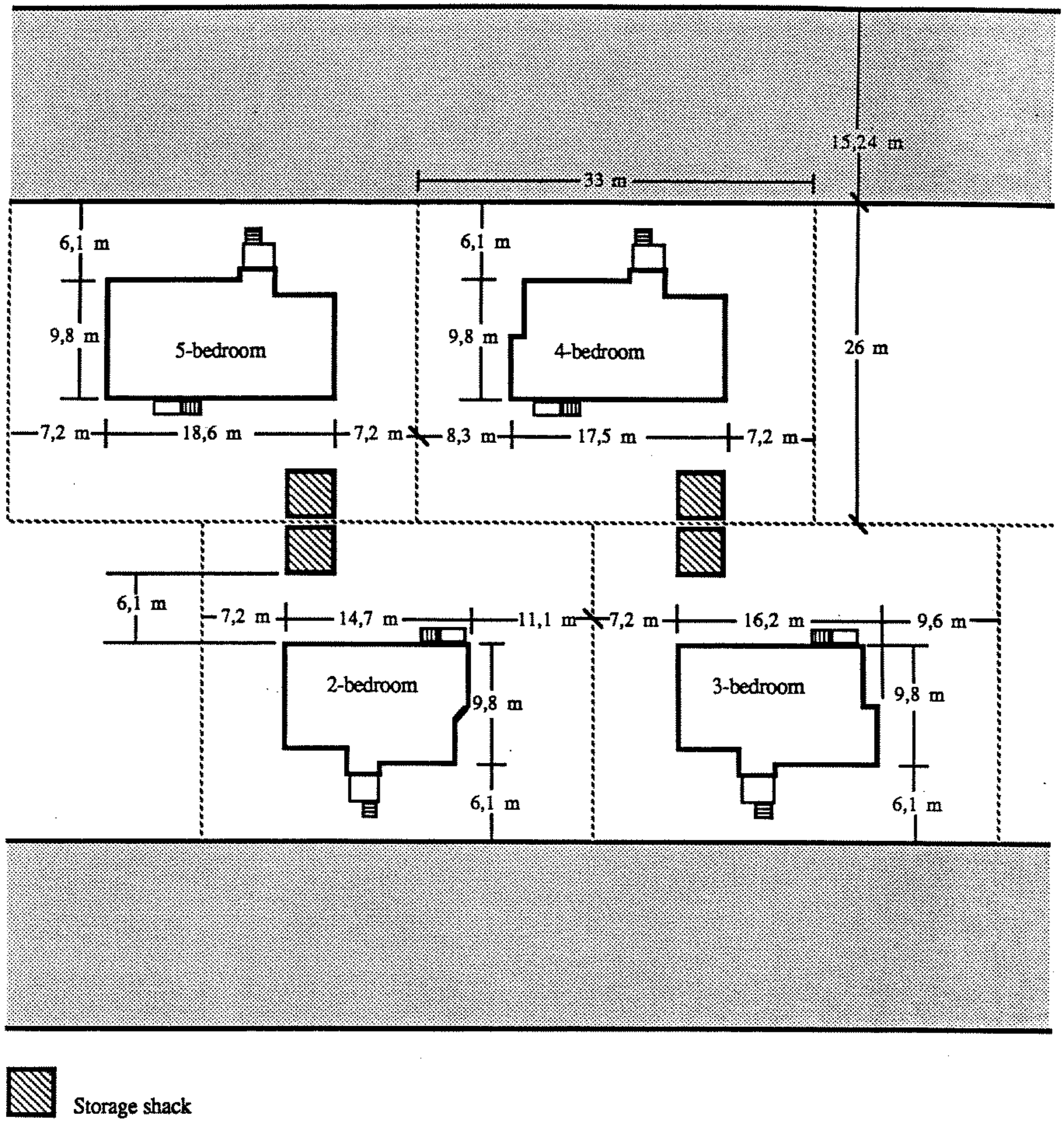


Figure 7.3
Position of Houses on Lots

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APPENDIX I
BREAKDOWN OF COSTS

To provide additional details concerning the cost of the buildings and infrastructures presented in the Section 4, the following cost breakdown is presented. The same section titles and numbers are used here in order to facilitate cross-referencing.

4.1.1 Houses

Based on SHQ costs for the renovation or construction of a 3-bedroom house in the North (average cost of 107 600 $ in 1985), the total cost of building a 3-bedroom house using the Inuit Housing Study models has been estimated at 115 000 $ by KRG's Housing Section. The cost of adding or subtracting one bedroom is estimated at 15 000 $ due to the semi-modular layout of the house. The total cost of each housing unit according to the number of bedrooms would therefore be:

2-bedroom	100 000 $
3-bedroom	115 000 $
4-bedroom	130 000 $
5-bedroom	145 000 $

4.1.2 Housing warehouse

The warehouse will comprise warehouse space and a shop. The warehouse space needed is 12 m x 9 m so a 12 m x 12 m building would be large enough to provide space for the shop as well. The height of the whole building will be that needed for the warehouse. The construction cost for such a building is estimated at 2 000 $\$/m^2$ or 288 000 $ for the whole building. Since the ratio of construction cost to total cost is 75 %, the total cost would be 385 000 $.

4.2.1 Office building and fire hall

Office buildings measuring 16,5 m x 7,2 m have been built recently in the North for a construction cost of 2 000 $\$/m^2$ in 1985 dollars. The relatively large size of the office building planned for Taqpangajuk would permit a scale economy of 35 %. Its construction cost is thus estimated at 485 700 $, and the total cost at 650 000 $.

4.2.2 School

The Kativik School Board has provided an estimate for a comparable school built in Aupaluk. This estimate, amounting to 2 200 000 $, can be found in Appendix V.

4.2.3 Nursing station

The Québec Ministère des Affaires sociales estimates the cost of building a nursing station at 725 000 $ (see Appendix V).

4.2.4 Community centre

The cost of a relatively large but low-ceilinged building is estimated at 1 500 $/m^2 . Thus the construction cost of the building would be 278 000 $, while the total cost would be 385 000 $.

4.2.5.1 Church

It is common practice for the inhabitants of a Northern community to build their own church. The Arctic Diocese of the Anglican Church of Canada has indicated that such a facility could be built for less than 100 000 $ (see Appendix V). However, in this study, it has been assumed that the church would be built at the same time as the rest of the village by the same workers. The cost of an attractive high-ceilinged building of an appropriate design has been estimated at 3 000 $/m^2 because of its relatively small size. An additional 15 000 $ has been added for accessories and decorations. The construction cost would thus be 283 000 $, and the total cost 385 000 $

4.2.5.2 Cemetery

As requested by the future residents, no facilities will be provided for the cemetery and no cost has thus been estimated.

4.2.6 Police station

Based on information provided by the Sûreté du Québec, the cost of a police station would be 130 000 $.

4.2.7 Freezers

Based on the cost of a freezer bought for Kuujjuaq, the total cost of installing a freezer in a Northern community is estimated at 100 000 $.

4.3.1 Store and warehouse

The total costs to be assumed by the FCNQ for building a store and a warehouse have been estimated at 125 000 $ and 75 000 $ repectively. These estimates were obtained during a telephone conversation with a representative of the FCNQ.

4.3.2 Commercial services building

Based on the needs expressed by Makivik, the cost of such a building is estimated at 1 600 $/m^2 for the first storey and 800 $/m^2 for the second storey, or 2 400 $/m^2 for the two-storey building. With a building area of 185,8 m^2, the construction cost is estimated at 441 000 $ and the total cost at 600 000 $.

4.3.3 Hotel

The hotel will consist of a 5-bedroom house at an estimated cost of 145 000 $. An additional cost of 55 000 $ has been foreseen to provide the house with heavy-duty appliances and furnishings.

4.4.1 Drinking water

The construction cost for a building located near the lake to house the pumping, disinfection and truck filling stations is estimated at 220 000 $. Based on a recent estimate for a similar project, this construction cost can be broken down as follows:

building	50 000 $	(25 m^2 at 2 000 $/$m^2$)
heating	30 000 $	
pumps	20 000 $	
disinfection	20 000 $	
generator	30 000 $	
electricity	30 000 $	
pipes, etc.	15 000 $	
arm and control	25 000 $	
Total	220 000 $	

Since the construction cost is 220 000 $, the total cost would be 300 000 $.

4.4.2 Wastewater

The cost of building an RBC can be broken down as follows:

building	380 000 $	(378 m^2 at 1 000 $/$m^2$)
RBC unit	135 000 $	(on a concrete slab)
Total	515 000 $	

Since the construction cost is 515 000 $, the total cost would be 700 000 $.

4.4.3 Solid waste

The cost of building a solid waste disposal site is as follows:

material (fence, etc.)	14 000 $
transportation	5 000 $
surface work	25 000 $
installation	25 000 $
rental, etc.	5 000 $
Total	74 000 $

Since the construction cost is 74 000 $, the total cost would be 100 000 $.

4.4.4 Municipal equipment

As per March 1986 report.

4.4.5 Municipal garage

Based on historical costs for six garages in Northern Québec, the construction cost per m^2, according to the number of overhead doors, would be:

4-door	2 205 $/m^2$
5-door	1 995 $/m^2$
6-door	1 830 $/m^2$
7-door	1 670 $/m^2$

Consequently, a 5-door garage measuring 20 m x 17 m would cost 678 000 $ to build, which represents a total cost of 905 000 $.

4.5.1.1 Powerhouse

Hydro-Québec has estimated the total cost of building a powerhouse at Taqpangajuk at 3 350 000 $ (see Appendix V).

4.5.1.2 Distribution network

Hydro-Québec has estimated the cost of a three-phase line and wooden poles at 75 000 $/km (see Appendix V). The total cost indicated in the March 1986 report was estimated based on a network length equal to the road length.

4.5.2 Tank farm

In private telephone conversations, the FCNQ has indicated that it will cost approximately 700 000 $ to build the tank farm, while Shell Canada Ltd. has estimated that it will cost between 700 000 $ and 1 000 000 $.

4.5.3 Telephone system

Bell Canada has indicated that the capital cost of installing a telephone system, to be assumed by Bell Canada, would be 490 000 $ (see Appendix V).

4.5.4 Radio and television facilities

TNI has indicated that a radio station would cost 10 000 $ (see Appendix V). The cost of a television station would be an additional 20 000 $. In the latter case, there is no studio to be built; only a receiving antenna and a transmitter would be required. This estimate is based on a similar 1-watt facility installed at LG-4 that cost approximately 12 000 $ in 1980.

4.6.1 Airport facilities

The Taqpangajuk airport (which is a comparable facility to the one that will be built in Salluit) is estimated by Transport Canada to cost 12 000 000 $. No cost breakdown is available (see Appendix V). From the tender documents available, it is not possible to assess the various costs involved except for that of the buildings and electrical work, which represents approximately 1 000 000 $. However, in private conversations with Transport Canada representatives, it was indicated that the construction of 3 km of roads for the Salluit airport would cost approximately 3 000 000 $. Thus the cost of an airport excluding the roads is estimated at 9 000 000 $.

Note: Although the cost of the Salluit airport was estimated at 12 000 000 $, the contract for its construction was only for 7 600 000 $.

4.6.2 Wharf

The cost of a floating wharf 24 m in length consisting of steel pontoons anchored to a crib structure on the shore is estimated at 500 000 $. This is consistent with an estimate of 300 000 $ made by Pluram Inc. in 1979 for a similar structure to be built in Umiujaq. This estimate was confirmed during a telephone conversation with Gaston Drouin of Gaston Drouin et Associés, a Québec firm specializing in maritime facilities. Further investigation is needed to give a more precise estimate.

4.6.3 Fishing boat haul-out facility

During a telephone conversation, Jean-Paul Côté of Les Industries A.C. Davie Ltd. indicated that the cost of parts for a wheeled cradle would be approximately 8 000 $. With transportation and final assembly at Taqpangajuk, the total cost of the haul-out device is estimated at 15 000 $. As regards the ramp, based on the assumption that construction can take place out of the water at low tide, on a 5 % slope, it will require 1 000 m^3 of run of the crusher material at a total cost of 35 000 $.

4.7.1 Foundations

Based on historical data, the costs for excavation of materials are as follows:

rock	25 $/t	(including processing)
granular	8 $/m^3	
common	2,50 $/m^3	

Based on historical data the costs for fill materials are as follows:

granular	8 $/m^3	
crushed	20 $/t	(from other sources)

4.7.2.1 Trenches, interceptor drains and ditches

Based on previous work, the construction cost for the trenches has been estimated at 37 \$/m. This would mean a total cost of 100 000 \$ for 2 km of trenches.

4.7.2.2 Dikes

The cost of the dikes for lake DW 1 was calculated based on a recent estimate made for the dikes of the oxidation ponds in Quaqtaq.

The installation planned for Taqpangajuk will consist of dikes with slopes of 3:1 and the following dimensions:

dike 1 : 20 m long x 1,1 m high
dike 2 : 40 m long x 1,1 m high
dike 3 : 58 m long x 3,1 m high

This will require 2 000 m^3 of crushed material for fill. At an estimated cost of 15 \$/t for fill, this will amount to :

$$2\,000\ m^3 \times 1{,}6\ t/m^3 \times 15\ \$ = 48\,000\ \$$$

An impervious membrane will also be required upstream of the dikes. The surface to be covered is 800 m^2. With the extra area needed for overlapping seams and anchoring the membrane at the crest and the toe of the dike, the total area of membrane required is 1 440 m^2. The cost of this would be:

purchase	36 000 \$
crating (10 %)	3 600 \$
transportation (5 %)	1 800 \$
installation	6 400 \$
anchoring at crest	350 \$
anchoring at toe	9 000 \$
Total	57 150 \$

The construction cost for the dikes and membrane would thus be 105 150 \$, or approximately 110 000 \$. With the construction cost to total cost ratio of 75 %, this makes a total cost of 150 000 \$ for the dikes.

The two alternatives that were considered are concrete dikes and earthen dikes with an impervious core.

Concrete dikes would require 260 m^3 of concrete and 520 m^2 of formwork. Concrete is estimated at 450 \$/m^3 while formwork is 150 \$/m^2 based on actual contract costs. Thus, the construction cost of this work would be 195 000 \$, while the total cost would be 260 000 \$.

Earthen dikes would need 90 m^3 of impervious moraine, 255 m^3 of filter sand (that would have to be imported from the South), 515 m^3 of crushed material as there is no sand or gravel and 625 m^3 of run of the crusher material. The outside slopes of the dikes have been estimated at 2:1. Considering the following unit costs of 8 $/$m^3$ for moraine, 290 $/t for filter sand (280 $/t for transportation alone), 15 $/t for crushed material and 11 $/t for run of the crusher material, the construction cost amounts to 142 400 $, making a total cost of 190 000 $.

4.7.3 Road network

The airport access road, secondary roads and streets have a roadway 7 m wide with a surface consisting of 150 mm of crushed rock and an additional 300 mm of run of the crusher material for the foundation. The airport access road also requires cut and fill work, at a cost of 350 000 $. The total cost per unit length would thus be:

streets and secondary roads	141,40 $/m
access road	258,45 $/m

The access road is 3,00 km long in Options 1 and 2 and 2,85 km long in Option 3.

APPENDIX II

Geological Information for Site Selection

Geology of Taqpangajuk

The Taqpangajuk peninsula, located on the northwest side of the entrance to Singer Inlet, is characterized by omnipresent bedrock thinly covered by moraine. The alignment of the rock masses parallel to the northwest direction of this fiord is also characteristic of the regional glacial relief.

