Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

REPORT RAPPORT

Canada - USSR Technical Exchange
Theme III - 2, Water and Sanitation
Tour of Canadian North
September 24 to October 7, 1985

J.R. Benner
October 22, 1986

Canada

EA-HQ-86-65

Services techniques et marchés

Technical Services and Contracts

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Report on the Visit of Soviet Specialists Regarding the Canada - USSR Technical Exchange Theme III - 2, Water and Sanitation September 24 to October 7, 1985

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1.0 Introduction

1.1 Purpose

The purpose of this report is to summarize the technical elements included in the tour of the visiting Theme III - 2 soviet specialists carried out under the program of Canada - USSR Technical Exchange. Special emphasis is directed toward those facilities visited where it was felt that the technology employed in northern communities of the N.W.T. or the Yukon represents a possible improvement to present Departmental practices in similar situations.

1.2 Background

In April 1984 an agreement was signed between Canada and the Soviet Union regarding a program of scientific exchanges between the two countries. Four themes were identified for scientific and technical cooperation.

The subjects of the four themes are as follows:

Theme I - Geosciences and Arctic Petroleum
Theme II - Northern Environment
Theme III - Northern Construction
Theme IV - Ethnography and Education

Theme III is subdivided into two sections as follows:

Theme III - 1 Buildings
Theme III - 2 Water and Sanitation

This and other federal departments as well as the territorial governments are participating in these exchanges.

Mr. Larry Elkin, Deputy Minister, Department of Public Works, G.N.W.T., is the Canadian chairman for the Theme III exchanges and Mr. R. Doherty, Assistant Deputy Minister, Department of Public Works, G.N.W.T. is the leader for the Theme III - 2 visits. Mr. J. Benner, A/Director, Technical Services Directorate, Technical Services and Contracts Branch, DIAND is the sole federal representative on the Canadian delegation for Theme III - 2. A complete list of Canadian and USSR participants in this exchange are given in Section 1.4 of this report.

CANADIAN DELEGATION (cont'd)

J. Cormie	Director Community and Transportation Services Y.T.G.
J. Benner	A/Director Technical Services Directorate Technical Services and Contracts Branch, DIAND
S. Cheema	Project Manager Engineering Division Public Works and Highways G.N.W.T.
L. Goit	Tour Coordinator Public Works and Highways G.N.W.T.
S.N. Tsivunin	Canadian Interpreter

2.0 Tour Schedule

The Soviet delegation arrived at Mirabel International Airport Monday, September 23 and departed from the same airport for return trip to Russia on October 7, 1985. While in Canada the delegation visited the following communities where technical programs had been arranged. Part 3.0 of this report provides details of these programs.

Date	Location
September 23	Arrive Mirabel/Ottawa
September 24 and 25	Ottawa
September 26	Lake Harbour
September 27	Frobisher Bay
September 28	Pagnirtung
September 29	Ranklin Inlet
September 30	Inuvik
October 1	Dawson City
October 2	Yellowknife
October 5	Travel to Ottawa
October 6	Ottawa
October 7	Depart Mirabel

3.2 Lake Harbour

The visit to the Hamlet of the Lake Harbour on the afternoon of Thursday, September 26 consisted of a tour of the National Health and Welfare Nursing Station which was recently constructed and a tour of community and staff housing. A community profile for Lake Harbour is found in Annex B.

Lake Harbour is a small isolated community with a population of about 300 people located on the southern end of Baffin Island. Water delivery and sewage collection are by truck with sewage collection consisting of holding tank pump-out or pick-up of bagged sewage. Holding tanks in homes are preferably 4500 litres for sewage while those for water are often one-half as large. Design criteria and procedures as well as guideline drawings and specifications are contained in the publication, Water Distribution and Sewage Disposal Systems in the Northwest Territories. This publication covers the full range of new systems currently used in the N.W.T. Because of its relevance to INAC municipal servicing activities, the entire document is included as Annex C.

The quality of new community housing was excellent, consequently, drawings and specifications were obtained for the various types of public housing (reference Annex D). This material has been forwarded to the Buildings Division for their information and retention. Details of house water and wastewater piped service connections are also included in this material. The cost of a serviced house was reported to be about $150,000.

In general the quality of facilities was reflected in the pride that the mayor and council exhibited for their community and their commitment to good planning.

3.3 Frobisher Bay

The visit of facilities at Frobisher Bay on September 27 included a complete tour of water and sewer facilities. Reference Annex E for a Community Profile and Annex F for briefing material presented for the water and sewer facilities.

In addition to aforementioned tour, there was a briefing session of DPW's operation and maintenance activities and a tour of the Housing Corporation maintenance facilities.

At the time of the visit there were approximately 235 buildings in the community of which 70 per cent had interior plumbing. Delivery of water to all buildings was done using two trucks, each having a 4500 liter storage tank. The average per capita water consumption is 110 liters/capita/day. New homes are equipped with a 1600 liter water storage tank as opposed to 900 liter tanks found in older homes. Water delivery occurs 2 to 3 times per week depending on weather conditions and on the possible need for rationing if the quantity of water in the community reservoir is low.

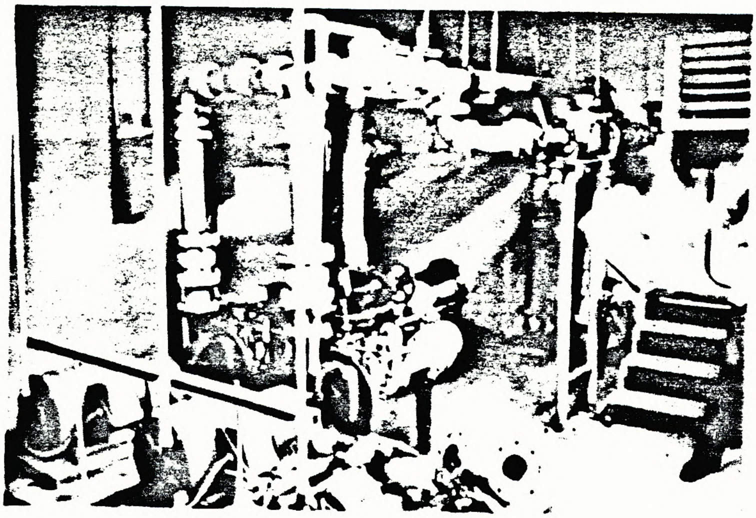
A new 71,000 m3 reservoir was under construction at the time of the visit and will replace the existing 9000 m3 reservoir which was inadequate (this includes an allowance for 2 m ice cover).

Sewage collection from residences is carried out using 1 truck for bagged sewage and 2 pump out vehicles for homes having sewage holding tanks (see Annex I for vehicle specification). In general, a sewage holding tank is at least 15 percent larger than the water storage tank servicing a building.

The new water reservoir includes intake pumping facilities from the nearby stream, a fill line, and a truck-fill station. The reservoir, will have a subdrain system consisting of 200 mm diameter pipes which are required to prevent uplift of the 2 mm HDPE liner. Complete reservoir details are included in the specifications included in Annex J. The drawings accompanying these specifications were passed to the Municipal Services Division for retention and future reference.

Several factors considered during the design of this reservoir are covered in the TRIP REPORT; Key Lakes Mine Site, Saskatchewan, Annex K.

This community makes use of a hydraulically assisted, side loading garbage truck, which is used to pick-up and deliver garbage to the incinerator located about 1 km from the community. No details have been provided on the incinerator since it is not considered to be very effective.



Pumping Equipment

New Housing

Sewage Macerator Station

Residential School

EXHIBIT 1 - RANKIN INLET

The other photograph shows a typical road crossing required by an above ground utilidor system. This utilidor although originally built in the late 50s is still in good shape and provides a cost effective service. The high cost of construction would preclude its being used today in light of the less expensive alternatives available such as lightweight insulated piping. These pipes can be buried without destroying the permafrost regime or creating surface structures that are not aesthetically pleasing or are subject to vandalism.

The power generating facilities, while of interest to the touring soviet specialists, are not reported on since the facility size far exceeds the applications which might arise within INAC.

3.7 Dawson City

The visit to this community on October 1 included a briefing by Stanley Associates Engineering Ltd. on the water distribution and sewage collection systems designed by them for Dawson City and constructed during 1979 and 1980. The systems consist of approximately 20,000 lineal metres of insulated polyethylene pipe buried in ice rich, organic, silt permafrost.

The water system consists of an infiltration well, an insulated reservoir, a pumphouse and six circulating loops varying in diameter from 150 to 250 mm.

The sewage system consists of insulated gravity sewer lines and a lift station. The sewage receives primary treatment by a rotoscreener and is then discharged to the Yukon River via a submerged outfall.

During the design of the project, a philosophy to minimize degradation of the permafrost, minimize frost heave and prevent freeze-up of the system was foremost.

Details on this system were presented in a paper entitled, Dawson City Water and Sewerage Program - An Overview, which was presented at an ASCE conference on "The Northern Community - A search for a Quality Environment" - This paper is presented in Annex N.

In this city the waste heat from the diesel electrical power house is used to add heat to the water being circulated in the looped water distribution system. The photos in Exhibit 3 show the pumphouse, the hot water supply and return line at the power house, a typical fire hydrant installation, and the support system being used under a new building resting on the typical ice rick permafrost soil of Dawson City.

3.8 Yellowknife

The visit to this city on October 2 included a briefing on and a tour of the city's water and waste water facilities and dealt in particular with the water intake, water treatment and heating, a water and sewer upgrading project, and a subdivision servicing project. The group saw, as well, a major road paving and trench repair project and the city garage and municipal equipment. A profile of the city and its municipal services is contained in Annex O.

Ninety percent of the population of 10,000 receive water supply and sewage disposal services by piped underground systems. Pipe lines are insulated and some are heat traced. The remaining 10 percent of the population have truck delivery of water and pick-up of sewage. Some of the homes on truck delivery have a piped water supply in the summer, using temporary pipelines laid on the ground surface.

The community is located on the precambrian shield in an area of discontinuous permafrost. Foundations for large buildings are piled to bedrock using wood, steel or timber piles up to 100 feet in length.

Some Facts Regarding Water and Sanitation in N.W.T.

	No. of Communities	% of Population
Tax Based	7	55
Non-Tax Based	55	45

The first priority is that drinking water meets basic public health parameters (i.e.) no bacteria. In permafrost zones, only two options are considered viable for both water supply and sewage disposal and they are; i) Piped systems, and ii) Truck systems.

Small lakes are often used as sewage lagoons since there is such an abundance of them.

3.9 Ottawa

Prior to returning to Ottawa, at the request of the Soviet delegation, arrangements were made to visit a water treatment plant in Ottawa and a manufacturing plant for the insulation of pipes used in water and sewer systems. Accordingly, a visit was made to the Britannia Water Purification Plant in Ottawa on October 6 and to Urecon Insulation Ltd. in St.-Lazare de Vaudreuil on October 7.

Details on the water purification process used in the Ottawa - Carleton region and specifically at the Britannia plant are contained in Annex P. Also included are the physical, chemical and bacteriological characteristics of the raw and treated water.

The visit to the Urecon plant featured a complete demonstration of the pipe insulation process. Insulated pipe samples were provided to the visiting Soviet specialists.

4.0 <u>Highlights of Tour</u>

During the two week period the Canada/USSR specialists visited many communities and toured numerous facilities. Each member of the group undoubtedly found certain projects of particular interest depending upon their experience and the potential for application within the organization that they represented. The following two subsections identify firstly, those technical aspects that appear to offer a good solution to a problem and would have direct application within INAC and, secondly, comments of the visiting soviet delegation on those technical aspects of the tour that was of most interest to them.

4.1 INAC Perspective

While the technology encountered was already known to the canadian members, the tour presented an opportunity to see the facilities in place and to form an opinion as to whether or not they represent an improvement over other practices and facilities being used. From this point of view, information was obtained for the following facilities/equipment and have been included or referenced in this report.

- The energy efficient garages and warehouses;

- The use of plastic pipes for water and sewer systems whereas in the USSR this material is used for gas pipelines;

- The instrument control systems;

- The use of individual heating systems in decentralized facilities such as garages, warehouses, etc.;

They did not note any significant differences in the equipment used for construction.

The Soviets have not used sewage lagoons and therefore do not favour them since their northern communities are generally much larger than ours.

In summary, the Soviets considered that Canada has moved far ahead in the use of insulating materials and finish materials for buildings, both interior and exterior. It was felt that Canada had found the compromise between expensive and inexpensive construction. They felt that closer cooperation of the sciences should be encouraged not just through the reading of literature but through the establishment of specialized colleges dealing with northern construction.

ANNEX A

TECHNICAL DOCUMENTS - OTTAWA

ANNEX A

OCT 30 1985

W. Slipchenko
Circumpolar Affairs Division
Northern Affairs Program

Canada/USSR Exchange on Northern Construction, Theme III -2

Attached is a detailed list of the technical documents which I delivered to your office for forwarding through our embassy in Moscow, to Mr. A. Ivanov, Head of the soviet delegation.

We should be receiving soon from R. Doherty a box of material that the soviet delegation left with him for forwarding to Mr. Ivanov.

ORIGINAL SIGNED BY
J. Benner

John Benner
A/Director
Technical Services
Technical Services and
Contracts Branch

c.c. R. Doherty

BENNER/sv

Water and Sanitation Material - Municipal Services Division

TSD's

- Rotating biological contactor development guidelines - Jan/85
- Extended aeration treatment plant development guidelines Feb/85
- Facultive lagoon development guidelines - March/85
- Planning for municipal services - Oct/84
- Standard maintenance task statements Oct/84
- Sanitary landfill design guideline - Feb/85 (Draft)

DRM 10-7

- Water supply and distribution - Nov/84
- Wastewater collection, treatment and disposal - Nov/84

Regional Municipality of Ottawa Carleton - handouts

- Brochure - Fleet Street pumping station
- Process description of the Brittania Water Purification Plant
- Physical chemical & bacteriological characteristics of Ottawa river water, raw and treated water
- Operating statistics at Lemieux & Brittania filtration plants
- Water purification & chemical treatment process
- The story of water supply (comic book format)

- INA House Designs C1 Standard 565
  1D3
  1D4
  1D12
  1D13
  C3
  D2
  F
  E
  SD2

- INA Report - northern housing

- INA House Designs 4
  3
  2
  1

- Three bedroom prefabricated northern house   Standard 565
- Report: Familiarization Study Northern Housing Frobisher Bay 1984
- Design guidelines and technology for northern housing construction, and the compilation, analysis and evaluation of energy conservation data for houses 562 and 442 Frobisher Bay NWT Final report, Oct/84
- Field performance evaluation of department houses 426 and 598 at Frobisher Bay NWT, Jan/83
- Status report on research and development project energy efficient northern housing F.B. NWT Sept/83

OIHC

- Residential building code for I.R./82
- Interpretation to residential building code for IR/82
- Interpretation to part 9 NBC

BTP

- House repairs and maintenance Sept/82
- Measures for energy-efficient northern housing (draft)
- Commentary on measures for energy-efficient northern housing
- The first 25 years (NRC) 2 copies
- Air vapour barriers EMR
- Efficient residential oil heating system (EMR)
- Building practice note - the principles and dilemma of designing durable house envelopes for the north (NRC)
- Mesures d'economie d'énergie dans les nouveaux bâtiments 1983 NRC
- National Research Council - Research Program 1985-86
- Urban terrain problems NRC
- Geology in urban areas of Canada and its relation to landslides NRC
- Avalance research NRC
- Reinstatement of municipal service trenches NRC
- Building Research 1973-1983 NRC
- Government of the NWT 1984 Annual Report

- NBC of Canada 1985
- Building Science for a cold climate (hard cover)
- Building construction technology (hard cover)

Technical Papers from NRC

Cyclic Creep of Frozen Soils, V.R. Parameswaran, Fourth International Symposium on ground freezing, Sapporo Aug/85

Altenuating Creep of Piles in Frozen Soils, V.R. Parameswaran, Proceedings from a session TCRR Council ASCE, Spring convocation, Denver, Co. Apr/85

Ground Freezing, S. Kinosita and M. Fukuda, Fourth International Symposium on ground freezing, Sapporo, Aug/85

Deformation behaviour and Strength of frozen Sand, V.R. Parameswaran, Canadian Geotechnical Journal, vol. 17, no. 1, Feb/80

Adfreeze Strength of Model Piles in Ice, V.R. Parameswaran, Canadian Geotechnical Journal, vol. 18, no. 1, Feb/81

Adfreeze strength of Frozen Sand to Model Piles, V.R. Paramesrawan, Canadian Geotechnical Journal, vol 15, no. 4, Nov/78

Field Measurement of Electrical Freezing Potentials in Permafrost Areas, V.R. Parameswaran and J.R. MacKay, Proceedings from Fourth International Permafrost Conference Fairbanks Alaska July/83

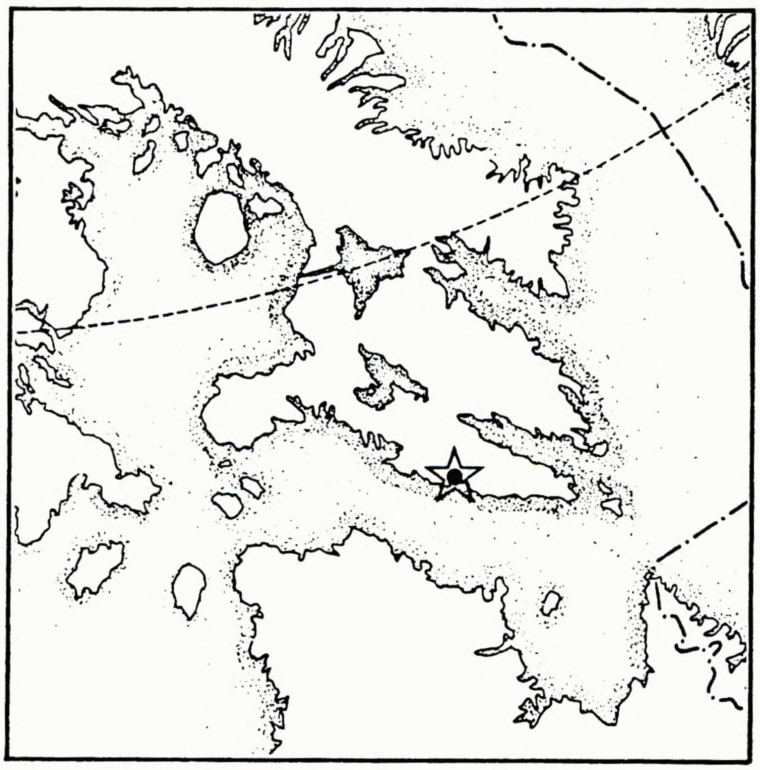
Displacement of Piles Under Dynamic Loads in Frozen Soils, V.R. Parameswaran, Proceeding from the Fourth Canadian Permafrost Conference, Calgary, Alberta March/61

Effects of Dynamic Loads on Piles in Frozen Soils, V.R. Parameswaran, Proceedings from the Third International Specialty Conference Cold Regions Engineering "northern resource development", April/84.

ANNEX B

COMMUNITY PROFILE ANNEX B

Lake Harbour



LAKE HARBOUR

SCALE - 1:7,500
N.A.P.L.
NO. A25552-70 & 71 2/8/80

A. GENERAL

A.1 Location

Lake Harbour is located on the southern end of Baffin Island on the Meta Incognita Peninsula at 62°51'N latitude and 69°53'W longitude. It is located at the upper end of a drowned valley some 23 km from the open sea. The settlement occupies a hummock at an elevation about a metre above sea level.

A.2 History

There have been Inuit in this vicinity for centuries, and they have been in contact with Whites since the mid 19th Century when they worked for the whalers. An Anglican Mission was established in 1900, a Hudson's Bay post opened in 1911, and the R.C.M.P. set up a post in 1924.

A.3 Community Information

The settlement of Lake Harbour is 93% Inuit and the overall population estimates for the past three years are as follows:

POPULATION	YEAR
301	1978
300	1979
297	1980

The population appears to be relatively stable at present.

The economy is based on local wage employment, hunting, the sale of handicrafts and some welfare. There is a nursing station, school and an R.C.M.P. constable located in the community.

A.4 Geology and Terrain

Lake Harbour is situated on an uneven deposit of granular glacial soil, hemmed in by high hills of precambrian rock with some deposits of limestone. Below the settlement there is a stoney beach at high tide level.

Bedrock is exposed extensively throughout the region and consists primarily of quartzite, schist and limestone. Quartzite and schist are resistant to the mechanical breakdown caused by the freeze-thaw cycles. Limestone is very susceptible to mechanical weathering. The area lies almost on a line separating the widespread discontinuous and continous permafrost zones, indicating that permafrost is present under most land areas to a depth of 60 m.

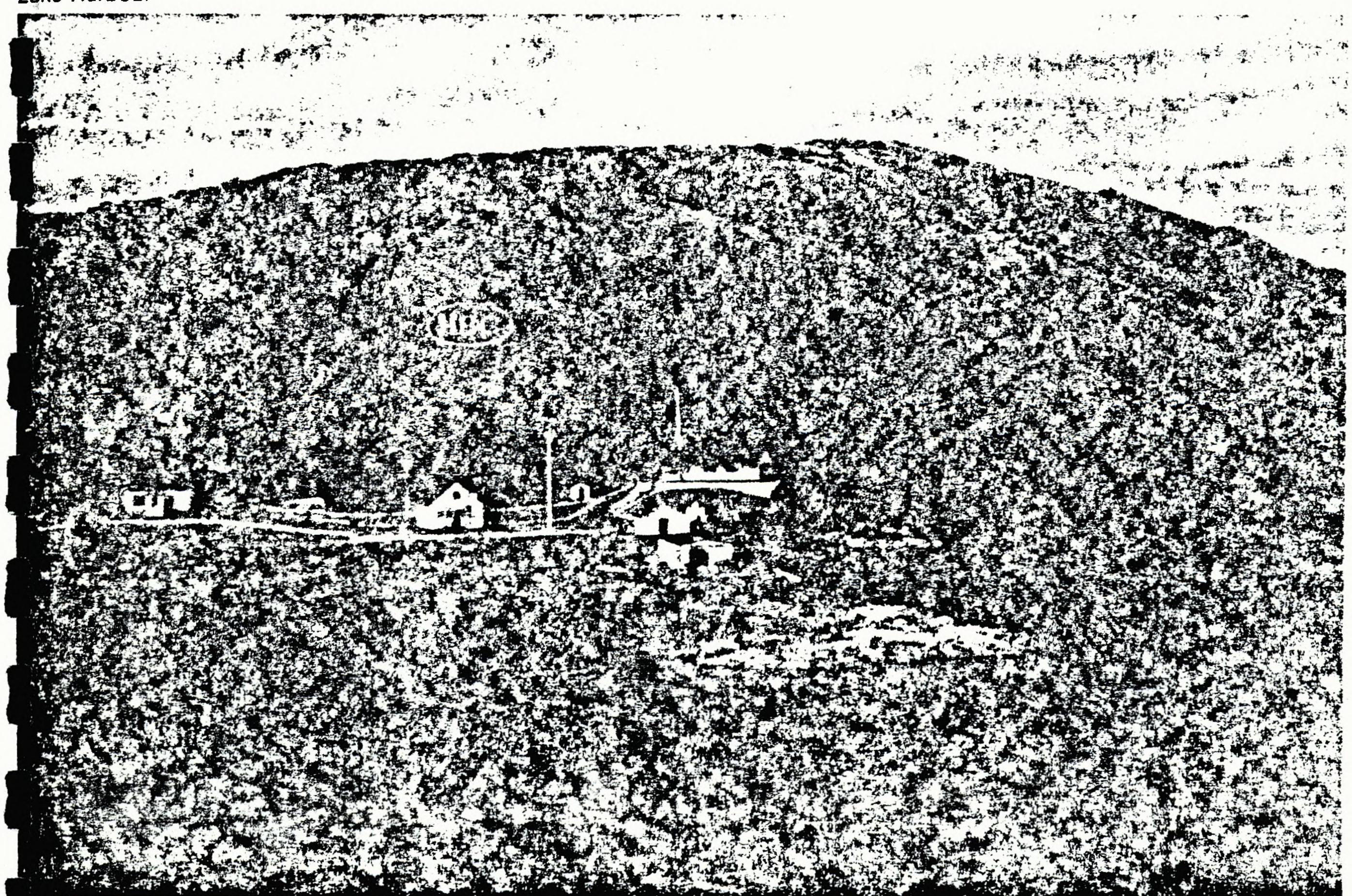
A.5 Vegetation

Vegetation is generally non-existent in the surrounding mountains with the exception of a few hardy mosses, lichens, or grasses.

A.6 Climate

Lake Harbour experiences unusually high temperatures for the Arctic and its sheltered location gives rise to rather mild winters.

Lake Harbour



The mean high and low temperatures for July are 12°C and 4.0°C respectively. January's mean high and low are -20°C and -27°C. Lake Harbour receives 202 mm of rain and 2100 mm of snow on average annually.

B. MUNICIPAL SERVICES

B.1 Water Supply

B.1.1 General

The residents currently obtain water from Lake Fundo approximately 2 km west of the community. In the summer the intake hose is suspended in the lake and the truck is filled on the shore. During the winter a hole in the ice about 60 m from shore is kept open to fill the truck using truck mounted pumping facilities.

Cost effective analysis studies on water supply alternatives have been carried out by the G.N.W.T. The studies suggest that the preferred alternative is for a truck fill station at Lake Fundo and that the road linking the lake to the settlement be upgraded.

B.1.2 Source

The present source and apparently the most economical for present and future purposes is Lake Fundo. It is located 2 km west of the settlement at an elevation of 34 m ASL. A typical chemical analysis is as follows: (NOTE: All values in mg/L unless otherwise indicated)

Parameters	
Alkalinity ($CaCO_3$)	70.0
Total Hardness ($CaCO_3$)	90.0
Chloride (Cl)	15.0
Total Iron (Fe)	<0.04
pH	7.9
Nitrate (N)	<0.1
Calcium (Ca)	6.0
Magnesium (Mg)	18.0
Potassium (K)	traces
Sodium (Na)	traces
Sulphates (SO_4)	traces
Fluoride (F)	<0.1
Phosphate (PO_4)	<0.1
Total Solids	67.0

(Sampled by: Jack Grainge, National Health and Welfare, August 12, 1974).

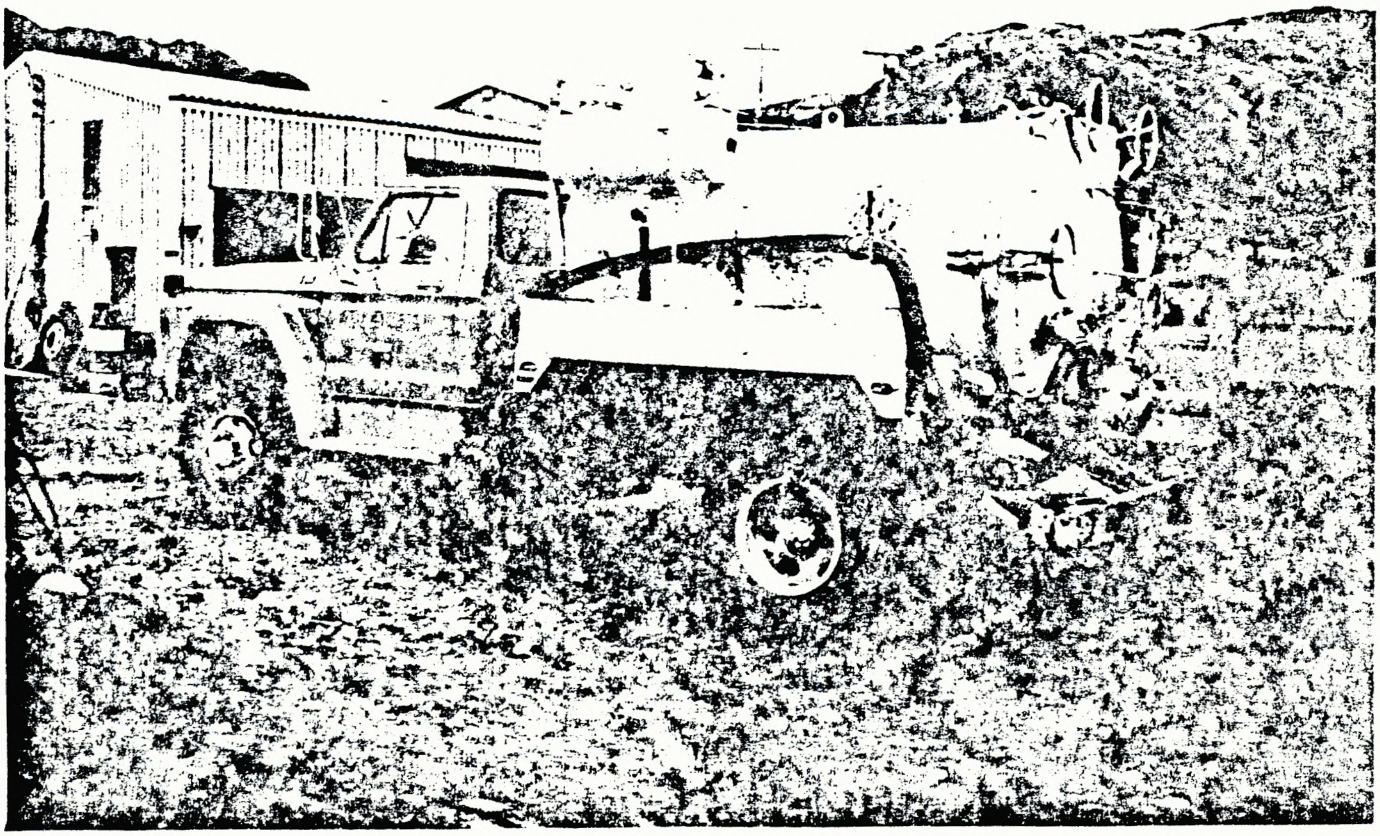
B.2 Water Distribution

A total of 300 people were served during the 1980-81 fiscal year by trucked delivery. The water is picked up at Lake Fundo and delivered through the town by a 4550 L (1000 Ig) wheeled water truck. The community consumes about 62,000 L/week or 8755 L/day. Water is delivered to the buildings three times a week under contract by the local council.

B.3 Sewage Collection

Bagged sewage is collected 7 days per week, and sewage is pumped out three days a week using a trucked system.

Sewage truck



Bagged sewage is placed on the ground beside the garbage barrels and is picked up along with the garbage in an open truck box mounted on a Muskeg Bombardier.

Sewage pumpout is handled by a 4550 L (1000 Igal) pumpout truck.

The local council holds the contract that at present serves about 300 people.

B.4 Sewage Disposal

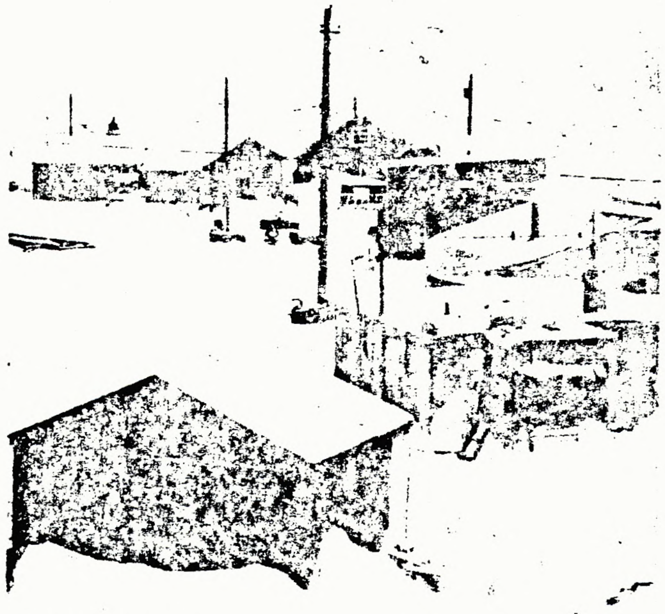
The sewage disposal area is located 3/4 km to the south of the community high in a valley. Access is over a winding gravel road. Sewage bags and liquid sewage are put into a man-made pit. Waste then leaches through the gravel and down a slope between the dump and the ocean inlet. Large tidal currents transport and dilute any effluent which enters the ocean.

B.5 Solid Waste

Solid waste is collected under the same contract as bagged sewage and is collected three days per week.

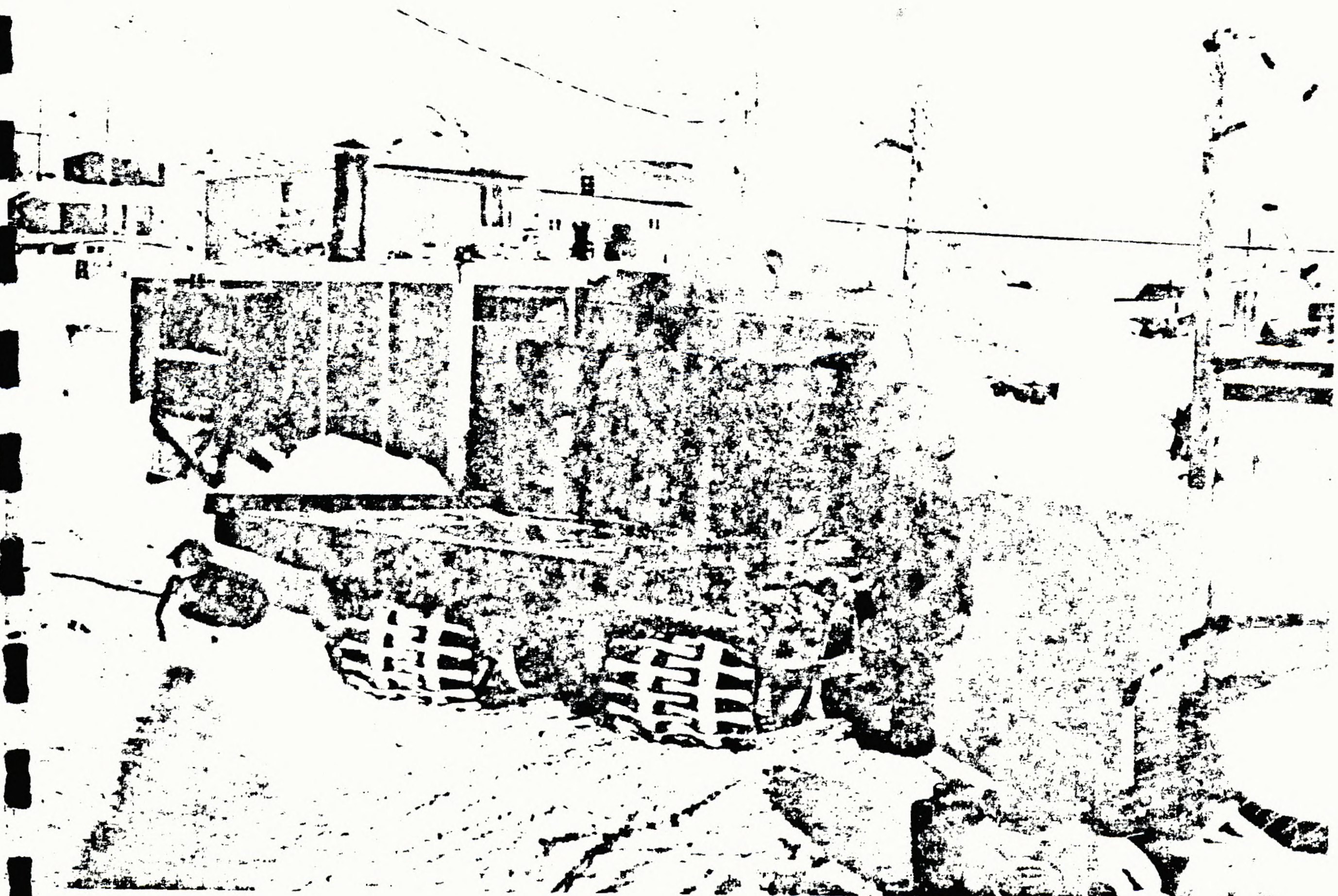
Abandoned bulldozers, trucks, washing machines and other mechanical devices are piled separately close to the new tank farm.

Garbage is deposited at the sewage dump site. It is regularly burned and covered yearly.



Winter in Lake Harbour

Garbage pickup



B.6 Roads
The roads in and around the community generally have steep grades. This can cause some problems with slippage, gas mileage, and higher wear and tear on vehicles. Many of the roads erode away during periods of rapid run-off. There are ample sources of gravel nearby for maintenance and construction.