The peninsula has a total area of 250 ha, is connected to the mainland by a 330-m-wide isthmus and is characterized by a cove closed by a sand bar which isolates a brackish lagoon.

Except for the sandy beach of the sand bar, the coast is composed of rock extending down to the sea, taluses or blocks occasionally covered with thin moraine or typical tundra vegetation. At low tide, the blocks or rocks become visible.

The rock is basically sound granitic gneiss with occasional granitic intrusions of the pegmatite dike type. In areas where the rock is exposed, called outcrops, it is superficially weathered and the surface is often broken by frost heaving. Where the relief is steeper, this phenomenon is more extreme and produces talus deposits or occasional boulder streams similar to the boulder pavements of fluvioglacial origin. These taluses, and the sand and gravel of the marine transgression zone on the beach, are the only granular deposits of any importance.

The moraines are chiefly found on five sites on the peninsula: to the northwest and northeast of the sandy beach, where they were not affected by the marine transgression because of their elevation; to the southwest of this beach, out of reach of the marine transgression and where they were partially transformed into swampy zones because of their impermeability and where in other higher locations they were transformed, at least on the surface, into sand and gravel; at the northeast part of the peninsula, where due to the steepness of the slopes (gentle to medium) and the oversaturation of the clayey active layer, they slid slowly towards the foot of the slope by the phenomenon of gelifluction (See "Geology of Uugalik" below).

The main joint systems which affect the bedrock are, in order:

- a northwest (310°-330°) system with a dip of 50°-60° to the east, which is parallel to the gneissic foliation;

- a southwest (240°-250°) system with a sub-vertical dip which is subsidiary to the preceding system (perpendicular to the direction of the above system);

- a north-south system (360°) with a dip of approximately 60° to the east, less regional and more local, which is mainly observed on rocks exposed at low tide or near the water and which are also the strike and dip angles of the pegmatite dikes.

Taqpangajuk is located in the continuous permafrost zone and thus in future studies the extent and depth of it must be determined. During the field survey in September, the temperature at the bottom of the deepest testpit was 1° C and the permafrost was not reached.

Geology of Uugalik

This alternative site is characterized by a valley contained between mountainous axes rising to 120 m, where there is a river flowing into an elongated inlet and through two narrows before opening into Ungava Bay.

The main soils found here are moraines whose main characteristic is that they are sliding towards the bottom of the gentle to medium slopes in the phenomenon of solifluction of the active layer during the summer. These moraines are usually composed of silt or clay and fairly uniform fine to medium-grained sand with a little fine gravel and some occasional blocks, especially near the surface. The active layer, above 70 cm, is oversaturated and slides in lobes towards the fiord; this is a very slow movement of less than 30 cm per year.

This gelifluction which takes place in oversaturated clayey soils must not be taken lightly since the high water content could indicate sensitive clays. Since some disastrous landslides have occurred in these clays, this danger must also be considered. The presence of clay is indicated by certain criteria measured on the site such as a positive dilatancy, a very high dry strength and a bearing capacity ranging from 48 kPa to 163 kPa, which converted to a shear strength gives 24 kPa to 82 kPa in the consistency range of firm to stiff (25 kPa to 100 kPa).

In order to determine the physical properties which are needed to evaluate the extent of this phenomenon in the present case, disturbed and non-disturbed samples must be obtained and analysed. Because these soils are so sensitive to even slight handling, these samples would require very sophisticated equipment, a delicate technique and careful handling, which not only exceeds the scope but also the means of this study.

The phenomenon of gelifluction is even more significant in this region since it could also occur in moraine type but non-clayey materials.

Because of the way in which they have been deposited, the moraines of the Ungava-Labrador region have a high void index which could account for their low plasticity index and low liquid limit (PI 8-20; LL 0-10). Because of these properties, even with a low water content, these moraines pass directly from a semi-solid state to a liquid state, a condition set off by a very small increase in the humidity or interstitial pressure. This effect is related to that observed in disturbed marine clays except that it is reversible upon removal of the load.

Where there is permafrost, the surfaces of these moraines develop special characteristics, such as occasional mudboils throughout the region or rib and through patterns. These characteristics are likely to occur since they require migration in the liquid state to form, and the low plasticity indices combined with the low liquid limits favor these conditions even in the dry climate characteristic of the region.

Thus, without detailed studies, construction on these materials cannot be considered without costly precautions.

In one area, near the mouth of the river, where the level of the soil is generally lower than elsewhere, it has become a wetland. There is a combination of small moraine hillocks with a sandy surface, large blocks, puddles and even peatlands. These wetlands are also found scattered around but on a smaller scale, on the site near the small surface streams, making up for the lack of natural drainage.

The rock here, as at Taqpangajuk, is basically sound granitic gneiss. Here also, frost heaving has caused surface weathering of the rock outcrops and this phenomenon causes taluses and block streams which could be considered for use as a granular material.

APPENDIX III

Report to the technical committee on site selection

Results of the visit and the Site Study

1. Available area

To start with, a fairly flat area of at least 16 hectares will be needed to build the village (and to allow for its growth), including a sizable rocky area for the installation of certain infrastructures. This criterion can be respected in cases, and in the main zone the areas which exceed this amount are naturally linked and for this reason have not been excluded. As for the expansion zone, it covers all the available adjacent area included in the study.

The different soils found on the sites have been classed according to the basic criteria of composition (including drainage), excavation and fill. So that they may be more easily compared, the figures are given in percentages in order to eliminate any advantage due to variations in the areas.

2. Foundation

As regards this criterion, Classes 1, 2 and 3 represent good foundations. When Class 1 (the best category) accounts for more than 50 % of the total area of the classes, the foundation is considered to be excellent. Construction can take place with little or no need for excavation and fill (except for the bedrock).

The other classes (4 and 5) represent poor foundations. They usually consist of the same basic materials (moraine) which on flat ground and gentle slopes often cause wetlands or which on sloping ground promote gelifluction.

Topography

The general aspect of the site is described according to the slopes that are found there. The topography of the bedrock (Class 3) has not been taken into account since once it is excavated (by blasting) its profile will be flat. Note that because of its topography and its low elevation in relation to the river, a good part of Site 2 at Uugalik would be exposed to flooding or ice scouring.

Construction materials

There is a general lack of natural granular materials (of sand and gravel type). This criterion has therefore not been included in the chart. The lack of these materials is due to the fact that the postglacial marine transgression did not exceed 15 m in this region. The only deposits above this level are thus glacial (usually tills).

3. Orientation

The prevailing winds during the winter period (from September to March) are southwesterly, westerly or northwesterly (18, 15 and 21 % respectively). These three sectors of the compass card account for more than 50 % of the winds for each month (except for March when the figure is 40 %) according to the climate data gathered at Port Burwell at the beginning of the 1930's.

Because they are located in a valley, the Uugalik sites are fairly well protected, while Taqpangajuk, which is located on Ungava Bay, is exposed to the winds. However, this very exposure is an advantage if the winds blow away the snow in winter. This could be used to avoid accumulations of snow on the service roads.

4. Traditional activities

Since the three sites studied are all within a 3,5 km radius, the halieutic and cynegetic potentials are very similar. The only advantage of the Uugalik sites is their proximity to a river and closer access to the Labrador Coast watershed. However, this slight advantage is overcome by the greater distance of these sites from Ungava Bay. Since sea access is a major criterion for the location of all Inuit villages, this accessibility is indicated, as is the period during which there are any navigable passages at high tide.

5. Transportation of supplies

This same criterion (sea access) controls the possibility of a wharf or unloading point for the barges. There again, because of its location on Ungava Bay the Taqpangajuk site is preferable to Uugalik. At Taqpangajuk, the unloading of goods and construction materials could even take place on the site of the village (at the beach), while in the case of Uugalik (2), a 3 km road would have to be built to provide access to the village as soon as construction is started. An access canal cannot be dredged at a reasonable cost because of the large area uncovered at low tide (3 km including rock to be excavated).

At first glance, the three sites seem similar from the point of view of feasibility of an airstrip. However, since only the Uugalik site was studied in depth by Transport Canada, we have included this criterion in the study. Because of a regional geological phenomenon, the direction of the alignment of the mountain peaks is different according to the site chosen. These sites will require much excavation of bedrock and the excavation material and fill will have to be optimized since there is a great lack of granular deposits.

6. Drinking water, wastewater and the solid waste disposal site

At this stage of the study, the costs foreseen for the delivery of drinking water and the removal of wastewater are similar, although the systems could be of different designs. The problem previously noticed at Taqpangajuk could be eliminated by converting the drinking water source (i.e. the lake) to a reservoir (diking needed in order to increase the retention capacity for winter) and by the possible addition of a pipeline along the road leading to the airport to get water in summer from a lake which is part of a watershed of about 1 000 000 m^2 (in case the reservoir cannot meet the demand). The water would be brought from the reservoir to a distribution point in the village by a continuous loop. For the other sites, the solution proposed is to use a natural lake located on top of the mountain and to bring the water to the village by the same means as that proposed for Taqpangajuk, i.e. by a loop to the distribution point in the village.

It should be pointed out that the pond south of the village at the Taqpangajuk site contains brackish water and that it was 5° C hotter than seawater at the time of our visit in September.

For the three sites, it is proposed to use a rotating biological contactor with disinfected effluent to solve the problem of treating wastewater, although the possibility of building an oxidation pond is being studied.

The only site where it would be economically feasible to build a solid waste disposal site (without extravagance) is Taqpangajuk, where the orientation of the site to the prevailing winds (NW in winter, SE in summer) would allow the construction of such a disposal site. At the other sites, the source of drinking water and the mountains are located to the west of the village, the south is upstream (the river), to the east there is a river and to the north is a body of water (the Inlet).

SELECTION CHART

(AS OF OCTOBER 7, 1985)

CRITERIA \ SITE	TAQPANGAYUK		OOGALIK(1)		OOGALIK(2)	
AREAS PER SITE	MAIN	EXPANSION	MAIN	EXPANSION	MAIN	EXPANSION
1	32 %	0 %	0 %	0 %	0 %	0 %
2	11 %	3 %	24 %	7 %	23 %	44 %
3	18 %	38 %	6 %	24 %	7 %	26 %
4	38 %	32 %	36 %	31 %	70 %	8 %
5	0 %	28 %	34 %	39 %	0 %	22 %
TOTAL (ha)	18,5	7,9	18	18,1	22,7	50,3
FOUNDATION: MAIN AREA EXPANSION	EXCELLENT 60 % POOR 40 % POOR 60 %		GOOD 30 % POOR 70 % POOR 70 %		GOOD 30 % POOR 70 % POOR 30 %	
TOPOGRAPHY	FAIRLY FLAT		GENTLY SLOPING 60 % FAIRLY STEEP 40 %		FAIRLY FLAT 70 % GENTLY SLOPING 30 % DANGER OF FLOODING	
ORIENTATION : WINDS SNOW	50 % EXPOSED(NW & W) WINDSWEPT		+ - PROTECTED ACCUMULATIONS		PROTECTED ACCUMULATIONS	
WATER ACCESS : DIST. FROM SEA PERIOD	ON UNGAVA BAY 0 KM NO RESTRICTION		ON CHRISTOPHER INLET 4,5 TO 5,5 KM HIGH TIDE + - 3 HOURS		ON NORMAN LAKE 6 TO 7 KM HIGH TIDE + - 0.5 HOUR	
PORT FOR SEALIFT: DISTANCE PROTECTION	4 SITES: E, N, W, SW 0.5, 0, 0.5, 1.5 KM YES, NO, NO, YES		1 SITE + MOORAGE 0 KM 1 KM YES YES		1 SITE 3 KM YES	
AIRSTRIP DISTANCE	1 SITE TO BE CHECKED 2,5 KM		3 SITES (OK BY DOT *) 1 KM, 2,5 KM*, 3 KM		2 SITES (OK BY DOT *) 2,5 KM*, 3 KM	
DRINKING WATER : WATER SUPPLY DISTANCE WATERSHED	RESERVOIR & LINE 1 KM & 2 KM NOT KNOWN		LAKE 2 KM NOT KNOWN		LAKE 2 KM NOT KNOWN	
WASTEWATER : TYPE DISTANCE	POND OR RBC APPROX. 1 KM		RBC (DISINFECTED EFF.) APPROX. 1KM		RBC (DISINFECTED EFF.) APPROX. 1KM	
SOLID WASTE	2 SITES		DIFFICULT		DIFFICULT	

APPENDIX IV
SITE SELECTION INCLUDING BELL INLET SITES

Site Selection Chart for Taqpangajuk, Uugalik 1 and 2, Bell Inlet 1, 2 and 3

Criterion	Weight	Evaluation of the options*						Weighted value of the options					
		Taq	Uu(1)	Uu(2)	BI(1)	BI(2)	BI(3)	Taq	Uu(1)	Uu(2)	BI(1)	BI(2)	BI(3)
Water access	20	9	5	3	5	2	3	180	100	60	100	40	60
Foundations	15	6	3	4	4	3	4	90	45	60	60	45	60
Drinking water	15	6	5	5	1	6	9	90	75	75	15	90	135
Available Areas	10	2	3	5	5	4	1	20	30	50	50	40	10
Airstrip	10	3	7	5	7	4	2	30	70	50	70	40	20
Wastewater	10	8	5	5	7	4	5	80	50	50	70	40	50
Orientation	5	4	5	7	5	7	6	20	25	35	25	35	30
Topography	5	9	4	7	6	5	6	45	20	35	30	25	30
Port	5	5	3	1	5	1	3	25	15	5	25	5	15
Solid waste	5	5	2	2	5	2	2	25	10	10	25	10	10
Total	100	57	42	44	50	38	41	605	440	430	470	370	420**

* On a scale of 1-10; an average site would rate 5 points.
** A perfect site would rate 1 000 points.

APPENDIX V
LETTERS FROM ORGANIZATIONS

COMMISSION SCOLAIRE KATIVIK SCHOOL BOARD

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KANGIRSUALUJJUAQ

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KUUJJUAQ

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TASIUJAQ

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AUPALUK

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KANGIRSUK

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QUARTAQ

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KANGIRSUJUAQ

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SALLUIT

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IVUJIVIK

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AKULIVIK

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POVUNGNITUK

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INUKJUAK

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KUUJJUARAPIK

ᒫᓚᓯ
MAILASI
(CHISASIBI)

331 MIMOSA,
DORVAL, QUE. H9S 3K5

TEL.: (514) 636-8120

Dorval, January 30, 1986

Kativik Regional Government
P.O. Box 9
Kuujjuaq, Quebec
JOM 1CO

Attention: Mr. Watson A. Fournier, Jr. Eng.

Dear Sir,

Please find enclosed the space requirements for the school and residences in the new village of Taqpangajuk.

Our estimates are based on the community of Aupaluk which is almost the same size as the new community.

Hoping that this will be satisfactory, we remain

Yours truly,

KATIVIK SCHOOL BOARD

Chanh Ma Quang
Director
Finance & Technical Services
/nf

encl.

c.c. Annie Popert, D.G.