B.7 Surface Drainage
Many of the roads are eroded by overland drainage. Proper drainage trenches, culverts and embankments would prevent this. The present haphazard arrangement of buildings also results in poor drainage of water. Dangerous ice sheets occur occasionally in the winter.

B.8 Fire Protection
The fire protection in Lake Harbour consists of the following:

- one mini-pumper capable of pumping 11-34 L/s (150-450 Igpm)
- 10 man volunteer fire brigade

B.9 Other Services
There is telephone service in Lake Harbour. Mail delivery is once a week from Frobisher Bay. Power is supplied by NCPC using diesel generator facilities.

INFORMATION SOURCES

1. Scott Brown, Department of Public Works, *Lake Harbour Water, Sewage and Garbage Pre-design Report*, April, 1980.

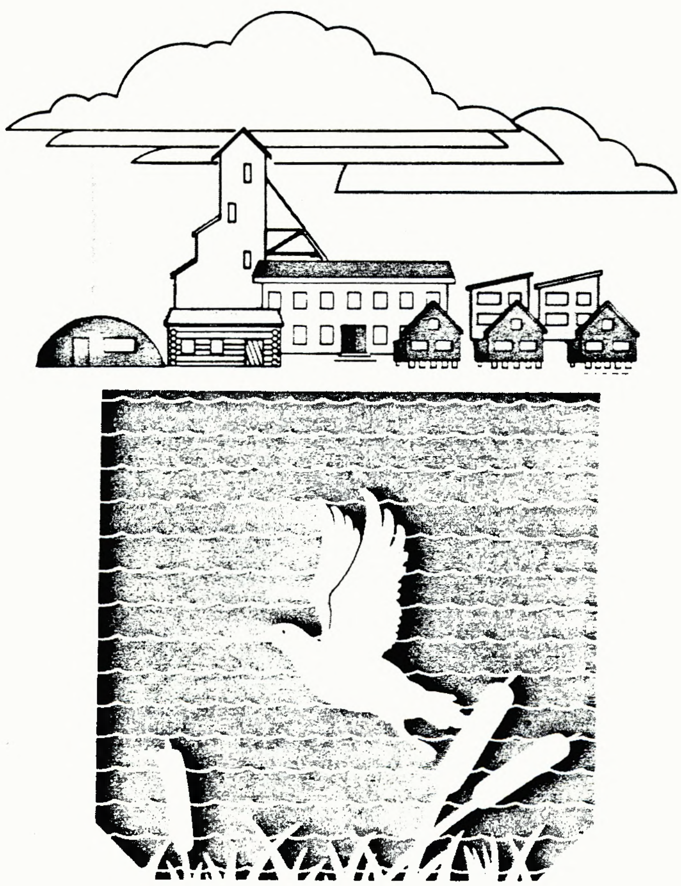
2. Jack Grainge, Health and Welfare Canada, Medical Services, *Report on Water Supply & Waste Disposal, Lake Harbour, N.W.T.*, March, 1977.

ANNEX C

Annex C

WATER DISTRIBUTION *and* SEWAGE DISPOSAL SYSTEMS

in the Northwest Territories



WATER DISTRIBUTION *and* SEWAGE DISPOSAL SYSTEMS

in the Northwest Territories

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August 1985

WATER DISTRIBUTION
AND
SEWAGE DISPOSAL SYSTEMS
IN THE
NORTHWEST TERRITORIES

- TABLE OF CONTENTS -

1.0 INTRODUCTION

The Northwest Territories is a vast expanse of land lying mostly north of the Sixtieth parallel and composing about one third of Canada's area. The population of this huge area is only 51,000. Over one half of this population is in one city and six towns and villages. The City of Yellowknife's population is approximately 11,000. The balance of the people live in over 45 settlements and hamlets and in numerous small camps and unorganized communities.

In the Northwest Territories the Territorial Government is responsible for providing water distribution and sewage collection systems in organized communities. In settlements and hamlets the government undertakes program delivery for capital improvements and subsidizes operating and maintenance costs. In tax-based communities (cities, towns and villages) the Government provides funds for major capital works such as intakes, pumphouses, lift stations and forcemains. Distribution systems, lateral extensions (water/sewer service connections) and improvements are the responsibility of the individual tax-based municipality as are the costs of operating and maintaining their systems.

Water supply and sewage collection systems of many types and materials have been installed in the past. While not always successful, these have provided invaluable experience and have all contributed to the development of the concepts utilized today. This report does not analyze past systems but presents the current rationale behind and the general guidelines for the provision of water and sewer services in those communities where the Government is directly responsible for program delivery.

The main objective of the Territorial Government is to provide at least a sufficient quantity of water to households for basic consumption, sanitation and personal hygiene requirements in a manner consistent with reasonable health and sanitation standards. In the Northwest Territories there are two primary pieces of Legislation: the Public Health Act and the Northern Inland Waters Act. The Regulations under the Public Health Act establish the planning, design and operation requirements of all water and sanitation facilities necessary to achieve and safeguard this aspect of public health.

In essence this act strives for a public health standard consistent with that expected elsewhere in Canada. The Northern Inland Waters Act is devoted to preservation of environmental quality, especially that of the inland rivers and lakes of the Northwest Territories, as opposed to public health. Under the Northern Inland Waters Act environmental constraints, guidelines or standards have been established for all industrial and community activities involving the taking of water from various water bodies and the return of wastewater.

2.0 COST EFFECTIVE ANALYSIS

In the Northwest Territories the present method for determining the most appropriate community water supply and sewage disposal system is the Cost Effective Analysis procedure detailed in the Water and Sanitation Policy. This is a procedure for estimating the present value of both capital and operating and maintenance expenditures over a twenty year planning horizon. This procedure is applied to a number of alternatives, for water supply, water distribution and sewage and garbage collection and disposal, which meet the minumum level of service established by the Water Supply and Sanitation Policy.

In the cost-effective computations the social desirability and social benefits arising from water and sanitation improvements are initially not addressed. Instead, the analysis focuses on the determination of expenditures for each alternative and presents these for comparison. This permits an informed assessment of the relative desirability of alternative types and levels of service against their associated cost. Economic analysis is an integral part of engineering design considerations including the optimization of components, such as tank or piping sizes, and the determination of the sensitivity of total costs and cost-effectiveness to changes in equipment, components or cost estimates.

The cost-effectiveness analysis includes all of the costs associated with water and sanitation systems without regard to who pays for them. Subsidies, grants and revenues are excluded, as these would distort the economic analysis and economic efficiency. The year by year capital and operations and maintenance expenditures for each component of a water and sanitation system are calculated over a specified design horizon and discounted to a present value at a specified discount rate. The total present value of an alternative is equal to the sum of the present values of its components. The system with the lowest present value is the most cost effective alternative.

Each alternative considered is divided into components such as: water intake, truck fill station, reservoir (storage), water distribution & sewage collection system, trucks, water treatment, filling system (water source to the storage), access to the source, power, (powerline vs on-site generation), building and a number of others. A computer program has been developed to facilitate the cost-effective analysis and to assist the decision making bodies.

The process involves the following major steps:

A. SELECT PRACTICAL SYSTEM ALTERNATIVES

This involves research of files for pertinent background information; field investigations and preliminary surveys; water sampling of potential sources; discussions with local council; discussions with government agencies and regulatory bodies; an inventory of existing facilities; and the definition of water supply and sewage disposal systems for further analysis.

B. ECONOMIC ANALYSIS OF ALTERNATIVES

A cost-effective analysis methodology is applied to all alternatives. It is the aim of the G.N.W.T. to determine the most economic system that will provide the long term demand for water and sewage at the minimum level of service defined by the policy.

C. MISCELLANEOUS FACTORS

After completion of the economic analysis, the various alternatives are analyzed and compared with respect to the following subjective criteria:

- Public Health
- Safety
- System reliability
- Fire protection
- Aesthetics
- Operation and maintenance requirements
- Land use

- Environment
- Other criteria, such as public opinion

D. REVIEW AND DECISION STAGE

This involves selection of a system alternative which satisfies the proposed objectives and which is economic in terms of a 20 year life cycle capital and operating and maintenance cost. Based on approval of the tentative alternative, development of the concept or system takes place.

3.0 DESIGN CRITERIA

The Government of the Northwest Territories has established guidelines for use in designing water and sewage facilities which are based on past experiences and observed water usages. These guidelines should not be confused with standards or regulations which must be absolutely complied with in order to obtain approval. It is not the intention of the Government of the Northwest Territories to stifle innovation. Whenever a designer can demonstrate that environmental and/or health conditions can be safeguarded by alternative approaches, such a method is or will be considered for approval. These guidelines are as follows:

- Average residential consumption of water in areas serviced by trucked water delivery and sewage collection systems is assumed to be 90 L/Capita/day. The peak residential water demand is assumed to be never greater than 115.0 L/Capita/day.

- If the entire community is serviced by a trucked water delivery and sewage collection system, the average per capita consumption of water for the total community (residential and non-residential) is a function of population. Consumption = Residential Consumption x (1 + 2.3315 x 10^{-4} x Population)

- Residential areas serviced by a piped water delivery system and trucked sewage collection system are assumed to have an average per capita water demand of 135 L/Capita/day.

- Communities totally serviced by a piped water distribution and sewage collection system are assumed to have an average per capita water demand of 450 L/Capita/day. The average residential water demand is assumed to be 275 L/Capita/day. A typical sanitary sewer design sheet is shown on Form #1.

- A sewage pump-out truck should be designed to hold a maximum of 4,500 L per load.

PROJECT NO. ____________

COMMUNITY ____________

FORM I

SEWER DESIGN DATA

AVERAGE SEWER FLOW ____ litres/capita/day

Location (Street)	From Manhole No.	To Manhole No.	Length (metres)	Tributary Area (Hectares)		Population (P) Density Residential = Density Commercial =	Peak Factor (P.F.) $1+\frac{14}{4+\sqrt{P\times10^{-3}}}$	Infiltration (I) @ ____ litres/s/ha	Max. Flow (Q) litres/s (P x PF x Av. Flow x 11.6 x 10^{-6}+I)	Diameter of Sewer (mm)	Slope % Coeff. of Roughness N= .013 Full Flow	Capacity litres/sec Q_o - Flow Full	Flow Ratio Q/Q_o	Velocity m/sec.			Invert Elevation (metres)		Surface Elevation		Depth of Cover	
				Increment	Total									Full Flow V_o	Self-Cleansing V_s	Design V	Upper End	Lower End	Upper End	Lower End	Upper End	Lower End

DESIGNED BY ____________

DATE ____________

APPROVED BY ____________________

(Department of Public Works)

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- Future projections of the volume of sewage generated may be assumed to be equal to the volume of water consumed.

- A building's water and sewage tanks should be sized for a minimum of five and seven days capacity, respectively.

- The life of the pipe system components is assumed to be twenty (20) years and the life of water and sewage vehicles to be four (4) years.

- In order to compare the cost of piped systems versus trucked systems, it may be assumed that the water demand by the non-residential development component and the residential component of a typical community will be proportionally the same for both systems.

- The volume of residential honeybag waste generated may be assumed to be 1.4 dm^3 /day/person.

- The volume of residential garbage generated may be assumed to be 9.90 dm^3 /day/person.

- The volume of school honeybag waste generated may be assumed to be 1.10 dm^3 /school day/student.

- All sewer mains shall be so designed and constructed to give main velocities, when flowing full, of not less than 0.6 m/s, based on Manning's formula using an "n" (Roughness Coefficient) value of 0.013.

- A minimum velocity of 0.6 m/s should be designed for under peak flow conditions (sewer flowing full) in order to avoid settling of solids. The maximum design velocities should be 3 m/s. The design of sanitary sewers should be based on the ultimate sewage flows. A 20-year design period is most frequently used for water supply systems. However, water distribution systems have useful life expectancies well in excess of 20 years and, if it is possible from a financial point of view, longer design periods may be used.

- No sewer and water mains smaller than 150 mm in diameter shall be used in sanitary sewage collection and water distribution systems.

- No sanitary sewer service connections smaller than 100 mm diameter, Series 45 (410 kPa Minimum) polyethylene pipe shall be used.

- Sanitary sewer service connections should be designed for a minimum grade of 2%.

- Water supply and distribution systems should be designed such that the normal operating pressure ranges between 350 kPa and 550 kPa under a condition of maximum daily flow. The maximum pressure in the water distribution systems should, in general, not exceed 700 kPa. Where areas have pressures above this level, the homes affected should be provided with individual pressure-reducing valves on their services. Under maximum hourly demand, the pressures should not fall below 275 kPa and under fire conditions not below 140 kPa.

- Water systems must be simultaneously capable of satisfying the maximum day and fire demands. The designer must consult the N.W.T. Fire Marshall's office for the design fire demand flows.

- Water supply systems should be designed to satisfy the greater of either maximum day plus fire flow demand or peak rate (maximum hourly demand).

- Fire hydrants are only installed on watermains capable of supplying fire flow requirements. The spacing for hydrants is normally recommended to be 120 - 150 m.

- The distribution piping system must be designed to withstand the maximum operating pressure plus the transient pressures to which it will be subjected. Transient pressures are caused by rapid valve operation, pump start-up and shut-down, power failure, etc.

- As a minimum allowance in the distribution system, it is recommended that the pipe strength be such that it can withstand the maximum operating pressure plus the pressure surge that would be created by instantaneous stoppage of a water column moving at 0.6 m/s.

- For water service connections, the minimum pipe size required is 20 mm inside diameter.

- Wherever possible, water distribution system layouts should be designed to eliminate dead-end sections. Where dead-end mains cannot be avoided, they should be provided with acceptable measures to prevent problems associated with stagnation and freezing.

- Air release valves should be placed at all significant high points of the water system.

- Precautions must be taken in the design of water distribution and plumbing to preclude the entrance of contaminating materials into the water supply.

- In view of the rising cost of energy and the possibility of future energy shortages, the design should attempt to minimize the number of sewage pumping stations required in sewage pumping collection systems.

- Standby power facilities should be provided to ensure uninterrupted water supply and sewage disposal.

3.1 SYSTEM OBJECTIVES:

The guidelines given are primarily intended to outline minimum acceptable levels of servicing to assist designers in the preparation of water distribution and sanitary sewage system designs that will meet the approval requirements of the Government of the Northwest Territories. These designs must also meet the following objectives:

- minimize energy input to operate
- be simple to operate and maintain
- be protected against severe climate conditions
- must have an freeze recovery mechanism

- should be capable of being drained
- should have a minimum 20 year design life
- should be capable of easily isolating sections at any time of the year
- should be designed and/or prefabricated to minimize on-site labour
- allow maximum use of the short construction season
- should meet all of the above objectives and remain economically practical

4.0 WATER SOURCE DEVELOPMENT

All traditional sources of water are present in most parts of the Northwest Territories but conditions specific to this region require special consideration of these sources prior to selection of a community water supply. The costs of developing, maintaining, and operating a water source in cold climates are greater in all respects than in temperate regions. Costs vary with each location, however, they generally increase with decreasing mean annual temperature and remoteness of the site. Detailed preliminary engineering studies and direct observation of local conditions are carried out, regardless of the apparent merits of a source under consideration, prior to final selection. Some type of water source may be developed in virtually any part of the cold region of Canada, but the physical difficulty of operation and maintenance or the associated costs may be highly unattractive.

4.1 WATER SOURCES

Water in cold regions comes from the same basic sources as in temperate areas, but there are some distinctive features to arctic and subarctic surfaces and ground water hydrology which merit comment.

Surface Water: Surface water results from precipitation and snowmelt and is replenished through the hydrologic cycle. In northern latitudes surface waters in shallow lakes and small streams are effectively eliminated in the winter because of complete freezing. Larger streams and deep lakes remain liquid beneath an ice cover but flows and volumes are reduced since there is no contribution from precipitaion until warm weather returns. Thus, because of the cold climate and quantity of ice, not all surface sources are available for continuous water supply. Sources which are suitable for continuous supply are large rivers and lakes.

Ground Water: Ground water is considered a desirable source of water in cold regions. Normally, ground water temperature is warmer than surface water in the winter and is a nearly constant temperature year round. Also, sub-permafrost ground water is almost always a year-round source of supply, so that alternate or dual source systems need not be developed.

The cost of exploring, drilling, developing and maintaining wells in cold remote areas is enormous and groundwater is generally high in mineral content. Wells are, therefore, not usually considered when developing water supply alternatives.

Other Water Sources: Snow, ice and direct catchment of rainfall are potential water sources for small or temporary establishments. In general, the natural quality of these sources is higher but contamination of the ice or snow stock-pile is a potential hazard and the cost of melting is significant.

4.2 WATER QUANTITY

One of the first steps in the selection of a suitable water supply source is determining the demand which will be placed on it. The essential elements of water demand include the average daily water consumption and the peak rate of demand. The average daily water consumptions must be estimated to determine the ability of the water source to meet continuing demands over critical periods and to determine quantities of stored water that would sustain demands during these critical periods.

The peak demand rates are estimated to determine pipe sizing, pressure losses and storage requirements necessary to supply sufficient water during periods of peak water demand.

4.3 WATER QUALITY

Water supply development is concerned with both the quantity and quality of water required to meet the needs of man in an efficient and economical manner. Neither factor is neglected. The usefulness of the maximum available water supply is determined in large part by its quality. Water for drinking, and other domestic uses should be safe, palatable and aesthetically appealing. It should be free from pathogenic organisms, hazardous chemical and radioactive substances and objectionable colour, odour and taste. Table #1 summarizes the limits for selected physical and chemical parameters that have been recommended in "Guidelines For Canadian Drinking Water Quality - 1978".

Before any construction takes place in a community, comprehensive planning is carried out to analyse the various water supply alternatives (Section 2.0). All potential water sources are sampled and a full chemical analysis is undertaken on each sample. The results are compared with these guidelines and, if a particular water source does not meet the criteria, it may be either abandoned as an alternative, or considered with the appropriate water treatment.

4.4 WATER TREATMENT

The Government of the Northwest Territories, through its Water and Sanitation Program, establishes basic water supply facilities to ensure that all residents have year-round access to water which will meet reasonable health and sanitation standards. All potential water sources are sampled and a full chemical analysis is undertaken on each sample. The "Guidelines for Canadian Drinking Water Quality - 1978" (Section 4.3), are used as the water quality standard for the Northwest Territories. The sample results are compared with these guidelines and if a particular water source does not meet the criteria, it may be either rejected as an alternative, or may still be considered with the appropriate subsequent treatment. The constructed facility may include some form of treatment to improve the water quality; however, most of the facilities constructed to date require only fine mesh screenings to remove solids and chlorination equipment for disinfection of potable water supplies.

The most common method of disinfection in use in N.W.T. truckfill stations is the two tank chlorination system; this consists of two 114 L polyethylene tanks, one of which is mounted above the other. The upper tank is utilized to mix the chlorine solution which, after an allowance for settling, is be decanted to the lower tank via plastic piping and a plastic valve. An impeller type mixer is used for mixing in the upper tank. The lower tank is equipped with a chlorine feed pump which has an adjustable feed rate to allow it to be matched to the truckfill rate to obtain proper concentration in the trucks or water storage facilities. This adjustable feed rate also allows for adjustment when the pumping rate decreases as the source water level decreases (reservoirs, lakes, rivers, etc.). The chlorine system is designed to utilize 65-70% calcium hydrochlorite powder or tablets and to pump a mixed 1% chlorine solution. This two tank system is illustrated in Appendix A, Division 6.

Some communities in the Northwest Territories have Waterboy type water treatment plants equipped with flocculators, tube settlers, mixed media filters and hypchlorinators, but, due to their complexity and limited capacities, they are not usually recommended. They have higher capital and operation and maintenance costs and require skilled labour to operate and maintain. They are normally constructed where turbidity (suspended solids) is a water quality problem.

4.5 WATER STORAGE

The total water storage requirement is the sum of flow equalization, emergency and fire requirements. The reliability of the water source and the community size, (i.e., equipment and expertise available) influences the storage requirements. Typically these requirements are two days total water demand plus the fire requirements and any seasonal requirements. Most piped and trucked water delivery systems require some storage capacity to meet daily and hourly water demand fluctuations. Emergency storage of at least one day's requirement is normally provided. Several day's supply is provided when the community is served by a long pipeline (piped system). For trucked systems storage of 60,000 litres within the community is required for fire protection plus some additional storage to overcome any supply interruptions. No emergency storage (fire protection) is required if there is a water source within 3.2 km of the community. A 1000 l/min pump is always available to refill water trucks (fire protection). For piped systems a minimum fire storage of 327,000 litres (3,630 L/Min x 90 Min) is normally provided.

Where a continuous water supply cannot be obtained, is too expensive, or is impractical to operate and maintain, enough water is stored to supply the demand during periods of supply failure. For example, where water intakes are inoperative during lake, stream or river freeze-up and break-up, short-term storage is provided. Complete winter storage is provided at locations where all water sources cease, freeze-up, or are inaccessible during the winter. A water supply pipeline from an inaccessible or distant water source is used in the summer to fill a winter storage reservoir or tank. Some communities in the North now have complete water storage facilities (reservoirs) to meet their year-round water supply demands.

TABLE NO. 1

WATER SUPPLY ANALYSIS

RECOMMENDED LIMITS FOR SELECTED PARAMETERS

Parameter	Maximum Acceptable Concentration*	Objective Concentration*	Basis**
Arsenic	0.05	$<=5 \times 10^{-8}$	H
Asbestos	-	-	-
Chlordane (Total)	0.007	$<=5 \times 10^{-8}$	H
Chloride	250	<250	A
Colour (TCU)	15	<15	A
Cyanide	0.2	<=0.002	H
Flouride	1.5	1.0***	H & A
Hardness	-	-	-
Iron	0.3	<0.05	A
Lead	0.05	<=0.0001	H
Nitrite (as N)	1.0	<=0.001	H
Odour	-	Inoffensive	A
pH	6.5 - 8.5	-	A
Phenols	0.002	<0.002	A
Sulphate	500	<150	H & A
Sulphide (as H_2S)	0.05	<0.05	A
Taste	-	Inoffensive	A
Temperature (deg. C)	15	<15	A
Total Dissolved Solids	500	-	A
Total Organic Carbon	-	-	-
Turbidity (NTU)	5	<1	H & A

* Unless indicated otherwise, the maximum acceptable and objective concentrations are specified in mg/L.

** Maximum acceptable and objective concentrations have been established on the basis of either aesthetic (A) or health (H) considerations.

*** In areas where the annual mean maximum temperature is below 10 degrees celcius, the objective is 1.2 mg/L.

Source "Guidelines For Canadian Drinking Water Quality - 1978"

5.0 WATER DISTRIBUTION SYSTEMS

Water distribution is carried out in three ways: self-haul, community-wide haul (trucked water) and piped systems. The system which should be used in any given situation depends on a number of factors:

- government policy;
- population;
- geographic and physical site location conditions;
- economic base of community;
- health standards;
- available technical skills;
- willingness of community to operate and maintain the facilities.

Given the factors involved for a particular northern community, a detailed economic analysis (Life Cycle Cost Analysis - Cost Effective Analysis) is always carried out to determine which alternative is the most appropriate system for that community.

5.1 SELF - HAUL SYSTEMS

The self-haul system has limited applications and a number of drawbacks which often make it undesirable for water distribution. In small settlements of 50 people or less, where no mechanization yet exists, the people obtain their water from a nearby lake or river and haul it to their house.

5.2 COMMUNITY - WIDE HAUL SYSTEMS

Community-wide haul systems are those systems where water is transported from a water source, reservoir or truckfill station to a fill point at the individual houses. The "truck" or vehicle-delivery system is used in all or portions of most communities in northern Canada where the population ranges from 50 to 1500.

In a nonpiped community, the water loading point or a truckfill station for the vehicle is usually a prefabricated building on the shore of a lake, river or reservoir.

5.2.1 Water Truckfill Stations

The purpose of this facility is to provide, on demand, year-round reliable capability of delivering an adequate water supply from a selected source of water (Reservoir, Lake, Stream, River, etc.) for domestic and fire-fighting purposes, (if required), to a water haul truck.

The objectives for the design of a water truckfill station are:

- maximize cleanliness and sanitation
- minimize spillage and subsequent freezing and ice buildup around the building
- provide efficient truck entry and exit routes taking into consideration prevailing winds and snow drifting
- minimize maintenance requirements
- be simple to operate and be self draining
- meet fire requirements (1000 L/Minute) on demand if storage is not provided in the community
- be recoverable after a power outage

The main components of the truckfill station are as follows:

Raw Water Intakes

The intakes consist of an inner and outer high density polyethylene pipe. The space, normally 75 mm, between the pipes is filled with a rigid polyurethane insulation. The intakes are concrete weighted to prevent flotation. Each intake has a 2.5 - 3.0 mm opening stainless steel screen on the lower end. The intakes are placed over the liner and cover material in reservoirs, with suitable liner protection, or on the shore of lakes and rivers. Where ice could damage the intakes they are suitably protected.

Submersible raw water pumps are connected to 75 mm or 100 mm butt fused high density polyethylene pipes and inserted in the inner intake pipe. Self limiting heat trace cable is attached to this discharge line to prevent freezing. Temperature controllers may be utilized to protect the pipe and cable.

Pumphouse

The pumphouse structure consists of a prefabricated, heavily insulated, well sealed panel system to minimize heat requirements. The building has a pumproom which is electrically heated and an unheated emergency power generation area.

The intakes terminate within the pumproom. Steel discharge piping, designed to be self draining, is connected to the pump discharge piping and carried through the pumproom to an exterior overhead fill arm. To ensure drainage of the piping when the system is not in use, check valves are not allowed.

An exterior pump control panel is provided so that truck operators do not have to enter the building. This panel normally includes start and stop buttons, a pump selector switch, indicator lights and an adjustable maximum run timer.

Within the pumproom provision is made for chlorine mix and feed tanks. A metering pump, activated by flow in the discharge line, injects chlorine solution into the discharge line. A paddle wheel type flowmeter, which totalizes flow and indicates rate of flow, is also installed in the discharge line. This type of meter does not impede the pipe draining.

Power Supply

An economic analysis (20 year life cycle) is conducted prior to design to determine whether it is more economically desirable to construct a powerline to the station or to provide on-site diesel power generation. While this economic analysis is the key factor in selecting the power supply source the operational convenience and practicality are also considered.

With either option a stand-by emergency generator is installed to ensure system reliability. The electrical load is arranged such that either pumping loads or heating loads are connected at one time. This minimizes generator size and load demand.

When a powerline is constructed a 225 L fuel-oil day tank and a low fuel alarm are provided. When on-site power generation is constructed a 4500 L exterior fuel storage tank is provided complete with dual fuel transfer pumps, interior day tank of 225 L, fuel meter, high and low fuel alarms and fuel filters.

Alarm System

As the truckfill station is generally remote from the community, an alarm system is highly desirable to give early warning of problems. The system consists of a radio activated by an annunciator. This radio in turn activates pocket pagers kept by the maintenance personnel. The normal alarm conditions are:

- low building temperature
- emergency generator failure
- fuel tank level (high and/or low)
- subdrain high pressure (lined reservoirs only)

Concept drawings of various components in the truckfill station are shown in Appendix A, Division 6.

5.3 PIPED SYSTEMS

Piped water systems are described in Section 7.0 and illustrated in Appendix A.

6.0 SEWAGE COLLECTION SYSTEMS

The collection of sewage in N.W.T. communities is done by individual hauling of buckets or bags to a dump point, by truck pump-out from holding tanks and hauling to a dump point, or by a piped collection system.

6.1 INDIVIDUAL BUCKET SYSTEMS

When indoor plumbing is not available, toilet facilities consist of pit privies or chemical toilets of various designs; however, they usually consist of "honey bags" (plastic bags in a container under the toilet). "Honey bags" are picked up daily or several times per week on a community wide basis. Greywater is, under this system, normally dumped on the ground adjacent to the buildings.

6.2 VEHICLE - HAUL WITH HOUSE STORAGE TANKS

Community-haul sewage collection deals with the collection of sewage (wastewater) from each dwelling and its transportation to a treatment and/or disposal facility. Facilities at the individual user's dwelling or building vary from simply emptying a honey-bucket into a tank on a truck to a holding tank within the building from which the sewage is pumped into the collection truck. In the Northwest Territories household tanks as large as 4500 litres have been used. It is commom practice to make the sewage holding tank up to twice as large as the water storage tank.

6.3 PIPED COLLECTION SYSTEMS

Piped sewage collection systems are described in Section 7.0 and illustrate in Appendix A.

7.0 PIPED SYSTEMS - WATER & SEWER

Where the economic analysis has indicated that a piped system is the optimum solution a decision of above ground or buried system must be made. Generally, buried systems are preferred where at all possible, however the decision depends on the particular site conditions of a given location. The criteria for selection of above or below-ground depends on the following factors:

- Site conditions
- Permafrost
- Access to location
- Soil Conditions
- Resources
- Energy Requirements
- Utilities
- Building designs
- Revegetation
- Construction season
- Transportation
- Economics

The major engineering consideration is the soil conditions at the site.

Other important considerations are:

- Vandalism and traffic damage;
- The allowable heat losses and the cost of energy required. Heat loss is directly proportional to the difference between the inside and outside temperatures. An above-ground system will have about three times the heat loss of a similar main buried below the surface;
- The necessity of holding grades with above-ground gravity flow;
- Buried systems are less expensive to install because they eliminate the need for piles, pipe supports, and road crossings;
- More expensive equipment is necessary to maintain buried mains.

The dominant characteristics of any cold region utility system is the need to prevent both the water and sewage lines from freezing. Heat may be added to the water, or to the mains, and continuous circulation maintained to prevent freezing. The degree of freeze protection required depends on whether the pipes are buried or built above ground.

Over the past eight to ten years in the Northwest Territories, a basic system and concept design has evolved for piped water and sewer systems suited to northern conditions throughout the continuous and discontinuous perma-frost zones. This system has enjoyed considerable success. An early system (constructed 1978/1979) utilizing this concept in Rae experienced a 36 hour power failure and stoppage of flow. The buried insulated lines were re-activated in a matter of hours following restoration of power. The only damage was to a few fittings in access vaults which were easily repaired.

This system of individually insulated water and sewer mains has replaced the "Utilidor" (multiple pipes in a box above ground). Above ground utility systems using this same concept are constructed in thermally sensitive, ice-rich, permafrost areas, or where excavation equipment is not available for installation and maintenance or for temporary facilities.

7.1 TYPES OF PIPED WATER SYSTEMS

Single - Pipe Recirculation

The single-pipe recirculation system (Rankin Inlet, Frobisher Bay, Resolute Bay and Fort Rae), whether above or below ground, is considered the best piping system for arctic conditions. This system consists of one or more uninterrupted loops originating at a recirculation facility and returning to that facility.

Water Wasting - Conventional Systems

In this type of system the water distribution network is laid out conventionally to ensure flow. At dead ends, loops, and service lines water is bled off to sewers at a number of areas to prevent freezing (Edzo, Frobisher Bay).

Single Pipe - No Recirculation

This system is employed where high volume users, such as larger apartment blocks, correctional centres, office buildings or fish processing plants, are strategically located at the ends of main lines to ensure a continual flow in the main without requiring a return loop (Frobisher Bay - Federal Building and Baffin Correctional Centre).

Dual Pipe System

In this type of system a larger supply line and a small return line are placed side by side in a trench or in a utilidor (Rankin Inlet-dead ends, Frobisher Bay, Edzo).

7.2 PIPED SEWER COLLECTION SYSTEMS

There are several variations of piped sewage collection systems. Normally, a conventional gravity system has the lowest life-cycle cost and is used whenever feasible. The layout of the site and/or the soil conditions may make other systems, such as pressure or vacuum sewage collection systems, desirable; however, due to higher operation and maintenance costs, such systems have not been recommended in the N.W.T.

Sewage collection mains are either placed above ground or buried depending on the local circumstances. The criteria for selection of above or below-ground systems were presented previously.

7.3 SYSTEM COMPONENTS: PIPED WATER & SEWER SYSTEMS

7.3.1 Water & Sewer Mains

Buried water and sewer mains are individual high density polyethylene pipe (HDPE) with a minimum of 50 mm of polyurethane insulation encased in a 1.14 mm polyethylene impermeable plastic jacket. The mains, both water and sewer, are pressure rated, continuously joined through the butt fusion process and are placed in the same trench. The separation is 1.0 m centerline to centerline. Minimum cover on the pipes is normally 0.6 m.

Above ground water and sewer mains are individual welded schedule 80 steel with 75 mm of polyurethane insulation encased in a light metal jacket. These mains are suspended from piles with adjustable supports.

7.3.2 Access Vaults

Access vaults for buried water and sewer systems are constructed at all intersections, changes in horizontal alignment, changes in grade, termination points of sewers and changes in pipe size. They are designed to allow all servicing to be done from the access vaults out of the weather in a heatable dry environment and consist of 9 mm double wall steel having approximately 130 mm minimum polyurethane insulation between the walls. In order to minimize plumbing on the job, the access vaults are prefabricated and assembled in a factory and arrive on the site with all the interior plumbing and fittings complete.

The access vaults are connected to the sewer or water mains with flanges. All fittings, including air-tight sewer cleanouts, inside the access vaults are galvanized. All sewer cleanouts are designed and sized to provide access to the sewer mains for cleaning, thawing and monitoring purposes. A closed circuit TV camera can be inserted to monitor the conditions of the sewer mains. Each access vault has a valved tapping from a water main for a water source if needed during sewer cleaning or thawing.

All valves, air-tight sewer cleanouts, hydrants, hydrant drains, intersections, bends and thaw tube terminations are installed inside the access vault. Access vaults are placed at a maximum spacing of 100 m for mains 150 to 450 mm in diameter and 150 m for mains 450 to 750 mm in diameter.

Access vault concept plans are shown in Appendix A, Division 4.

7.3.3 Service Connections

Water service connections consist of a 100 mm diameter duct, of butt fused Series 45 (410 kPa) high density polyethylene pipe, with 50 mm of urethane insulation encased in a 1.14 polyethylene jacket. Two minimum 20 mm inside diameter Series 160 (1100 kPa minimum) high density polyethylene water service pipes are field installed inside the duct. The 20 mm water service pipes and a 13 watt/metre heating cable are taped together at 2 metre intervals using two turns of 50 mm wide polyester packaging tape. Tapping saddles for water services are bronze or stainless steel with stainless steel straps or approved equal for use on polyethylene pipe.

Ball valves on 20 mm water service lines are bronze. The valves are fitted to the polyethylene service pipes with 20 mm adaptors as recommended by the pipe manufacturer. Valves, adaptors, and couplings with polyethylene pipe are supplied with tight fittings stainless steel inserts to suit the pipe's internal diameter. These 75 mm long inserts one installed in each end of the polyethylene pipe to be joined.

Sanitary sewer service connections consist of a butt fused minimum 100 mm diameter, Series 45 (410 kPa minimum) high density polyethylene pipe with 50 mm of urethane insulation encased in a 1.14 mm polyethylene jacket connected to the main with a 90 degree bend. Sanitary sewer saddles are one piece stainless steel with a rubber coupling and gasket. The saddle is secured to the sewer main by use of stainless steel worm drive hose clamps.

For both sewer and water connections at the main, a sheet metal form is attached to the main and the service pipe. This is filled with polyurethane insulation after the connection is made to completely insulate the connection.

Service connection details are illustrated in Appendix A, Divisions 1, 2 and 3.

7.3.4 Service Connections - Freeze Protection

To provide freeze protection on water service connections a pump is installed in each housing unit. One of the 20 mm service lines supplies the pump and the building and the second 20 mm functions as a return line to the main. A flow switch is installed in the supply 20 mm line which activates the heat trace when flow stops in the line. The heat trace is thermostatically controlled with a low limit thermostat for freeze protection and a high limit thermostat for protection of the pipe.

This freeze protection is illustrated in Appendix A, Division 5.

8.0 SEWAGE LIFT STATIONS & FORCEMAINS

8.1 SEWAGE LIFT STATIONS

Sewage lift stations, if required, are used with gravity collection systems to lift liquid wastes from one level of the collection system to another or to pump to a sewage treatment facility through a forcemain. Submersible pumping stations are predominantly used in the Northwest Territories for the following reasons:

- Reduced capital costs
- Low maintenance levels
- Minimum total energy requirements
- Skilled operators are not required
- Small populations are adequately served

Other pumping stations such as dry well/wetwell, etc., require more land-use and higher initial cost than submersible pumping station and therefore, are not usually recommended in the Northwest Territories.

Guidelines For The Design Of Sewage Lift Stations

- Sewage pumping stations should be designed to handle the 20 year peak sewage flow

- In sizing the components, a complete economic analysis should be made before deciding whether to:

(i) Install equipment large enough to handle the entire range of present and future flows or;

(ii) Make suitable provisions for increasing the capacity of the station at some time in the future

- In view of higher energy costs it is recommended that designers evaluate gravity sewer alternatives to sewage pumping stations by comparing the total of the capital, operating and maintenance costs, the flexiblity with respect to maintenance and pumping capacity increase, the anticipated life of structures, safety and the requirements for and availability of skilled tradespeople for installation and operation of the two approaches

- Repumping should be eliminated wherever possible

- Each pumping station should be equipped with an alarm system that covers all critical components of the pumping system such as operation of pumps, standby power, temperature and high water level. These alarms should be connected to a central alarm panel or to the operator's home or work telephone.

- Submersible pumping stations are recommended but typical efficiencies of the two types of pumping systems (wet well vs dry well) along with capital, operating and maintenance costs should be considered when choosing between the two types of stations.

- In a station equipped with two pumps, each pump should be capable of pumping the maximum flow from the station.

- In a station equipped with unequally sized pumps, the smallest pump and one other pump working in parallel should be capable of pumping the maximum flow to the station. The third pump will be the same as the larger of the other two pumps.

- In a station equipped with three equally sized pumps, two pumps in parallel should be capable of pumping the maximum flow to or from the station. The third pump provides 50 percent standby.

- System head calculations and curves should be drawn for the following three conditions where C is the Hazen-Williams coefficient:

  I. C = 120 and low water level
  II. C = 130 and medium water level
  III. C = 140 and high water level in the wet well

- Curve II should be used to select the pump and motor since this will reflect the normal operating condition.

- Although it is normal to size pumps and motors for the 10 year peak flows, consideration should be given to how the 20 year and ultimate sewage flow requirements can be handled.

- The maximum speed for a pump should be determined by the net positive suction head available at the pump, the quantity of sewage being pumped and the total head. In general, it is not good practice to operate sewage pumping units at speeds in excess of 1750 rpm. Larger pumps should operate at lower speeds.

- Careful attention should be given to surge control wherever a pump discharges into a forcemain of appreciable length.

- Provide capacity in the wet well between normal low and high water levels such that the maximum number of starts per hour for the pumps is not exceeded. The wet well should not be sized so large that sewage is retained long enough to go septic. It is desirable to limit storage to a maximum of 30 minutes.

- The wet well should be benched to minimize solids deposition and to allow the solids to be transported into the zone of influence of the pump suction.

- All wet wells must be provided with ventilation.

- Suction pipework velocity shall be in the range of 0.76 to 1.98 m/s, preferably at the lower end in the initial stage.

- The outside of the pumping station should be insulated with at least 75 mm of urethane or styrofoam with an outer protective covering to protect the insulation from moisture. Insulation should also be placed underneath the station to prevent settling due to thawing of frozen ground.

- All stations must be checked for buoyancy.

- The minimim size of wet well should at least be 2.4 m in diameter.

Form #2, 3 and 4 are typical design forms used in the design of sewage lift stations and forcemains.

8.2 FORCEMAINS

Forcemains are pressure lines into which the pumps in the lift station discharge. They are utilized to transport the pumped sewage to a separate gravity system or to a treatment/disposal facility.

Guidelines for the Design of Forcemains

- Minimum velocity = 0.76 m/s (Based on proposed pumping capacity)

- Maximum velocity = 3 m/s (Based on ultimate pumping capacity)

- The forcemain size should be determined considering capital and pumping costs and must be sized to accommodate ultimate flows. Minimum size should not be less than 100 mm diameter.

- The forcemain should be checked for its ability to withstand whatever waterhammer pressures may be experienced.

- Acceptable forcemain material is high density polyethylene pipe insulated with rigid polyurethane foam.

- Air release valves, suitable for use with sewage, should be considered at all forcemain high points.

- Sufficient flow must be available to prevent freezing, or alternate means of freeze protection must be provided.

- The forcemain should be capable of being drained in an emergency.

- The forcemain must have provision for thawing and re-starting if it is ever frozen.

FORM 2

GOVERNMENT OF THE NORTHWEST TERRITORIES

DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

SEWAGE PUMPING STATION DESIGN - TABLE I

COMMUNITY ______________________ PROJECT No. __________

PUMPING STATION No. OR NAME ______________________

DESIGNED BY ______________________ DATE __________

Design Subject	Unit	Initial Period	10 years Period	20 years Period	ULTIMATE Period
TRIBUTARY AREA A: Residential B: Commercial C: Industrial	Hectare				
POPULATION DENSITY	persons/ha.				
POPULATION OR EQUIVALENT A: Residential B: Commercial C: Industrial	No.				
PER CAPITA FLOW	litres/cap/d				
AVERAGE FLOW	litres/sec				
PEAK FLOW FACTOR	$1+\frac{14}{4+\sqrt{P\times10^{-3}}}$				
PEAK FLOW	litres/sec				
INFILTRATION RATE	litres/sec/ha				
INFILTRATION	litres/sec				
TOTAL MAX. FLOW	litres/sec				
PUMPS	No.				
PUMP DISCHARGE	litres/sec				
FORCE MAIN DIA.	mm				
VELOCITY	m/sec				

Rev 8/85

FORM 3

GOVERNMENT OF THE NORTHWEST TERRITORIES
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
SEWAGE PUMPING STATION DESIGN - TABLE II

COMMUNITY ______________________ PROJECT No. ____________
PUMPING STATION No. OR NAME ______________________
DESIGNED BY ______________________ DATE ____________

Flow litres/sec	F. Main Diam.	Vel. m/sec	H.L. m/1000m	Dist. m.	H.L. m	Fitting H.L. m	P.S. H.L m	Total H.L. m	L.W.L. W/Well	H.W.L. W/Well	F. Main End El.	STATIC HEAD		TOTAL DYN. HEAD	
												MAX.	MIN.	MAX.	MIN.

Rev. 6/85

FORM #4

GOVERNMENT OF THE NORTHWEST TERRITORIES

DEPARTMENT OF PUBLIC WORKS
TABLE III DATA FORM

For

SUBMERSIBLE SEWAGE PUMPS

For

THE SUPPLIER'S INFORMATION

1.1 Station Data Required For:

.1 Project No. ______________________ Station No. ______________

.2 Location & Jobsite ____

.3 Contract No. ____

1.2 Pump Data for Each Pump:

.1 Present & 10-Year Requirements ________ L/S ________ L/S ________ L/S

.2 Total Dynamic Head ________ m. TH ________ m. TH ________ m. TH

.3 System Curve Attached ______________________________________

1.3 Elevations at Jobsite, Etc. (Elevations are basically in a descending order for convenience)

.1 Top of Pumping Station ______________________ m

.2 Finished Ground Level ______________________ m

.3 Invert of influent sewer ______________________ m

.4 Invert of discharge forcemain ______________________ m

.5 Invert of overflow, or flood level ______________________ m

.6 Actuate high level alarm ______________________ m

.7 Start standby pump (Max. Fluid Level) ______________________ m

.8 Start Pump #2 ______________________ m

Start Pump #1 ______________________ m

.9 Stop all pumps (Low Fluid Level) ______________________ m

.10 Bottom of wet well ______________________ m

.11 Plan size of wet well ______________________ m^2

1.4 Pump Assembly & Auxiliary Equipment

.1 Pump lifting chain length ______________________ m

.2 Pump cable length ______________________ m

.3 Float cable length ______________________ m

.4 No. & Min. size of access covers ______________________ m

1.5 Control Panel

.1 Power supply (V/Ph/Hz) ______________________.

.2 A standby generator ______________ being provided at the site.

.3 Pump starters shall be ______________ voltage type.

.4 Pump control circuit to Drawing No. ______________.

.5 Enclosure (indoor or outdoor & CEMA type) ______________.

.6 Enclosure mounting (wall or pole, etc.) ______________.

1.6 Special Requirements

Issued by: ______________________
(Consultant)

Date: ______________________

9.0 SEWAGE TREATMENT AND DISPOSAL

Sewage treatment and disposal has two main objectives. These are as follows:

A. Safeguard Public Health by:

- designing efficient outfalls to ensure frequented shoreline is normally free of pathogenic organisms
- ensuring natural treatment facilities are 500 metres from the nearest inhabited dwelling
- posting natural treatment facilities so persons entering the vicinity are aware of the dangers
- locating facilities such that odours do not affect the community
- ensuring recreational waters are not pathogenically contaminated
- ensuring water sources are not contaminated

B. Safeguard the Environment by:

- ensuring natural aesthetics of the effluent receiving bodies are either maintained or enhanced
- ensuring that the eutrophic effect of an effluent discharge on a receiving water body does not unacceptably alter the habitat for the existing aquatic life

The system designer has six distinct steps to undertake to determine the most suitable solution for a particualr community.

Consider - general community characteristics
Determine - ultimate receiving bodies
Assess - ultimate receiving bodies

Estimate - levels of treatment and flow control required
Estimate - costs
Determine - cost-effective solution(s)

The effluent quality guidelines for municipal wastewater discharges, as prepared by the Northwest Territories Waterboard, are indicated in Table 2 and its accompanying notes. Other parameters may affect a particular design or community on a site specific basis. Designers in the Northwest Territories have, to this point, been able to meet these guidelines by utilizing a variety of simple lagoons or direct discharges.

Direct discharge may be discharge after maceration, discharge to marshes or discharge direct to the receiving body. Lagooning may be primary settling or varying retention (20-300 days) with discharge to a receiving body or swampland. This ability to meet guidelines using simple low maintenance lagoons and discharges has allowed designers to avoid the higher operation and maintenance costs and the need for skilled operators which occur with permanent mechanical sewage treatment plants.

The sewage treatment and disposal system must, however, be designed such that it may be expanded and/or upgraded to provide higher levels of treatment over the design life of the facility. This flexibility is critical to provide for future population increases and effects on the environment revealed during operation.

TABLE 2

Effluent Quality For Municipal Wastewater Discharges (1)*

Wastewater Flow Ratios (2) (Sewage Strength)	Parameters	Receiving Environment							
		Streams, Rivers and Estuaries (3)				Lakes (3)		Marine (6)	
		Dilution (4)				Residence Time or Dilution (5)		Open	Bays and Fjords
		>10:1 <100:1	>100:1 <1000:1	>1000:1 <10000:1	>10000:1	$T_r > 5$ yr. or $\frac{Qt}{Qw} \leq 1000$	$T_r \leq 5$ yr. or $\frac{Qt}{Qw} > 1000$		
≤0.5 (high)	BOD, mg/L SS, mg/L pH Oil and Grease P, mg/L (7) Coliforms	30 35 6-9 none visible 9 (8) $<10^3$ (9)	90 110 6-9 none visible — (8) $<10^4$ (9)	360 250 6-9 none visible — (8) $<10^5$ (9)	360 250 6-9 none visible — (8) $<10^6$ (9)	30 35 6-9 none visible 1.0 10^3 (9)	90 110 6-9 none visible 2.0 $<10^4$ (9)	600 725 — none visible — (10)	360 250 — none visible 2.0 (10)
>0.5 <2.0 (normal)	BOD, mg/L SS, mg/L pH Oil and Grease P, mg/L (7) Coliforms	30 35 6-9 none visible 5 (8) $<10^3$ (9)	45 55 6-9 none visible — (8) $<10^4$ (9)	180 125 6-9 none visible — (8) $<10^5$ (9)	180 125 6-9 none visible — (8) $<10^6$ (9)	30 35 6-9 none visible 1.0 $<10^3$ (9)	45 55 6-9 none visible 2.0 $<10^4$ (9)	300 360 — none visible — (10)	180 125 — none visible 2.0 (10)
≥2.0 (low)	BOD, mg/L SS, mg/L pH Oil and Grease P, mg/L (7) Coliforms	25 30 6-9 none visible 2 (8) $<10^3$ (9)	25 30 6-9 none visible — (8) $<10^4$ (9)	90 60 6-9 none visible — (8) $<10^5$ (9)	90 60 6-9 none visible — (8) $<10^6$ (9)	25 30 6-9 none visible 1.0 $<10^3$ (9)	25 30 6-9 none visible 2.0 $<10^3$ (9)	150 180 — none visible — (10)	90 60 — none visible 2.0 (10)

* Bracketed numbers refer to the notes which follow

Notes to Table 2

1. The values in Table 2 are to be met for average daily wastewater flows greater than 30 m^3/day. If the wastewater is less than 30 m^3/day, values for BOD, SS, P may be multiplied by a factor of 1.5.

2. Definition of flow ratio

   $$\text{Flow Ratio} = \frac{Qa}{Qr}$$

   Where Qa = Actual Wastewater Flow (L/person/day)

   Qr = Reference wastewater Flow (L/person/day)

   The Qa can be determined directly by actual measurement or may he calculated from the design average wastewater flow per person for the community under consideration. The reference wastewater flow, Qr, is the assumed average wastewater flow rate in the N.W.T. This assumed rate is 300 L/person/day.

3. Untreated wastewater discharges are not permitted to any inland waters, except where the Water Board has specifically permitted the use of inland waters for the containment or treatment of municipal wastewater.

4. For continuous discharge, dilution is calculated as follows:

   $$\text{dilution} = \frac{\text{minimum average monthly stream flow}}{\text{average daily wastewater flow}}$$

   (where both flows are expressed in the same units)

   For estuaries, the stream flow is to be based on the fresh water content.

   For discontinuous discharge, the stream flow can be based on the average flow at the time of discharge.

5. In the case of lakes, the requirements for effluent quality depend on lake residence time or wastewater dilution by incoming tributaries, defined as follows:

   $$\text{residence time } T_r = \frac{V}{Qt} \text{ (years)}$$

   $$\text{dilution } DD = \frac{Qt}{Qw}$$

   where V = volume of Lake (m^3)

   Qt = annual outflow from lake (m^3/yr)

   Qw = wastewater flow (m^3/yr)

   If the dilution is less than 200:1, a site-specific study may be required. Confined bays are to be treated as individual water bodies.

6. Wastewater with the specified characteristics must be discharged by outfalls which are designed according to the specifications given in Appendix A. In general, discharge of untreated wastewater to the open sea is permitted, if as minimum, floatable materials are removed and the discharge is comminuted or macerated. The requirements of discharges to bays and fjords may be relaxed, depending on the findings of site-specific studies.

7. The requirements for limitation of effluent concentrations of phosphorus are considered to be flexible. Site-specific studies may dictate less or more stringent requirements.

8. Untreated phosphorus discharges into streams are permitted only if the discharge point is located at least 10 km from the next downstream lake.

   Otherwise restrictions as in the case of lakes may be required.

9. The defined coliform levels are based on maintaining a concentration outside its mixing zone such that not more than 10 per cent of raw water samples in a 30 day period have a fecal coliform density in excess of 10 per 100 mL, with a fecal coliform to fecal streptococci ratio of more than 3:1 or a total coliform density of more than 100 per 100 mL. Any requirement for wastewater disinfection would be considered on a site-specific basis based on public health considerations.

10. Only in the case of a fishery or recreational use of water would bacteriological standards be of concern.

10.0 HISTORICAL COST RECORDS

10.1 PIPE SYSTEM

For a standard 150 mm water main and 200 mm sewer main in the same trench with hydrant/access vaults the costs for both individually insulated pipes per metre has been as follows:

Frobisher Bay

- Phase III	- 1978	$390.00/Lin. m
- Phase IV	- 1979	315.00/Lin. m
- Phase VI	- 1985	207.00/Lin. m
- Fed. Bldg. & B.C.C.	- 1985	407.00/Lin. m
- W/S Service Connections	- 1984	452.00/Lin. m

Rankin Inlet

- Expansion Area 3	- 1983	$280.50/Lin. m (150s & 200w)
- Area 2	- 1979	170.00/Lin. m (200 & 200)
- W/S Service Connections	- 1979	329.50/Lin. m (200 & 200)

Fort Rae

- W/S Extensions to Senior Citizen Complex	- 1985	$294.00/Lin. m.
- W/S Extension to Rae Recreational Complex	- 1984	$450.00/Lin. m

10.2 INDIVIDUAL ITEMS

- Access Vaults (Prefabricated Steel)	= $ 22,000 - $ 30,000
- Hydrants (On Line)	= $ 1,500 - $ 2,500
- Truckfill Stations Intake, building, mech/ Elec., complete	= $250,000 - $500,000
- Back-up Power Supply (Generators)	= $ 35,000 - $ 50,000
- Water & Sewer Service Connections	= $ 10,000 - $ 12,000
- Water Intakes (Dual)	= $ 90,000 - $110,000

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APPENDIX "A"

NORTHWEST
TERRITORIES PUBLIC WORKS & HIGHWAYS

WATER SEWER

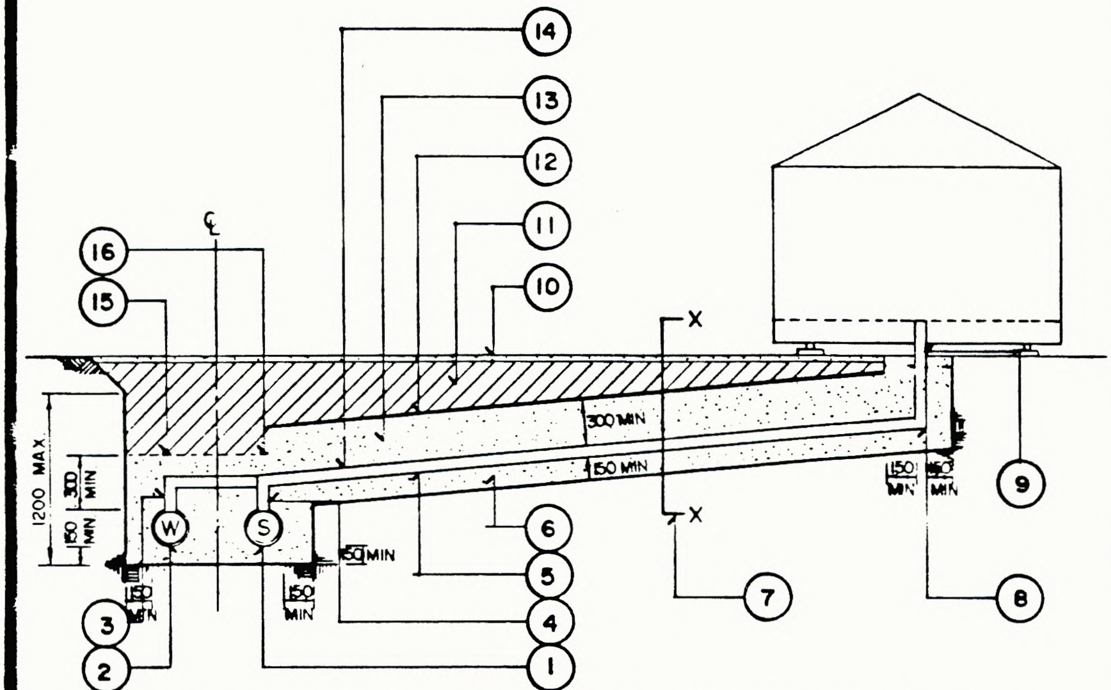
CONCEPT PLANS

ENGINEERING DIVISION
DEPT. OF PUBLIC WORKS
& HIGHWAYS
GOVERNMENT OF THE NWT

DIVISION 1

BEDDING DETAILS FOR WATER AND SEWER SYSTEMS

ENGINEERING DIVISION



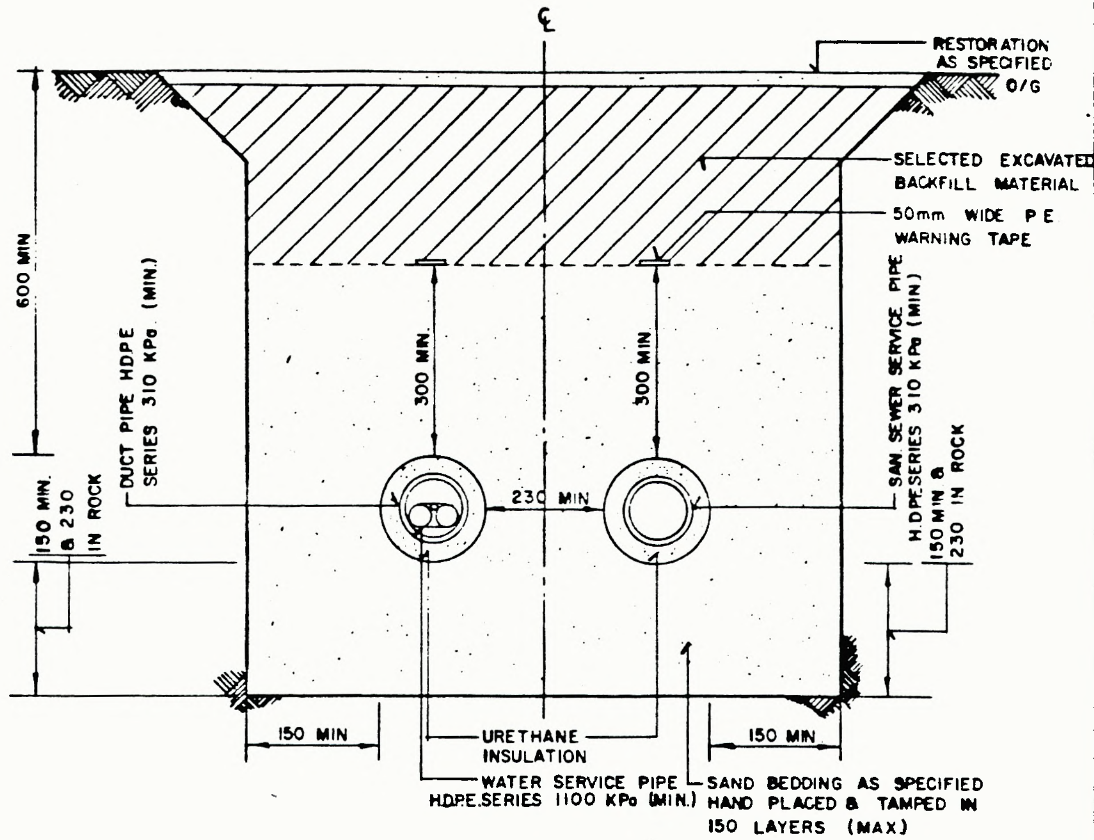
TYPICAL HOUSE WATER AND SANITARY SEWER SERVICE CONNECTION

N.T.S.

KEY TO NUMBERED PARTS

1. SEE DRWGS. S-2 & S-4
2. SEE DRWGS. W-2, W-4 & W-5
3. SEE DRWG. W-2
4. SEE DRWG. S-1
5. SECTION 7.3.3.
6. SEE DRWG. B-2
7. SEE DRWG. B-2
8. SEE DRWGS. S-3 & W-3
9. HOUSE FOUNDATION / SUPPORT
10. RESTORATION (SEE DRWG. B-2)
11. BACKFILL MATERIAL
12. WARNING TAPE
13. BEDDING MATERIAL
14. SECTION 7.3.3.
15. SEE DRWG. B-2
16. SEE DRWG. B-2

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R J S
		GOV'T OF THE N.W.T.	DATE:	84/10/2
		TYPICAL BEDDING DETAILS	SCALE:	N.T.S.
			DRAWING NO.	B-1



TYPICAL TRENCH SECTION – SERVICE CONNECTION

N.T.S.

NOTES :

1. BEDDING MATERIAL SHALL BE COMPACTED TO 95% PROCTOR DENSITY
2. MAINTAIN THE MINIMUM COVER OF 600 (IF PERMITTED)
3. MAINTAIN THE MINIMUM GRADE OF 2% - SANITARY SEWER SERVICE CONNECTION
4. WARNING TAPE FOR WATER SERVICE CONNECTION SHALL BE BLUE IN COLOUR AND HAVE FACTORY APPLIED MARKINGS AT ONE METRE INTERVALS IE: "CAUTION - BURIED WATER SERVICE LINE"
5. WARNING TAPE FOR SANITARY SEWER SERVICE CONNECTION SHALL BE GREEN IN COLOUR AND HAVE FACTORY APPLIED MARKINGS AT ONE METRE INTERVALS IE: " CAUTION - BURIED SANITARY SEWER SERVICE LINE"
6. WATER SERVICE LINES SHALL BE CONTINUOUS AND WITHOUT JOINTS OR SPLICES BETWEEN TWO VALVES IE: STREET SERVICE VALVE AND BUILDING STOP
7. ALL FUSION JOINTS SHALL BE MADE BY A QUALIFIED AND LICENSED JOINTING TECHNICIAN.
8. JOINTS AND SPLICES SHALL NOT BE ALLOWED ON HEATING CABLES
9. IT SHOULD NOT BE CONSTRUED THAT THE TRENCH LIMITS AS SHOWN CONFORM TO SAFETY REGULATIONS GOVERNING SUCH TRENCHES
10. ALL DIMENSIONS ARE IN METRIC.

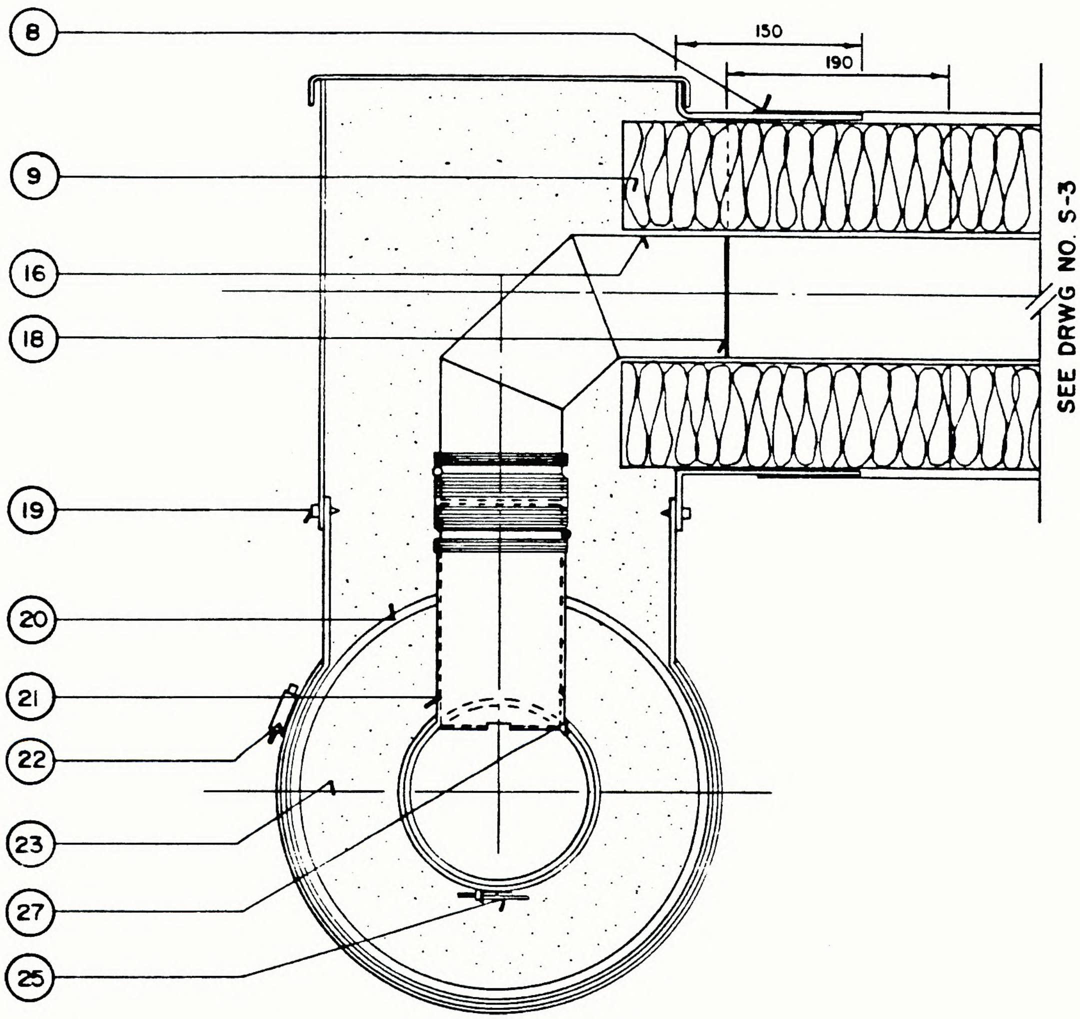
REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY	
DATE	BY		APPROVED BY	
			DRAWN BY:	R.J.S
		GOV'T OF THE N.W.T.	DATE:	84/09/25.
		TYPICAL BEDDING DETAILS	SCALE:	N.T.S
			DRAWING NO.	B-2

DIVISION 2

SANITARY SEWER SERVICE CONNECTION

ENGINEERING DIVISION

NOTE 1 ALL DIMENSIONS ARE IN METRIC
2 SEE DRWG S-5 FOR KEY NUMBERED PARTS
3 SEE DRWG S-2 FOR FRONT VIEW



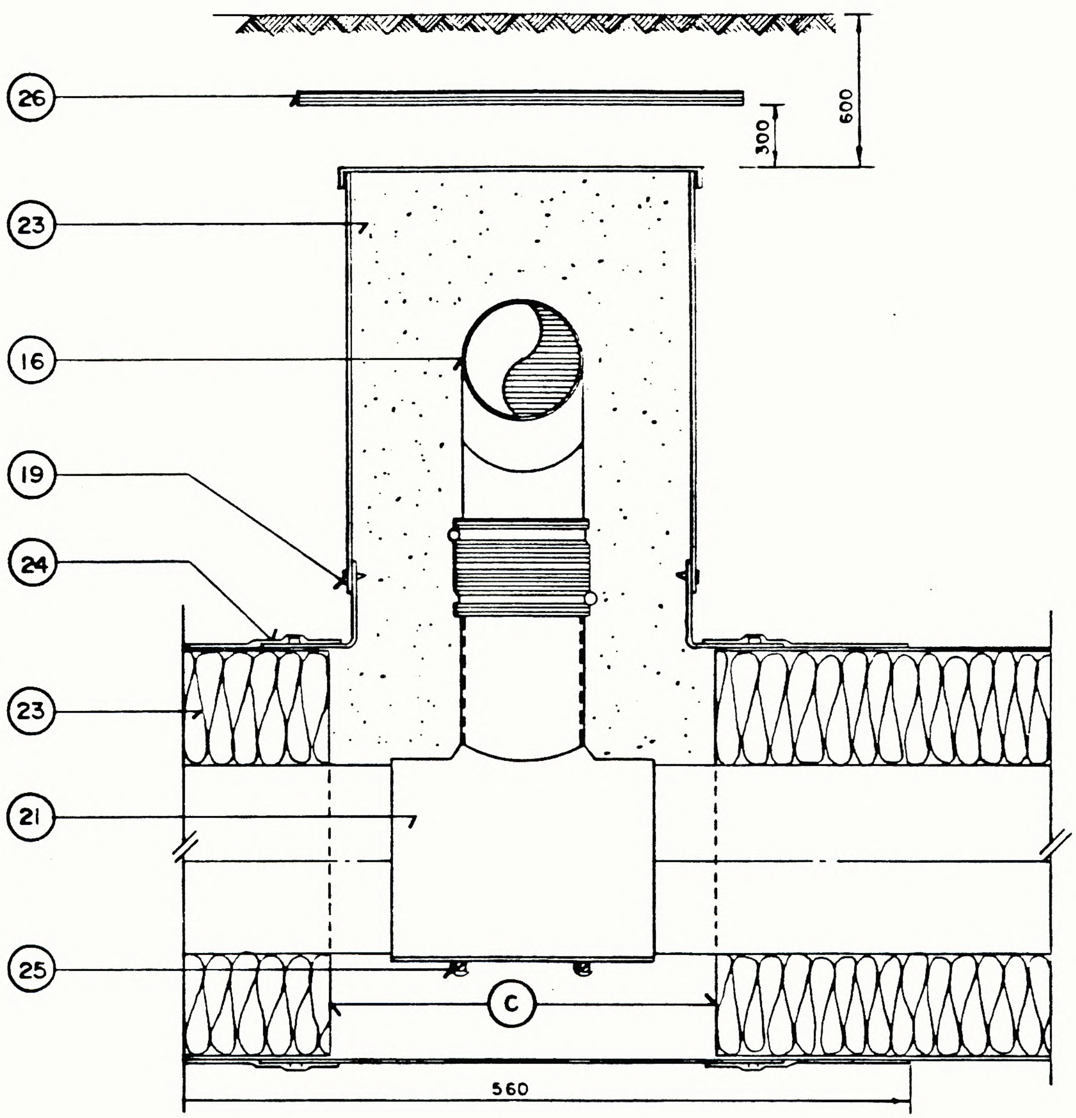
SEWER SERVICE CONNECTION AT MAIN

N.T.S.

SIDE VIEW

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J S.
		GOV'T OF THE N.W.T.	DATE:	84/09/20
		TYPICAL SEWER SERVICE	SCALE:	N T S
			DRAWING NO:	S-1

NOTE 1 ALL DIMENSIONS ARE IN METRIC.
2 SEE DRWG NO. S-5 FOR KEY NUMBERED PARTS.
3 SEE DRWG S-1 FOR SIDE VIEW



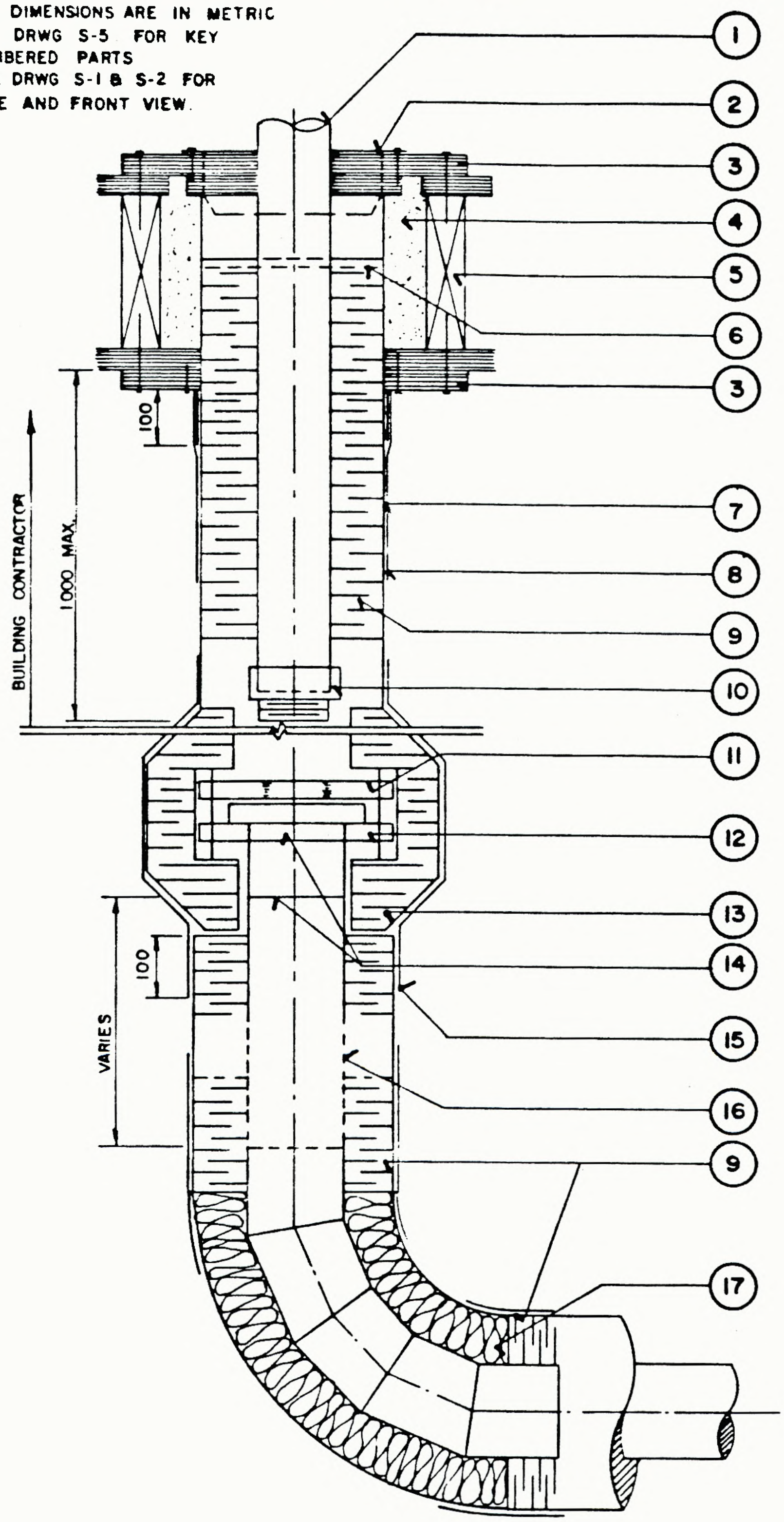
SEWER SERVICE STUB

N.T.S.