TAQPANGAJUK

Space requirements:		10,000 m^2
School with single gym	1,100 m^2	
Lot	7,172 m^2	
2 duplex	1,728 m^2	
Preferred foundations:		Concrete footings
Preferred location:		In the village
Design period:		One year
Construction period:		One year

School

Construction cost & contingencies	$1,740,000
Professional fees	170,000
Miscellaneous	35,000
M.A.O. & Library	125,000
Arts Integration	20,000
	$2,090,000

Residences

Construction cost	$ 620,000
Furniture	60,000
Professional fees	60,000
	$ 740,000
Grand Total	$2,830,000

Gouvernement du Québec
Ministère de la Santé et des Services sociaux
Direction générale de l'administration et des systèmes d'information

RECEIVED
FEB 6 1986

Ste-Foy, le 29 janvier 1986

Monsieur Watson A. Fournier, ing. jr.
Administration Régionale Kativik
P.O. Box 9
Kuujjuaq, (Québec)
J0M 1C0

Objet: Taqpangajuk

Monsieur,

Tel que demandé dans votre lettre du 20 janvier dernier, voici les principales coordonnées des dernières constructions (résidence "jumelée" et dispensaire) tel que réalisées dans plusieurs villages nordiques:

Résidence

Une bâtisse de 14,8m X 11,2m incluant un appartement de deux (2) chambres à coucher et un autre d'une (1) chambre à coucher, avec un réservoir d'eau potable (850 gallons) et deux réservoirs de rétention des eaux usées; elle est construite sur un remblai "pad" de 15m X 20m environ. Il est souvent demandé de pouvoir circuler en véhicule autour de l'édifice.

Dispensaire

La bâtisse a 18,75m X 14,4m et est sise sur des trépieds ajustables qui reposent sur un remblai "pad" de 30m X 30m afin de pouvoir circuler autour de l'édifice. Cette édifice inclus un réservoir d'eau potable de 500 gallons (approximativement) et un réservoir d'eaux usées correspondant.

... 2

Ces deux édifices sont (seront) réalisés à partir de plans existants, ce qui réduit la période de conception; quant à l'exécution, la résidence a été construite en six (6) semaines et le dispensaire en au plus trois (3) mois; si le matériel arrive au village à la fin Juillet, le tout est terminé à la fin d'octobre.

Quant à l'emplacement, le dispensaire doit être dans le secteur communautaire et central de préférence; la résidence est normalement non loin, mais c'est l'établissement (en l'occurence le CH de l'Ungava) qui choisit et/ou accepte le site.

Quant aux coûts, ils sont environ de:

Résidence	225 000,00$
Transport des matériaux	20 000,00$
Surveillance & honoraires	25 000,00$
	270 000,00$
Dispensaire	575 000,00$
Transport des matériaux	70 000,00$
Honoraires	80 000,00$
	725 000,00$

Si d'autres informations te sont nécessaires, n'hésite pas à me contacter.

Amicalement et professionnellement,

Marc Bouchard, ing.
Chef de division
Division-Services de santé
Les Services Techniques

MB/jc

c.c. Germaine Castonguay

P.S.: Si la SHQ bâtit les logements, elle pourrait construire la résidence et ce à meilleurs frais à partir de plans existants.

2050 boul. St-Cyrille ouest, 6e étage
Sainte-Foy, QC G1V 2K8
Tél.: 643-6551

The Diocese of The Arctic

ANGLICAN CHURCH OF CANADA

1055 AVENUE ROAD
TORONTO, ONTARIO M5N 2C8

RT. REV. JOHN R. SPERRY, D.D.
BISHOP OF THE ARCTIC

RT. REV. JAMES C. M. CLARKE, D.D.
BISHOP SUFFRAGAN

VEN. PETER C. BISHOP
EXECUTIVE ARCHDEACON

TELEPHONE
AREA CODE 416
481-2263

RECEIVED DEC 9 1985

3rd. December '85

Watson A. Fournier Jr. Eng.
Municipal Technical Assistance Dept.,
Kativik Regional Government,
P.O. Box 9,
Kuujjakk (Fort Chimo),
Quebec, JOM ICO

Dear Sir,

Thank you for your letter of the 21st. November and the news that a community is being planned for Taqpangayuk. As we wish to serve our people wherever they might live I thank you for inviting us into the plan at this time.

Having said that however I must also point out that we do nothing without consulting the local people and indeed without them accepting considerable responsibility for the church work that is done in a community. Any planned church building would therefore have to be discussed with the people living or planning to live in the new community.

The figures I have quoted are those for a new building. As you are probably aware we do have a church building at the site of Port Burwell. I do not know the condition of that building, but it maybe appropriate to use that, or at least material from it, for a church in Taqpangayuk. This would be a matter of discussion with the Executive Committee of the Diocese and also the people of the new community.

You will note that I have mentioned on the form a Mission House. This is looking a long way into the future as a community of the size which is proposed would not normally have a full time salaried minister. This may change however and it might be advisable, if not to have a full mission house, to have at least a small building where a visiting minister could stay when he comes to serve the people there.

I must say we are very interested in the proposal, but would add that much discussion has to take place with the local church people who will be involved, the parish into which the community will come, the Executive of the Diocese which meets each Fall and the Bishops. This must all happen before firm plans can be drawn up for erecting a building.

Thank you.

Yours truly,

Peter C. Bishop
Executive Archdeacon

cc. Rev. Napartuk
Rt. Rev. J.R.Sperry & J.C.M.Clarke

Church requirements

See Letter attached.

Space requirements — Lot for 48' x 20' Church Building (Lot for Mission House in distant Future)

Preferred foundation — Piles but Pad satisfactory

Preferred location — Central to Residential area

Design period — Designs on hand now being ~~standard designs.~~ (years)

Schedule Year 1
Year 2
Year 3, etc.

Cost breakdown

Plans and specifications:	Architecture		$
	Engineering		
	Soil studies		
Purchasing costs			$ 80,000
Construction costs	(much volunteer labour normally used.)		5,000
Construction supervision:	Architecture		
	Engineering		
	Soils		
Transportation costs			12,000
Other costs			$

RECEIVED
JAN 20 1986

Hydro-Québec
Région Montmorency
5200 boul. Neuvialle, Lebourneuf, Québec, G2C 1P1

Québec, le 10 janvier 1986

Administration Régionale Kativik
P.O. Box 9, KUUJJUAQ (Fort Chimo)
Québec, Qc
JOM 1CO

Compétence de: M. Raymond Gagnon, Ing.
Département de l'Assistance
technique aux municipalités

OBJET: Nouveau village sur la Baie d'Ungava (Taqpangayuk)

Monsieur,

Suite à votre demande en date du 6 novembre 1985 à M. Franz Mitterer, il nous fait plaisir de vous faire parvenir l'information demandée concernant l'implantation des facilités nécessaires pour fournir l'énergie électrique à ce futur village.

1- Besoins en espace:

- Centrale, remise à véhicule, poste de transformation etc...: 100 m X 120 m

- Maison de transit: 30 m X 60 m

2- Fondation préférée:

- Centrale:
  - Fondations sur le roc sain;
  - Absence de pergélisol

... /2

3- <u>Localisation préférentielle</u>:

- Centrale: - À proximité des réservoirs de produits pétroliers;

  - Tenir compte des vents dominants (bruit);

  - Maison: - À déterminer.

4- <u>Calendrier</u>:

An 1: - Choix de site

An 2: - Ingénierie

An 3: - Construction des bâtiments
- Ingénierie

An 4: - Installation des équipements de génération et mise en service

5- <u>Coûts ($'85)</u>:

An 1: - 50,000.

An 2: - 300,000.

An 3: - 2,000,000.

An 4: - 1,000,000.

J'espère que ces données rencontrent vos besoins et je suis à votre disposition pour vous fournir toute autre information que vous jugerez utile.

G. Tessier

Gilbert Tessier
Chef de division
Planif. et Exploitation
Distribution et Projets

GT/js

c.c.: Hervé Bélanger
Franz Mitterer
Robert A. Rouleau
René Guay

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La Fédération
des Coopératives
du Nouveau-Québec
8102, route Trans-Canada
Ville Saint-Laurent
Montréal, Québec
H4S 1R4
(514) 332-0880

le 26 novembre 1985

Mr. Raymond Gagnon, ingénieur
Département de l'Assistance
Technique aux municipalités
A.R.K.
P. O. Box 9
Kuujjuak, Québec
J0M 1C0

Monsieur,

Faisant suite à votre lettre du 6 novembre 1985, veuillez trouver ci-contre les informations requises sauf les données financières.

1) besoin en espace: 70 mètres carrés.

2) fondation préférée: base de roc plat, avec;

   2 couches de 200 mm chacunes
   de matériel granuleux de 0-63 mm
   1 couche de 200 mm de 0-19 mm compacté.

3) localisation préférentielle:

   200 mètres de la mer à proximité de la génératrice.

4) période de conception:

   an 1 - Décision relative à la sorte d'installation et capacité des réservoirs.

   an 2 - Choix du site et obtention des autorisations nécessaires.

an 3 - Conception, érection et mise en opération du dépôt.

Espérant que ces quelques informations vous seront utiles, je demeure à votre entière disposition.

Claude Savage,
Directeur des services pétroliers

CS/mjb

Administration Régionale Kativik
Département de l'Assistance
technique aux municipalités
Boîte Postale 9
Kuujjuaq

Bell

Attention: Mr W.A. Fournier, ing. jr

Date: 1986 04 02

Sujet: Nouveau village (Taqpangajuk)

Monsieur,

Vous trouverez à l'annexe A, les informations sollicitées dans votre lettre du 20 janvier dernier.

Ces données vous sont communiquées sous toute réserve et ne pourront être considérées comme un engagement de la part de Bell Canada à fournir le service téléphonique, ni à respecter les coûts ou l'échéancier visé.

Ces coûts vous seront sûrement utiles pour finaliser votre étude mais si vous désirez plus d'informations, vous pouvez communiquer avec P. Lafontaine de mon groupe au numéro (418) 688-7311.

D. Marquis

Denis Marquis
Ingénieur principal
Planification du réseau local (Provincial)

c.c.: M. Claude Proulx
Directeur divisionnaire
Planification, RQ (Bell)

(1391W)

1) BESOINS BELL CANADA

a) Terrain grandeur approx. 20 mètres x 25 mètres, pouvant accepter une roulotte montée sur des coffrages en bois aux coins extérieurs.

b) Terrain normalement situé entre l'Hydro-Québec et le village pour les besoins de câbles aériens à proximité de Télésat.

c) Raccordement électrique (208V, 1 phase, 100A).

d) Période minimum pour l'installation d'un commutateur est de 18 mois. Cette période est fonction de la date de l'avis d'autorisation et peut s'allonger jusqu'à 30 mois.

Ex:	Date de l'avis	Date de service
	Avant mai	18 mois (août-sept.)
	Après mai	26-30 mois (août-sept.)

2) DONNÉES DIVERSES

A) Coût pour service permanent	Investissement pour Bell Coûts $86
a) Commutateur	288 000.$
b) Bâtisse	
- Roulotte	50 000.$
- Transport	50 000.$
- Surveillance, aménagement plans & devis	42 000.$
c) Câblage extérieur	60 000.$
Total:	490 000.$
(dollars 1988):	540 000.$

B) Coût pour service temporaire

	Coût pour l'abonné	
	1 circuit	2 circuits
- Frais d'installation	3 500.$*	3 500.$*
2e circuit si installation subséquente		1 000.$
- Taux annuel d'abonnement	139 500.$	228 100.$

* Plus frais inhabituels

TO:

Tommy Gordon
Katlvik Regional Government
Kuujjuaq, Northern Quebec

FROM:

Mark T. Gordon
Secretary/Treasurer
Taqramiut Nipingat Inc.
Montreal, Quebec

Taqramiut Nipingat Incorporated
185 Dorval Ave., Suite
Montreal, Quebec H9S 5J9
(514) 631-1394
(800) 361-2657
Salluit, Northern Quebec
J0M 1S0
(819) 255-8989 Television
255-8822 Radio
ᑕᖅᕋᒥᐅᑦ ᓂᐱᖓᑦ

March 18, 1986.

WE HAVE HERE THREE QUOTATIONS FOR AN INSTALLATION OF FM RADIO EQUIPMENT.

THE DIFFERENCE IN THE TOTAL COST IS OUR QUOTATIONS WITH THREE DIFFERENT TRANSMITTERS AS FOLLOWS:

PETRIE	.6 watt	7225.00
PETRIE	10.0 watt	7725.00
OTHER	10.0 watt	12825.00

THE OTHER COMMUNITIES ARE NOW SUPPLIED WITH PETRIE .6 WATT TRANSMITTERS. WE WILL OVER A PERIOD OF TIME UP-GRADE THEM TO PETRIE 10.0 WATTS. OUR EXPERIENCE HAS SHOWN THAT THE PETRIE TRANSMITTERS ARE ADEQUATE AND SUPPLY THE NEEDS OF THE COMMUNITY.

IF YOU HAVE ANY FURTHER QUESTIONS, PLEASE DO NOT HESITATE TO GET IN CONTACT WITH ME.

Mark T. Gordon

RADIO STATION

Transmitter & antenna		
-0.6 watt		
Retrie Telecommunications	T1) $	900
-10 Watts		
Retrie Telecommunications	T2) $	1,400
Other manufacturer	T3) $	6,500
Audio mixer Broadcast Electronics Model 4M 50	$	2500
Turntables (X2) Technics model SL 1200 MK2	$	1100
Phono cartridges Stanton model 500 AL	$	80
Stylus (4 spare) Stanton D5107AL	$	75
Cassette deck #1	$	450
Cassette deck #2 (optional)	$	450
Microphones (x2)	$	450
Headphones (2 pairs)	$	80
FM tuner	$	50
Tel. pickup	$	10
AC power bar (X2)	$	50
Speaker	$	100
Mic stands (2 X table top type)	$	30
Cables and connectors	$	300
Installation (3 days/1 pers.)	$	600
(air fares + lodging)	$	?
Carpentry	$	?
Electricity	$	?
Delivery (Nordair & Air Inuit)	$	?
Total 0.6 Watt	$	7225
10 Watts, Petrie	$	7725
10 Watts, Other	$	12825

These prices do not constitute a quote. Their main purpose is to get an idea of what is required to have a replica of the existing facilities in Kuujjuarapik. They are estimates.

Transport Canada / Transports Canada

Le 09 décembre 1985

Votre référence

5168-1 (QAOS)

Monsieur Rem Westland
Secrétariat de mise en oeuvre
des revendications du Québec
Secteur des Orientations Générales
Ministère des Affaires Indiennes et du Nord Canadien
Terrasse de la Chaudière
Pièce 1923
10 rue Wellington
Hull, P.Q.
K1A 0H4

Monsieur:

Les 31 octobre et 01 novembre 1985 une équipe de Transports Canada a effectué un choix de site aéroportuaire à Taqpangayuk.

Le site choisi se situe à environ deux (2) kilomètres du site proposé pour le futur village. En comparant la difficulté de ce site avec les onze (11) autres sites déjà choisis et estimés dans autant de villages, nous croyons que l'aménagement d'une telle piste coûtera douze (12) millions de dollars (dollars de 1985). Les études de faisabilité (incluant arpentage et préparation des plans et devis), campement et transport s'élèveront à environ $300,000.00 (dollars de 1985). Les études de faisabilité seront exécutées une année avant la réalisation du projet de construction de l'aéroport.

Tel qu'entendu lors de nos précédentes conversations téléphoniques, Affaires Indiennes Canada incluera ces

.../2

estimations de coûts dans la présentation qui sera faite au Cabinet concernant la relocalisation des Inuit de Killinek à Taqpangayuk au début de l'année 1986.

Compte tenu des difficiles conditions de terrain rencontrées à Taqpangayuk, nous croyons qu'il serait opportun de réévaluer les coûts de construction d'une piste et d'un village, à Bell Inlet.

Il nous apparaît possible d'aménager une piste à un coût beaucoup moindre (50%) puisque le terrain y est nettement plus favorable. Le site de Bell Inlet a été examiné assez sommairement par la firme Pluram en 1982 et a été rejeté. Nous croyons qu'une étude plus poussée de ce site devrait être effectuée tant du point de vue site aéroportuaire que du point de vue implantation du village.

Nous nous proposons de discuter ces questions, de façon exploratoire, avec le personnel de l'Administration Régionale Kativik, avec Makivik ainsi qu'avec Affaires Indiennes Canada.

Pour toute question relative à Taqpangayuk, veuillez contacter M. Rhéaume Allard à (514) 636-3245.

PIERRE CHAMPAGNE
Directeur Général Régional
Aéroports
Région du Québec

c.c. M. Anthony Price
Administration Régionale Kativik
Makivik, Att'n de M. Gilles Gagné

APPENDIX VI

ORIGINAL KILLINIQ RELOCATION LIST BY FAMILY, AGE SEX, AND COMMUNITY OF PRESENT RESIDENCE

KANGIQSUALUJJUAQ

UNATWEENUK (1 house)

Sanak	4-1-27	(M-58)
Lizzie	1-1-31	(F-54)
Martha	17-7-53	(F-32)
Sammy	27-11-55	(M-30)
Tommy	19-6-61	(M-24)
Bobby	20-12-63	(M-22)
Maggie	28-2-66	(F-19)
Daisy	24-2-66	(F-19)
Harriet	6-8-69	(F-16)
Matthiew	27-10-70	(M-15)
Jimmy	8-3-76	(M-9)
Ned	6-6-76	(M-9)
Jobie	12-1-83	(M-2)
Mae	12-8-84	(F-1)

ASSEVIK (2 houses)

Pennina	1--28	(F-57)
Tommy	15-10-62	(M-23)
Lucy	6-3-65	(F-20)
Matthiew	20-4-68	(M-14)
Bobby	8-12-74	(M-11)
David	24-5-75	(M-11)
Ned	2-9-75	(M-10)
Helena	25-6-83	(F-2)
Kenny	30-1-51	(M-34)
Mae	1-1-65	(F-20)
Alma	1-1-84	(F-1)

TOOMAS (2 houses)

Paul	8-6-46	(M-39)
Theresa	28-2-51	(F-34)
Sabina	6-2-81	(F-4)
Namy	1-1-77	(F-8)
Tomasi	1-5-78	(M-7)
Lucy	12-10-48	(F-37)
David	1-1-69	(M-16)
Johnny	28-1-82	(M-3)
Tony	1-1-84	(M-1)

ANGNATUK (1 house)

Johnny	15-9-54	(M-31)
Kitty	9-6-59	(F-26)
Edouard	12-6-76	(M-9)
Tommy	1-9-78	(M-7)
Eva	26-12-83	(F-2)

SNOWBALL (1 house)

Norman	10-2-48	(M-37)
Hilda	12-3-52	(F-33)
Mary	15-6-74	(F-11)
Danny	2-12-77	(M-8)
Benjamin	4-12-83	(M-2)

ANGNATUK (1 house)

Noah	1-1-12	(M-73)
Lizzie	6-11-42	(F-43)
Tommy	11-1-64	(M-21)
Matthiew	19-9-70	(M-15)
David	22-9-74	(M-11)

QUAQTAQ

JARARUSE (1 house)

Benjamin	17-8-24	(M-61)

KEELAN (1 house)

Sophie	24-5-48	(F-37)
Mike	4-2-53	(M-32)
Pasha	14-4-74	(F-11)
Charlie	22-8-75	(M-10)

ANNATOK (2 houses)

Willie	18-3-29	(M-56)
Johnny	2-12-71	(M-14)
Moses	16-5-70	(M-15)
Elisape	2-6-76	(F-9)
Helena	7-2-79	(F-6)
Tommy	6-7-64	(M-21)
Annie	5-8-65	(F-20)
Suzie	3-3-85	(F-1)

ANNATOK (1 house)

Emily	1-1-13	(F-72)
Elijah	16-8-63	(M-22)
Josepi	4-10-66	(M-19)
Sammy	15-7-68	(M-17)
Jessie	10-6-76	(M-9)

KUUJJUAQ

MUNICK (1 house)

Poassie	25-7-57	(M-28)

TASIUJAQ

THOMASSIAH (2 houses)

Peter Solarseak	1-1-34	(M-51)
Charlotte	1-1-29	(F-26)
Jimmy	5-12-60	(M-25)
George	16-7-68	(M-17)
Bobby	7-7-72	(M-13)
Markossie	28-11-61	(M-24)
Annie	1-8-62	(F-23)
Daniel	9-1-83	(M-2)
Jessika	21-10-84	(F-1)

KANGIQSUJUAQ

ANNAHATUK (* house)

Mark	1-1-19	(M-66)
Johnny	12-10-54	(M-31)
Selina	20-1-65	(F-20)
Elisa	20-1-64	(F-21)
Noah	21-5-66	(M-19)
Mary	1-8-71	(F-14)
Sammy	13-12-77	(M-8)
Tommy	25-10-84	(M-1)

TUKAK (1 house)

Davie	1-1-31	(M-54)
Mary	8-6-38	(F-47)
Jeannie	7-3-67	(F-18)
Mark	25-5-69	(M-16)
George	7-5-71	(M-14)
Williami	25-6-77	(M-8)
Bobby	6-3-85	(M-1)

KILLINIQ AND TAQPANGAJUK

ANNAHATUK (from GWR, 1 house)

Annie	24-12-46	(F-39)
Petertom	17-8-51	(M-34)
Emily	8-12-78	(F-7)
Tomasi	29-3-82	(M-3)

JARARUSE (from Quaqtaq, 1 house)

Pauloosie	22-4-50	(M-35)
Susie	8-2-56	(F-29)
Willie	7-12-77	(M-8)
Emily	10-2-79	(F-6)
Danny	13-2-80	(M-5)
Paul	14-4-81	(M-4)
Angela	17-5-84	(F-1)

TERRAIN ANALYSIS
FOR
FEASIBILITY STUDY
OF PROPOSED COMMUNITY
TAQPANGAJUK

Prepared for

Makivik Research Department

by

L.A. Rivard

Terrain Evaluation Consultant

September 1985

Table of Contents

List of Maps

1. INTRODUCTION

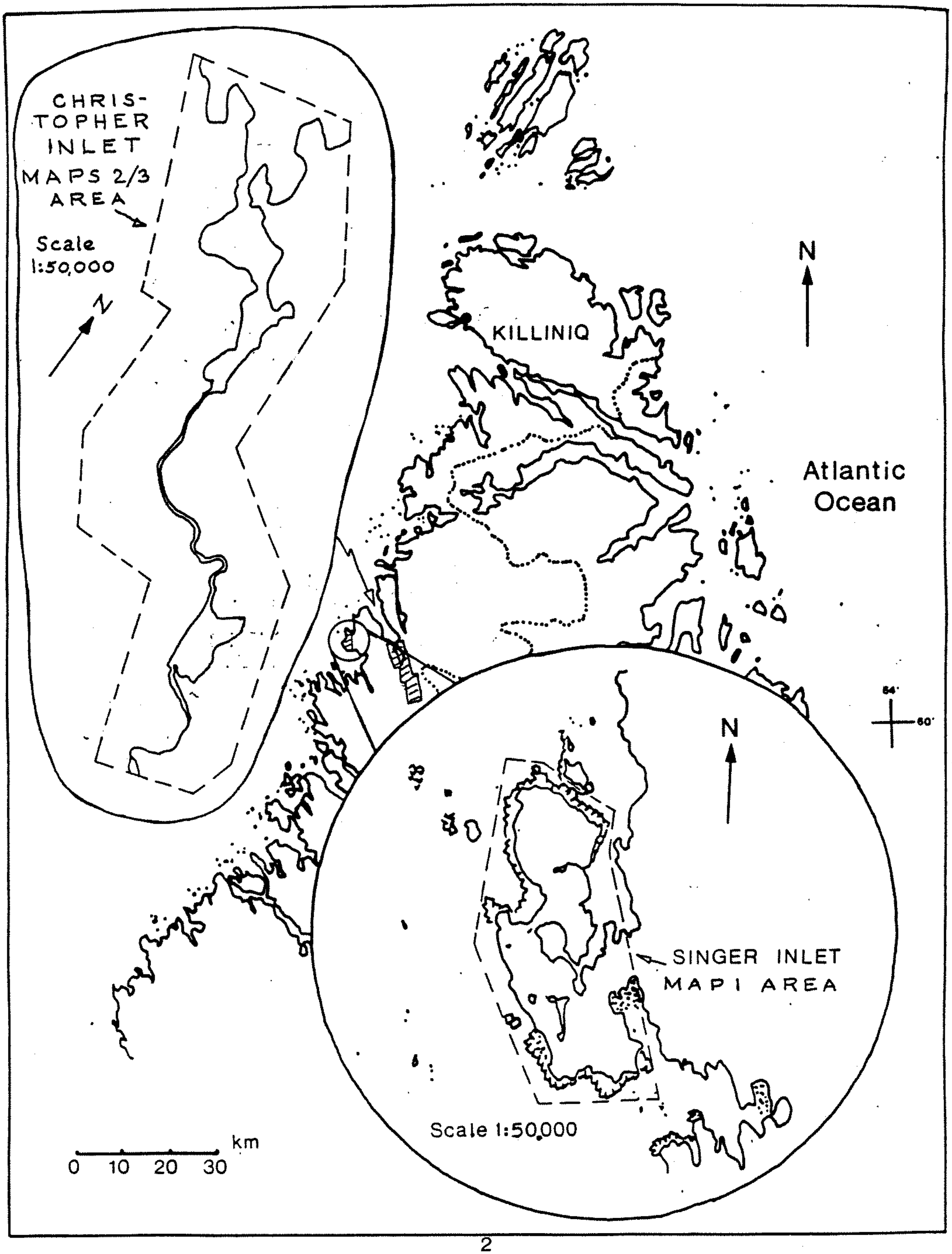
1.1 PURPOSE OF THE STUDY

The work reported in this document comprises the air photo interpretation activity of the feasibility study components - item 3.2.2 of Mr. W.B. Kemp's Project Brief, August 20, 1985.

Such activity was aimed at developing information concerning the physical characteristics of the terrain for a designated settlement area on the eastern shore of Ungava Bay. The settlement is intended to accomodate a population of about 150-200 persons and its facilities are to include housing, community services, infrastructures and provision for future expansion.

1.2 SINGER AND CHRISTOPHER INLETS DISTRICT

Initially the area to be studied by airphoto analysis was to include a quadrangular block 10 x 10 km in extent, arbitrarily drawn on a map to include the land adjacent to a potential settlement site (Singer Inlet) identified during a previous investigation (see Section 3). This block of land which included neighbouring Polunin and Christopher Inlets was photographed from the air at a nominal scale of 1: 10,000 in early August 1985 by Makivik Corporation's air photographer.


CHRIS-
TOPHER
INLET
MAPS 2/3
AREA
Scale
1:50,000
N
KILLINIQ
N
Atlantic
Ocean
N
SINGER INLET
MAP 1 AREA
Scale 1:50,000
km
0 10 20 30

2. AREAS POTENTIALLY SUITABLE FOR DEVELOPMENT

2.1 GENERAL

Following the completion of Maps 1 and 2, it was evident that the Christopher Inlet site merited at least as much field examination as the Singer area (see Figure 1). Since the latter had already been visited once and reported on, we decided to focus our attention on Christopher Inlet and produce an interpretative map derived from the geomorphic analysis and identify the location and extent of areas potentially suitable for development as an additional document (see Map 3) to guide investigations.

2.2 SELECTION CRITERIA

Evaluation of the geomorphic mapping results suggested that if a number of site criteria were applied, terrain unit areas meeting the requirements could be selected and assigned either a primary or a secondary order of value. Resulting primary unit areas have been designated housing areas, and secondary unit areas have been designated in this rough apportionment as areas for community services, infrastructure and future expansion.

The selection and classification criteria applied were:

1 - Foundation material type
2 - Foundation material thickness
3 - Drainage
4 - Slope steepness
5 - Slope orientation
6 - Surface roughness

The first 3 criteria were applicable by reference to the geomorphic map, while the latter 3 required viewing of photo stereo models.

2.3 HOUSING AREAS

These areas have the following characteristics with respect to the selection criteria:

Foundation material type: glacial till (units M and V).

Foundation material thickness: glacial blanket is best, but areas of adjoining glacial veneer have been included where other criteria are met.

Drainage: areas are apparently presently well-drained or relatively easily drainable given regional permafrost active layer behaviour.

Slope steepness: gentle slopes or gradually rising slopes.

Slope orientation: north facing slopes have been avoided and preference given to south facing.

Surface roughness: glacial veneer till areas with apparently minimal microrelief are included.

2.4 AREAS FOR SERVICES, INFRASTRUCTURE AND EXPANSION

These areas still meet all the criteria but there is a qualitative downgrading, relative to the housing areas with respect to drainage, slope steepness, orientation and surface roughness.

2.5 CONSTRUCTION MATERIAL SOURCES

A. Material sources indicated on Map 3 are talus deposits (Unit X) which are immediately adjoining the two classes of development area. Additional sources are determinable from Map 2.

B. Regulated shoreline setback distances have not been considered here.

C. Glacial till material has not been selected but might be used locally if borrow depth is limited to the active layer and/or borrow pits are opened sufficiently in advance of construction to allow thawing of the material.

2.6 WATER SUPPLY

This factor has not been considered in our study other than to note that the watershed area tributary to Christopher Inlet valley is some 75 km^2 in extent and contains several large lakes.

Groundwater sources such as supra, intra and sub-permafrost types are not easily assessed on the basis of airphoto analysis prior to fieldwork.

2.7 AIRSTRIP LOCATION

The 1800 meter long area of glacial till lowland at the upper end of the Christopher Inlet valley has been the focus of our attention for an airstrip site. We have not been able to define a tentative alignment for a number or reasons:

- M.O.T.'s indecision concerning type of facility;
- lack of stereo photo coverage in the area of interest;
- lack of other elevation data in plan form.

Our current observations about the upper valley terrain are:

A. It is the only long level area in the district;

B. Foundation material is evidently glacial till blanket relatively deep;

C. Material is evidently underlain by permafrost throughout and may have an active layer depth of plus or minus one meter;

D. Approach surface slopes seem to have less physical restrictions than transitional surface slopes;

D. Orientation options are limited.

3. PREVIOUS STUDIES

To the extent of our present knowledge, the Singer and Christopher Inlets district of the Ungava Bay coast does not appear to have been the object of detailed biophysical studies. Neither Geological Survey of Canada nor Québec's Ministère de l'Énergie et des Ressources seem to have issued reports on the area other than generalized statements in the context of broader regional descriptions. The only site specific information available to us was an eight-page text reporting on a cursory visit to the Singer area by a field party from Pluram Inc. in August 1982, whose mandate was primarily to survey sites in the Bell Inlet area further south (see Port Burwell Community Relocation Study, September 1982, Pluram Inc.).

4. AIRPHOTO ANALYSIS PROCEDURE

The use of stereoscopic airphotographs in an analysis of a given physical environment is a technique that is routinely applied because it has the advantage of facilitating the classification and mapping of observable landforms into relatively homogeneous morphogenetic units which are of specific significance in engineering geology.