FRONT VIEW

REVISIONS		DEPARTMENT OF PUBLIC WORKS &HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84/09/20
		TYPICAL SEWER SERVICE	SCALE:	N.T.S
			DRAWING NO:	S-2

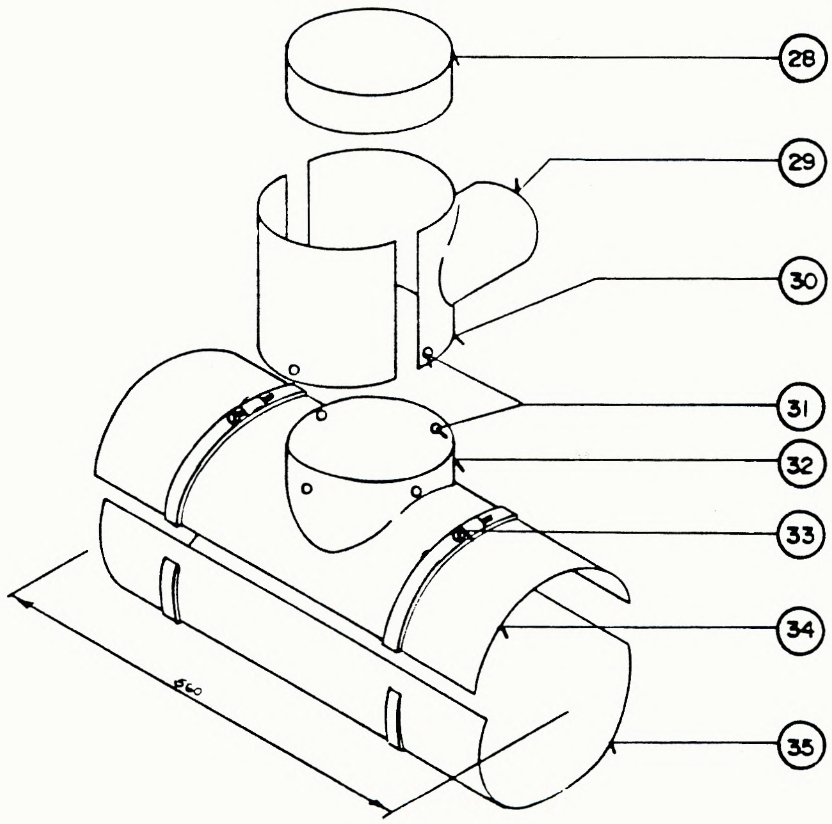
NOTE 1 ALL DIMENSIONS ARE IN METRIC
2 SEE DRWG S-5 FOR KEY NUMBERED PARTS
3 SEE DRWG S-1 & S-2 FOR SIDE AND FRONT VIEW.



SANITARY SEWER RISER

NTS

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84/09/21
		TYPICAL SEWER SERVICE	SCALE:	N.T.S.
			DRAWING NO.	S-3



ISOMETRIC SEWER SERVICE STEEL INSULATION FORMS

N.T.S.

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84 /09/ 24
		TYPICAL SEWER SERVICE	SCALE:	N.T.S.
			DRAWING NO:	S-4

KEY TO NUMBERED PARTS

1. 75mm DIA PVC OR ASBESTOS PIPE
2. 200mm CHIMNEY CLEANOUT PLUG CUT HOLE TO FIT O.D. OF PIPE
3. 20mm PLYWOOD GLUED & SCREWED TO JOIST/STUDS AND HEADERS
4. URETHANE INSULATION FROM PORTABLE FOAM PACK
5. FLOOR JOIST
6. SILICON SEALER APPLIED TO THIS SECTION BEFORE INSERTING INSULATED PIPE INTO OPENING
7. 290mm GALV THIMBLE 22ga TOP & BOTTOM SCREWED TO PLYWOOD
8. HEAT SHRINK TO FIT 290 O.D.
9. URETHANE HALF SHELLS CUT TO LENGTH COATED WITH FIELD APPLIED MASTIC
10. 75mm DIA A35 MALE FITTING ADAPTER SOCKETS XMPT 75mm LONG
11. REDUCING FLANGE 75mm x 225mm x 1030 KPa WITH RUBBER GASKET
12. BACK UP RING FOR FLANGE ADAPTER
13. INSULATION KIT FOR FLANGE ASSEMBLY SEE NOTE A
14. FLANGE ADAPTER BUTT FUSED TO 100mm P.E. PIPE
15. HEAT SHRINK TO FIT OVER INSULATION KIT ASSEMBLY
16. SANITARY SERVICE 100mm DIA STUB END SERIES 45 MIN.
17. RIGID POLYURETHANE INSULATED FACTORY MANF. HALF SHELLS TO FIT LONG RADIUS 90° ELL
18. FIELD BUTT FUSION JOINT
19. 4 FIELD APPLIED HEX HEAD METAL SCREWS
20. YELLOW / BLACK JACKET
21. 90° ENTRANCE STAINLESS - STEEL SEWER - TAPPING SADDLE
22. 2 SS GEAR CLAMPS HOLDING SS. URETHANE FORM SADDLE
23. FIELD POUR URETHANE
24. MASTIC LINED HEAT SHRINK TAPE 100mm OVERLAP ON SHELLS AND PIPE JACKET
25. SADDLE - CLAMP HOLDING SEWER SADDLE TO P.E. PIPE
26. 600 x 600 x 12 mm PLYWOOD PAINTED FLUORESCENT ORANGE
27. HOLE FOR SERVICE TO BE DRILLED IN MAIN WITH HOLE SAW
28. SECURITY CAP
29. DIA TO SUIT INSULATED PIPE
30. 290 O.D.
31. HOLES TO BE DRILLED IN FIELD TO SUIT
32. 285 ⌀
33. DIA. TO SUIT INSULATED PIPE
34. GEAR CLAMPS STAINLESS STEEL
35. DIA. TO SUIT INSULATED PIPE O.D & REQUIREMENT OF 25 mm ON BOTH SIDES.

GENERAL NOTES:

A. 290 DIA. HALF TEE SHALL BE SLID ON SERVICE LATERAL PRIOR TO MAKING BUTT FUSION JOINT

B. PLASTIC MARKER TAPE 150 WIDE TO BE PLACED OVER ALL LATERALS. (FLUORESCENT ORANGE)

C. ALL EXPOSED SURFACES COATED WITH FIELD APPLIED MASTIC-INCLUDE URETHANE

D. THE INSIDE SURFACES OF METAL SHALL BE COATED WITH OIL

E. ALL DIMENSIONS ARE IN METRIC.

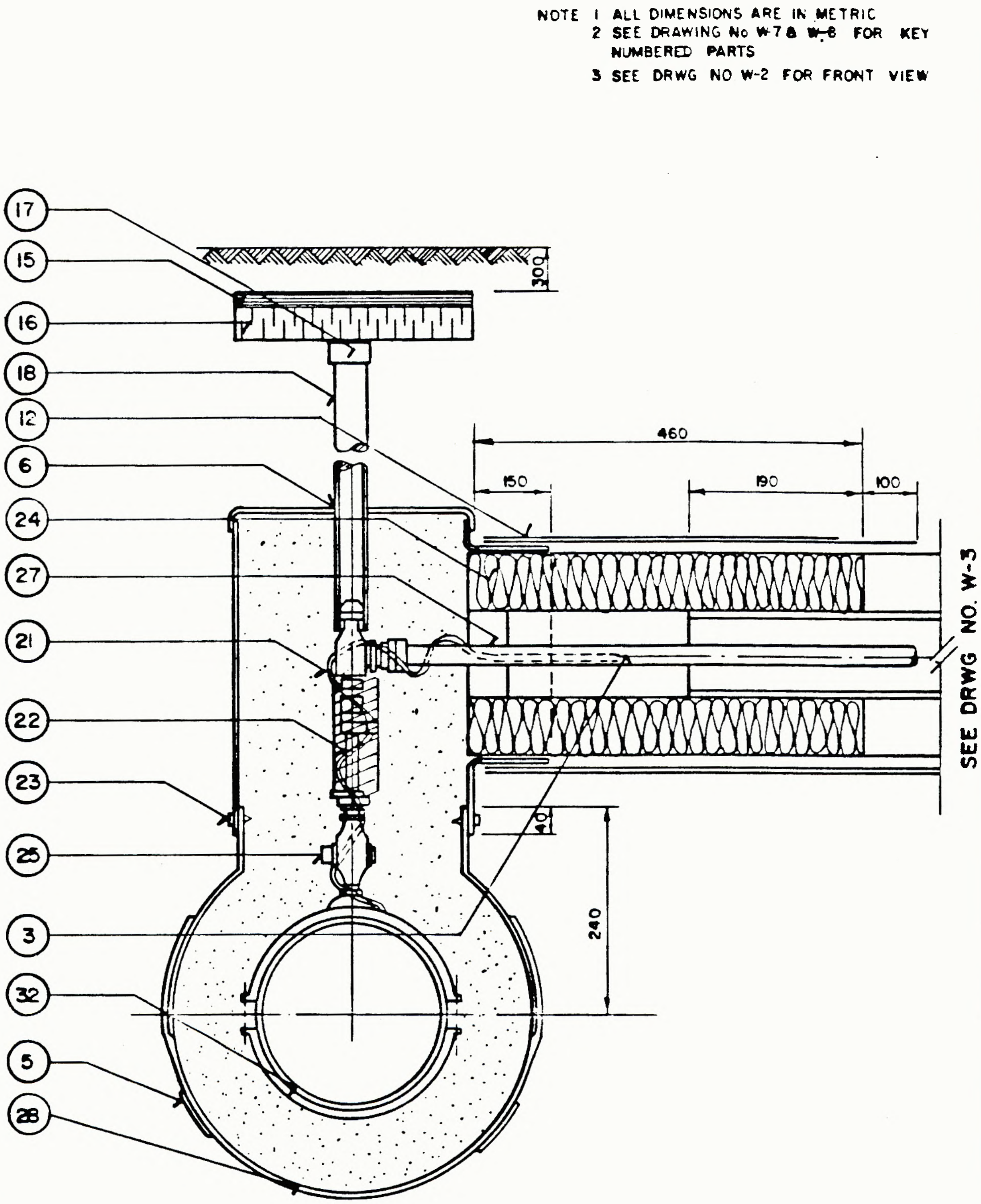
F. SEE DRWGS. S-1, S-2, S-3, & S-4

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R. J. S
			DATE:	84/09/21
		TYPICAL SEWER SERVICE	SCALE:	N.T.S
			DRAWING NO:	S-5

DIVISION 3

WATER SERVICE CONNECTION

ENGINEERING DIVISION



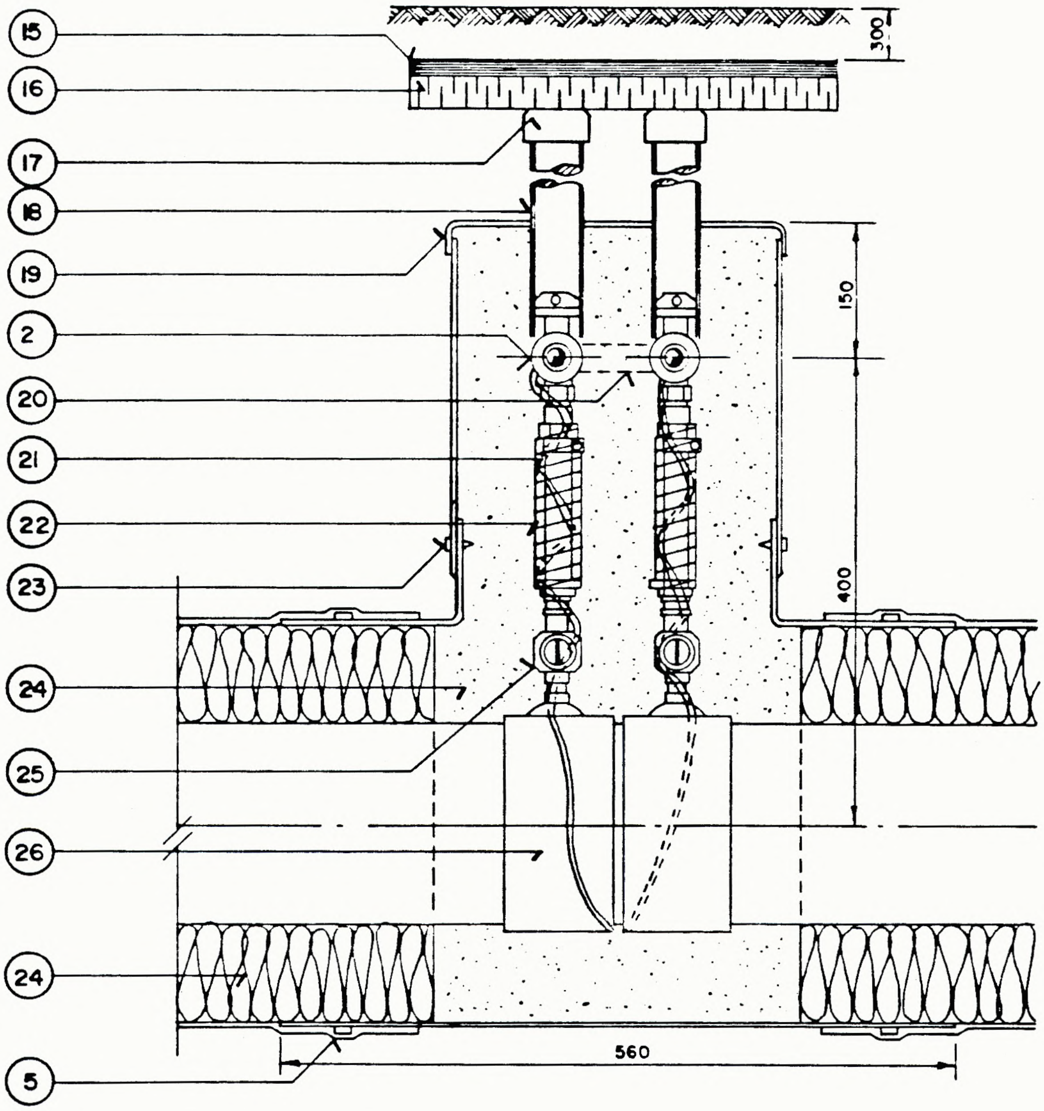
WATER SERVICE CONNECTION AT MAIN

N.T.S.

SIDE VIEW

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
		GOV'T OF THE N.W.T.	DATE:	84/09/12
		TYPICAL WATER SERVICE	SCALE:	N.T.S
			DRAWING NO:	W-1

NOTE: 1 ALL DIMENSIONS ARE IN METRIC.
2 SEE DRAWING NO W-7 & W-8 FOR KEY NUMBERED PARTS.
3 SEE DRWG NO. W-1 FOR SIDE VIEW.



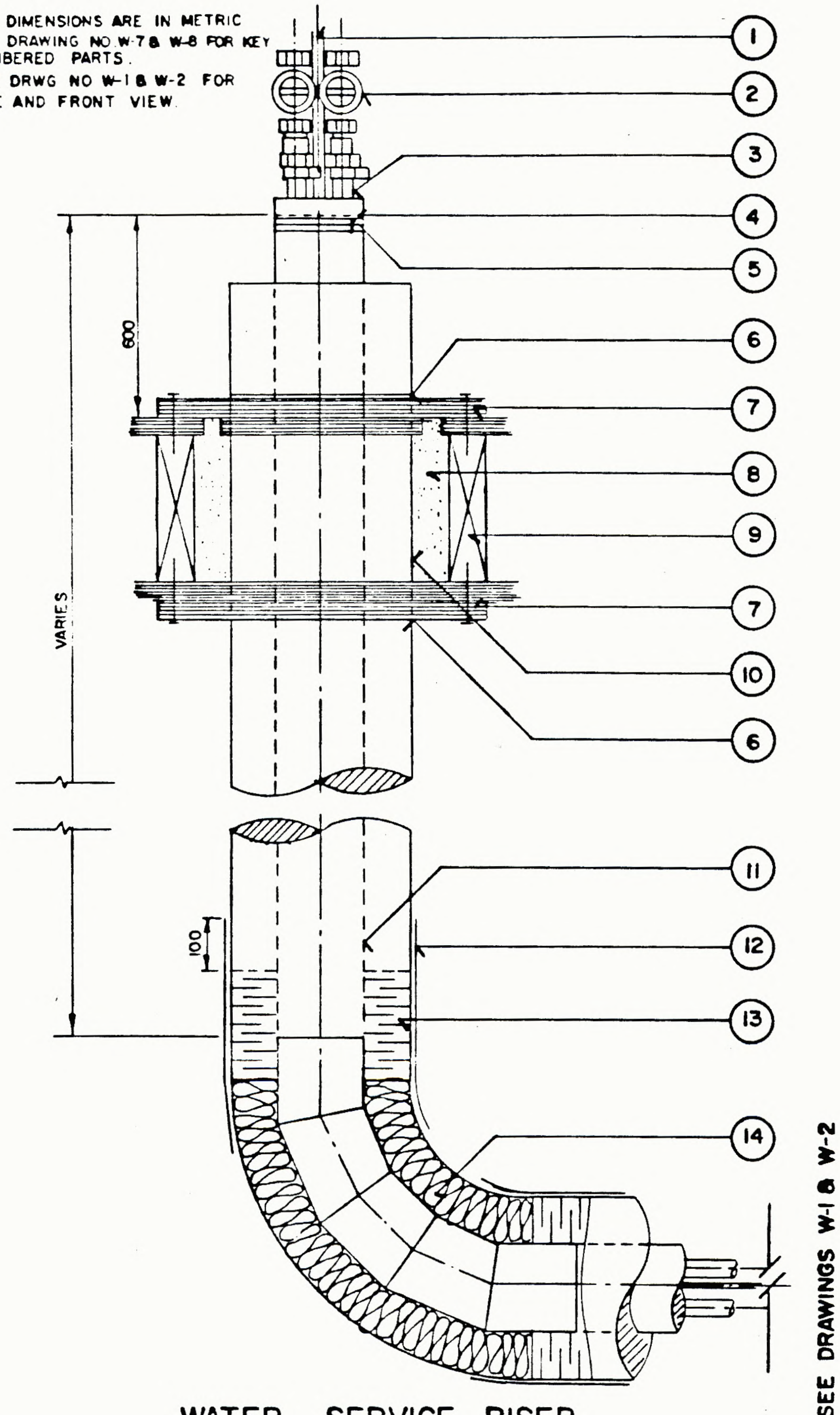
WATER SERVICE STUB

N.T.S.

FRONT VIEW

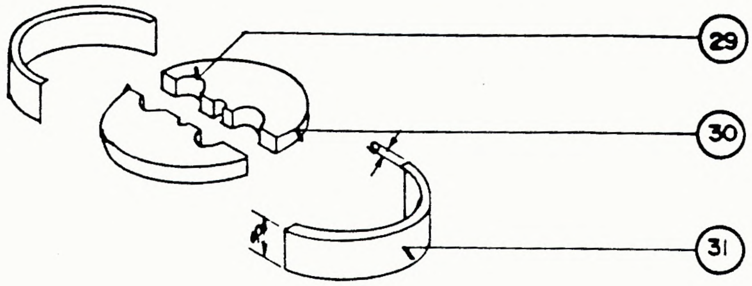
REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY	
DATE	BY		APPROVED BY	
			DRAWN BY	R.J.S
		GOV'T OF THE N.W.T.	DATE	84/09/12
		TYPICAL WATER SERVICE	SCALE	N.T.S
			DRAWING NO	W-2

NOTE 1. ALL DIMENSIONS ARE IN METRIC
2. SEE DRAWING NO W-7 & W-8 FOR KEY NUMBERED PARTS.
3. SEE DRWG NO W-1 & W-2 FOR SIDE AND FRONT VIEW.



WATER SERVICE RISER
N.T.S.

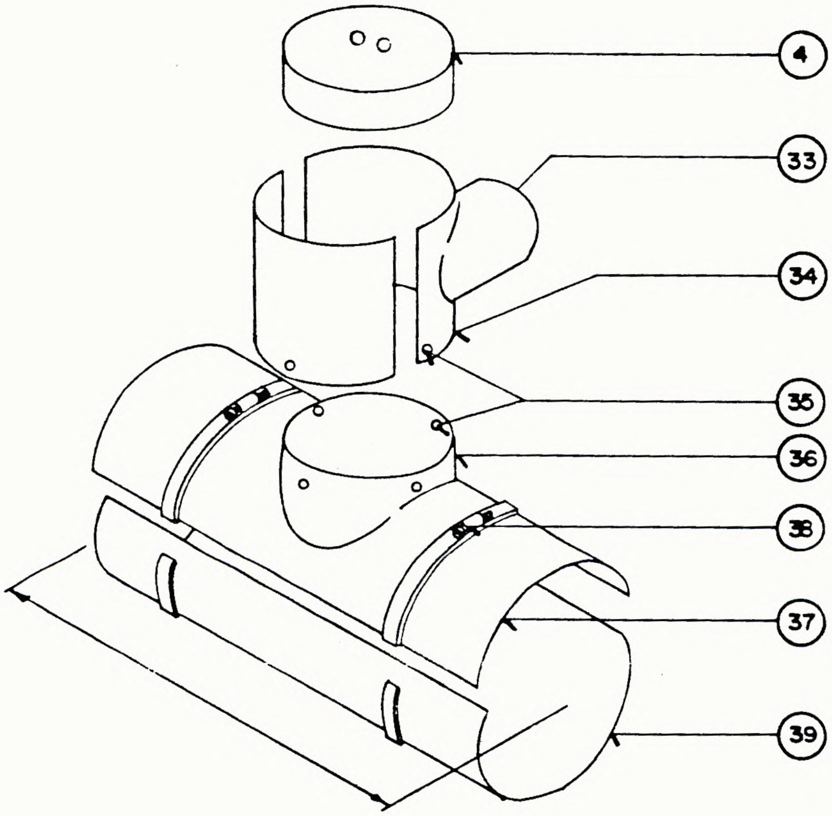
REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S
		GOV'T OF THE N.W.T.	DATE: 84/09/12
		TYPICAL WATER SERVICE	SCALE: N.T.S.
			DRAWING NO: W-3



NOTE: 1. ALL DIMENSIONS ARE IN METRIC.
2. SEE DRWG NO. W-7 & W-8 FOR KEY NUMBERED PARTS.

SECURITY CAP

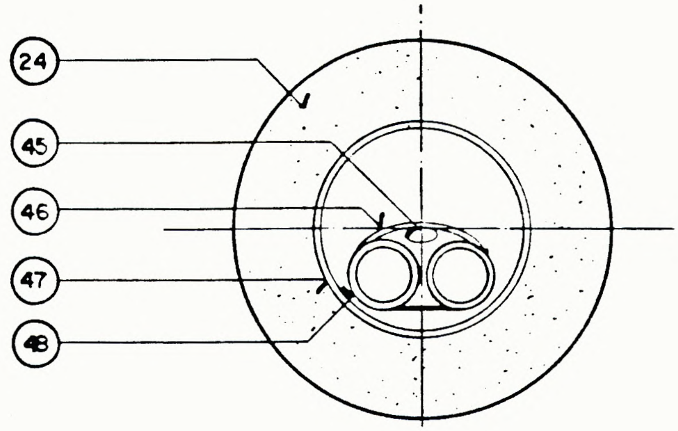
N.T.S.



ISOMETRIC WATER SERVICE STEEL INSULATION FORMS

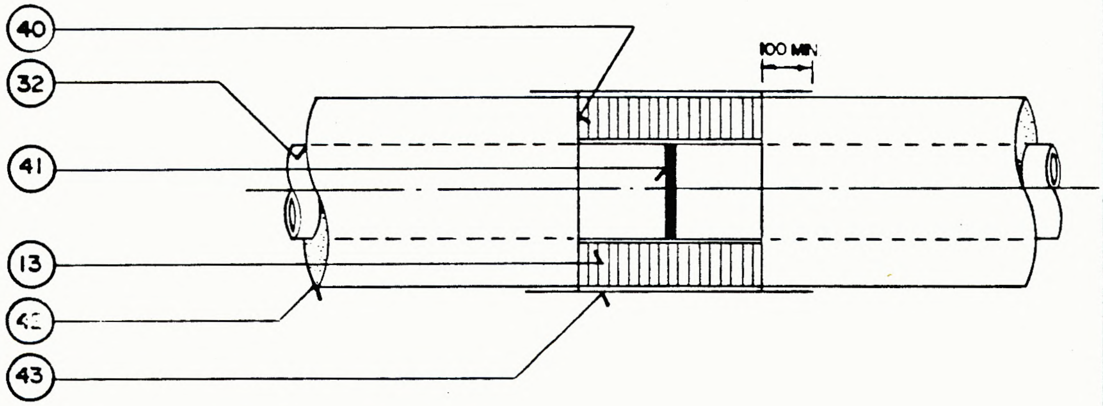
N.T.S.

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS		
DATE	BY		CHECKED BY:	
			APPROVED BY	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84/09/13
		TYPICAL WATER SERVICE	SCALE:	N.T.S.
			DRAWING NO:	W-4



SECTION THROUGH WATER SERVICE

N.T.S

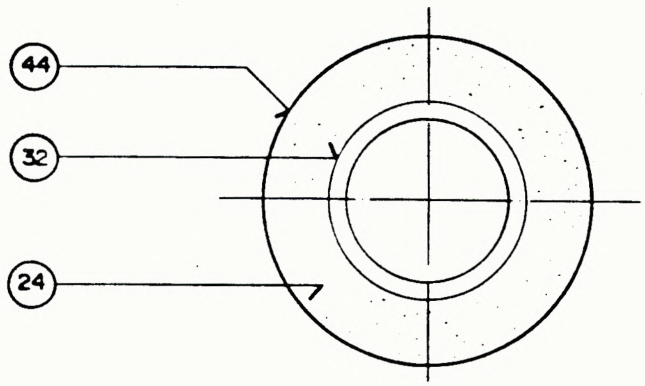


TYPICAL JOINT ON SERVICE CONNECTIONS

N.T.S

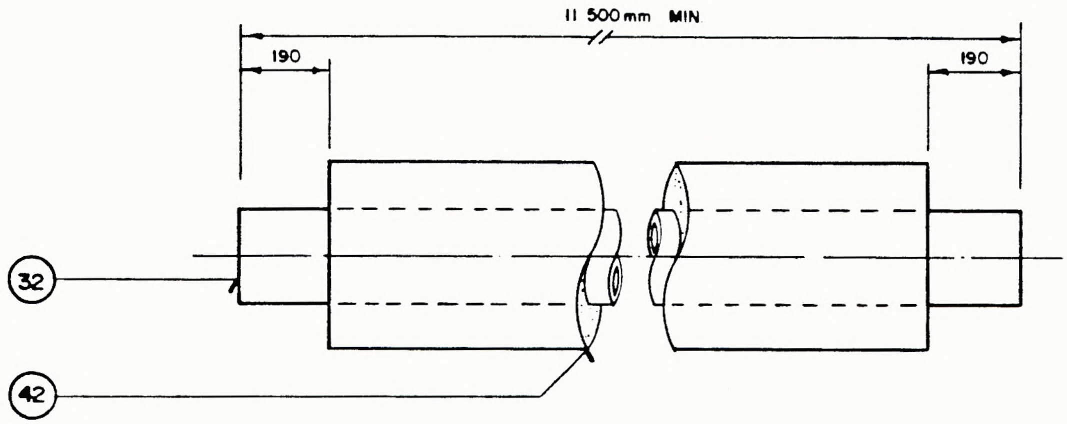
NOTE: 1. ALL DRWGS ARE IN METRIC.
2. SEE DRWGS W-1, W-2, W-3, W-4 FOR DETAILS.
3. FOR KEY NUMBERED PARTS SEE DRWG NO W-7 & W-8

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84/09/17
		TYPICAL WATER SERVICE	SCALE:	N.T.S.
			DRAWING NO.	W-5



SECTION OF MAINS

SCALE 1:5



TYPICAL WATERMAIN OR SEWERMAIN PIPE

N.T.S.

NOTE: 1. ALL DRWGS ARE IN METRIC.
2. SEE DRWG NO. W-7 & W-8 FOR KEY NUMBERED PARTS.

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
		GOV'T OF THE N.W.T.	DATE:	84/09/17
		TYPICAL WATER SERVICE	SCALE:	AS SHOWN
			DRAWING NO:	W-6

KEY TO NUMBERED PARTS:

1	2000mm EXCESS HEATING CABLE TO BE LEFT AT DWELLING END	17	METAL PIPE CAPS
2	20mm BALL VALVES	18	50 PE PIPE VALVE EXTENSION FIELD CUT TO LENGTH AND FILLED WITH SILICON GREASE
3	20mm P.E. SUPPLY & RECIRCULATION PIPE	19	REMOVABLE GALV SHEET METAL CAP
4	SECURITY CAP	20	BLOCK AND TIE PIPE TO PREVENT MOVEMENT DURING URETHANE CASTING
5	SS. GEAR CLAMP HOLDING SECURITY CAP IN PLACE	21	HEATING CABLE WRAPPED AROUND SERVICE RISER AND MAIN.
6	CAULK WITH SILICON ALL AROUND	22	HEAT TRANSFER TAPE
7	20mm PLYWOOD GLUED & SCREWED TO JOIST / STUDS AND HEADERS	23	4 FIELD APPLIED SHEET METAL SCREWS
8	URETHANE INSULATION FROM PORTABLE FOAM PACK TO FILL VOID	24	POURED URETHANE 345 KPa COMPRESSION STRENGTH
9	FLOOR JOIST	25	20 MAIN STOP MALE THREAD TO BE COMPATABLE WITH FEMALE TAPPING INTO THE SADDLE
10	FIBERGLASS REINFORCED PLASTIC THIMBLE	26	TAPPING SADDLES FOR HDPE PIPE
11	WATER SERVICE CARRIER PIPE 100 mm DIA. SERIES 45 MIN.	27	PLUG
12	HEAT SHRINK TO FIT 290 OD.	28	BOTTOM INSULATION FORM OF 760 x 560 GALV. SHEET STEEL
13	URETHANE HALF SHELLS CUT TO LENGTH AND COATED WITH APPLIED MASTIC	29	HOLES TO FIT 20mm P.E. LINES
14	RIGID POLYURETHANE INSULATED FACTORY MANUFACTURED HALF SHELLS TO FIT LONG RADIUS 90° ELL	30	20mm PLYWOOD TO FIT PIPE O.D.
15	PLYWOOD 600x600x12 mm PAINTED FLURESCENT ORANGE	31	22 ga SHEET METAL GALV.
16	75mm THICK STYROFOAM	32	200 SERIES 860 KPa P.E WATERMAIN WITH 380 O.D. INSULATION.

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRIC.
2. SEE DRWGS W-1, W-2, & W-3.
3. ALL EXPOSED SURFACES INCLUDE URETHANE TO BE FIELD COATED WITH MASTIC.
4. THE INSIDE SURFACES OF METAL SHALL BE COATED WITH OIL.

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
			DATE:	84/09/13
		TYPICAL WATER SERVICE	SCALE:	N.T.S.
			DRAWING NO:	W-7

KEY TO NUMBERED PARTS:

4	SECURITY CAP 295 D.A.
33	DIA. TO SUIT INSULATED PIPE O.D.
34	290 OIA
35	HOLES TO BE DRILLED IN FIELD TO SUIT
36	285 DIA
37	DIA. TO SUIT INSULATED PIPE O.D
38	GEAR CLAMPS STAINLESS STEEL
39	OIA TO SUIT INSULATEO PIPE O.D. ANO REQUIREMENT OF 25mm LAP ON EACH SIDE
40	FIELD COAT ALL EXPOSED URETHANE WITH MASTIC
32	MAIN (POLYETHYLENE PIPE)
41	BUTT FUSION JOINT ON MAIN
13	URETHANE HALF SHELLS
42	YELLOW JACKET & SHOP CAST URETHANE INSULATION
43	HEAT SHRINK SLEEVE MIN.100mm LAP ON YELLOW JACKET AFTER SHRINKAGE
44	YELLOW JACKET
32	200 ⌀ P.E.I.P.S. SERIES 860 KPa WATERMAIN OR 150 ⌀ P.E I.P.S SERIES 100 OR 686 KPa SEWER
24	URETHANE INSULATION 337 O.D ON 200 ⌀ PIPE, 283 O.D. ON 150 ⌀ PIPE
45	SELF LIMITING HEATING CABLE WITH TEFLON JACKET
46	TWO FULL TURNS OF POLYESTER PACKAGING TAPE APPLY EVERY 2m MIN.
47	100 P.E. SERIES 410 KPa CARRIER PIPE BUTT FUSED IN FIELD
48	FIELD INSTALLED 20 P.E. SERIES 1100 KPa WATER SERVICE PIPES OF COIL STOCK CONTINUOUS LENGTHS

GENERAL NOTES:

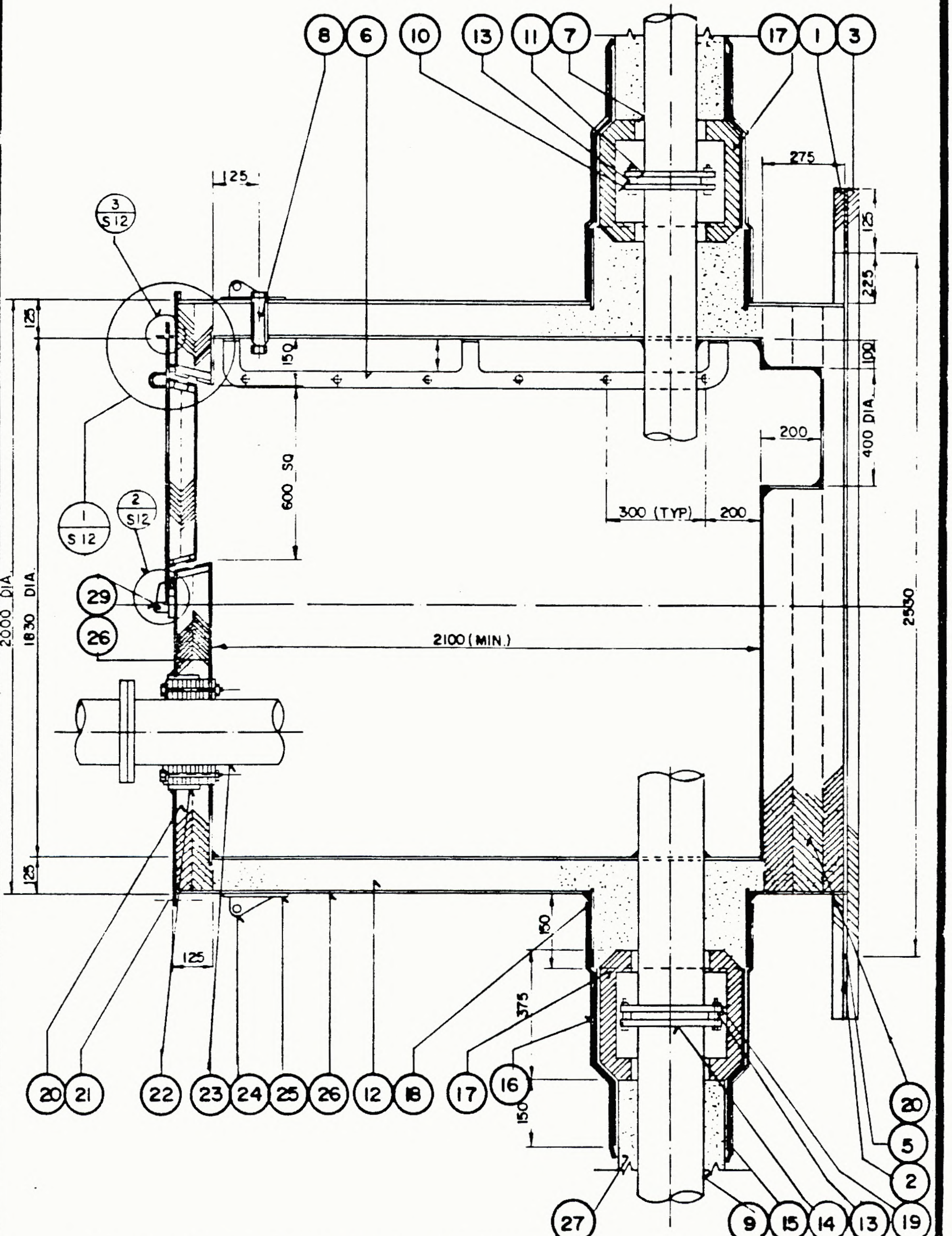
1. ALL DIMENSIONS ARE IN METRIC
2. SEE DRWGS W-5, W-6, & W-7.
3. ALL WATER AND SEWER PIPES WILL HAVE MARKER TAPE 300mm ABOVE PIPE MARED EITHER BURRIED OR WATER PIPE

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
		GOV'T OF THE N.W.T.	DATE:	84/09/18
		TYPICAL WATER SERVICE	SCALE:	N.T.S
			DRAWING NO:	W-8

DIVISION 4

STEEL ACCESS VAULTS
AND APPURTENANCES

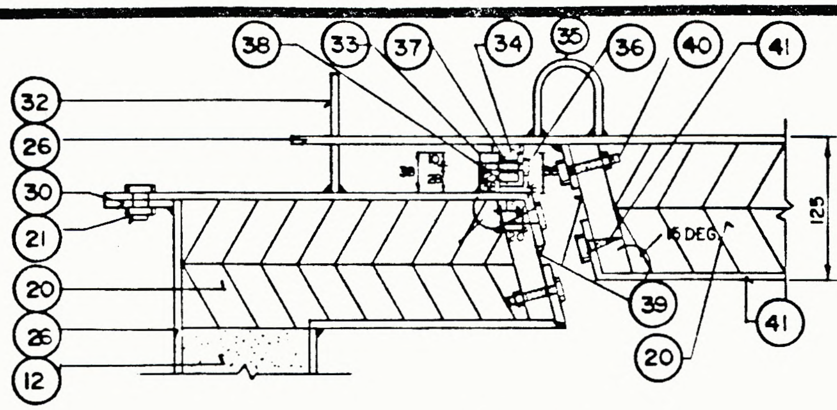
ENGINEERING DIVISION



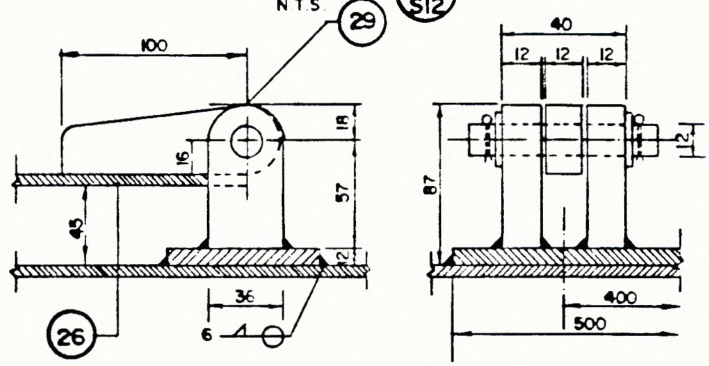
STEEL PREFABRICATED ACCESS VAULT TYPICAL SECTION

NTS

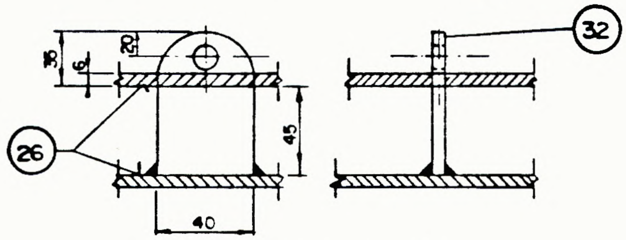
REVISIONS		DEPARTMENT OF PUBLIC WORKS &HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
			DATE:	84/09/25
		TYPICAL ACCESS VAULT	SCALE:	N.T.S
			DRAWING NO:	AV-1



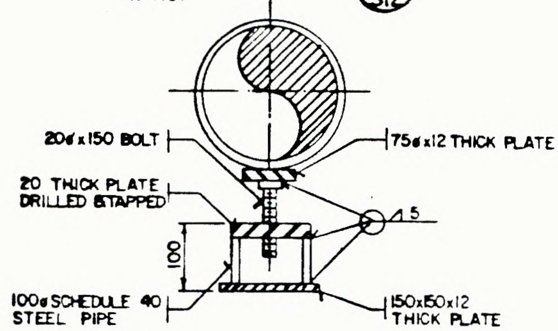
DETAIL 1/S12
N.T.S.



COVER HINGE DETAIL 2/S12
N.T.S.

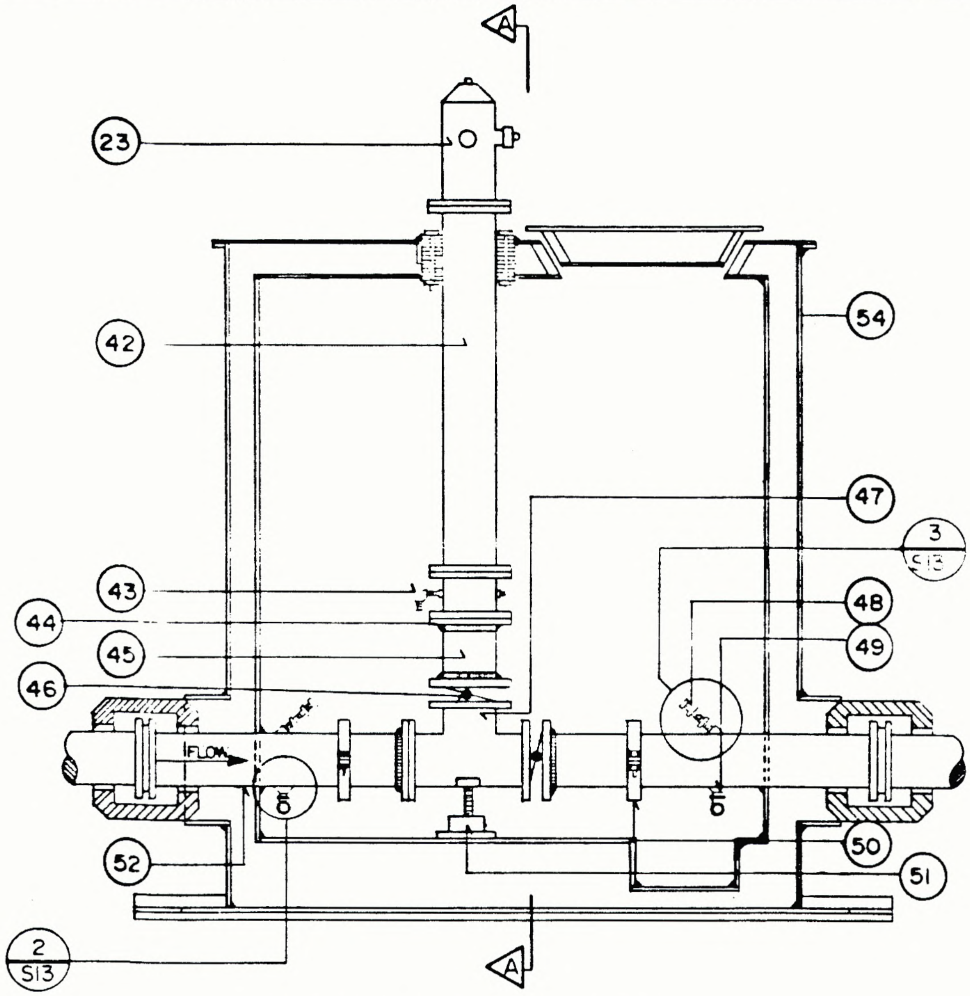


HASP DETAIL 3/S12
N.T.S.

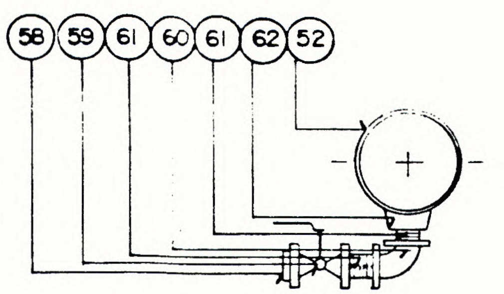


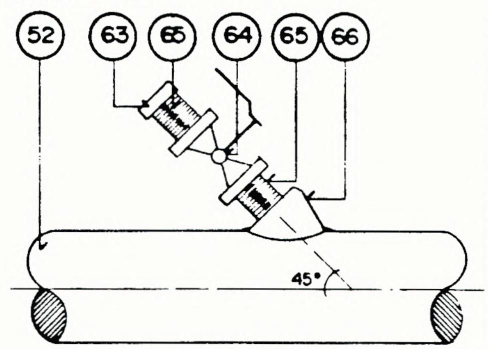
PIPE SUPPORT DETAIL 4/S12
N.T.S

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
			DATE:	84/09/26
		TYPICAL ACCESS VAULT	SCALE:	N.T.S
			DRAWING NO.	AV-2



TYPICAL HYDRANT DETAIL

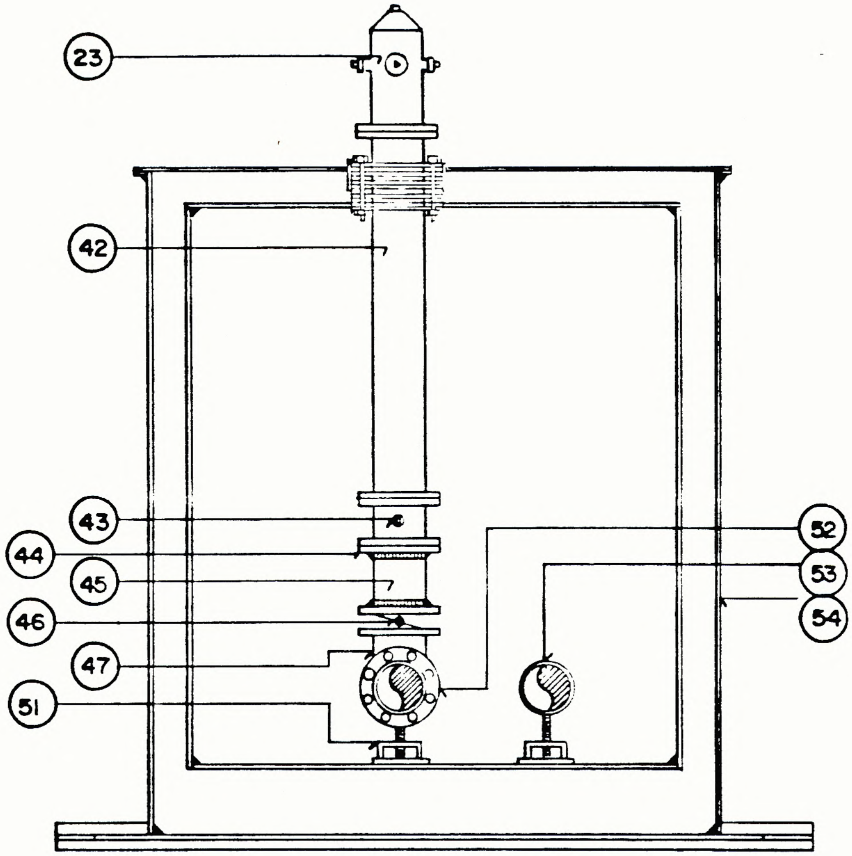




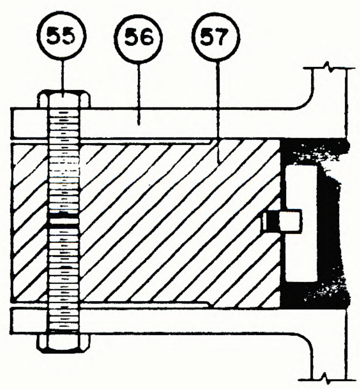
WATERMAIN DRAIN DETAIL (2/S13)
(TYPICAL)

LATEROLET CONNECTION DETAIL (3/S13)
(TYPICAL)

REVISIONS		DEPARTMENT OF PUBLICWORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R J S
			DATE:	84/09/27
		TYPICAL ACCESS VAULT	SCALE:	N T.S
			DRAWING NO.	AV-3

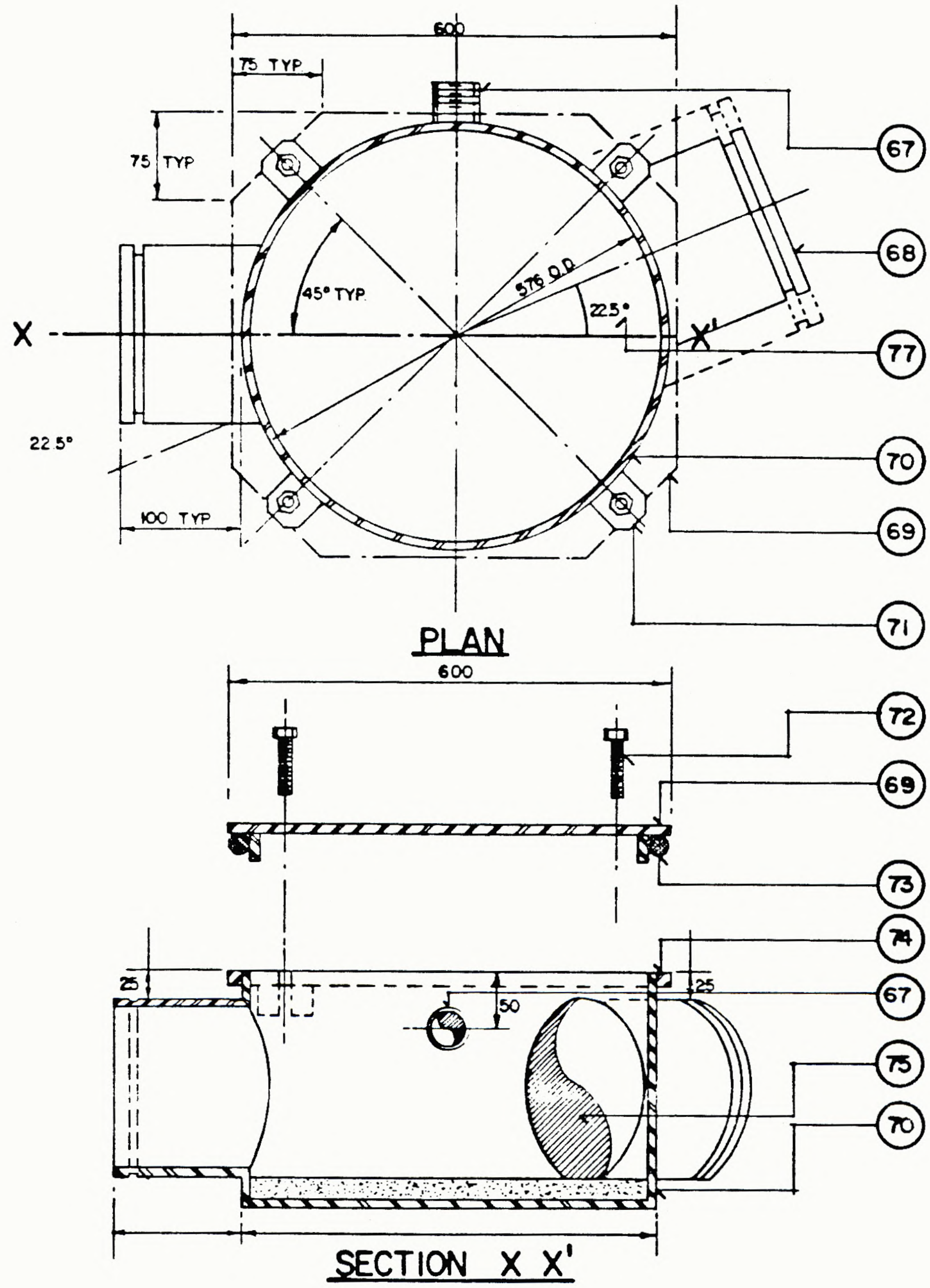


SECTION A A'



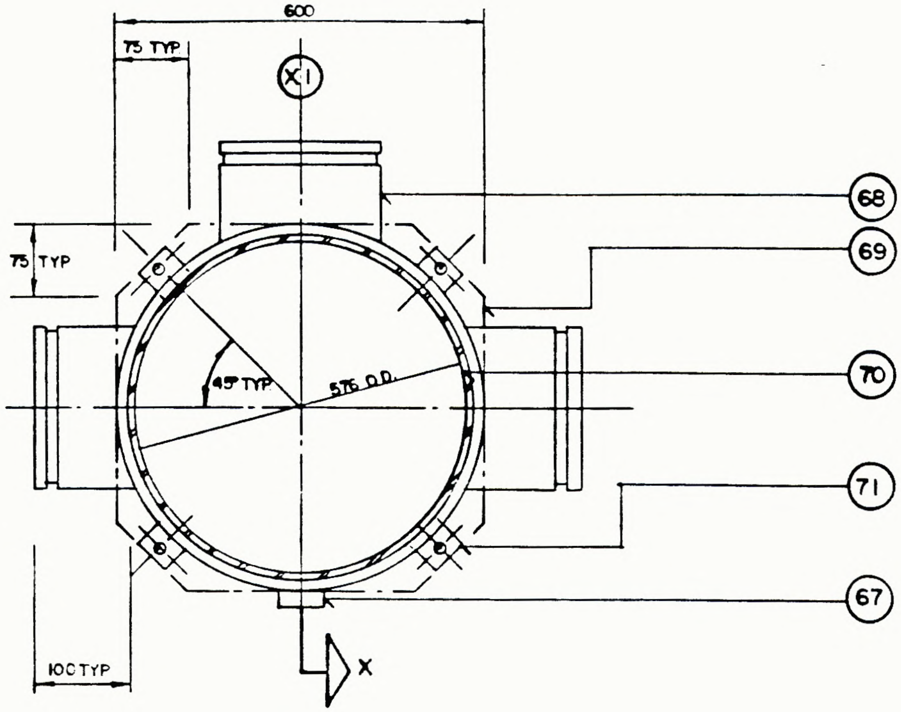
CAP SCREW DETAIL FOR LUG TYPE BUTTERFLY VALVE (1/S13)

REVISIONS		DEPARTMENT OF PUBLIC WORKS&HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
			DATE:	84/09/27
		TYPICAL ACCESS VAULT	SCALE:	N.T.S.
			DRAWING NO:	AV-4

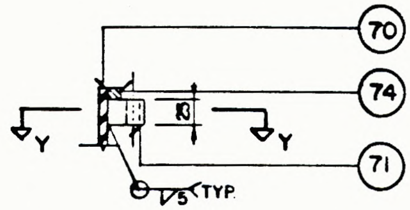


CLEANOUT - TYPE 1 & BOLT LUG DETAIL

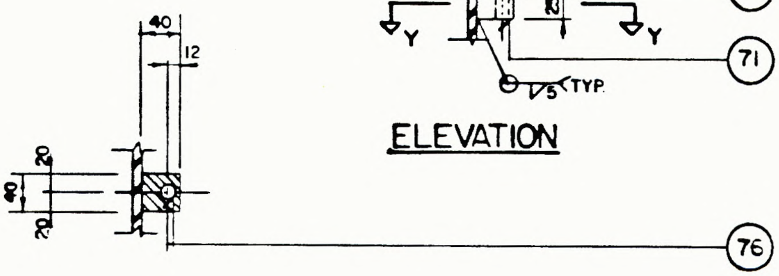
REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S
		GOV'T OF THE N.W.T.	DATE: 84/09/28
		TYPICAL ACCESS VAULTS	SCALE: N.T.S
			DRAWING NO: AV-5



PLAN (TEE)



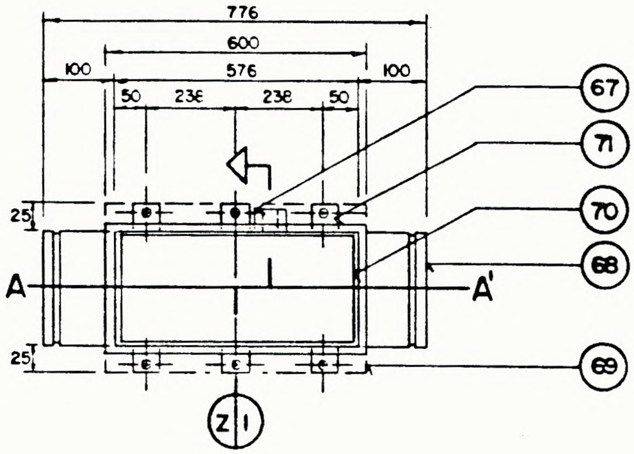
ELEVATION



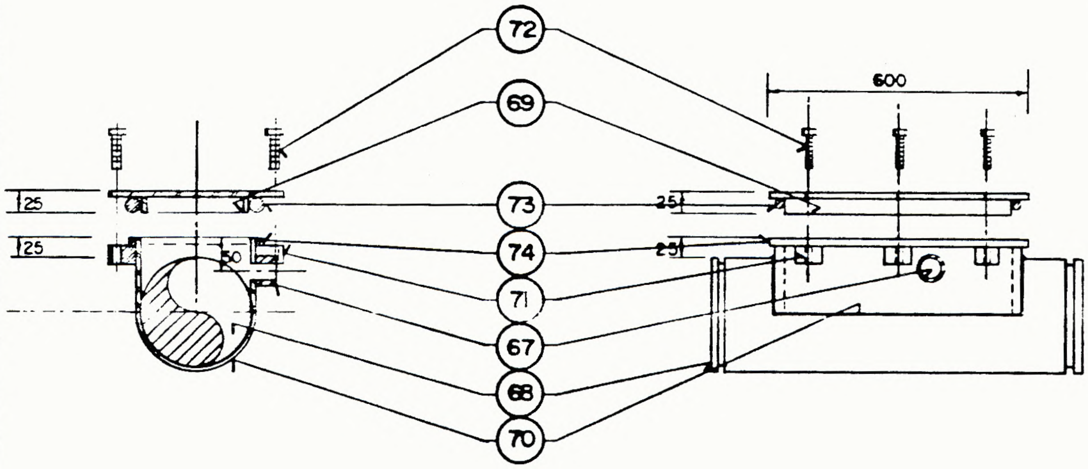
PLAN SECTION Y-Y

CLEANOUT – TYPE 1 & BOLT LUG DETAIL

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
		GOV'T OF THE N.W.T.	DATE:	84/10/1
		TYPICAL ACCESS VAULTS	SCALE:	N.T.S
			DRAWING NO:	AV-6



PLAN

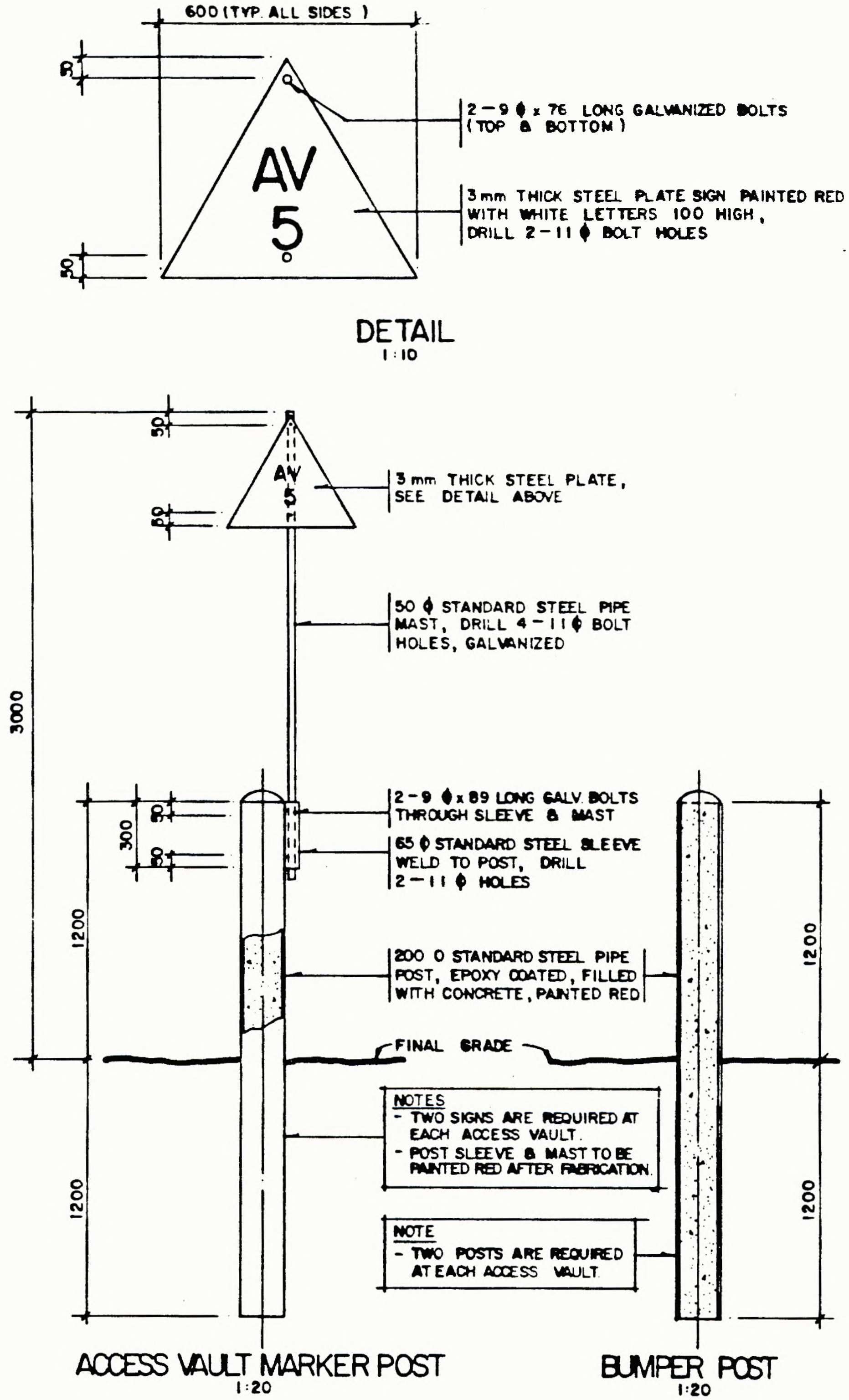


SECTION Z–Z

SECTION A–A'

CLEANOUT - TYPE 2

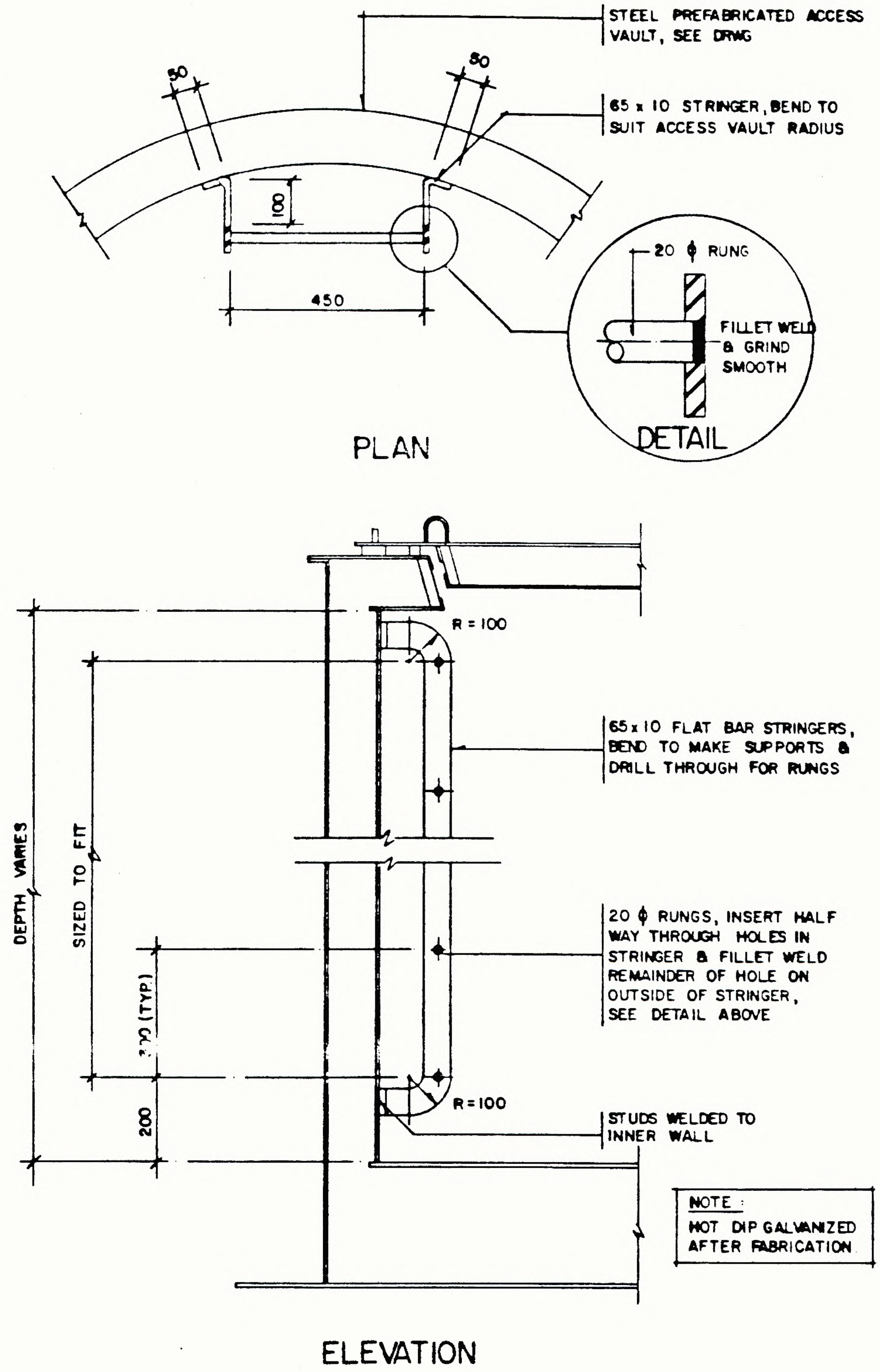
REVISIONS		DEPARTMENT OF PUBLIC WORKS &HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S.
		GOV'T OF THE N.W.T.	DATE: 84/10/1
		TYPICAL ACCESS VAULTS	SCALE: N.T.S.
			DRAWING NO: AV-7



MARKER & BUMPER POST DETAILS

AS SHOWN

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S.
			DATE: 84/10/1
		TYPICAL ACCESS VAULTS	SCALE: N.T.S.
			DRAWING NO: AV-8



ACCESS VAULT LADDER DETAIL

1:10

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S.
		GOV'T OF THE N.W.T.	DATE: 84/10/1
		TYPICAL ACCESS VAULT	SCALE: N.T.S.
			DRAWING NO: AV-9

KEY TO NUMBERED PARTS:

1. 38 THICK STYROFOAM CUT TO MATCH EXTERIOR WALL RADIUS
2. FILLER PIECE 10 THICK INSULATION
3. 38 THICK x 2830 x 2830 STYROFOAM INSULATION
4. PIPE SUPPORT SEE DETAIL 2/AV-2
5. 10 THICK x 2830 STEEL BASE PLATE
6. LADDER LENGTH AS REQUIRED, 450 WIDE MADE FROM 65 x 12 FLAT BARS, VERTICALS AND SUPPORTS WITH 20 ø RINGS.
7. 150 ø I.P.S SIZE H.D.P.E PIPE
8. 50 ø THREADED P.E NIPPLE FOR ELECTRICAL CONDUIT C/W CAPS
9. 200 I.P.S. SIZE H.D.P.E. PIPE
10. 150 ø 1030 KPa SLIP ON FLANGE, F.S. FLAT FACE AS A B 16.1 WELDED TO STEEL PIPE
11. SLIP ON BACK-UP RING FOR 150 H.D.P.E. PIPE & STUBEND C/W GASKET
12. FORMED IN PLACE URETHANE INSULATION
13. 8 BOLTS—ASTM A307 GRADE B CARBON STEEL
14. SLIP ON BACK-UP RING FOR 200 H.D.P.E. PIPE & STUBEND C/W GASKET
15. FIRST LAYER OF HEAT SHRINK TAPE (0.09" THICK BLACK POLYETHYLENE SELF ADHES)
16. SECOND LAYER OF HEAT SHRINK TAPE (SAME AS 15 ABOVE)
17. INSULATED COVER FOR FLANGE ASSEMBLY
18. STEEL RING SECTION WELDED TO MANHOLE OUTER WALL 8 THICK x 470 I.D. PROTRUDING 150
19. 200 ø 1030 KPa SLIPE ON FLANGE F.S. FLAT FACE AS A B 16.1 WELDED TO STEEL PIPE
20. URETHANE SHEET INSULATION CUT TO SIZE
21. 12 CAD PLATED STEEL BOLT, NUT, WASHER, 32 AT EQUAL SPACING
22. 350 ø SCHEDULE 10 (346.05 I.D.) STEEL PIPE x 100 LONG WELDED TO MANHOLE, GALVANIZED
23. 200 ø HYDRANT
24. LIFTING LUGS TWO PER ACCESS VAULT 150 x 75 x 12 THICK WITH 38 ø LIFTING EYE
25. REINFORCING PLATE 200 x 200 x 12 CURVED TO EXTERIOR WALL RADIUS
26. 6 THICK STEEL PLATE ACCESS VAULT CONSTRUCTION
27. URETHANE PIPE INSULATION
28. LINK SEAL
29. HINGES SPACED AT 400 APART – SEE DETAIL
30. 10 THICK x 50 x 2080 I.D STEEL RING C/W 3 x 50 COMPRESSIBLE NEOPRENE RUBBER GASKET
31. # 12 30 PAN HEAD SHEET METAL SCREWS AT 100 SPACING
32. HASP ASSEMBLY SEE DETAIL 3/AV-2
33. 12 x 38 x 500 STEEL BAR UNDER HINGES
34. 20 x 38 SOFT COMPRESSIBLE NEOPRENE GASKET (CLOSED CELL)
35. LIFTING EYE 12 ø x 40 INSIDE LOOP
36. 6 x 31 CAD. PLATED STEEL BOLT 150 SPACING
37. 6.5 x 17 SPACER
38. 3 x 32 x 20 GALVANIZED IRON.

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S.
			DATE:	84/10/1
		TYPICAL ACCESS VAULTS	SCALE:	N.T.S.
			DRAWING NO:	AV-10

KEY TO NUMBERED PARTS:

(39) 20 THICK HIGH DENSITY POLYETHYLENE SHEET

(40) 6 GALVANIZED BOLT, NUT AND WASHER AT 100 SPACING

(41) 20 GAUGE METAL

(42) HYDRANT BARREL

(43) HYDRANT DRAIN

(44) 1034 KPa SLIP-ON WELD FLANGE

(45) 200 LONG SPOOL PIECE

(46) LUG TYPE BUTTERFLY VALVE C W WHEEL OPERATOR

(47) 1034 KPa CAST IRON TEE (COLD TAR EPOXY COATED)

(48) LATEROLET CONN. DETAIL - SEE DETAIL 3/AV-3

(49) WATERMAIN DRAIN DETAIL - SEE DETAIL 2/AV-3

(50) VICTAULIC COUPLING

(51) PIPE SUPPORT — SEE DETAIL 4/AV-2

(52) WATERMAIN

(53) SANITARY SEWER (TYP.)