A fundamental methodological rule in airphoto analysis is to proceed from the general, regional (small scale) images of an area to the large scale more site specific photographs. Thus before using the specially flown 1: 10,000 scale photos we studied 1:40,000 scale coverage from National Air Photo Library.

This step yielded two results:

- it allowed an elimination of a large part of the area as having no potential value for the intended development;
- it revealed a hitherto unnoticed site at the head of Christopher Inlet as a possible alternative to the Singer site.

Our detailed analysis of the 1: 10,000 scale photos thereafter concentrated on these two areas, the results of which are presented as Maps 1 and 2.

5. CLASSIFICATION OF GEOMORPHOLOGIC TERRAIN UNITS SINGER INLET AND CHRISTOPHER INLET AREAS

Suite 1 - Mass Movement (degradational) Units

Symbol	Unit
----|--->	Bedrock Colluvium
--------->	Blanket Solifluction Lobes
X	Talus Deposits
K	Thermokarst Subsidence

Suite 2 - Glacial and Rock Units

Symbol	Unit
M	Glacial Blanket
V	Glacial Veneer
R	Bedrock Outcrop
W	Wetland

Suite 3 - Hydrologic Units

Symbol	Unit
A and ---	Fluvial Active
T	Fluvial Inactive
L	Boulder Field
A/M	Reworked Till

Suite 4 - Estuarine/Marine Environment

Symbol	Unit
Z	Rock Shoreline
G	Till Shoreline
H	Beach Raised
N	Beach Sandy
C	Beach Cobbly
D	Beach Discontinuous
B	Boulder Barricade
F	Intertidal Flat
S	Offshore Sediments

6. TERRAIN UNIT CHARACTERIZATION FORMS

SUITE 1 (4 UNITS)

MASS MOVEMENT
DEGRADATIONAL UNITS

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	1-1
Unit	Symbol	:	——|——>
	Name	:	Bedrock Colluvium

Locational Factors

Topographic Site : on flanks and foot of slopes of bedrock hills; especially north and east slopes - lingering snow drift sites

Slope steepnesses : moderate to steep

Inferred Attributes

Bulk material composition : Sub-angluar debris & blocks rderived by weathering & frost heave from granitic/gneissic rock upslope. there can be a matrix of smaller fragments & sand.

Hydrologic situation : well drained

Active processes : slopewash, creep, flow & slide caused by frost action and erosion by melt waters

Thermal characteristics : see above

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	1-2
Unit	Symbol	:	———>
	Name	:	Blanket Solifluction

Locational Factors

Topographic Site : occurs on Unit M, in Christopher Inlet valley

Slope steepnesses : gentle to moderate slopes; micro relief of flowage lobes

Inferred Attributes

Bulk material composition : occurs on Unit M, Blanket till - see

Hydrologic situation : (see active processes)

Active processes : downslope flowage of saturated active layer

Thermal characteristics : (see Unit M)

- active layer (may be as little as 0.5 m)
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	1-3
Unit	Symbol	:	X
	Name	:	Talus

Locational Factors

Topographic Site : foot of cliff or steep slope

Slope steepnesses : steep to vertical cliff

Inferred Attributes

Bulk material composition : angluar & sub-angular rubble

Hydrologic situation : well-drained

Active processes : rockfall from cliff or steep rock slope

Thermal characteristics : permafrost should not occur in deposit

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	1-4
Unit	Symbol	:	K
	Name	:	Thermokarst

Locational Factors

Topographic Site : associated with Unit T. Fluvial terrace in upper valley of Christopher Inlet

Slope steepnesses : flat

Inferred Attributes

Bulk material composition : occurring in relatively fine-grained alluvial sediments

Hydrologic situation : see below

Active processes : melting of ground ice (exposed by fluvial erosion) causing local subsidences. The water in resulting ponds further melts the uppermost permafrost.

Thermal characteristics :

- active layer : n.a.
- ground ice : high ground ice content

SUITE 2 (4 UNITS)

GLACIAL AND ROCK UNITS

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

Unit	Number	:	2-1
	Symbol	:	M
	Name	:	Glacial Blanket

Locational Factors

Topographic Site : generally occurs on lower ground & bedrock depressions

Slope steepnesses : gentle & moderate slopes

Inferred Attributes

Bulk material composition : 2 meters thick, heterogeneous mass of non-sorted glacially transported crystalline rock debris - may have high fine fraction

Hydrologic situation : better drained than adjacent blanket solifluction units - but surface layer has high water content

Active processes : near continuous pattern of stripes indicates active layer solifluction creep

Thermal characteristics : see above

- active layer : may be as little as 0.5 m
- ground ice : much ground ice anticipated

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	2-2
Unit	Symbol	:	V
	Name	:	Glacial Veneer

Locational Factors

Topographic Site : associated with bedrock occurences

Slope steepnesses : full range from gentle to moderate & steep; micro relief mimics underlying bedrock surface

Inferred Attributes

Bulk material composition : 0.5 - 2 m thick, discontinuous layer of non-sorted debris
See Unit M

Hydrologic situation : may be better drained than related Unit M

Active processes : solifluction stripes not evident as in related Unit M

Thermal characteristics : see above

- active layer
- ground ice :little ground ice anticipated

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	2-3
Unit	Symbol	:	R
	Name	:	Bedrock

Locational Factors

Topographic Site : hills summits, interfluve & upper slopes

Slope steepnesses : ranges from steep escarpments to moderate & low slopes

Inferred Attributes

Bulk material composition : granitic gneiss

Hydrologic situation : generally well-drained, channelled water located in linear fracture systems

Active processes : frost wedging along joints

Thermal characteristics :

- active layer : 3 - 5 m
- ground ice : minor occurences in fissures

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	2-4
Unit	Symbol	:	W
	Name	:	Wetland

Locational Factors

Topographic Site : local depressions in overburden or rock basins; common in linear depressions in Singer area

Slope steepnesses : n.a.

Inferred Attributes

Bulk material composition : possibility of a thin organic mat covering poorly drained tills

Hydrologic situation : impeded drainage sites; local active layer saturation related to underlying permafrost impermeability

Active processes : (probably influenced by those of adjacent units)

Thermal characteristics :

- active layer
- ground ice : segregated ice may be anticipated under saturated sediments

SUITE 3 (4 UNITS)

HYDROLOGIC UNITS

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	3-1
Unit	Symbol	:	A and ---
	Name	:	Fluvial Active

Locational Factors

Topographic Site : in Christopher Inlet valley bottom

Slope steepnesses : flat

Inferred Attributes

Bulk material composition : bedded sequences of undifferentiated alluvial sediments

Hydrologic situation : a few minor streams & gullies of concentrated flow elsewhere in Christopher area - also local waterfall & rapids in a tributary stream

Active processes :
1 - flooding
2 - scouring & lateral bank erosino by water & ice

Thermal characteristics :

- active layer : deep
- ground ice : not anticipated

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	3-2
Unit	Symbol	:	T
	Name	:	Fluvial Inactive

Locational Factors

Topographic Site : low terrace above summer flow levels along main stream in Christopher Inlet valley

Slope steepnesses : flat

Inferred Attributes

Bulk material composition : layered sequence of fine sands & silts

Hydrologic situation : better drained than adjacent Unit A, but see below

Active processes : these areas are above Unit A flood zone but are probably flooded intermittently during spring peak runoff

Thermal characteristics :

- active layer : approx. 0.5 - 1 m
- ground ice : thermokarst evident locally suggests occurence of massive ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	3-3
Unit	Symbol	:	L
	Name	:	Boulder Field

Locational Factors

Topographic Site : melt water flow channels

Slope steepnesses : n.a.

Inferred Attributes

Bulk material composition : lag concentrate of cobbles & boulders of underlying & adjacent glacial till

Hydrologic situation : location in broad channels generally poorly drained

Active processes : frost heaving

Thermal characteristics : similar to surrounding units

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	3-4
Unit	Symbol	:	A/M
	Name	:	Reworked Till

Locational Factors

Topographic Site : in upper valley of Christopher Inlet area

Slope steepnesses : subdued surface of glacial till relief

Inferred Attributes

Bulk material composition : composite of possible surface veneer of fluvial deposit & underlying glacial till

Hydrologic situation : probably as per underlying Unit M

Active processes : probably as per Unit M

Thermal characteristics : probably as per Unit M

- active layer
- ground ice

SUITE 4 (9 UNITS)

ESTUARINE/MARINE ENVIRONMENT

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-1
Unit	Symbol	:	Z
	Name	:	Rock shoreline, smooth

Locational Factors

Topographic Site : narrow linear zones of exposed unsheltered shorelines, mainly in Singer area

Slope steepnesses : moderate to steep; limit or recurrent storm wave activity is indicated on photos by upper limit of vegetation - free bedrock

Inferred Attributes

Bulk material composition : local granitic/gneissic bedrock

Hydrologic situation : n.a.

Active processes : high wave energy has either removed unconsolidated materials or has allowed no deposition to take place

Thermal characteristics : n.a.

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-2
Unit	Symbol	:	G
	Name	:	Till Shoreline

Locational Factors

Topographic Site : in more sheltered sites than Z units, at heads of & along inner bays

Slope steepnesses : gentle slopeseaward

Inferred Attributes

Bulk material composition : similar to Unit M but may have surface concentration of coarse fraction

Hydrologic situation : well-drained

Active processes : wave energies less than on Z unit shorelines

Thermal characteristics : similar to Unit M but moderated by location

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

Unit	Number	:	4-3
	Symbol	:	H
	Name	:	Beach, raised

Locational Factors

Topographic Site : continuous, uplifted broad ridges at bay heads

Slope steepnesses : flat

Inferred Attributes

Bulk material composition : evidently coarser sand at Singer site than at Christopher Inlet. Polygons at latter suggest finer grained material

Hydrologic situation : well-drained

Active processes :
- no longer susceptible to marine processes, but possibility of storm washovers
- local wind erosion where little vegetation cover

Thermal characteristics :

- active layer
- ground ice : ice wedges anticipated in parts of Christopher Inlet deposit

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-4
Unit	Symbol	:	N
	Name	:	Beach, sandy

Locational Factors

Topographic Site : 1 - few pocket beaches in Singer area
2 - mainly shorelines of estuarine basin at head of Christopher Inlet

Slope steepnesses : level to low sloping; inland edge delimited by break in slope between sediment & steeper hillside

Inferred Attributes

Bulk material composition : grain sizes comparatively smaller than C Unit main source of sediment is glacial deposits which flank inner bays

Hydrologic situation : well-drained

Active processes : relatively low-wave-energy, 0 - 2 m wave-wash height

Thermal characteristics : ?

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-5
Unit	Symbol	:	C
	Name	:	Beach, cobbly

Locational Factors

Topographic Site : mainly short, isloated, pocket beaches located in rock structural fractures of Singer area

Slope steepnesses : low sloping

Inferred Attributes

Bulk material composition : material appears to be locally-derived cobbly/bouldery compared with N Unit

Hydrologic situation : well-drained

Active processes : moderate energy wave-wash height 2-6 m, including storm waves

Thermal characteristics : ?

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-6
Unit	Symbol	:	D
	Name	:	Beach discontinuous

Locational Factors

Topographic Site : outer shorelines of Singer area

Slope steepnesses : moderate to steep

Inferred Attributes

Bulk material composition : boulders, cobbles & pebbles from adjacent jointed bedrock

Hydrologic situation : n.a.

Active processes : high energy wave scour; wave-wash zone may attain 6 m height

Thermal characteristics : n.a.

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-7
Unit	Symbol	:	B
	Name	:	Boulder barricade

Locational Factors

Topographic Site : intertidal flats at heads of bays

Slope steepnesses : barricade height may be about 2 m & the ramparts appear exposed even near high tide

Inferred Attributes

Bulk material composition : sub-angular boulders derived from up-valley bedrock sources

Hydrologic situation : n.a.

Active processes : stable ice in intertidal zone during spring breakup presents a barrier to evacuation of stream bed loads

Thermal characteristics : n.a.

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-8
Unit	Symbol	:	F
	Name	:	Intertidal Flat

Locational Factors

Topographic Site : seaward of shorelines & beaches

Slope steepnesses : n.a.

Inferred Attributes

Bulk material composition : uncertain, 1: 10,000 photos taken at high tide
1: 40,000 photos taken at low tide

Hydrologic situation : n.a.

Active processes : - width of this zone appears to be a function of tidal range & bedrock slope
- may be little sediment deposition

Thermal characteristics : n.a.

- active layer
- ground ice

- Rivard

Geomorphological Analysis Map - Terrain Unit Characterization

	Number	:	4-9
Unit	Symbol	:	S
	Name	:	Offshore Sediments

Locational Factors

Topographic Site : 1 - seaward of intertidal flats
2 - in semi-enclosed basin estuarine lake at head of Christopher Inlet

Slope steepnesses : n.a.

Inferred Attributes

Bulk material composition : uncertain, 1: 10,000 photos taken at high tide occurences mapped are apparent turbid zones

Hydrologic situation : n.a.

Active processes : material in suspension or shallow bottom deposition in low energy brackish & saline water masses

Thermal characteristics : n.a.

- active layer
- ground ice

APPENDIX

THE PHYSICAL ENVIRONMENT OF NORTHEAST UNGAVA BAY COASTAL DISTRICT

A. REGIONAL GEOLOGIC STRUCTURES

The plateau of which the Singer/Christopher district is a part dissected by fracture-controlled valleys and arms of the sea, the inlets. Most local escarpments and depressions are aligned parallel to such lineaments.

The structural planes marked by these lineaments group into two distrinct trends:

A north-south trend localizes Polunin Inlet and the part of Christopher Valley upstream from the estuarine lake.

A northwest-southeast trend controls the axes of Christopher and Singer Inlets. Judging from the evidence of 1: 80,000 and 1: 40,000 photos, to the extent that the former group of fractures are faulted the movements may be normal (vertical) while the latter group may be wrench (lateral shear) faulted. Gneissic foliation evidently also influences the northwest-southeast trend. We are of the opinion that these structural/topographic grains are in part a consequence of the rifting of Canada from Greenland and in part related to the location of the district on the margin of the Ungava Basin.

Relatively horizontal scarp-bounded rock benches elevated about 25 meters on either side of the peninsula at the head of Christopher Inlet could be portions of erosion surfaces due to subaerial denudation or they may be raised shore platforms of marine erosion.

Although terrain units consisting of unconsolidated materials are largely independent of structural considerations, their general distribution is determined by the structural lines described above.

B. BEDROCK TYPES

Bedrock outcrops and bedrock underlying all other terrain units are composed of granites and gneisses which are typical of much of the Precambrian Canadian shield.

However, as suggested in the preceding and succeding sections, the physiographic evolution rather than the physical properties of these rocks has been dominant in the development of the local terrain.

C. UNCONSOLIDATED MATERIALS

The occurence of unconsolidated materials in this district is related to the last major geological episodes of terrain development in the eastern arctic, the pleistocene glaciations and post glacial marine transgression.

Glaciation

During the last glaciation, all of the eastern Ungava Bay coast was covered by ice flowing from the west off the bay area itself. About 10,000 years ago, the ice began to retreat from the district and wasted in a general southwesterly direction toward the center of the Labrador - Ungava peninsula. Judging from the paucity of glacial deposits in the area, there was probably little weathered bedrock mantle for the ice to erode.