(54) FOR TYPICAL ACCESS VAULT CONSTRUCTION SEE DRAWING AV

(55) CAP SCREWS (CADMIUM PLATED)

(56) 1034 KPa FLANGE

(57) BUTTERFLY VALVE SECTION

(58) 25 Ø N.P.T. PLUG

(59) 25 Ø BALL VALVE

(60) 25 Ø - 90° GALVANIZED ELBOW

(61) 25 Ø N P T NIPPLE

(62) 25 Ø THREADOLET

(63) 50 Ø N.P.T. CAP

(64) 50 Ø BALL VALVE

(65) 50 Ø N.P.T NIPPLE

(66) 50 Ø LATEROLET

(67) 25 N.P.T. HALF COUPLING

(68) STANDARD 40 STEEL PIPE NIPPLE VICTAULIC GROOVED

(69) FABRICATE CLEANOUT COVER FROM 6 THICK PLATE CONTINUOUS BUTT WELDED AND HOT DIPPED GALVANIZED AFTER FABRICATION

(70) FABRICATE CLEANOUT BODY FROM 6 THICK PLATE CONTINUOUS BUTT WELDED AND HOT DIPPED GALVANIZED AFTER FABRICATION

(71) BOLT LUGS TAPPED

(72) 1/2 in N.C x 2 in LONG CAD. PLATED HEX HEAD CAP SCREW

(73) 20 Ø ONE PIECE SOFT RUBBER GASKET STRETCH TO FIT COVER

(74) 12 SQ ROD RIM

(75) ASPHALT COATED MORTAR FILL BOTTOM AND SIDES TO MATCH BOTTOM HALF OF SEWER

(76) DRILL AND TAP 1/2 in N.C

(77) 22.5° MAX ROTATION OF PIPE STUBS WHERE REQUIRED

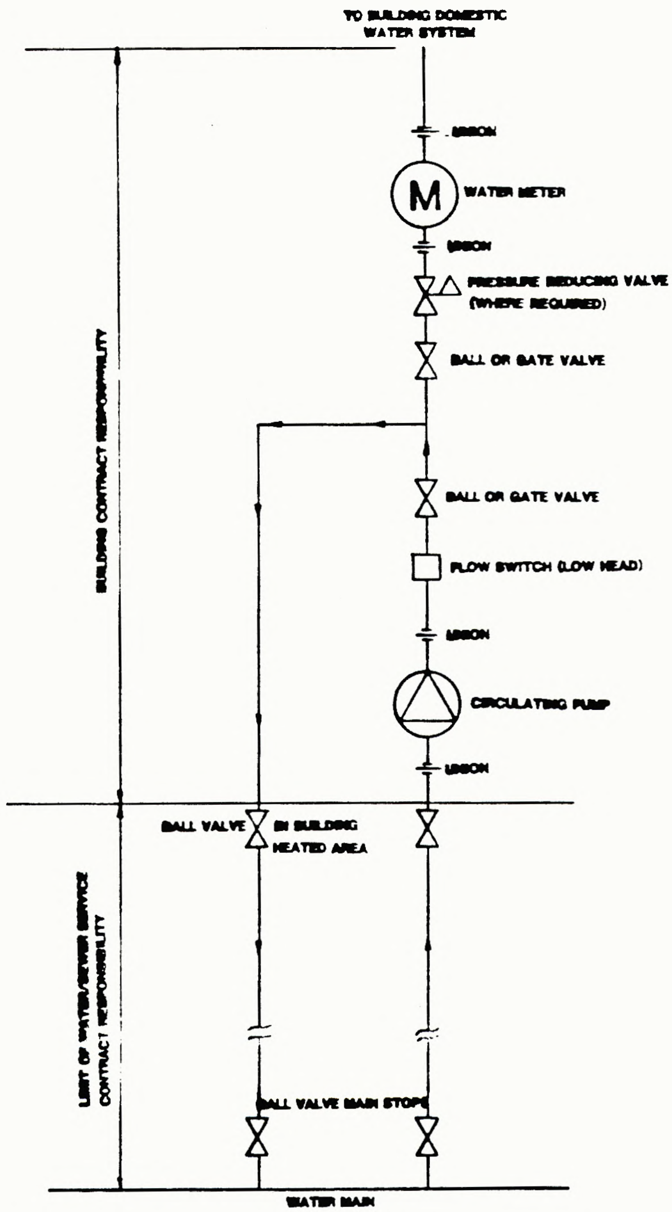
(78) COVER OUTLINE

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: R.J.S.
			DATE: 84/10/1
		TYPICAL ACCESS VAULTS	SCALE: N.T.S.
			DRAWING NO: AV-11

DIVISION 5

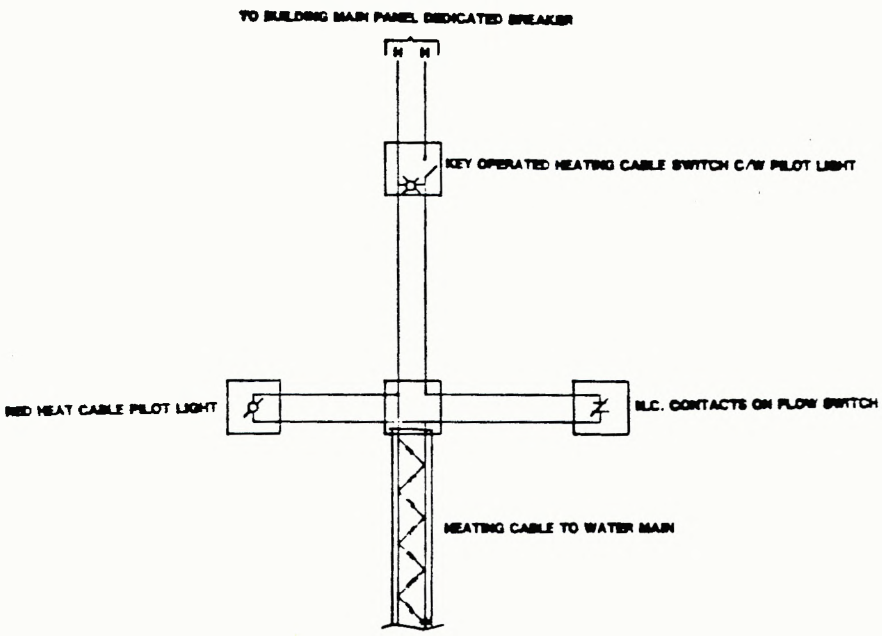
WATER RECIRCULATION SERVICES

ENGINEERING DIVISION

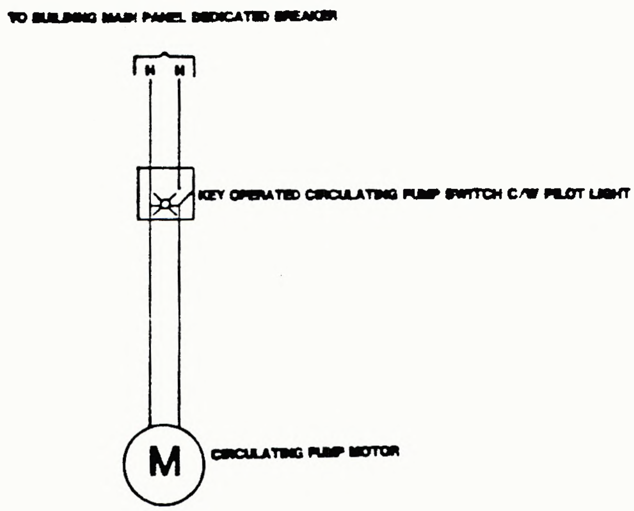


MECHANICAL DETAIL

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R J S
		GOV'T OF THE N.W.T.	DATE:	84/10/15
		WATER RECIRCULATION	SCALE:	N.T.S
			DRAWING NO	WR-1



ELECTRICAL DETAIL
HEATING CABLE



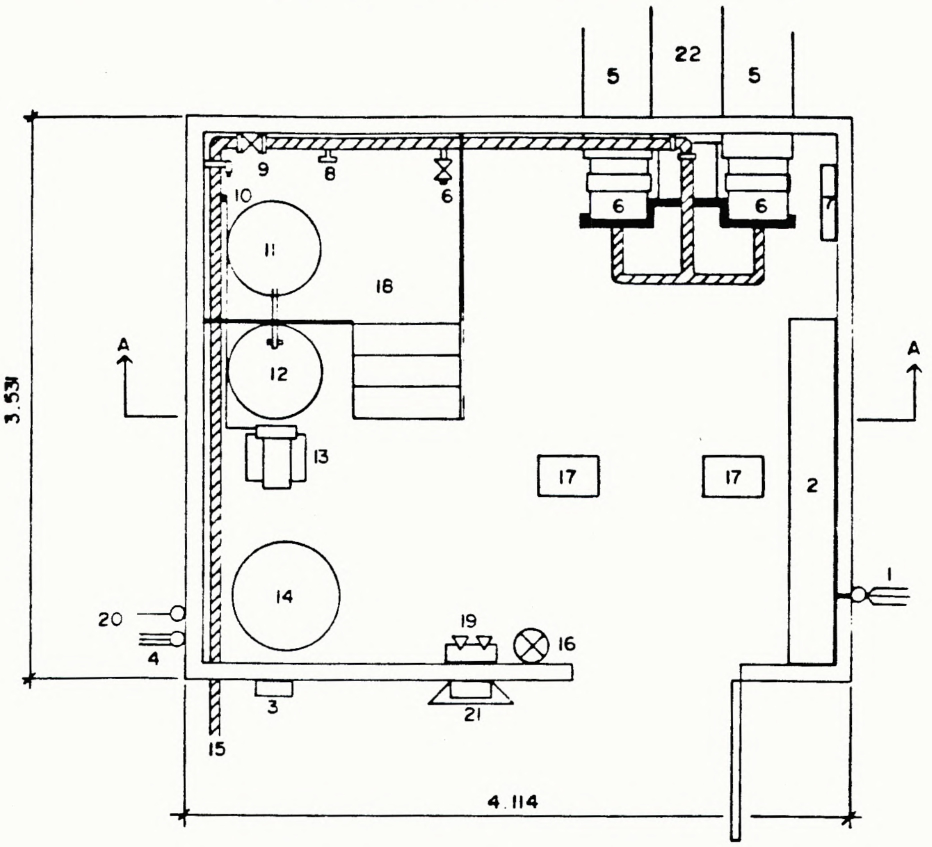
ELECTRICAL DETAIL
CIRCULATING PUMP

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:	
DATE	BY		APPROVED BY:	
			DRAWN BY:	R.J.S
		GOV'T OF THE N.W.T.	DATE:	84/10/19
		WATER RECIRCULATION	SCALE:	N T S
			DRAWING NO:	WR-2

DIVISION 6

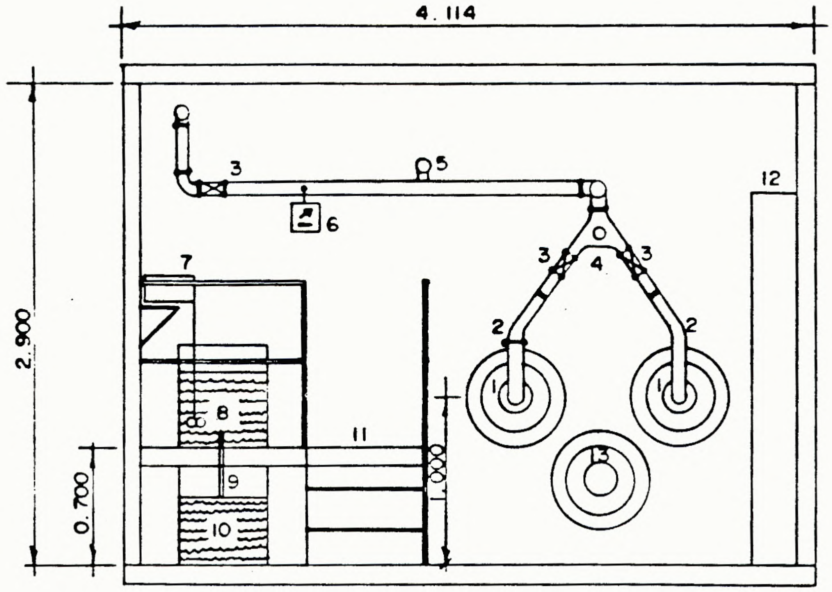
TRUCKFILL STATION

ENGINEERING DIVISION



1. MAIN ELECTRICAL SERVICE
2. ELECTRICAL PANELS
3. TRUCK FILL CONTROL PANEL
4. POWER TO/FROM POWER BLDG.
5. INTAKES
6. BACKWASH HOSE CONNECTION
7. BACKWASH HOSE STORAGE
8. FLOWMETER
9. CHLORINE PUMP FLOW SWITCH
10. CHLORINE INJECTOR
11. CHLORINE MIX TANK
12. CHLORINE TANK
13. CHLORINE PUMP
14. CHEMICALS
15. DISCHARGE TO TRUCK.
16. FIRE EXTINQUISHER
17. WINCH FLOOR BRACKETS
18. ACCESS PLATFORM
19. EMERGENCY LIGHT
20. TO REMOTE EMERGENCY LIGHT
21. EXTERIOR LIGHT
22. SUBDRAIN PUMP SHAFT (IF REQUIRED)

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY
			DRAWN BY: D.W.W.
		GOV'T OF THE N.W.T.	DATE: 85/7/25
		TRUCKFILL BLDG. PLAN VIEW	SCALE: N.T.S.
			DRAWING NO: TS-1



1 POLYETHYLENE 75° BEND

2 45° BEND

3 VALVES

4 FLAPPER BALL VALVES

5 BACKWASH HOSE CONNECTION

6 FLOWMETER (WALL MOUNTED)

7 IMPELLOR TYPE MIXER (WALL MOUNTED)

8 CHLORINE MIX TANK

9 PLASTIC DECANT PIPE & VALVE

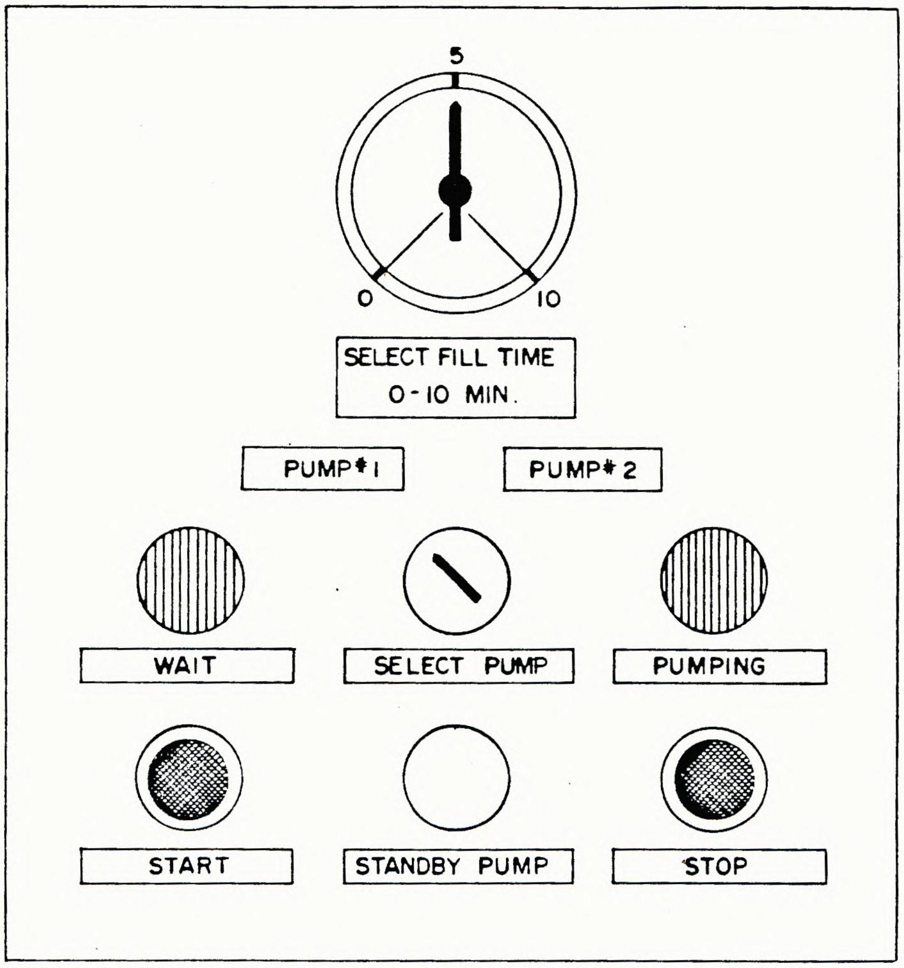
10 CHLORINE PUMP TANK

11 ACCESS PLATFORM

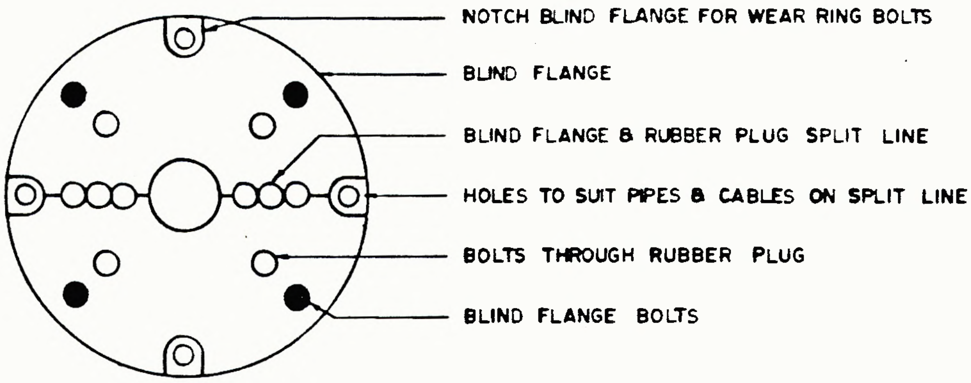
12 ELECTRICAL CONTROLS

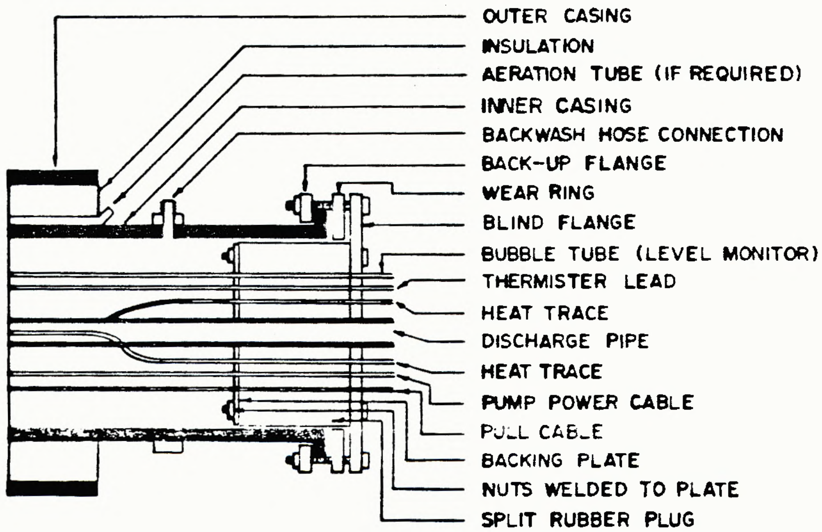
13 SUBDRAIN PUMP SHAFT (IF REQUIRED)

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: C.E.A.
		GOV'T. OF THE N.W.T.	DATE 85/07/25
		TRUCKFILL BLDG. SECTION A-A	SCALE: N.T.S.
			DRAWING NO: TS-2

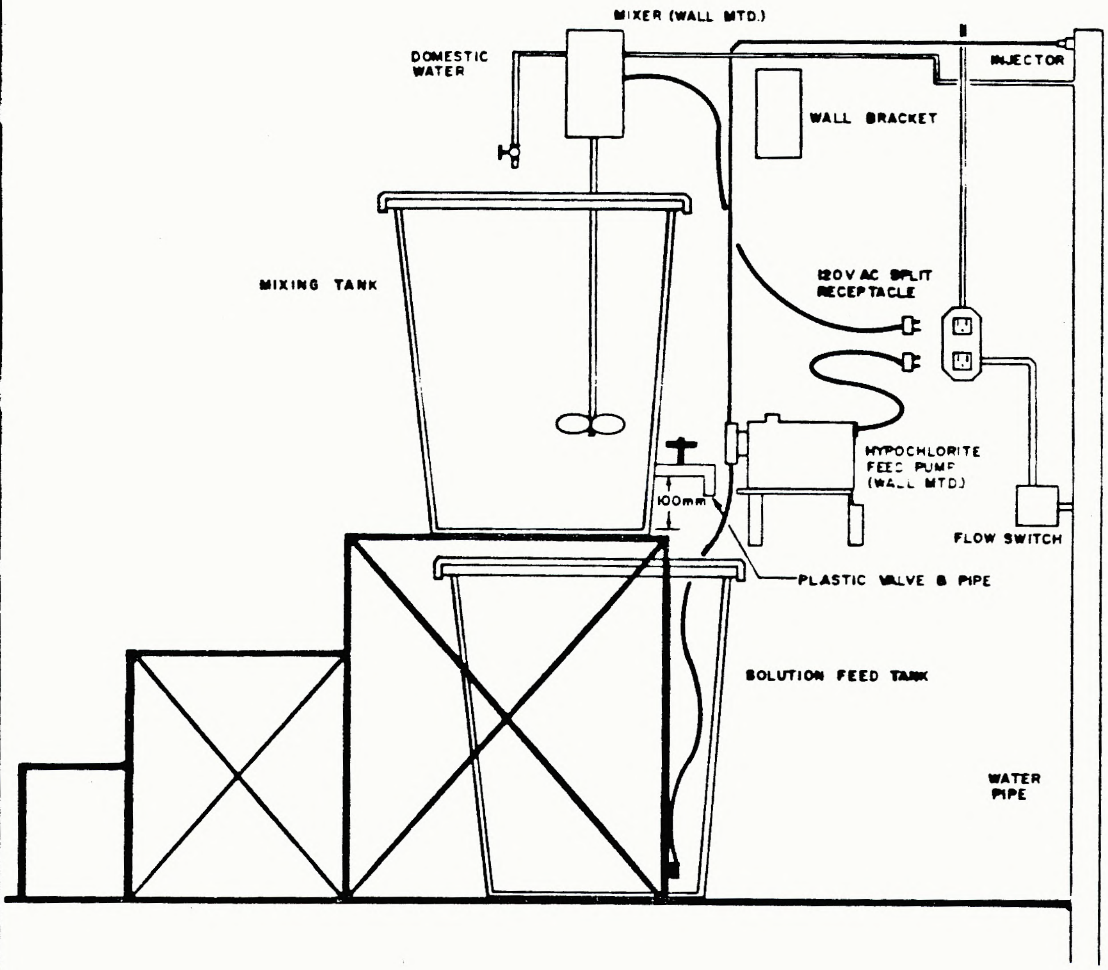


REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: D.W.W.
		GOV'T OF THE N.W.T.	DATE: APRIL/85
		EXTERIOR CONTROL	SCALE: N.T.S.
		PNL. TRUCKFILL STN.	DRAWING NO TS-3

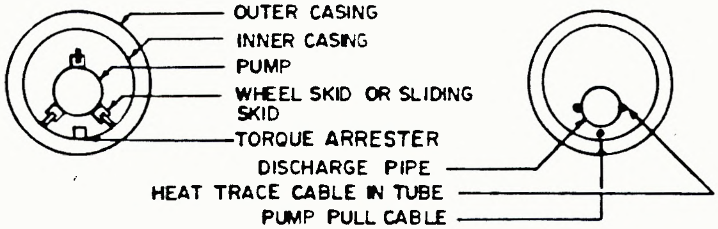




REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: D.W.W.
		GOV'T OF THE N.W.T.	DATE: APRIL /85
		INTAKE TERM.	SCALE: N.T.S.
		TRUCKFILL BLDG	DRAWING NO TS-4

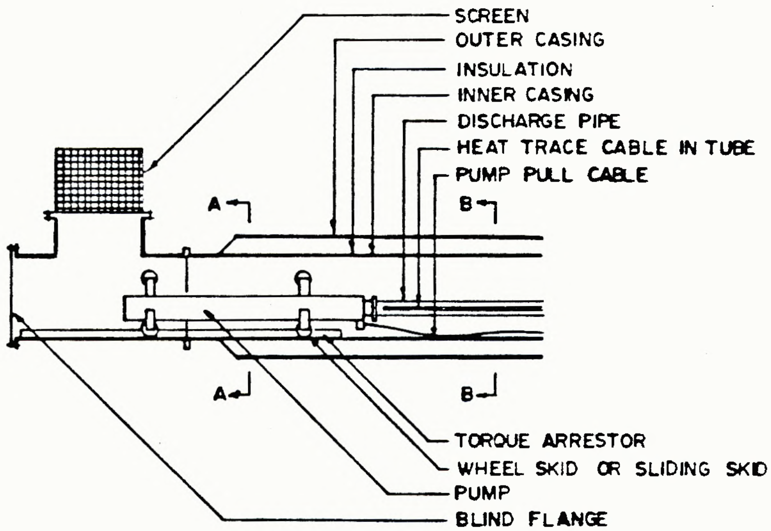


REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: D.W.W
		GOV'T OF THE N.W.T.	DATE: NOV./84
		HYPOCHLORITE FEEDER	SCALE: N.T.S.
			DRAWING NO: TS-5



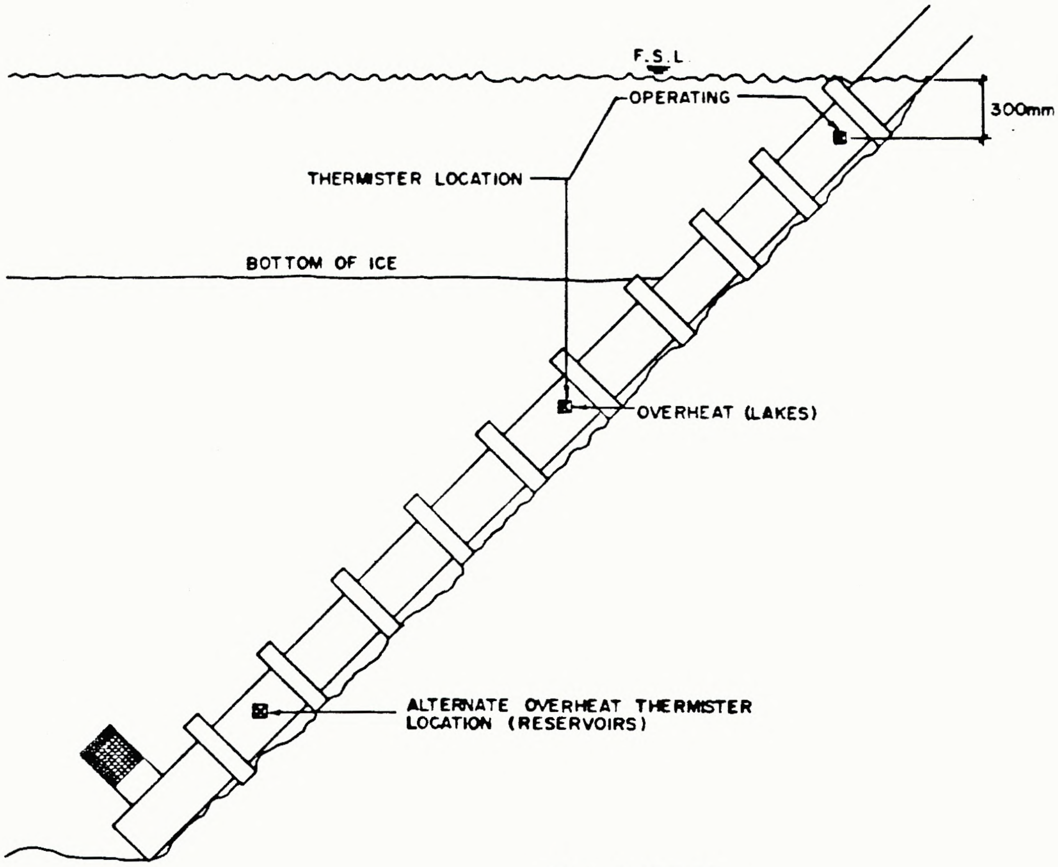
SECTION A-A

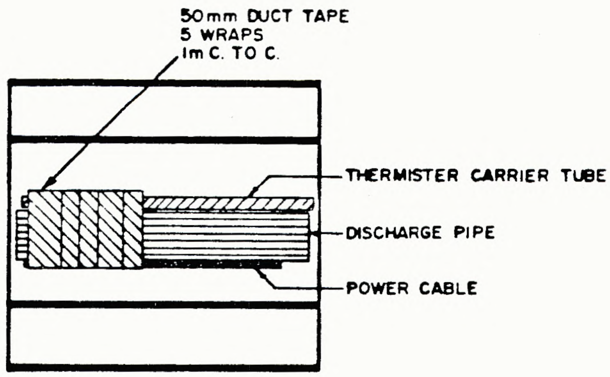
SECTION B-B



RESERVOIR END INTAKE DETAIL

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: D.W.W.
		GOV'T OF THE N.W.T.	DATE: APRIL /85
		RES. END INTAKE DETAIL	SCALE: N.T.S.
			DRAWING NO: TS-6





THERMISTER DETAIL

REVISIONS		DEPARTMENT OF PUBLIC WORKS & HIGHWAYS GOV'T OF THE N.W.T.	CHECKED BY:
DATE	BY		APPROVED BY:
			DRAWN BY: D.W.W.
			DATE: AUG./84
		INCLINED SHAFT INTAKE	SCALE: N.T.S
			DRAWING NO: TS-7

ANNEX D

ANNEX D

Northwest Territories Housing Corporation

Our Ref.: 545-General

February 3, 1986

Mr. John Benner
Acting Director
Technical Services
Technical Services Contracts Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudiere
Hull, Quebec
K1A 0H4

Dear Sir:

RE: N.W.T. HOUSING CORPORATION
1986 PUBLIC HOUSING

As requested by Mr. Mike Sims, Contracts and Capital Planning Manager, Department of Public Works, I am forwarding to you one (1) set of drawings* for each of the following house types: two bedroom duplex, one bedroom fourplex, three and four bedroom detached. Also find enclosed, one (1) set of specifications* which is applicable to all house types and all regions.

If you require further information, please do not hesitate to contact the writer at (403) 873-7861.

Yours truly,

* MATERIAL PROVIDED TO BUILDINGS DIVISION 6 JUNE, 1986 BY J. BENNER.

R.S. Bushell
Manager
Design/Development Section
Construction/Development

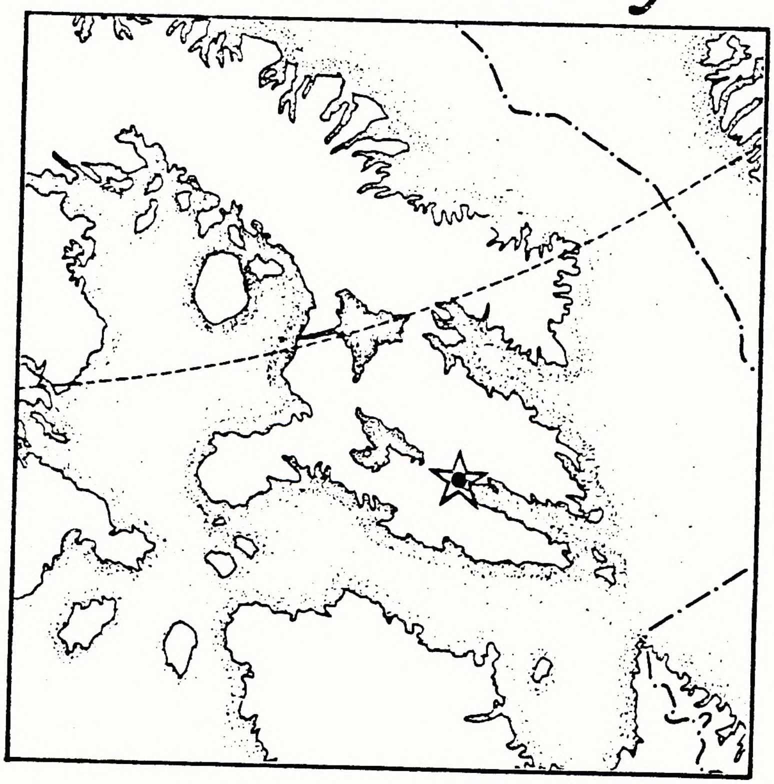
c.c. Mike Sims - Department of Publice Works - Yellowknife

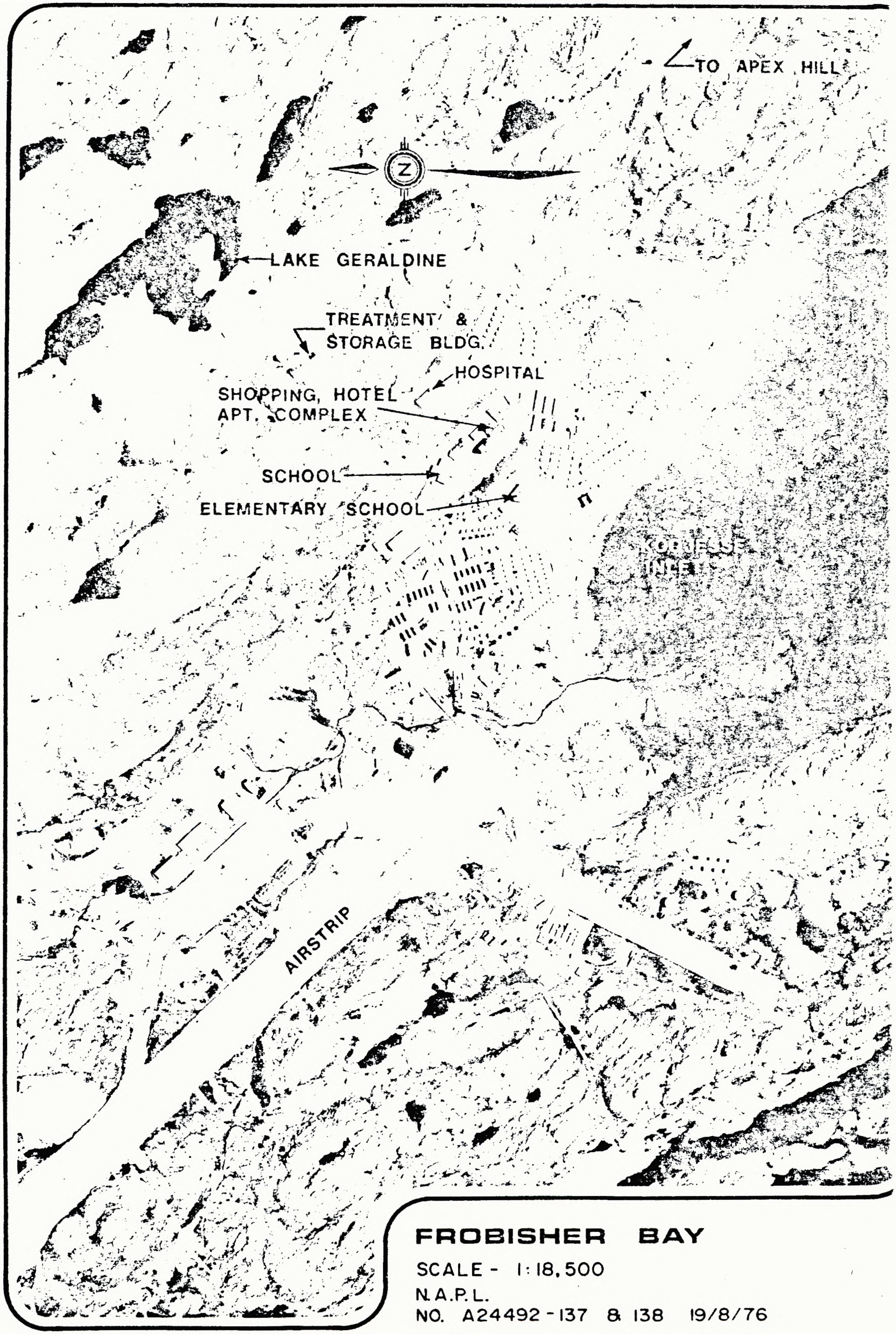
ANNEX E

COMMUNITY PROFILE

ANNEX E

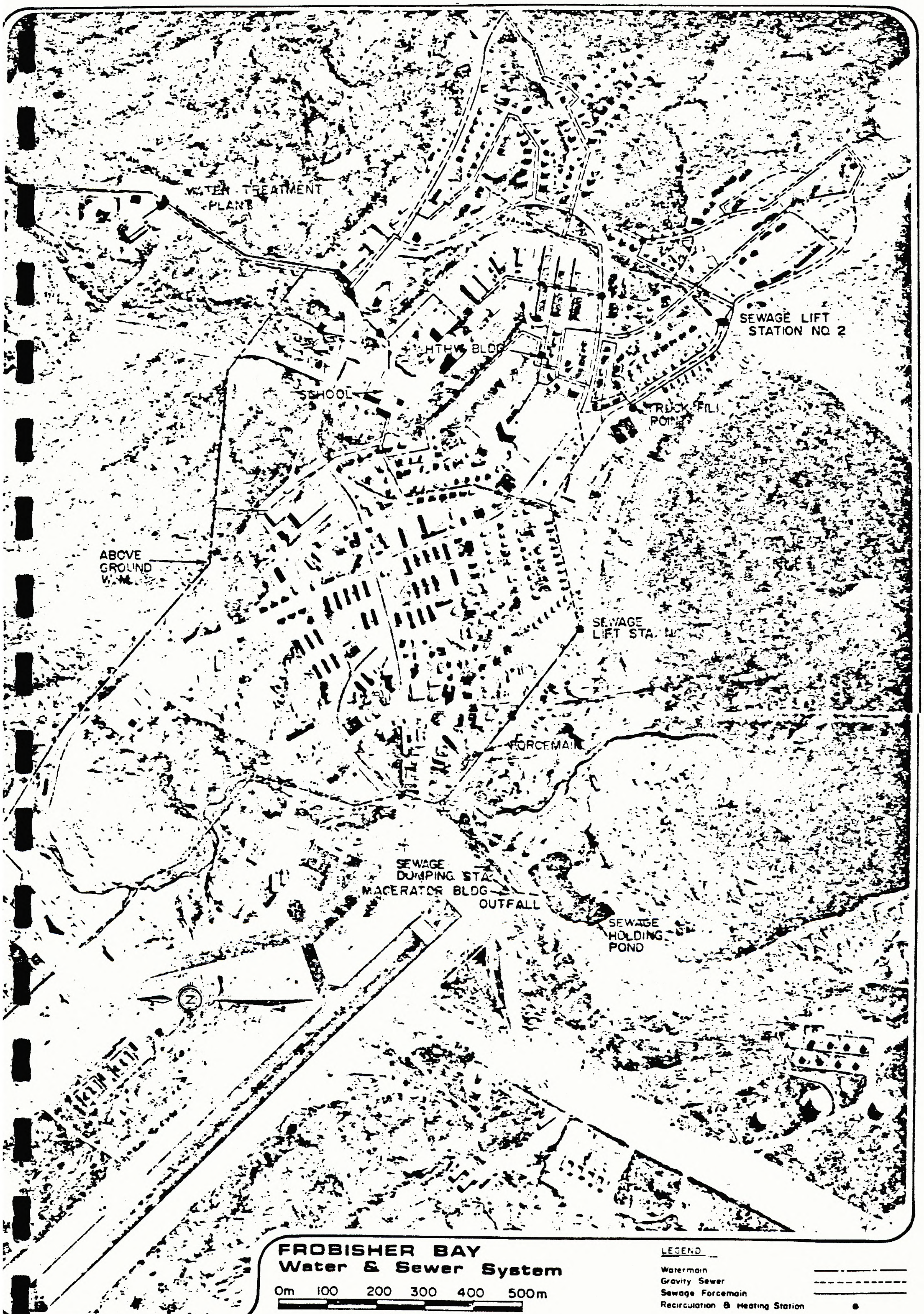
Frobisher Bay





FROBISHER BAY

SCALE - 1:18,500
N.A.P.L.
NO. A24492-137 & 138 19/8/76



PL NO. A25553-131,132,133,135,141,142,143 & 145
TE 7/80

A. GENERAL

A.1 Location

Frobisher Bay, the largest community in the Baffin Region, is located at the south end of Baffin Island, about 2060 km north of Montreal and 2275 km east of Yellowknife. The geographical co-ordinates are 64°44'N latitude and 68°31'W longitude.

A.2 History

Sir Martin Frobisher sailed into Frobisher Bay in 1576 in search of a Northwest Passage. The present community is near the site of a traditional Inuit fishing camp called Iqluit. A U.S.A. base was established in 1942 and turned over to the Royal Canadian Air Force in 1946-1950, but significant growth did not occur in the area until DEW Line construction commenced in 1955.

A.3 Community Information

Frobisher achieved Town status in 1980. The economy is based on government institutions and services though private facilities are increasing in numbers. Primary, secondary, and adult education are available. Various social institutions, a general hospital, stores, a Legion, a hotel, and crafts centre provide services in a quantity not found anywhere else in the Arctic east of Inuvik. The Town enjoys recreational facilities such as an arena, library, swimming pool, youth centre, and parks.

The Town population in 1980 was 2419 of which approximately 60% are Inuit. The number of people has remained stable over the past few years.

Access is by sea or by air. Freight is shipped from Montreal from July to September. The asphalt airstrip is 2743 m by 61 m at 33.5 m ASL. Frobisher receives five flights weekly from Resolute and Montreal as well as two flights from Yellowknife weekly.

A.4 Geology and Terrain

A rolling terrain surrounds the community. The subsoil is made up of glacial drift over a granitic Precambriam bedrock. The overburden, silty sand, sand, gravel, and boulders, varies from 0 to 18 m thick.

The depth of thaw of the permafrost ranges from 1 m to 1.8 m. The water table is very high and segregated ice lenses may be found

A.5 Vegetation

Vegetal cover is limited on Baffin Island. Lichens, mosses and hardy flowers and grasses flourish in the summer months.

A.6 Climate

Frobisher experiences 8 months of the year in which the average daily temperature is below freezing. The warmest month, July, has an average daily temperature of 7.9°C. January has an average daily temperature of -26.2°C. The mean annual rainfall is 18 cm and the mean annual snowfall is 246.9 cm. The average windspeed is about 15 km per hour.

Frobisher Bay

B. MUNICIPAL SERVICES

B. Water Supply

B.1.1 Source

Lake Geraldine is the source of the Town's water (see aerial photo). It is at an elevation which permits gravity feed to the water treatment plant. The maximum volume of the lake is 2050 million L.

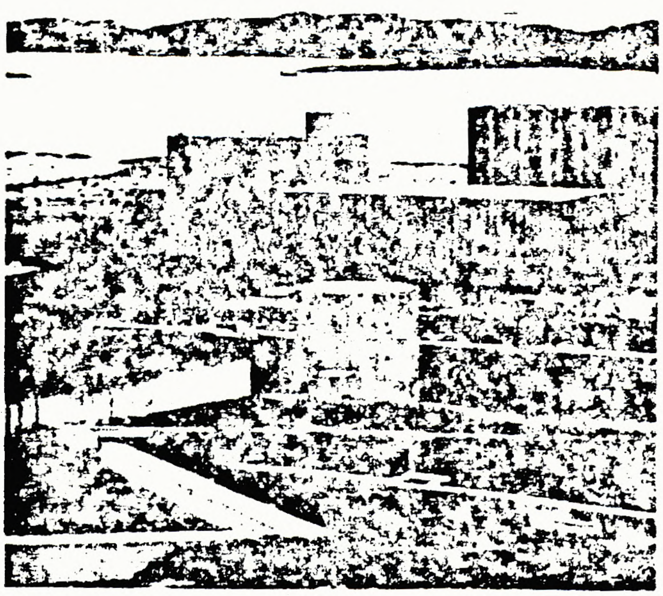
The raw water is clear, soft and low in dissolved minerals. An analysis of the water, partially presented below, was collected on May 27, 1976. (All constituents in mg/L unless otherwise noted)

Constituents	
pH	7.3
Total Hardness (as $CaCO_3$)	27
Alkalinity (as $CaCO_3$)	26
Iron (total)	0.1
Calcium (Ca)	8
Total Dissolved Solids	38

B.1.2 Intake Facilities

The intake is 5.4 m below the crest of a dam at the lake outlet. Water flows to the treatment plant through 213 m of 250 mm diameter steel pipe. Heated water is continously circulated through the intake line to prevent freezing. The incoming raw water is thus maintained at a minimum of 10°C.

Looking towards Koojesse Inlet



B.1.3 Treatment

The water treatment plant was finished in 1963. It was built with provisions for chlorination, flocculation and settling, fluoridation, lime treatment and ozonation. Ozonation, flocculation and settling have been discontinued.

The mixing chamber is 3.81 m x 1.22 m x 5.03 m deep with six over and under baffles. The two rapid sandfilters have a combined area of 9.10 m². The flow rate is approximately 100 L/m²/min. The filters are backwashed at a 1.8 m loss of head or a maximum time lapse of 48 hours.

The plant at full capacity is capable of treating 1.8 million L (400,000 Igal) every 24 hours; currently, however, only daytime operation is necessary to supply the town.

B.1.4 Storage

The storage reservoirs on the first floor of the treatment building have a total combined capacity of 633,950 L (139,450 Igal).

B.1.5 Pumping Facilities

There are two circulation pumps in the treatment building with these specifications:

1. Function: Circulate heated water through intake line
   Model: Bell & Cosset 1BDR
   Motor: CGE Model 111573 1/4 hp, 3 phase/575 v/60 Hz, 1725 rpm
2. Function: same as above
   Model: Armstrong H41546
   Motor: 1/4 hp, 3 phase/575 v/60 Hz, 1725 rpm

The fire pump has the following specifications:

Model: Darling 75771LH
Motor: Tamper 356US-DB5, 3-phase/575V/60 Hz, 1772 rpm

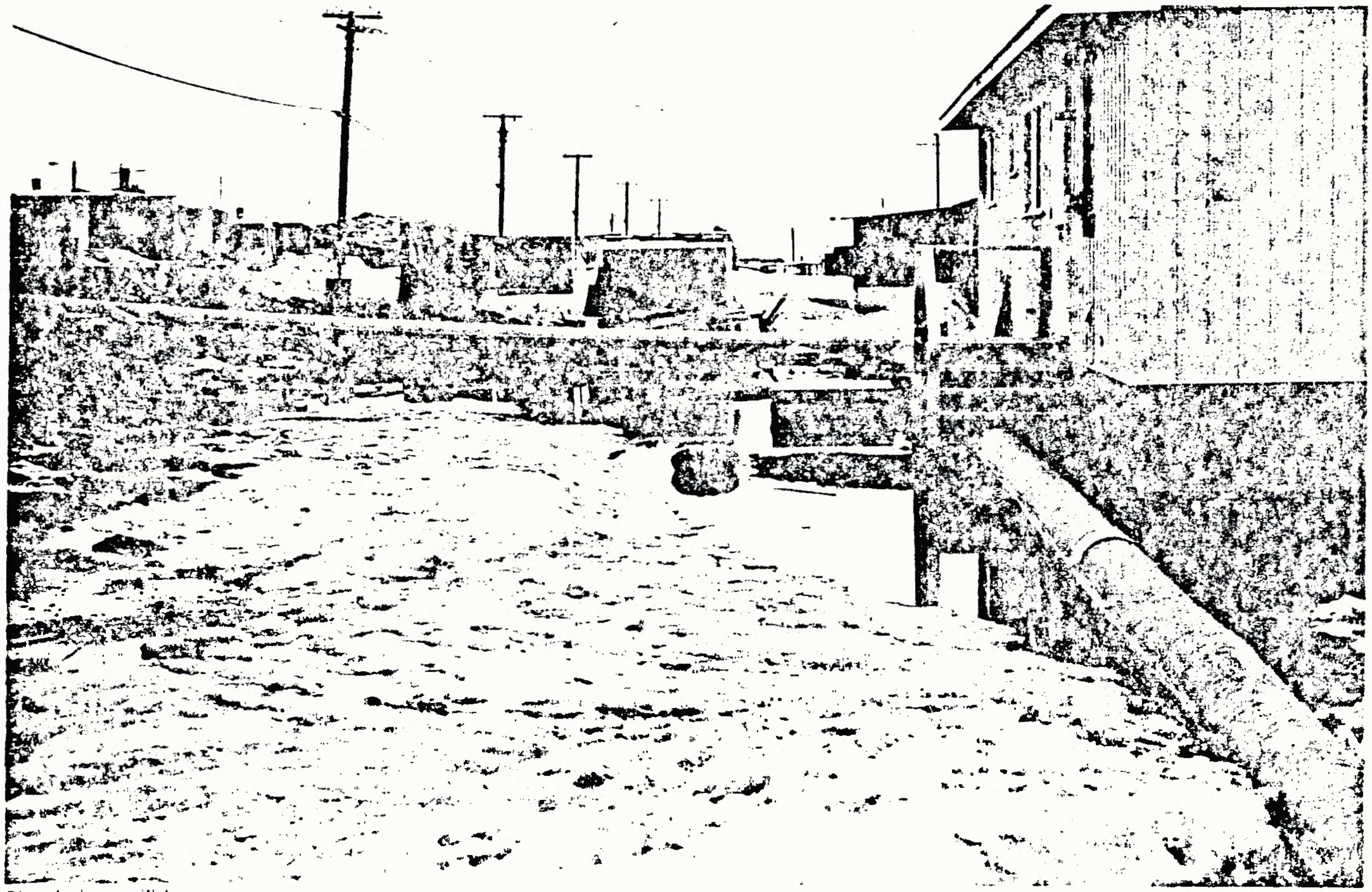
Pressure in the distribution is maintained by the natural head available at water flows by gravity from the treatment plant through the storage facilities. The pressure gradient throughout the Town ranges from 690 to 965 kPa (100 to 140 psi).

B.2 Water Distribution

The original utilidors, built during the eary 1960's, serviced only the hospital, a central complex, the Federal Building, and some residences. Portions of these corrugated metal utilidors remain.

Construction commenced in 1976 on a multi-phase project to expand the piped water and sewage system. Two new buried loops service the east and central portion of town.

A 250 mm ductile iron water main with a 25 mm return encased in an insulated above ground metal box runs between the hospital, high school, and hotel-apartment-shopping complex. A double 50 mm supply and 20 mm return line still serves the G.N.W.T. staff houses.



Circulating utilidor system

Part of one of the new buried looped water mains is 200 mm diameter pipe but generally all recently installed water mains are 150 mm with 37 mm return lines.

In Phases I and II, class 3 insulated ductile iron pipe was installed. Victaulic joints were used in Phase I and Tyton joints were used in Phase II. A 19 mm electrical metallic tubing (EMT) was placed on top of the pipe for the heat trace cable. The pipe and tubing were insulated with 75 mm of polyurethane foam and wrapped in a high density polyethylene jacket.

Series 160 Sclaircor polyethylene pipe was utilized in Phases III and IV of the project. A 25 mm polyethylene thaw tube was installed instead of heat trace. Both pipes are covered with 50 mm of rigid polyethylene foam and a 1.15 mm thick jacket.

A heat trace cable providing 8.2 watts per lineal metre @ 115 V was applied to 50 mm and 100 mm pipe. A cable supplying 16.4 watts per lineal metre @ 115 V was laid on 150 mm, 200 mm and 250 mm pipe. Temperatures are controlled by thermostats in the service manholes.

The Phase I and II water mains and sewer lines are shallow buried and supported on 250 mm x 300 mm timber beams 2400 mm long and spaced at 2.4 m center to center. The ends of the beams are anchored in permafrost and are expected to prevent the pipes from sagging upon local thawing. Phase III and IV piping is supported by granular bedding.

Valves were installed at regular intervals to prevent isolation of relatively small pipe sections in the event of a break or leak. There are facilities to completely drain the system in an emergency.

The manholes used in Phase I and II are precast concrete and contain either or both the sewer and water mains, electrical equipment for heat tracing, and heaters for heating the manholes. Hydrants are at a maximum spacing of 150 m and some are in manholes.

B.2.2 Service Connections

Boxes of 50 mm thick polyurethane 60 cm, covered with 12 mm plywood encase the service connections. Upon hook-up the boxes were filled with polyurethane foam. The Phase I and II copper supply and return water lines are 12 mm or 15 mm in diameter. In Phase III 2-20 mm water lines and a heat trace cable were threaded through a 75 mm polyethylene duct. The domestic circulating pumps are 19 mm Armstrong Model S25 pumps with electric motor, and are designed to run continuously.

B.2.3 Re-circulating Pumphouse

The heating and re-circulating building was built in 1979 between the high school and the hospital. It houses two re-circulating pumps and a hot water converter. Hot water from the N.C.P.C. generating plant heats domestic water in the converter. This water is then injected into the northern loop and unused amounts are re-circulated through the converter. The two Armstrong S-35 pumps have capacities of 1.26 L/s @ 660 kPa.

B.2.4 Trucked System

Approximately one-half of the population is still served by a trucked water system. The community is presently in a period of conversion to a piped system, although Apex will remain on completely trucked system. The municipality contracts the delivery service to private enterprise. At present, five GMC wheeled water tankers are used to handle the community's requirements.

B.3 Sewage Collection

B.3.1 Piped System

The gravity sewer system was expanded during a 5 year period. In the first two construction phases a class 2 ductile iron pipe with cement lining and Tyton joints was laid. A length of 19 mm diameter metallic tubing on top of the pipe contains a heat trace cable. Insulation consists of 75 mm of polyurethane foam covered by a 1.12 mm (HDPE) jacket. The arrangement is supported on the same timber beams as the water main.

For Phases III and IV 100 mm Series 45 Sclaircor HDPE pipe was used. It is not heat traced but is insulated with 50 mm of rigid polyurethane foam and wrapped in a 1.15 mm HDPE jacket. These pipes are simply supported by the granular bedding. The sanitary sewer mains are equipped with a prefabricated clean-out.

B.3.2 Service Connections

Phase I and II sewer service connections are of 100 mm ductile iron heat traced pipe. Phase III and IV connections utilize Series 45 HDPE heat traced pipe in a bundle with the water supply and return lines. The mains and service line connections are enclosed in an insulated plywood box.

B.3.3(a) Sewage Lift Station No. 1

The main (1976) lift station is located at the western end of the gravity collection system. It collects all sewage and discharges it through a 200 mm forcemain towards a macerator building.

The pumphouse contains a wet well and two sewage pumps with the following specifications.

Type:	self-priming centrifugal
Model:	Gorman Rupp Company Model T6A3-B
Capacity:	44.2 L/s @ 174 kPa (580 Igpm @ 58' TDH)
Motor:	Crompton Parkinson 25 HP, 1800 rpm, 3/60/575

There is no standby power supply or pump in case of pump failure. The wet well is equipped with an

Locals assisting in construction

emergency overflow which discharges to the ocean through a 250 mm pipe.

B.3.3(b) Sewage Lift Station No. 2

The second lift station, finished in 1977, collects sewage from the southern section of the town. Waste is pumped through a 150 mm forcemain to a manhole and flows from there to Lift Station #1 by gravity.

The station is composed of a wet well and an underground pump room with these two pumps:

Type:	Self-priming centrifugal pumps
Model:	Gorman Rupp T-3A3-B
Capacity:	13.9 L/s @ 114 kPa (185 Igpm @ 38' TDH)
Motor:	Leroy Somer 7.5 HP, 3/60/575 v, 1750 rpm

There is no standby power supply for this station. It is equipped with a 200 mm overflow pipe which allows sewage from the wet well to flow into the sea in the event of a lift station failure.

B.3.4 Macerator and Outfall

The macerator and outfall were built to replace 5 outfalls along the shore of Frobisher Bay. It was discovered the macerator will not process bagged waste. As there are insufficient solids in the piped sewage to necessitate maceration, currently all sewage flows from the 300 mm inflow pipe through a bypass and outfall to a sewage holding pond on the seashore.

The macerator unit (Chittenden-Howard Type F5019) and hopper are contained inside a buried concrete unit. Trucked sewage is dumped into the sewage main upstream. The macerator was intended to accept bagged sewage, but vortexing problems have occurred in the hopper using bags. The future of the macerator is currently under review.

The retention pond has the capacity to store one winter's production of sewage. After thawing, waste is released over land to the sea.

B.3.5 Sewage Pumpout and Truck Pick-up

Bagged sewage is collected from about 206 units at least 3 times weekly. The annual number of bags collected was estimated at 60,000 for 1979 (Ref. No. 4).

B.4 Bagged Sewage Disposal

Bagged waste is dumped at the landfill site about 3 km northwest of the Town beside the domestic garbage in the west. It is collected under private contract using a Ford F-100 pick-up truck at present.

Three sewer tankers are used for sewage pumpout under contract from the Town (2 GMC and 1 IHC). The liquid sewage is disposed of at the sewage dumping station located near outfall line to the sewage holding area.

B.5 Solid Waste Collection and Disposal

Solid waste was hauled by compactor trucks and open trucks to the dump until the winter of 1979. This waste combined with bagged sewage was hauled to a site beside Apex, a collection of homes south of the Town. Use was undesirable due to the proximity to homes. A new site on rocky ground in the West 40 has been chosen. The garbage thus cannot be covered with soil but may be burned periodically.

B.6 Roads and Surface Drainage

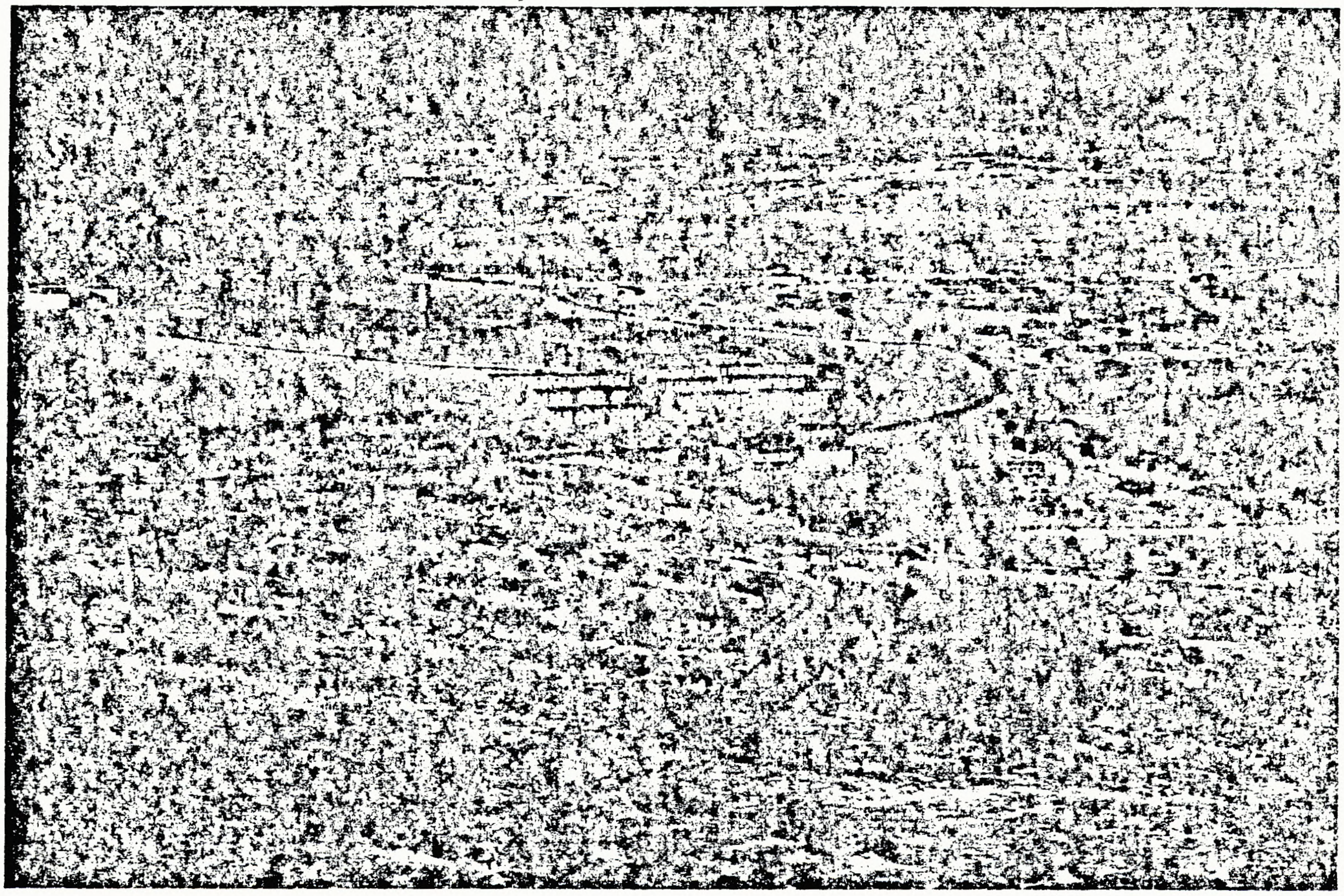
The base of the roads is composed of gravel, which is in abundant supply. A dust problem was partially alleviated in recent years by paving of the main roads.

B.7 Fire Protection

The Town owns two triple combination pumpers and two tank trucks. These are stored at strategic points throughout the populated area. A volunteer force of 33 is summoned by the fire alarm.

B.8 Other Services

Frobisher Bay has a weekly newspaper, a radio station, telephone and telex service, television, and mail delivery five times per week. A bank, taxi service, and hotel are added conveniences. NCPC operates the power generating facilities which have a combined capacity of 11,300 KW.



INFORMATION SOURCES

1. Neil Bryant, Inspector under The Northern Inland Water Act, DIAND, *Village of Frobisher Bay Inspection Report,* Visit of April 9, 10, 1980.

2. M.W. Scott, G.W. Heinke, University of Toronto, Department of Civil Engineering, *Macerator Study for Government of the Northwest Territories,* September, 1980.

3. J.L. Richards & Associates Ltd., Consulting Engineers and Planners, *Operations and Maintenance Manual for Village of Frobisher Bay Municipal Services,* Volume 1, Ottawa, November, 1979.

4. J.L. Richards & Associates Ltd., Consulting Engineers and Planners, *Drawings of Master Water System Plan and Master Sewage System Plan, No.'s 79-5712-1 to 79-5712-4, for Frobisher Bay,* August, 1979.

5. Jack Grainge, Regional Engineer, Health and Welfare Canada, *Report on Water Supplies, Wastes Disposal and Swimming Pool, Frobisher Bay, N.W.T.,* July, 1977.

6. J.L. Richards & Associates Ltd., Consulting Engineers and Planners, *Report on Solid Waste Disposal Study, Frobisher Bay, N.W.T.,* August, 1979.

7. Regitse Johnsen, 'Lille Moelle', Christians Havns Vold, Copenhagen, Denmark, *Municipality of Frobisher Bay, N.W.T.,* 1976.

ANNEX F

ANNEX F

CANADA/USSR
ARCTIC
SCIENCE EXCHANGE PROGRAM
BAFFIN
SEPTEMBER 26 - 29, 1985

BRIEFING ON THE FROBISHER BAY'S WATER/SEWER FACILITIES

1. WATER SUPPLY

1.1 Source (storage of untreated water)

Lake Geraldine is the source of the Town's water. It is at an elevation which permits gravity feed to the water treatment plant. The maximum volume of the lake is over 2100 million litres.

1.2 Water Intake Facilities

The intake is 6.6 m below the crest of a dam at the lake outlet. Water flows to the Treatment plant through 213 m of 250 mm diameter steel pipe. Heated water is continuously circulated through the intake line to prevent freezing. The incoming raw water is maintained at a minimum of 10°C.

1.3 Water Treatment Plant

The water treatment plant was built in 1963 with provisions for chlorination, flocculation, and settling, flouridation, lime treatment and ozonation. The mixing chamber is 3.81 m x 1.22 m x 5.03 m deep with six over and under baffles. The two rapid sandfilters have a combined area of 9.10 sq. m. The flow rate is approximately 100 L/sq. m./min. The filters are backwashed at a 1.8 m loss of head or a maximum time lapse of 48 hours. The plant at full capacity is capable of treating 1.8 million litres (400,000 gallons) every 24 hours.

The raw water is clear, soft, and low in dissolved minerals, and, therefore, ozonation, flucculation, and settling have been discontinued.

1.4 Storage of Treated Water

The storage reservoirs on the first floor of the water treatment building have a total combined capacity of 633,950 litres.

1.5 Water Pumping Facilities (water treatment plant to the water distribution system and water intake)

There are three pumps (two circulation pumps and one fire pump) in the treatment plant/building. Two pumps circulate heated water through the intake line (second pump provides 100 percent standby) and the third one provides the required fire flow. Pressure in the water distribution system is maintained by natural head (static) available at water flows by gravity from the water treatment plant through the storage facilities. The pressure gradient throughout the Town ranges from 100 to 140 PSI (690 to 965 KPA)

1.6 Water Distribution

Water supply systems of many types and materials have been installed in the past-200 mm or 250 mm ductile iron water main, with a 25 mm return encased in an insulated above ground metal box, insulated ductile iron pipe (phase I & II) with 19 mm electrical metallic tubing on top of the pipe for the heat trace cable (the pipe and tubing were insulated with 75 mm of polyurethane foam and wrapped in a high density polyethylene pipe (phase III & IV) with 25 mm polyethylene thaw tube instead of heat trace (both pipes were covered with 50 mm of rigid polyethylene foam and a 1.15 mm thick jacket.)

A heat trace cable providing 8.2 watts/lineal metre @ 115 V was applied to 50 mm and 100 mm pipe. A cable supplying 16.4 watts/lineal metre @ 115 V was laid on 150 mm, 200 mm, and 250 mm pipe. Temperatures are controlled by thermostats in the manholes.

The Phase I and II water and sewer mains are shallow buried and supported on 250 mm x 300 mm timber beams 2400 mm long and spaced at 2.4 m center to center. The ends of the beams are anchored in permafrost. Phase III and IV piping is supported by granular bedding.

Valves are installed at regular intervals to permit isolation of relatively small pipe sections in the event of a break or leak. There are facilities to completely drain the system in an emergency. The manholes used in Phase I to IV are either of precast concrete or poured in place concrete and contain either or both the sewer and water mains, electrical equipment for heat tracing and heaters for heating the manholes. Phase V - prefabricated steel access vaults.

1.7 Water Service Connections

In Phase I & II copper supply & return lines are 12 mm or 15 mm in diameter. Boxes of 50 mm thick polyurethane covered with 12 mm plywood encase the service connections. Upon hook-up the boxes were filled with polyurethane foam. In Phase III & IV 2-20 mm water lines and a heat trace cable were threaded through a 75 mm polyethylene duct. To provide freeze protection a pump was installed in each housing unit. For Phase VI new developed concept has been used (STANDARDS).

.../3

While not always successful, these haveprovided invaluable experience and have all contributed to the development of the concepts utilized today. Phase VI "Water and Sewer Extensions": pre-fabricated steel access vaults, buried high density polyethylene pipe (HDPE) with 50 mm of polyurethane insulation encased in a 1.14 mm polyethylene impermeable plastice jacket, water and sewer service connections (Standards) and freeze protection. Concept plans or standards on new developed concepts are detailed in the paper"water distribution and sewage disposal systems in the Northwest Territories" prepared by Sukhi Cheema and Robert Boon which will be presented in Yellowknife on October 5, 1985.

1.8 Recirculation Pumphouse

To provide a positive flow in the water distribution system (at no flow condition) and to raise water temperature in the system in certain sections a heating a recirculating facility, has been added to the existing system.

1.9 Trucked Water System

Approximately one-half of the population is still served by a trucked water system. The community is presently in a period, of conversion to a piped system.

2. SEWAGE COLLECTION

2.1 Piped System

In the first two construction Phases (I & II) a class 2 ductile iron pipe with cement lining was laid. A 19 mm diameter metallic tubing on top of the pipe contains a heat trace cable. Insulation consists of 75 mm of polyurethane foam covered by a 1.12 mm (HDPE) jacket. The arrangement is supported on the same timber beams (Art 1.6) as the water mains. For Phase III & IV 100 mm Series 45 Sclaircore HDPE pipe was used. It is not heat traced but is insultated with 50 mm of rigid polyurethane foam and wrapped in a 1.15 HDPE jacket. In phase VI a buried high density polyethylene pipe (HDPE) with a minimum of 50 mm of polyurethane insulation encased in 1.14 mm polyethylene impermeable jacket is used. The mains are pressure rated, continuously joined through the butt fusion process and are placed in the same trench with water.

2.2 Sanitary Sewer Service Connections

Phase I & II sewer service connections are of 100 mm ductile iron heat traced pipe. Phase III & IV connection utilizes Series 45 HDPE heat traced pipe in a bundle with the water supply and return lines. In Phase VI the sanitary sewer service connections consist of a butt fused minimum 100 mm diameter, series 45 (410 KPA) high density polythylene pipe 50 mm of urethane insulation encased in a 1.14 mm polyethylene jacket connected to the main with a 90° bend.

2.3 Sewage Lift Stations (#1)

It is located at the western end of the gravity collection system. It collects all sewage and discharge and discharges it through a 200 mm force main towards sewage treatment facility (lagoon). There is no standby power supply or pump in case of pump failure. The wet well is equipped with an emergency overflow which discharges to the ocean through a 250 mm pipe.

Sewage Lift Station (#2)

It collects sewage from the southern section of the town. Sewage is pumped through a 150 mm forcemain to a manhole and flows from there to Lift Station # 1 by gravity. There is no standby power supply for this station. It is equipped with a 200 mm overflow pipe which allows sewage from the wet well to flow into the sea in the event of a lift station failure.

2.4 Sewage Pumpout and Truck Pick-up and Bagged Sewage Disposal

Bagged sewage is collected from the unserviced (piped) units at least three times weekly. The liquid sewage is disposed of at the sewage dumping station located near outfall line to the sewage holding area. Bagged waste is dumped at the landfill site about 3 km northwest of the Town beside the domestic garbage in the west.

2.5 Sewage Treatment

The sewage is treated in a retention pond. If has the capacity to store one winter's production of sewage. After this treatment, the effluent is released overland to sea.

Sukhi Cheema, P. Eng,
Project Manager,
Department of Public Works
and Highways.

ANNEX G

ANNEX G

Northwest Territories Canada

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS, YELLOWKNIFE, N.W.T.

SPECIFICATION

SET NO. 6

PASSED TO BUILDINGS DIVISION
FOR INFORMATION AND RETENTION
17 SEPTEMBER, 1986.
John Benner

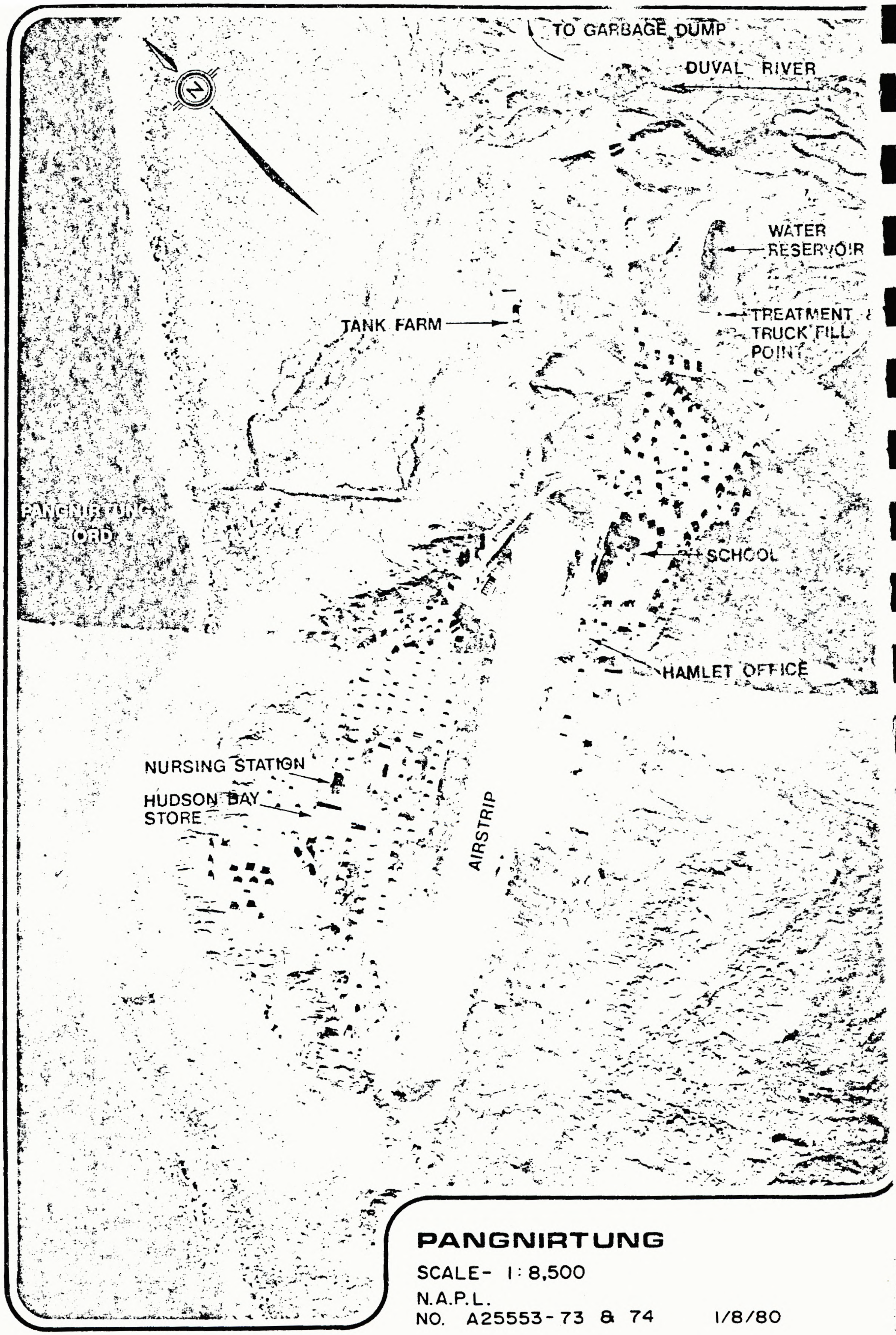
PROJECT NO. **85-4501**

PROJECT

G.R.E.C.
ROOF RETROFIT
FROBISHER BAY

ANNEX H

Pangnirtung


TO GARBAGE DUMP
DUVAL RIVER
N
WATER RESERVOIR
TREATMENT & TRUCK FILL POINT
TANK FARM
PANGNIRTUNG
SCHOOL
HAMLET OFFICE
NURSING STATION
HUDSON BAY STORE
AIRSTRIP
PANGNIRTUNG
SCALE- 1: 8,500
N.A.P.L.
NO. A25553-73 & 74 1/8/80

Aerial view

A. GENERAL

A.1 Location

Pangnirtung is located on the southeastern shore of Pangnirtung Fiord, Cumberland Peninsula, Baffin island at an approximate altitude of 66°09'N and longitude of 65°45'W. By air it is 300 km north of Frobisher Bay.