Marine transgression

Although regional coastal valleys and inlets were partially drowned following the retreat of the ice, local evidence of this event is relatively slight. Unit H materials (raised beach) were deposited along shorelines which are presently about 25 -30 meters above sea level. These materials were deposited by waves when the earth's crust was still depressed by loading of ice and water forces. Subsequent isostatic recovery of the crust raised the deposits to their present position.

Another mapped line which demarcates marine submergence is that which delimits the lowest occurence of small areas of till on the elevated benches mentioned in the discussion of geologic structures.

D. ACTIVE SURFICIAL PROCESSES

A number of geomorphic processes are presently modifying the terrain in this part of the arctic:

- rock weathering
- mass movements
- patterned ground
- ground ice
- river and sea ice
- snow
- stream flow
- marine waves

The majority of these processes affect fluvial and glacial units A and M, some have associated hazards, and not all are visible on the airphotos.

Rock weathering

No evidence of this process is provided by the 1: 10,000 photos but it is mentioned here since the possiblity exists that some structures might be placed on bedrock (unit R) and a local hazard might occur as frost heaving of bedrock blocks.

Mass Movements

All or our Suite 1 units are the result of downslope movement (creep, sliding, slipping, rolling, falling) of material by self-weight or in conjunction with interstitial water. Much of this activity is thaw periodic. These unstable slope areas have been avoided in our selection of potentially suitable land.

An additional hazard might occur from rockfalls and slides in the vicinity of talus deposits designated as construction materials sources.

Patterned ground

This group of micromorphological phenomena has not been mapped in our analysis. They are indicative of frost action in surficial materials and are visible on the photos as stripes on occurences of glacial blanket (unit M) and polygon nets on the raised beach at the head of Christopher Inlet.

Ground ice

The presence of segregated ice masses in surficial materials is difficult to predict on the basis of airphoto evidence.

A potential hazard associated with such occurences would be the development of slope failures in glacial blanket materials if these were excavated and massive ice was intercepted. One area where ground ice is predicted with some assurance is in the units mapped as K/T, just downstream from the shallow lake at the head of Christopher Inlet valley. Here the evidence of degradation of the ground ice underlying the alluvial materials is provided by the presence of thaw (thermokarst) lakes.

River and sea ice

As river ice moves downstream at breakup there is abrasion of unconsolidated banks. This erosion is not produced so much by floating ice as by ice stranded on banks by the spring high water stage. When this ice melts and slides back into the water it carries much sediment with it.

Boulder barricades (Unit B) occuring in both Singer and Christopher Inlets are developed by stable near shore sea ice masses. These form a local restriction to boat travel (in addition to intertidal flats) as they can be crossed only at high tide if at all.

Snow

Water percolating and freezing into till material at the rear of snowbanks surviving in protected locations will incorporate some of the mass into solifluction movement when the bank eventually melts. This process creates erosive depressions called nivation hollows. Small local occurences of this form have been included with either blanket solifluction lobes or bedrock colluvium in our mapping.

Stream flow

Stream flow in the main Christopher Inlet valley has eroded some glacial materials (Unit L boulder field and Unit A/M reworked till) and created 2 types of deposits: deposits that are flooded every year or two (Unit A) and those that are not (Unit T). The former appear to be barely above water level at the time of photography. the latter are perched above the present flood zone but may be susceptible to inundation following heavy winter snowfalls.

Marine waves

The terrain units belonging to the estuarine/marine environment may be divided into three groups:

- shorelines of erosion - - - - - - - - - Units Z and G
- shorelines of deposition - - - - - - - Units N, C and D
- intertidal units - - - - - - - - - - - - - Units B, F and S

PRELIMINARY ARCHEOLOGICAL SURVEY IN THE SINGER INLET REGION IN CONJUNCTION WITH THE PROJECT TO RELOCATE THE COMMUNITY OF KILLINIQ

Presented to

Makivik Research Department

by

Luc Litwinionek

Avataq Cultural Institute

April 1986

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Summary

This document contains the results of a preliminary archeological survey conducted in the Singer Inlet and Christopher Inlet regions, on the east coast of Ungava Bay, Northern Québec. The survey was commissioned by Makivik Corporation in conjunction with the planned relocation of the community of Killiniq to Tapangajuk.

Six new sites were found: four contained evidence of multiple occupations associated with contemporary and/or historic Inuit, and in two cases, Dorset groups. The two other sites belong to an undertermined paleoeskimo culture.

The study was carried out in areas selected for construction of facilities for the new Inuit village of Taqpangajuk. Thus, all the sites will eventually be disturbed, if not completely destroyed, by the construction work as planned. A number of measures to mitigate the effects of the work and a systematic archeological inventory of the region are recommended.

Acknowledgements

The transportation and logistics of the archeological survey were organized by the Project Coordinator, Mr. William B. Kemp of Makivik Corporation. Mr. Colin Bird, also of Makivik, provided these services in the field.

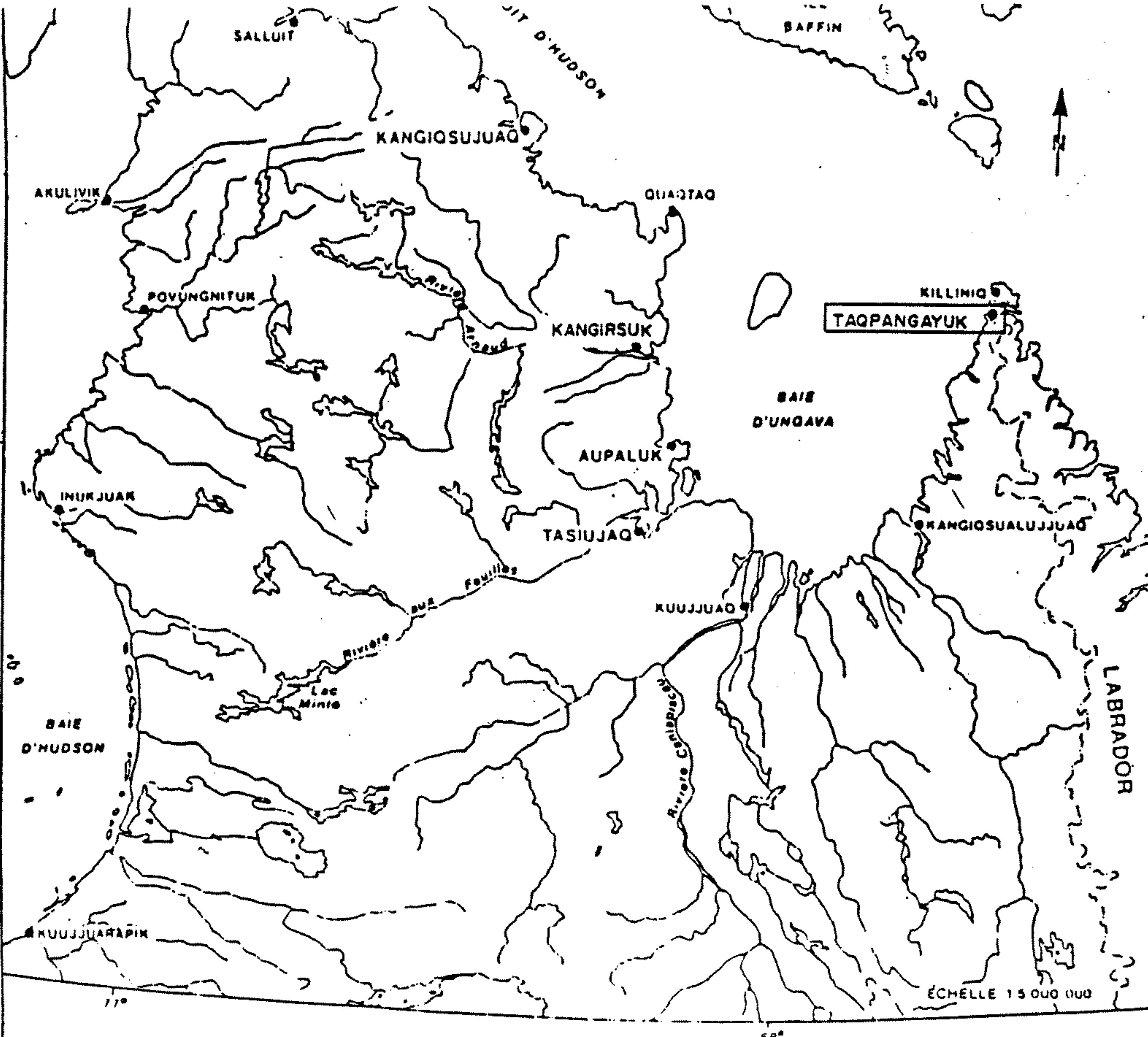
The team of investigators went from Kuujjuaq to Singer Inlet aboard the Naturalik, which was owned and operated by Mr. Charlie Gordon, with the assistance of his son Willie and Mr. Bobby Snowball. We would like to express our special gratitude to Mr. Norman Snowball for his help in the field.

We want to thank all these people for their assistance in the archeological survey.

1.0 INTRODUCTION

In September 1985, the Makivik Research Department commissioned Avataq Cultural Institute to design and carry out an archeological field survey in Singer Inlet and Christopher Inlet. The survey was in conjunction with the feasibility study on the planned relocation of Inuit from the community of Killiniq to Taqpangajuk and it took place during the field investigation, between September 7 and 17. During this 10-day period, a number of zones previously selected as potential locations for facilities for the planned village were surveyed according to standard archeological procedures. In this section, the findings that related directly to the feasibility of Tagpangajuk are presented. The need for an archeological survey prior to any development work is required by the Ministry of Cultural Affairs and by the impact assessment process. A more detailed analysis has also been completed and submitted ot the Ministry of Cultural Affairs which is responsible for permits and supervision.

The territory studied is on the northeast coast of Ungava Bay in Ungava County, Northern Québec (Figure 1), between 60°04' and 60°06'N and 64°57' and 65°05' W. It contains two large bodies of water, Singer Inlet and Christopher Inlet (Figure 2). The survey of Singer Inlet was limited to the northern part of the inlet, a 4 km^2 peninsula bordered on the west and north by Ungava Bay and connected to the continent by an isthmus to the east. A 1 km^2 area in the center of the peninsula was covered, and three zones were defined (Figure 3). The first, on the south side, was defined by two projections of land northward into the Bay. Opposite this zone, i.e. to the west, is the second, a somewhat flatter area that can be described as a hillside, gently sloping towards the east. The third, at the western extermity of the isthmus, is made up of a beach and a small bay with an elongated "U" shape. Previous archeological surveys in the Singer Inlet area were limited to brief reconnaissances by air or boat. There has not been any systematic survey or planned excavation. A review of the available literature indicates that only one site in the study region has been registered with a Borden site designation (Aménatech, 1984).



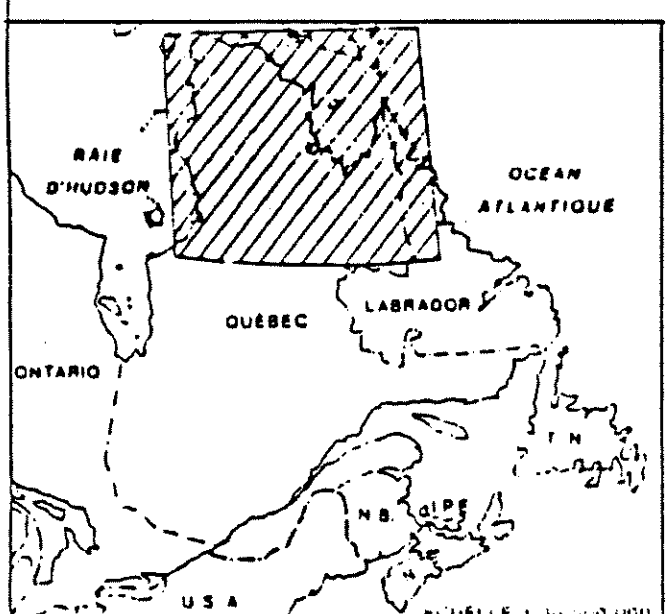


FIGURE 1

LOCALISATION DU TERRITOIRE A L'ETUDE

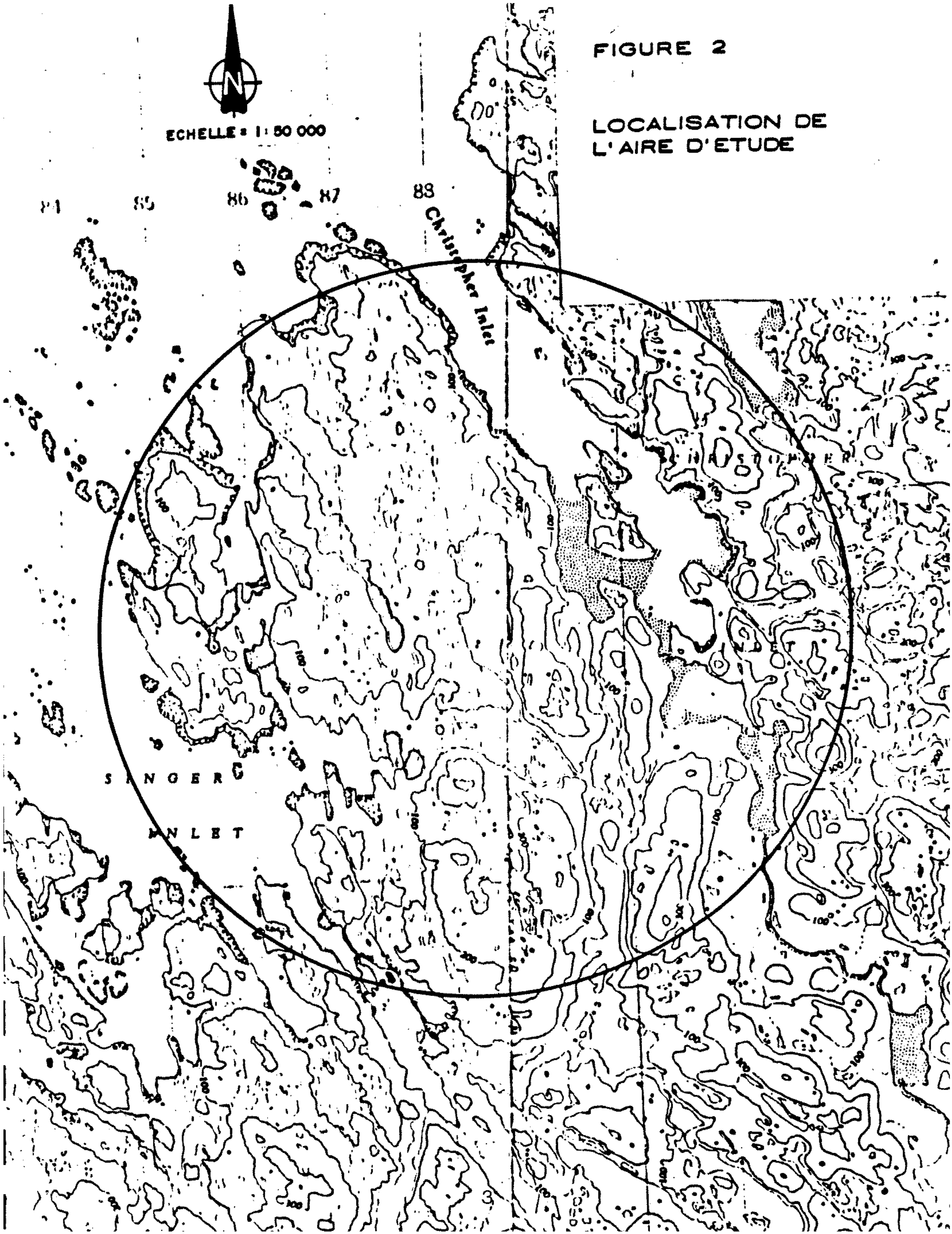


FIGURE 2

LOCALISATION DE L'AIRE D'ETUDE

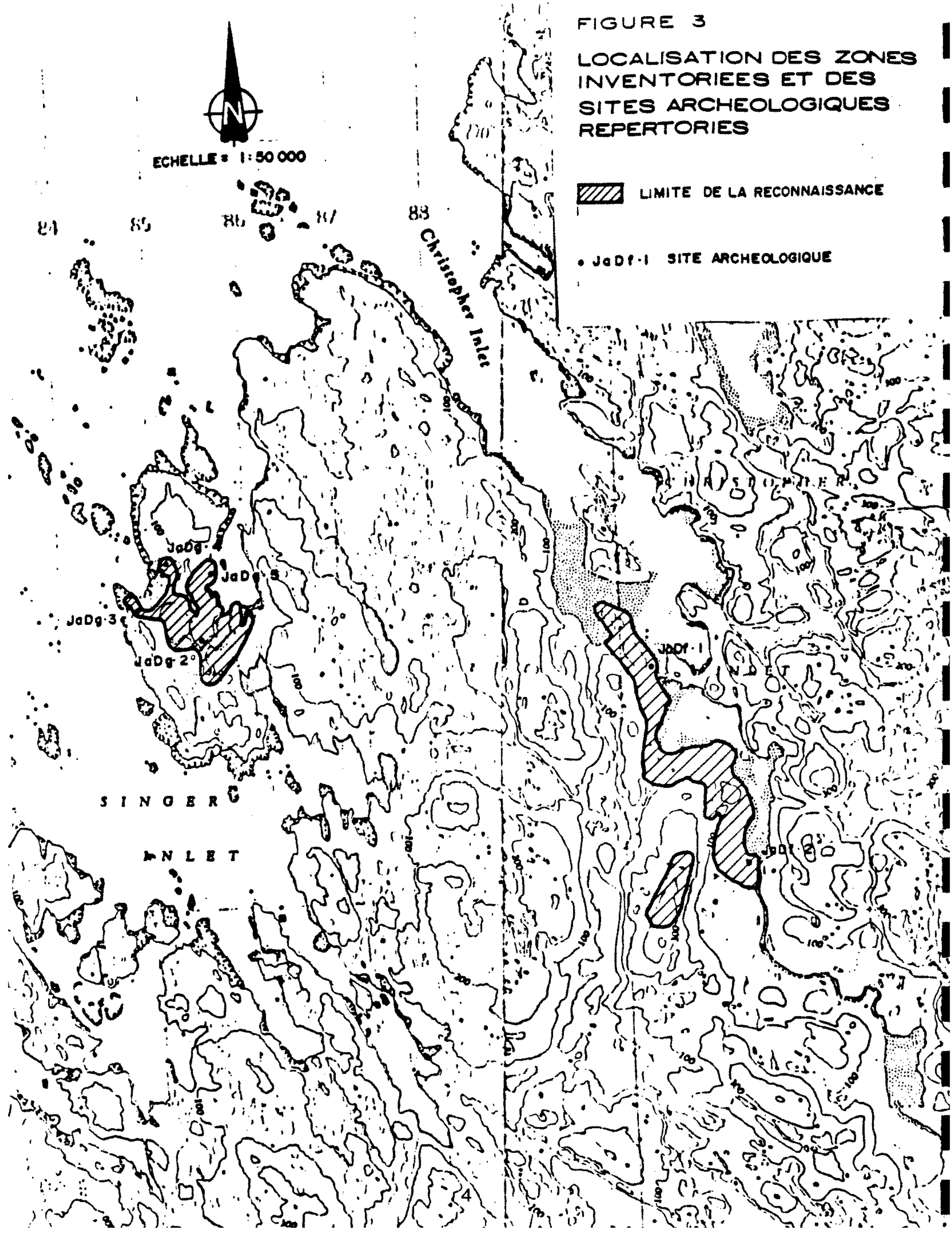


FIGURE 3
LOCALISATION DES ZONES INVENTORIEES ET DES SITES ARCHEOLOGIQUES REPERTORIES
LIMITE DE LA RECONNAISSANCE
• JaDf-1 SITE ARCHEOLOGIQUE
N
ECHELLE : 1:50 000
84
85
86
87
88
Christopher Inlet
SINGER
INLET
JaDg-4
JaDg-5
JaDg-3
JaDg-2
JaDf-1
JaDf-2
100
200

2.0 METHODOLOGY

2.1 Sampling Techniques

All the localities inventoried were first visually inspected for their archeological potential. Second, 50 cm X 50 cm test pits were excavated in specific sites within these localities and in all the archeological sites located from the visual inspection. The pits were oriented north-south and were excavated by trowel. The number of pits and the interval between each one varied from place to place and according to site. In the first case, the pits were excavated based on the surface area, the geomorphological phenomena and the soil characteristics. No systematic sampling procedure was used: places intuitively considered to have archeological potential were selected for testing. Most of the test pits were located in or near presumed habitation structures. The emphasis was on collecting data that could provide an insight on the time and cultural occupation of the site.

2.2 Data Registration

Standard methods of registration were used. Any cultural materials recovered on the surface were collectively registered according to concentration, structure and site. Any cultural material found in the test pits was registered according to quadrant (25 cm X 25 cm), and stratigraphic horizon. Man-made objects were registered individually by their horizontal position relative to the north and east walls of the test pit and vertical position relative to ground level. All material was given a catalogue number and then put into labeled bags.

A detailed map drawn to scale was prepared for every site. These maps include the location of surface collections, text pits and structures. The general topographic features adjacent to the site were also included on these maps. When test pits were dug, cultural horizons, if present, were identified on a stratigrapic profile that could then be compared for each site.

Finally, the zones inventoried, sites discovered and the habitation structures found on each site were photographed to complete the data registration.

3.0 DESCRIPTION OF THE ARCHEOLOGICAL SITES

A total of six archeological sites were inventoried during the preliminary survey of the region (Figure 3). Two of these sites were found in Christopher Inlet, while the other four were located at Tagpangajuk.

Two of the sites contained only prehistoric materials, two had evidence of multiple-component prehistoric, historic and contemporary occupation and two others suggested only one historic or contemporary Inuit occupation (Table 1).

3.1 Tagpangajuk Archeological Sites

The four archeological sites discovered in the Singer Inlet region are all located on 5 m high terraces near small interior or exterior bays that form the coastal configuration of Tagpangajuk.

TABLE 1
LOCATION AND BRIEF DESCRIPTION OF THE ARCHEOLOGICAL SITES FOUND

Site	Geographic Coordinates	U.T.M.	Map	Altitude	Distance/ Shoreline	Cultural Affiliation
JaDf-1	N60°05'10" W64°58'18"	20VLB903624	25 A/2W	4	1-10	Historic and Contemporary
JaDf-2	N60°04'02" W64°57'08"	20VLB913604	25 A/2W	14	50	Undetermined Paleoeskimo
JaDg-2	N60°05'24" W65°03'16"	20VLB857630	25 A/3E	4	2-10	Undetermined Paleoeskimo
JaDg-3	N60°05'32" W65°04'08"	20VLB849633	25 A/3E	3	5-20	Dorset, Historic & Contemporary Inuit
JaDg-4	N60°05'46" W65°03'47"	20VLB856637	25 A/3E	4	10-50	Dorset, Historic & Contemporary Inuit
JaDg-5	N60°05'33" W65°03'13"	20VLB854633	25 A/3E	5	10	Contemporary Inuit

3.1.1 JaDg-2

Location

Geographic Coordinates	:	N : 60°05'24" W: 65°03'16"
MAP: 25A/2 0-W	:	U.T.M. : 20VLB857630
Altitude (m.a.s.l.)	:	4
Distance/shoreline (m)	:	2-10
Cultural affiliation	:	Undetermined Paleoeskimo

JaDg-2 is on a small terrace with a maximum width of 20 m, which parallels an interior bay north to south. The site covers 1000 m^2. The terrace is bordered on the west by a rocky outcrop and on the east, by the bay. The site is composed of alluvial deposits, probably of marine origin, and several big boulders and erratics are scattered over the surface. There is a relatively thick plant cover of lichens and sphagnum.

Sampling and Stratigraphy

Ten test pits were excavated on the site, and all were sterile. Seven were excavated on the terrace and three inside habitation structures. As in the other cases, the stratigraphic profile is rather simple :

- a relatively thick layer of vegetation, 15 cm deep;
- compact clayey humus, 20 cm thick;
- coarse brownish sand of marine origin.

Habitation Structures

Four habitation structures were noted on this site (Table 2) and were identified as tent rings. They all are oval and measure 3 m X 2.50 m on the average. They are defined by rock edges, that are partly hidden by the vegetation. Two of these structures are at the southern end of the terrace, while the two others are some 80 m further north.

TABLE 2
SUMMARY OF HABITATION STRUCTURES IDENTIFIED IN SITE JaDg-2

Structure	Context	Type	Form	Dimensions	Remarks
1	Alluvial deposits	tent	oval	3.0 m x 2.75 m	
2	Alluvial deposits	tent	oval	3.0 m x 2.5 m	
3	Alluvial deposits	tent	oval	3.5 m x 3.0 m	
4	Alluvial deposits	tent	oval	3.0 m x 2.75 m	

3.1.2 JaDg-3

Location :		
Geographic coordinates	:	N : 60°05'32" W : 65°04'08"
MAP : 25A/3 E	:	U.T.M. : 20VLB8496
Altitude (m.a.s.l.)	:	3
Distance/shoreline (m)	:	5-10
Cultural Affiliation:	:	Prehistoric Dorset, Historic and Contemporary Inuit

The terrace where JaDg-3 is located runs along a horseshoe-shaped bay that opens on Ungava Bay. It is formed primarily of sand deposits of marine and *eolian* origin. The topography of the terrace is marked by eroded areas which are still being affected by the winds. The site itself is at the southern end of the terrace, and is approximately 3000 m^2. It is bordered by a rocky outcrop to the west and by the edge of the terrace to the east. The vegetation is relatively thin and irregular because of the sandy nature of the deposits and wind action. In certain places, there are sphagnum and lichens whereas in others, there are only creeping species, such as green alder, scattered on the sand.

Sampling and Stratigraphy

Fifteen test pits were excavated on this site. Five were inside habitation structures while 10 others were excavated on the terrace itself. They were all sterile. The stratigraphic profile is uniform from one pit to another:

- 5 cm thick plant cover;
- a 10 cm layer of humus with organic deposits mixed with sand;
- a fine sand horizon of eolian nature, 15 cm thick;
- a coarser sand horizon of marine origin.

Habitation Structures

Twenty-one habitation structures, all defined as tent rings, were noted on this site. Four are prehistoric, six are associated with the historic period and 11 are contemporary (Table 3). The four prehistoric habitation structures are located at the northwest end of the site. They are oval and their average dimensions are 3 m X 2.50 m. These structures are defined by alignments of small rounded stones often partly covered by vegetation, in which case their shape is more difficult to determine. However, other alignments were observed, but we were not able to trace their border exactly.

Most of the six historic habitation structures are in the center of the site. However, two were noted at the east extremity, about 75 m away from the principal area of the site. These structures are composed of rather big flat stones and are either circular or rectangular. The circular structures have a mean diameter of 3.50 m and the average dimensions of the rectangular structures are 3 m X 2.75 m. It seems that the rectangular structures are older since they are less well conserved than the circular structures.

The eleven contemporary habitation structures are generally composed of an inner and outer edge of big stones. They are all circular, and their respective average diameter is homogeneous, that is 3.5 m for the inner edge and 5 m for the outer edge. These structures are found all over the site.

TABLE 3
SUMMMARY OF HABITATION STRUCTURES IDENTIFIED IN SITE JaDg-3

Structure	Context	Type	Form	Dimensions	Remarks
1	Beach terrace	tent	circular	4.0 m diameter	
2	Beach terrace	tent	circular	3.5 m diameter	
3	Beach terrace	tent	circular	3.5 m diameter	
4	Beach terrace	tent	oval	3.0 m x 2.75 m	
5	Beach terrace	tent	oval	2.75m x 2.5 m	
6	Beach terrace	tent	oval	3.0 m x 2.5 m	
7	Beach terrace	tent	circular	4.0 m diameter	
8	Beach terrace	tent	circular	4.0 m diameter	
9	Beach terrace	tent	circular	4.0 m diameter	
10	Beach terrace	tent	oval	2.5 x 2.8 m	
11	Beach terrace	tent	circular	4.0 m diameter	
12	Beach terrace	tent	circular	3.5 m diameter	
13	Beach terrace	tent	circular	3.5 m diameter	
14	Beach terrace	tent	oval	3.0 m x 2.8 m	Stone pavement in back
15	Beach terrace	tent	circular	3.0 m diameter	Stone pavement in back
16	Beach terrace	tent	circular	3.0 m diameter	
17	Beach terrace	tent	circular	3.0 m diameter	
18	Beach terrace	tent	circular	3.5 m diameter	
19	Beach terrace	tent	circular	3.5 m diameter	
20	Beach terrace	tent	circular	3.0 m diameter	
21	Beach terrace	tent	circular	3.0 m diameter	

Interior Structures

Some interior structures were observed in several habitation structures on the site. Three historic structures have flat stone pavements inside. The position of the pavements varies from one structure to another. Some are at the back of the structure whereas others are in the central section of the structure, thus covering its entire length. The pavements vary in width from 75 cm to 1.25 m.

Some contemporary structures contained a few stones arranged either at the center or at the front. Most likely, according to our field observations, these stones served as a base for a heating stove.

Hearth

A hearth was noted in the southwest section of the site: a concentration of burnt grease and bones was found on the surface of the sand in one of the exposed portions of the site. This 1 m diameter concentration was composed of clumps of burnt grease containing small bones and bone fragments. These ecofacts were distributed stratigraphically to a depth of 5 cm in the eolian sand horizon. The combustion area did not appear to be directly associated with any of the habitation structures registered, and it proved difficult to identify its period. On the other hand, the presence of lithic materials 1 m from this area suggests that it corresponds to an element from prehistoric occupation of the site. A sample of grease and a few bones were collected to enable us to make a chronological determination.

Lithic specimens

Seven fragments were collected at the surface. They were all found in the northern part of the site on the sand, scattered over a radius of 2m. All the fragments were produced from ramah quartzite, six of which were translucent and one smoked. These surface lithic specimens could not be related to any habitation structures.

3.1.3 JaDg-4

Location

Geographic coordinates	:	N : 60°05'46" W : 65°03'47"
MAP : 25A/3 E	:	U.T.M. : 852634
Altitude (m.a.s.l.)	:	4
Distance/shoreline (m)	:	10
Cultural affiliation	:	Prehistoric Dorset, Historic and Contemporary Inuit

JaDg-4 is located on the same terrace as JaDg-3 at the other side of the bay. At this point, the terrace is bordered to the east by a small ascending valley and to the north by a rocky outcrop. On the southeast side of the terrace, there is also a small, dried-out lake. The site covers most of the terrace and has a surface area of 3500 m^2. The topography is quite irregular, the terrace being shaped by the wind. In spite of this eolian phenomenon, the plant cover is good and there are fewer deflation areas than elsewhere on the terrace.

Sphagnum and lichens are present, the former seeming more abundant than elsewhere on the terrace.

Sampling and Stratigraphy

Only 5 test pits were excavated on this site and they were all sterile. The stratigraphic profile was similar to that observed all over the terrace, that is :

- plant cover averaging 10 cm in thickness;
- compact and clayey humus, 5 cm thick;
- fine sand of eolian origin, 15 cm thick;
- coarser sand of marine origin.

Habitation Structures

Twenty habitation structures, all tent rings, were noted on this site (Table 4). Four are prehistoric, six historic and ten contemporary.

The tent rings associated with prehistoric occupation are in the northeast portion of the site. They are oval in shape and measure 3 m X 2.5 m on the average. They are defined by alignments of small rounded stones partly hidden by the vegetation. Other alignments of stones were observed in the locality but it was not possible to identify them as tent rings.

Historic tent rings are in the central portion of the site. They are all circular and their average diameter is 3 m. These rings are formed of flat stones, more or less angular. Their state of conservation varies from one structure to another, and this is probably related to their age. The contemporary tent rings are scattered all over the site. As in the case of other sites found with such habitation structures, they are composed of an inner and outer circle made of big stones and measure 3.50 m in diameter at the inner circle and 5 m at the outer circle.

TABLE 4
SUMMMARY OF HABITATION STRUCTURES IDENTIFIED IN SITE JaDg-4

Structure	Context	Type	Form	Dimensions	Remarks
1	Beach terrace	tent	oval	2.5 m x 2.0 m	
2	Beach terrace	tent	oval	2.0 m x 2.5 m	
3	Beach terrace	tent	oval	3.0 m x 2.75 m	
4	Beach terrace	tent	oval	3.0 m x 2.75 m	
5	Beach terrace	tent	oval	3.5 m x 3.25 m	
6	Beach terrace	tent	circular	4.5 m	
7	Beach terrace	tent	oval	3.5 m x 3.0 m	
8	Beach terrace	tent	circular	3.5 m	
9	Beach terrace	tent	oval	3.3 m x 3.0 m	
10	Beach terrace	tent	oval	3.5 m x 3.0 m	
11	Beach terrace	tent	circular	3.5 m	
12	Beach terrace	tent	oval	3.5 m x 3.25 m	
13	Beach terrace	tent	oval	3.5 m x 3.25 m	
14	Beach terrace	tent	circular	4.0 m	
15	Beach terrace	tent	circular	3.5 m	
16	Beach terrace	tent	circular	3.5 m	
17	Beach terrace	tent	circular	3.5 m	
18	Beach terrace	tent	circular	3.5 m	
19	Beach terrace	tent	oval	3.5 m x 3.25 m	
20	Beach terrace	tent	circular	5.0 m	

3.1.4 JaDg-5

Location

Geographic coordinates	:	N : 60°05'53" W : 65°03'13"
MAP : 25A/3 E	:	U.T.M. : 8576633
Altitude (m.a.s.l.)	:	5
Distance/shoreline (m)	:	10
Cultural affiliation	:	Contemporary Inuit

JaDg-5 is located on a vast terrace which extends on the west side of an interior base leading to the northern extremity of Singer Inlet. To the west, the terrace goes uphill and is bordered to the south by a rocky outcrop. The topography is uneven, the plant cover being very thick and mainly composed of sphagnum. The site is on a small projection in the center of the terrace and covers only 300 m ^{2}.

Sampling and Stratigraphy

Only one test pit was excavated on this site, and no cultural materials were found. The stratigraphic profile is as follows:

- surface vegetation, 10 cm thick;
- compact clayey humus, 15 cm thick;
- alluvial sand of marine origin.

Habitation Structures

A portion of this contemporary site was occupied in the summer of 1985. It is composed of small rectangular hut built of wood planks and measuring 2 m by 6 m, one tent covered with an hexagonal canvas about 3 m in diameter. In addition, there is a tent ring about 6 m to the east; it is composed of an inner circle of big stones and has a diameter of 4 m. This tent ring seems older and probably dates back to previous occupations of this site.

TABLE 5
SUMMMARY OF HABITATION STRUCTURES IDENTIFIED IN SITE JaDg-5

Structure	Context	Type	Form	Dimensions	Remarks
1	Alluvial deposits	cabin	rectangular	6 m x 2.0 m	Made of wood
2	Alluvial deposits	tent	hexagonal	4.0 m	Canvas still in place
3	Alluvial deposits	tent	circular	4.0 m	

4.0 PRELIMINARY INTERPRETATIONS

This section contains an attempt to establish the cultural chronology of the study area based on the findings of the archeological survey. In addition, interpretations of the possible nature of this territory's occupations are presented.

4.1 OCCUPATION CHRONOLOGY

With respect to prehistoric occupation, there are no strong indications that Paleoeskimo groups were present in the region. However, we believe that the prehistoric sites JaDg-2 at Singer Inlet and JaDf-2 at Christopher Inlet may be fairly old since the poor state of conservation of the habitation structures observed on JaDg-2 suggests ancient occupation of the site. As for JaDf-2, its geographic position and the lithic specimens found on the surface suggest a similar ancient occupation. Evidence has been reported of a pre-Dorset presence in the locality of Nunangoq, some 50 km north of the territory (Jordan 1985). Moreover, the Labrador side of the bay contains indications of a pre-Dorset occupation in the Nain and Okak regions (Fitzhugh 1977). Thus, it seems quite possible that such groups may have sporadically occupied the study area.

The lithic materials found on site JaDg-3 leave no doubt as to the presence of Dorset groups here. Although we only found six worked fragments, there is reason to believe that they correspond to Dorset lithic debris. The raw material used, ramah quartzite, is closely related to the type of raw material found in the Dorset lithic collections for neighboring regions. The presence of these groups has also been established for the region of Nunangoq and the northeast coast of Labrador. Although we found no lithic specimens on site JaDg-4, the similarity between the habitation structures on JaDg-4 and JaDg-3, as well as the similarity in the relative distribution of structures within the sites strongly suggest that the same Dorset groups occupied both these sites.

Use of this territory does not seem to have ended at the prehistoric period, as indicated by historic habitation structures in sites JaDg-3, JaDg-4 and JaDf-1. It also seems that there was no marked transition between the two periods since prehistoric and historic structures were present simultaneously on sites JaDg-3 and JaDg-4. It can be assumed that this occupation continued from the prehistoric to the historic period.

It is likely this occupation continued up to our times. The archives mention the presence of Inuit families in the region in 1811 (Vézinet 1982). From the beginning of the century, a permanent population was in the area and continued to use the study area up to the present day (Vézinet 1982). There seems to be a desire to perpetuate use of the territory, as camps, such as those found at JaDg-5, were still occupied at the time of our visit.

4.2 NATURE OF THE OCCUPATION

The northeast coast of Ungava Bay poses certain topographic and physiographic limitations on the number of sites suitable for human occupation. Numerous reefs, enclosed fjords and a steep shoreline make access to areas where camps could be set up extremely difficult, if not impossible. Despite the fact that this territory restricts the range of areas that can be occupied, the variety of animal species available on the coast justifies such a use of the territory.

From this information, it is highly likely that occupation was concentrated in specific places and was repeated throughout the ages. Although intensive, use of the territory was limited to certain areas, and the stays were brief. The archeological sites noted in the survey tend to confirm this hypothesis. The presence of sites, such as JaDg-3 and JaDg-4, where prehistoric, historic and contemporary habitation structures were found suggest such an occupation. Furthermore, this apparent restriction in the options for an occupation site is well illustrated by the geographic situation of sites JaDf-1 and JaDf-2.

As a result of these physiographic characteristics, it is believed that part of the Ungava coast was occupied very locally, if not in a very specific way. This suggests that a site may contain a mixture of cultural evidence illustrating the sequence of occupation in the study area, and that this aspect should be considered in future studies.

5.0 RECOMMENDATIONS

- Given the findings of the archeological survey and the fact that there is only one preliminary description of the archeological sites;

- Given the existence of a number of zones with high archeological potential in the territory under study and that the archeological sites registered, as well as most of the zones with high archeological potential, will be disturbed, if not actually destroyed, by the infrastructures that will be built for the new village of Taqpangajuk;

- And lastly, given the timetable set for the development work;

5.1 ARCHEOLOGICAL SURVEY

It is recommended:

- That a systematic archeological survey be prepared for the Singer Inlet region as soon as possible.

The inventory should cover all the sites defined in the development plan for the new village of Taqpangajuk. The study should conform to the guidelines oand technical procedures agreed upon by Avataq Cultural Institute and the Ministère des Affaires culturelles. All the sites planned for construction of the infrastructures for the future village must be inspected, including the sites of the administrative, commercial and residential buildings, the airport, the landing stage, warehouse, access roads, borrow pits.

An intensive study of the archeological sites that have been registered in the study region should also be made.

Finally, the survey should include sites considered to have major archeological potential that are in the vicinity of the community and which could be adversly affected by normal patterns of land use and activity.

This survey must be done as soon as possible. Then, measures can be implemented to mitigate adverse effects at these sites and zones before the development work begins. This might involve adjusting plans, to avoid direct disturbances, undertaking salvage excavations on the threatened sites and establishing protections for sites not directly threatened yet which are near construction, staging and potential activity areas..

To facilitate the work and minimize costs, some prior research is needed.

5.2 ARCHEOLOGICAL POTENTIAL

It is recommended:

- That a study of the territory's theoretical archeological potential be carried out before the field inventory and mitigating measures are begun.

This study will make it easier to organize the survey in a coherent way. Thus, it should be designed to define the most likely places for human occupation by prehistoric, ethnohistoric and contemporary Inuit population for the area of potential impact. The results will be helpful in planning the itinerary, schedule and budget for the field work. The study of archeological potential will also enable the importance of the Taqpangajuk sites to be evaluated within the context of the regional occupation and culture history.

The center coastal area northeast of Ungava Bay is suggested for study. This region extends from Bell Inlet in the south to Coates Inlet in the north and includes Singer and Christopher Inlet. Until now, only sporadic archeological studies have been made of the east coast of Ungava Bay and surrounding regions. Although these studies did not provide much information, they did identify some important archeological sites.

5.3 STUDY ORGANIZATION AND CONTROL

It is recommended that :

- All Inuit organizations, especially the community of Killiniq, participate directly in all aspects of the planning and actual archeological work that will be conducted by Avataq Cultural Institute under the permit from the Ministère des Affaires culturelles.

The purpose of this recommendation is to have the Inuit people concerned participate in the studies on their own heritage. It involves close cooperation with the community as a participant and planner of the studies.

5.4 DISTRIBUTION AND USE OF INFORMATION

If the above recommendation is implemented, it is also recommended that :

- All information obtained from the planned studies and archeological survey be distributed to the community of Killiniq in particular and to the Inuit of Northern Québec in general. This would involve use in the local school and the preparation of a culture history of the region for both the school and non-school population.

Archeological data are generally distributed only to archeologists involved in research into the North's past, and the residents of the areas studied are rarely given information about their heritage.

It is by this type of approach that the archeological data collected can become, not only accessible to the Inuit, but actually their possession, as they should be. If we want the population to be more than just a beneficiary and to eventually become the driving force for such studies, it seems clear that all available information should be made intelligible and be returned to the Inuit community.

6.0 STAFF

The field work was done by Mr. Luc Litwinionek, Assistant Archeologist for Avataq Cultural Institute. Mr. Litwinionek also wrote the original report. Mr. Maurice Portnoff, a cartographer with Makivik Corporation, reproduced the maps, and Mrs. Paule Lamarche typed the text and tables.

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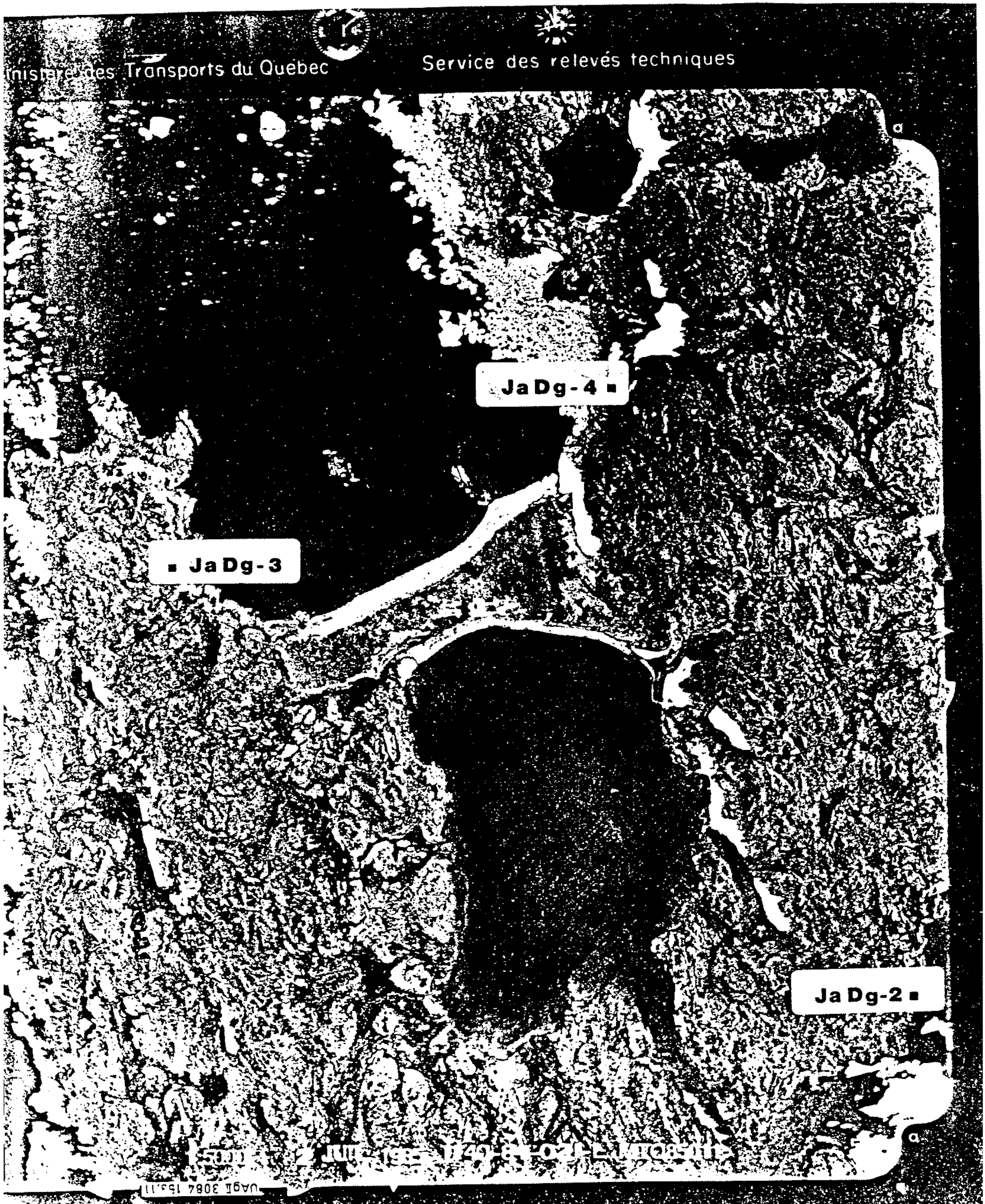
APPENDIX 1

LOCATION OF ARCHEOLOGICAL SITES ON THE AVAILABLE AERIAL PHOTOGRAPHS


Ministère des Transports du Québec
Service des relevés techniques
JaDg-4
JaDg-3
JaDg-2