A.2 History

Whalers and explorers began visiting the area around 1600. An Anglican Mission became established at a whaling station at Black Lead Island, near the south shore of Cumberland Sound, in the late 1800's. The Mission moved to Pangnirtung in 1926. In 1921, the Hudson's Bay Company established a post and the R.C.M.P. started a detachment in 1923. Shortly after that, a hospital was built by the Mission in 1931. Over these years, a school was opened and a nursing station was also established.

A.3 Community Information

Pangnirtung achieved Hamlet status on April 1, 1972. Between 1978 and 1980, the population of the hamlet increased from 878 to 899, indicating a gradual annual increase. The economy of the community is mainly dependent on the Federal and Territorial governments. The Hudson's Bay Co. and Peyton Lodge also employ a sizeable number of the local people.

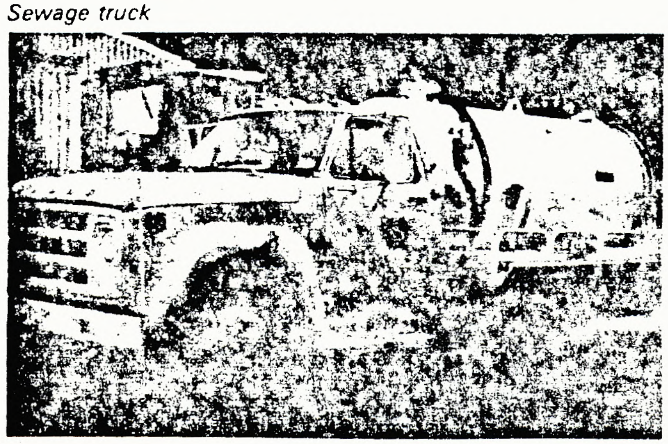
Community services include two R.C.M.P. constables, two nurses, community centre, primary school and library.

A 825 m x 30 m gravel surfaced airstrip bisects the community.

A.4 Geology and Terrain

The community occupies a position generally situated on the remains of a tidal beach, glacial drift and an old river delta inland from the present delta to the east. The maximum depth from foreshore flat to the plateau behind the community is about one-half mile. The Hamlet is bounded on the north and west by the fiord, on the south by steep hills and on the east by the Duval River.

Sewage truck



A.5 Vegetation

Vegetation consists of mosses and lichens with the odd stand of hardy grasses.

A.6 Climate

The climate in Pangnirtung is severe. The July mean high and low temperatures are 11.1°C and 3.9°C respectively. The January high and lows are -25.6°C and -37.8°C respectively. The total average yearly precipitation of 341 mm consists of 162 mm rain and 1803 mm of snowfall.

B. MUNICIPAL SERVICES

B.1 Water Supply

B.2 Source

During the summer, water is pumped into a storage reservoir from the Duval River at a point approximately 1 km east of the community for winter storage (see aerial photo).

During the summer, springs in the hills above town are used directly as a potable water source. Both the Duval River and spring waters are of good quality. A typical chemical analyses follows: (All values in mg/L unless otherwise noted)

Parameter	Duval River	Springs
pH	6.2	6.1
Total Hardness (as $CaCO_3$)	8	8
Total Alkalinity (as $CaCO_3$)	6	6
Iron, Total (Fe)	<.02	<.02
Manganese, Total (Mn)	<.02	<.02
Color	<5 units	<5 units
Turbidity	<1 unit	<1 unit
Nitrate Nitrogen (N)	0.2	0.2
Sulphate (SO_4)	<5	5
Fluoride (F)	<0.1	<0.1
Specific Conductance	25 micromhos	27 micromhos

B.1.3 Storage

During the summer, water is pumped into the reservoir from the Duval River. There it is stored for winter use. The construction of the reservoir in 1967 required burning fuel oil to melt the permafrost and bulldozing the frozen and unfrozen gravel. The reservoir is roughly 67 m x 183 m with 7.6 m high berms at the deepest end.

The useable volume of water assuming at least 2 m of ice, is in the range of 9 million litres (2 million Igal). With 0.6 m (2 ft.) freeboard, the useable volume with no ice, is roughly 18 million litres (4 million Igal).

An investigation in 1972 revealed seepage into and out of the reservoir and in 1976, a 30 mil Hypalon liner was added. Air vent pads were installed on the liner above the high water level at 10 m centres lengthwise and 4.6 m centres across the reservoir. The reservoir does not have a subdrainage system and liner "ballooning" has subsequently occurred due to water pressure build-up beneath the liner.

B.1.4 Intake Facilities

Intake facilities in the reservoir consist of an insulated underground heat traced pipe with the following specifications:

Length:	21.3 m
Diameter:	50 mm
Type:	Schedule 40 Steel Pipe

The deep well submersible pump is located in the intake and is used to fill the water truck.

B.1.5 Pumping Facilities

Pumping facilities consist of a deep well submersible pump in the intake. Pump specifications are as follows:

Type:	TRW Pleuger of Canada P63, 2 stage
Motor:	4-1/2 HP, 208 volt, 3 phase, 60 cycle
Capacity:	9.5 L/s @ 208 kPa TDH (125 Igpm @ 70' TDH)

Truck fill station at the reservoir consists of an insulated heated building includes chlorination facilities, water meter and storage space.

B.1.6 Treatment

Treatment is provided by a Wallace and Tiernan hypochlorinator equipped with a 136 L (30 Ig) polyethylene chemical feed tank and an electric mixer.

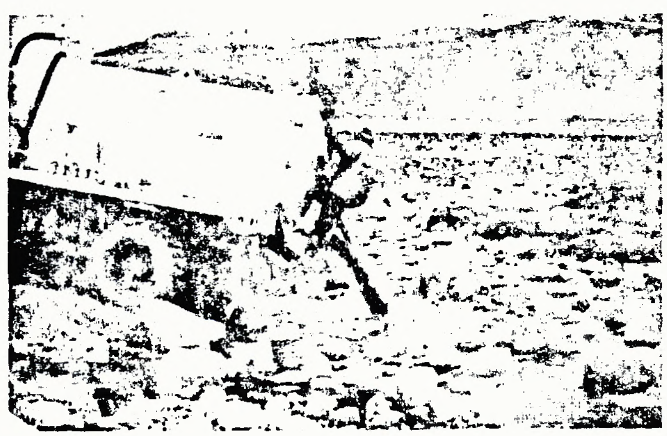
B.2 Water Distribution

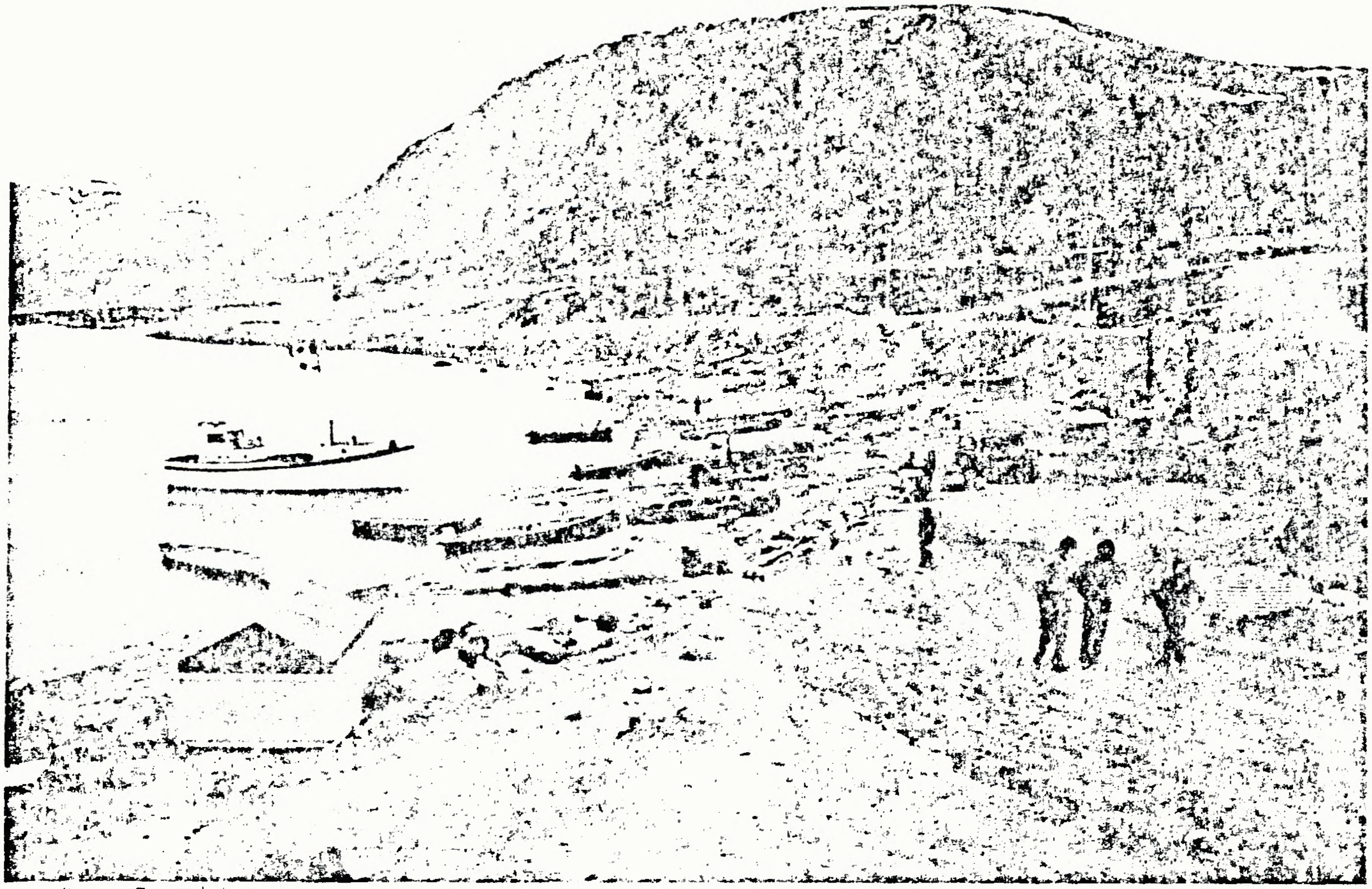
All water is delivered by trucks except in the summer when some residences are served by a temporary piped system.

Water is delivered using two 4550 L (1000 Ig) wheeled vehicles with the contract being landed by

B.3 Sewage Collection

Bagged sewage and liquid sewage is collected by the Hamlet. Pumpout is via one 4510 L (1000 Ig) wheeled sewage pumpout vehicle. Only 20 residences, the school, and the nursing station have pumpout facilities.




Shoreline at Pangnirtung

Bagged sewage is collected daily along with the garbage. They are placed outside the houses in half barrels. These wastes are then hauled away to the disposal area using an open box truck.

B.4 Sewage Disposal
Presently bagged sewage and solid wastes are deposited in one of two places. One disposal area is about 1200 m northeast of the Duval River; however, this area is not always easily accessible. The road to this site is difficult to adequately maintain due to washouts from surface run-off, and snow drifting in the winter.

Sewage pumpout is dumped along the banks of the Duval River near its mouth.

Plans were underway to improve the present methods of disposal by constructing a macerator east of the Hamlet. This facility was intended to accept bagged sewage and pumpout liquid wastes and macerate the contents prior to disposal, these plans have been suspended pending further investigations on the design and operation of the facility.

B.5 Solid Waste
Garbage is placed in 205 L (45 Igal) drums and collected along with the bagged sewage. It is carried out under contract by the Hamlet and is presently disposed of in the same manner and location as sewage bags.

Plans were underway to construct incineration facilities designed to reduce the volume of wastes and, thereby eliminate nuisance and other disposal problems. These plans have been suspended until further investigations have been carried out on the cost effectiveness, and operational characteristics of the facilities.

B.6 Roads
Road surfaces throughout the community are generally in poor condition.

Good road building materials are not present in a natural state. Mixing and crushing operations would be required to provide a suitably graded material for road construction.

B.7 Surface Drainage
The steep inclines behind the Hamlet tend to produce a high peak volume in the spring-summer thaw. This results in a more active soil layer with a high degree of solifluction and soil creep. The present alignment of the roads also hinders surface drainage.

B.8 Fire Protection
Fire protection in Pangnirtung consists of the following:

- call boxes throughout the community directly connected to a siren
- one 1977 mini-pumper capable of pumping 11-34 L/s (150-450 Igpm)

- an office and firehall in one building
- a 10 person volunteer fire brigade

B.9 Other Services
There is twice weekly mail service, a local newspaper, and a telephone system operated by Bell Canada. Power is supplied by NCPC using diesel generation facilities.

INFORMATION SOURCES

1. W.D. Buchanan Ltd., *General Development Plan, Pangnirtung, N.W.T.,* May, 1979.

2. Health and Welfare Canada, Medical Services N.W.T. Region, *Report on Water Supplies & Wastes Disposal, Pangnirtung, N.W.T.,* November, 1976.

3. J.L. Richards & Associates Ltd., *Report on Waste Disposal Study Pangnirtung, N.W.T.,* January, 1980.

4. Government of N.W.T., Department of Public Works, *Specifications for Incinerator and Sewage Disposal Facility Panginirtung, N.W.T.,* May, 1979.

CANADA/USSR

ARCTIC

SCIENCE EXCHANGE PROGRAM

BAFFIN

SEPTEMBER 26 - 29, 1985

Annex H 2 of 2

BRIEFING ON THE PANGNIRTUNG'S

WATER DISTRIBUTION, SEWAGE

COLLECTION AND DISPOSAL FACILITIES

CLIMATE

The climate in Pangnirtung is severe. The July mean high and low temperatures are 11.1°c and 3.9°c respectively. The January high and lows are minus 25.6°c and minus 37.8°c respectively. The total average yearly precipitation is 341mm including 162mm from rain.

1) WATER SUPPLY

1.1 WATER SOURCE

During the summer, water is pumped into a storage reservoir from the Duval River at a point approximately 1 km east of the community for winter storage. During the summer, springs in the hills above town are used directly as a potable water source.

1.2 WATER STORAGE

During the summer, water is pumped into the reservoir from the Duval River. There it is stored for winter use. The reservoir was constructed in 1967. The reservoir is roughly 67m x 183m with 7.6m high ~~beams~~ berms at the deepest end. The useable volume of water with at least 2m of ice, is in the range of 9 million litres. with 0.6m freeboard, the useable volume with no ice, is approximately 18 million litres.

An investigation in 1972 revealed seepage into and out of the reservoir and in 1976, a 30 mil Hypalon liner was added without a subdrainage system.

1.3 TRUCK FILL STATION

Truck fill station (water truck filling facility) at the reservoir consists of an insulated heated building includes chlorination facilities, water intake (50mm - Sch 40 Steel) with heat trace, water meter and storage space.

1.4 WATER TREATMENT

Treatment is provided by a hypochlorinator equipped with a 136 litre polyethylene chemical feed tank and an electric mixer.

1.5 WATER DISTRIBUTION
All water is delivered by trucks except in the summer when some residences are ~~saved~~ serviced by a temporary piped system. Water is delivered using two 4550 litre wheeled vehicles.

2) SEWAGE COLLECTION AND DISPOSAL

2.1 SEWAGE COLLECTION
Bagged sewage and liquid waste is collected by the Hamlet. Pumpout is via one 4510 L wheeled sewage pumpout vehicle. Bagged sewage is collected daily along with the garbage. They are placed outside the houses in half barrels. These wastes are then hauled away to the disposal area using an open box truck.

2.2 SEWAGE DISPOSAL
Presently bagged sewage and solid wastes are deposted in one of two places. One disposal area is about 1200m northeast of the Duval River and other one is banks of the Duval River at its mouth.

But the existing water system is not big enough to meet our 20 year water demand. Currently a system to meet our 20 year water demand is under construction at estimated cost of $5.5 million. Reg Andres, Project Engineer assigned to the project will explain the new system with design guidelines, standards and project management activities.

Sukhi Cheema, P. Eng.,
Project Manager
Public Works & Highways

ANNEX I

ANNEX I

Northwest Territories Public Works and Highways

Equipment Management Division

SPECIFICATION
607/419/420

SEWAGE PUMPOUT VEHICLE

TYPICAL	27500lbs/GVW/4X2	SPECIFICATION NUMBER	419
	1. Ford F700		
	2. GMC C70	REVISED DATE	D/M/Y
	3. IHC 1700		21/08/85

0.0 INSTRUCTIONS TO DEALER

0.1 Quote a factory new and latest model only.

0.2 If some attachments/accessories specified are either not recommended by factory/dealer or you are unable to exactly comply with any of the items, you must determine if, in fact, any alternate proposal(s) is acceptable by telexing Purchasing Manager, Government Services immediately upon receipt of the attached tender. For these items, mark NO and attach with tender a letter of explanation, submitting an alternate proposal(s) with separate costs. However, the acceptablility of the alternate proposal will be entirely at the discretion of the Government of the Northwest Territories and shall be final and binding.

0.3 Some features/accessories may not be available as factory options or standard equipment and must be supplied and installed by dealer separately. These costs are to be included in quote.

0.4 Where **blank spaces** are provided **enter** the information indicated.

0.5 Quote to include pre-delivery inspection and servicing, and 3/4 tank of fuel at F.O.B. point. If dual tanks are required, only main tank to be fueled.

0.6 Unit is subject to inspection before acceptance by Government of the Northwest Territories, Department of Public Works Equipment Management or it's representative.

0.7 Dealer's Name and Address: ____________________

____

Telephone Number: ____________________

Attention: ____________________

CAB AND CHASSIS

INDEX OF SECTIONS

1.0 MAKE AND MODEL

STATE:

1.1 Tendered Make: ____________________

1.2 Series: ____________________

1.3 Model: ____________________

2.0 ENGINE

2.1 Six (6) cylinder in-line diesel. Minimum of 210HP at 2600RPM.

2.1.1 State: Model# __________ and ________L

2.1.2 Max. kW ______(B.H.P.____).

2.2 Operates on P50 Arctic Grade Fuel.

2.3 V-8 gasoline engine. Minimum of 160HP at 3600RPM.

2.3.1 State: Model# __________ and ________L

2.3.2 Maximum HP:________ at ________RPM

2.4 Operates on leaded gasoline.

2.5 Space has been provided on enclosed tender document to quote price on gasoline and diesel engines. If one or the other is not available from a Manufacturer, the dealer must indicate by entering N/A in appropriate space above.

3.0 ENGINE ACCESSORIES

3.1 Two (2) 600 watt block heaters.

3.1.1 Power cord for block heater to exit above front bumper, below grille section.

3.2 Extra capacity cooling system complete with heavy duty clutch fan assembly.

3.3 Quilted type vinyl storm front. Storm front to cover entire grille opening, but must be installed with turn latch type hardware to allow for its removal. Storm front must also have small closeable openings for moderate weather operations.

4.0 ENGINE INSTRUMENTS

4.1 Ammeter

4.2 Oil pressure gauge.

4.3 Coolant temperature gauge.

4.4 Hobbs 15001 hours-run meter. NO SUBSTITUTE.

4.5 Tachometer.

4.5.1 NOTE: Gauges must be provided. TELL-TALE WARNING LIGHTS NOT ACCEPTABLE.

5.0 ANTI-FREEZE

5.1 Cooling system protected to -45°C.

5.2 Windshield washer solvent protected to -37°C.

6.0 TRANSMISSION AND DIFFERENTIAL

6.1 Allison MT543 automatic transmission, four (4) speed with P.T.O. gear, auxiliary external oil cooler and oil temperature guage. ONLY FACTORY INSTALLATION ACCEPTABLE.

6.2 Spicer Manual Transmission - 5 speed Model 4054A.

6.3 Single speed rear axle; STATE:_________ratio.

6.4 Two speed rear axle; STATE: Hi ratio_______, Low ratio________.

6.4.1 Space has been provided on front of tender document to quote separately on items 6.1/6.2/6.3/6.4. Please enter ratios in spaces above.

6.5 Magnetic drain plug in differential.

7.0 WHEELS AND TIRES

7.1 Wheels:

7.1.1 Type: STANDARD CAST SPOKE

7.2 Rims:

7.2.1 Type: Three (3) piece

7.2.2 Size: 7.0" X 0.5" X 20"

7.2.3 Quantity: Seven (7)

7.3 Tires:

7.3.1 Size: 9:00 X 20

7.3.2 Type: Bias ply

7.3.3 Load Range: F

7.4 Tread:

7.4.1 Front: highway

7.4.2 Rear: mud and snow

7.4.3 Spare: mud and snow

7.5 STATE:

7.5.1 Make: ____________________

7.5.2 Style: ____________________

7.6 Tread Design:

7.6.1 Front: ____________________

7.6.2 Rear: ____________________

7.6.3 Spare: ____________________

7.7 Spare tire and wheel to be securely fastened for shipment with unit.

8.0 CAB AND CHASSIS

8.1 Regular cab with forward tilting hood and fender assembly.

8.2 Dual, outside, rear-view mirrors - 7"X 16", Westcoast style with lights and convex auxiliary mirror.

8.3 Optional, high-output, fresh-air heater and defroster.

8.4 Dual sun visors.

8.5 Windshield washers.

8.6 Interior dome light.

8.7 Heavy duty rubber floor mats.

8.8 Back-up lights.

8.9 Standard individual seats for driver and one (1) passenger with premium cloth and vinyl upholstery.

8.10 Colour keyed interior.

8.11 Two speed electric windshield wipers.

8.12 Gas tank - L.H. and R.H. each to have a minimum capacity of 35 gallons.

8.12.1 State capacity: L.H._____ gallons

8.12.2 State capacity: R.H._____ gallons

8.13 Cab to axle distance to be 84 inches.

8.15 Cab clearance light package.

8.16 Cab grab handles L.H. and R.H.

8.17 Shock absorbers - FRONT ONLY.

8.18 Standard front bumper.

8.19 Dual electric horns.

8.20 Four (4) hooks, Two (2) front, two (2) rear attached directly to frame with a minimum of two (2) 9/16" diameter bolts per tow hook.

9.0 BODY

9.1.1 Described in attached specification No._____ dated _________________.

10.0 ELECTRICAL SYSTEM

10.1 Two (2) heavy duty batteries, minimum capacity of 500 CCA each.

10.1.1 State Rating:________________________

10.2 Batteries to be located rear of cab on L.H. frame rail.

10.3 Each battery to have a battery blanket installed with a minimum size of 80 watts of heat.

10.3.1 A single power cord is to be routed through frame rail to exit above front bumper, below grille section.

10.3.2 Power cord to be secured with tie wraps at a minimum interval of 16 inches.

10.4 Heavy duty alternator, minimum 60 ampere.

10.4.1 State Rating:________________________

11.0 STEERING AND SUSPENSION

11.1 Front axle and suspension, minimum 9000lbs. capacity.

11.1.1 State: GAWR_________lbs.

11.2 Rear axle and suspension, minimum 18500lbs. capacity.

11.2.1 State: GAWR_________lbs.

11.3 Power steering.

12.0 BRAKES

12.1 Power assist brakes

12.2 Spring set hydraulic parking brake.

12.3 Orscheln parking brake lever complete with red warning light - dash mounted.(If Item 12.2 not available).

13.0 SAFETY FEATURES

13.1 All manufacturers standard safety features.

13.2 One (1) 2.27kg (5 lb.) Ansul Model A5 Nitrogen Conversion Cartridge ABC class, dry chemical fire extinguisher mounted in cab for easy access with Ansul Model #A7077 mounting bracket.

14.0 PAINT AND MARKINGS

14.1 Yellow Gloss Enamel - Federal Code #CGSB-1-GP-12C-505-101 or CIL #2329-80824.

15.0 WARRANTY

15.1 Standard factory warranty on all components.

15.2 STATE: ____________Kilometers

____________Months

APPROVED:

James Pierce,
Equipment Technical Officer,
Department of Public Works
and Highways.

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
STANDARD MOBILE EQUIPMENT SPECIFICATION

Northwest Territories

TYPICAL	26000lbs/GVW/4X4	SPECIFICATION NUMBER	420
	1. Ford F700		
	2. IHC 1754	REVISED DATE	D/M/Y 21/08/85

0.0 INSTRUCTIONS TO DEALER

0.1 Quote a factory new and latest model only.

0.2 If some **attachments/accessories** specified are either not recommended by factory/dealer or you are unable to exactly comply with any of the items, you must determine if, in fact, any alternate proposal(s) is acceptable by telexing Purchasing Manager, Government Services immediately upon receipt of the attached tender. For these items, mark NO and attach with tender a letter of explanation, submitting an alternate proposal(s) with separate costs. However, the acceptablility of the alternate proposal will be entirely at the discretion of the Government of the Northwest Territories and shall be final and binding.

0.3 Some features/accessories may not be available as factory options or standard equipment and must be supplied and installed by dealer separately. These costs are to be included in quote.

0.4 Where **blank spaces** are provided **enter** the information indicated.

0.5 Quote to include pre-delivery inspection and servicing, and 3/4 tank of fuel at F.O.B. point. If dual tanks are required, only main tank to be fueled.

0.6 Unit is subject to inspection before acceptance by Government of the Northwest Territories, Department of Public Works Equipment Management or it's representative.

0.7 Dealer's Name and Address: ____________________

____

Telephone Number: ____________________

Attention: ____________________

CAB AND CHASSIS

INDEX OF SECTIONS

1.0 MAKE AND MODEL

STATE:

1.1 Tendered Make: ______________________________

1.2 Series: ______________________________

1.3 Model: ______________________________

2.0 ENGINE

2.1 Six (6) cylinder in-line diesel. Minimum of 210HP at 2600RPM.

2.1.1 State: Model# __________ and _______L

2.1.2 Max. kW ______(B.H.P.____) at______RPM.

2.2 Operates on P50 Arctic Grade Fuel.

2.3 V-8 gasoline engine. Minimum of 160HP at 3600RPM.

2.3.1 State: Model# __________ and _______L

2.3.2 Maximum HP: _______ at ______RPM

2.4 Operates on leaded gasoline.

2.5 Space has been provided on enclosed tender document to quote price on gasoline and diesel engines. If one or the other is not available from a Manufacturer, the dealer must indicate by entering N/A in appropriate space above.

3.0 ENGINE ACCESSORIES

3.1 Two (2) 600 watt block heaters.

3.1.1 Power cord for block heater to exit above front bumper, below grille section.

3.2 Extra capacity cooling system complete with heavy duty clutch fan assembly.

3.3 Quilted type vinyl storm front. Storm front to cover entire grille opening, but must be installed with swing latch type hardware to allow for its removal. Storm must also have small closeable openings for moderate weather operations.

4.0 ENGINE INSTRUMENTS

4.1 Ammeter

4.2 Oil pressure gauge.

4.3 Coolant temperature gauge.

4.4 Hobbs 15001 hours-run meter. NO SUBSTITUTE.

4.5 Tachometer.

4.5.1 NOTE: Gauges must be provided. TELL-TALE WARNING LIGHTS NOT ACCEPTABLE.

5.0 ANTI-FREEZE

5.1 Cooling system protected to -45°C.

5.2 Windshield washer solvent protected to -37°C.

6.0 TRANSMISSION AND DIFFERENTIAL

6.1 Allison MT543 automatic transmission, four (4) speed with P.T.O. gear, auxiliary external oil cooler and oil temperature guage. ONLY FACTORY INSTALLATION ACCEPTABLE.

6.2 Spicer Manual Transmission - 5 speed Model 4054A.

6.3 Single speed rear axle; STATE:__________ratio.

6.3.1 Space has been provided on front of tender document to quote separately on items 6.1/6.2. Please enter ratios in spaces above.

6.4 Two speed transfer case.

6.4.1 STATE: Make: ________________

6.4.2 Model: ________________

6.5 Four wheel drive complete with locking hubs.

6.5 Magnetic drain plug in differential.

7.0 WHEELS AND TIRES

7.1 Wheels:

7.1.1 Type: STANDARD CAST SPOKE

7.2 Rims:

7.2.1 Type: Three (3) piece

7.2.2 Size: 7.0" X 0.5" X 20"

7.2.3 Quantity: Seven (7)

7.3 Tires:

7.3.1 Size: 9:00 X 20

7.3.2 Type: Bias ply

7.3.3 Load Range: F

7.4 Tread:

7.4.1 Front: highway

7.4.2 Rear: mud and snow

7.4.3 Spare: mud and snow

7.5 STATE:

7.5.1 Make: ____________________

7.5.2 Style: ____________________

7.6 Tread Design:

7.6.1 Front: ____________________

7.6.2 Rear: ____________________

7.6.3 Spare: ____________________

7.7 Spare tire and wheel to be securely fastened for shipment with unit.

8.0 CAB AND CHASSIS

8.1 Regular cab with forward tilting hood and fender assembly.

8.2 Dual, outside, rear-view mirrors - 7"X 16", Westcoast style with lights and convex auxiliary mirror.

8.3 Optional, high-output, fresh-air heater and defroster.

8.4 Dual sun visors.

8.5 Windshield washers.

8.6 Interior dome light.

8.7 Heavy duty rubber floor mats.

8.8 Back-up lights.

8.9 Standard individual seat for driver and one (1) passenger with premium cloth and vinyl upholstery.

8.10 Colour keyed interior.

8.11 Two speed electric windshield wipers.

8.12 Gas tank - L.H. and R.H. each to have a minimum capacity of 35 gallons.

8.12.1 State capacity: L.H._____ gallons

8.12.2 State capacity: R.H._____ gallons

8.13 Cab to axle distance to be 84 inches.

8.15 Cab clearance light package.

8.16 Cab grab handles L.H. and R.H.

8.17 Shock absorbers - FRONT ONLY.

8.18 Standard front bumper.

8.19 Dual electric horns.

8.20 Four (4) hooks, Two (2) front, two (2) rear attached directly to frame with a minimum of two (2) 9/16" diameter bolts per tow hook.

9.0 BODY

9.1.1 Described in attached specification No.______ dated _______________.

10.0 ELECTRICAL SYSTEM

10.1 Two (2) heavy duty batteries, minimum capacity of 500 CCA each.

10.1.1 State Rating:________________________

10.2 Batteries to be located rear of cab on L.H. frame rail.

10.3 Each battery to have a battery blanket installed with a minimum size of 80 watts of heat.

10.3.1 A single power cord is to be routed through frame rail to exit above front bumper, below grille section.

10.3 Heavy duty alternator, minimum 60 ampere.

10.3.1 State Rating:________________________

11.0 STEERING AND SUSPENSION

11.1 Front axle and suspension, minimum 7500lbs. capacity.

11.1.1 State: GAWR_________lbs.

11.2 Rear axle and suspension, minimum 18500lbs. capacity.

11.2.1 State: GAWR_________lbs.

11.3 Power steering.

12.0 BRAKES

12.1 Power assist brakes

12.2 Spring set hydraulic parking brake.

12.3 Orscheln parking brake lever complete with red warning light - dash mounted. (If item 12.2 not available).

13.0 SAFETY FEATURES

13.1 All manufacturers standard safety features.

13.2 One (1) 2.27kg (5 lb.) Ansul Model A5 Nitrogen Conversion Cartridge ABC class, dry chemical fire extinguisher mounted in cab for easy access with Ansul Model #A7077 mounting bracket.

14.0 PAINT AND MARKINGS

14.1 Yellow Gloss Enamel - Federal Code #CGSB-1-GP-12C-505-101 or CIL #2329-80824.

15.0 WARRANTY

15.1 Standard factory warranty on all components.

15.2 STATE: ____________Kilometers

____________Months

APPROVED:

James Pierce,
Equipment Technical Officer,
Operations Division,
Department of Public Works
and Highways.

TYPICAL	VACUMAX	SPECIFICATION NUMBER	607
		REVISED DATE	D/ M/ Y 21/08/85

VACUUM INDUCTOR SEWAGE TRUCK-P.T.O. DRIVE

0.0 SPECIFICATION INSTRUCTIONS

0.1 Quote on factory new and latest equipment only.

0.2 If some **attachments/accessories** specified are either not recommended by factory/dealer, or you are unable to exactly comply with any of the items, you must determine if, in fact, any alternate proposal(s) is acceptable by telexing Purchasing Manager, Government Services, immediately upon receipt of the attached tender. For these items, attach a letter of explanation, submitting an alternate proposal(s) with separate costs. However, the acceptability of the alternate proposal(s) will be entirely at the discretion of G.N.W.T. and shall be final and binding.

0.3 Where **blank spaces** are provided, **enter** the information indicated.

0.4 Two complete copies of specifications are enclosed; one (1) copy to be submitted with tender, one (1) copy to be retained by Vendor.

0.5 The Vendor must ensure that the sewage truck tank body, including all components, is compatible with the cab and chassis as per attached specifications #419 and #420 dated August 21,1985.

0.6 Unit is subject to inspection before acceptance by Government of the Northwest Territories, Department of Public Works and Highways, Equipment Management or it's representative(s).

0.7 STATE:

Dealer's Name and Address:______________________

____

TANK BODY

INDEX OF SECTIONS

TANK BODY

1.0 PRODUCT

1.1 Domestic sewage and waste water.

2.0 CAPACITY

2.1 4546 Litres (1000 Imperial Gallons), nominal.

2.2 Single compartment tank.

3.0 INSTALLATION

3.1 To be installed on chassis supplied by contractor as per specification(s) attached (607-S2).

3.2 Tank mounted on rubber bedding, attached to chassis with U-bolts. Thefastening mechanism for the U-bolts must be with a crossbar, springs, washer(s) and double lock nuts. In addition to U-bolts, four (4) only steel lugs and pockets are to be installed; two (2) only at the front and two (2) only at the rear; to prevent lateral and longitudinal shifting of tank on chassis.

3.2 Tank body removable from chassis as a unit, lifting lugs provided and positioned so body is properly balanced for hoisting.

3.4 Installed to provide proper weight distribution between front and rear axles as recommended by chassis manufacturer.

4.0 CONSTRUCTION

4.1 All welded steel:

4.1.1 walls: ____________mm(__________inches)

4.1.2 end bells:____________mm(__________inches)

4.2 Round cross-section, overall width not to exceed width of cab.

4.3 Rear work step provided with open mesh, expanded metal surface. Step to be a minimum 30.48cm (12 inches) deep, extended width of tank body.

4.4 Hinged rear end bell or hinged manhole cover installed, minimum 81.28cm (32 inch) diameter. Installed with a re-usable gasket.

4.5 Float type water level guage visible from operator's position while filling. Float designed so as not to rest on tank bottom when tank is empty (to prevent freezing).

4.6 Storage trays for suction hose on side of tank body.

4.7 Hooks installed on side of tank for temporary storage of fully assembled suction hose.

4.7 Rear Bumper:

4.8.1 A rear bumper will be installed to protect the rear of the tank body;

4.8.2 The bumper must be constructed of 127.0mm (5 inch) channel iron;

4.8.3 The bumper must be as wide as the tank body and extend a minimum of 76.2mm (3 inches) beyond the controls protruding from the rear compartment excluding the rubber dock bumpers;

4.8.4 Four (4) rubber dock bumpers installed on the rear bumper.

4.8 Rear wheel fenders.

4.9 Mud flaps installed in front of and behind rear wheels.

5.0 VACUUM/PRESSURE PUMP

5.1 P.T.O.:

5.1.1 V-belt drive;

5.1.2 Angle gear drive.

5.2 Transmission P.T.O. drive:

5.2.1 STATE: Make: ____________________

5.2.2 Model: ____________________

5.2.3 RATED: ______kW(______HP) at ______RPM

5.3 Pump:

5.3.1 Vane type, rated 58.9 dm^3/S (125CFM) free air and up to 91.43kPa (27 inches) of Mercury Vacuum minimum.

5.3.1.1 STATE: Make: ____________________

5.3.1.2 Model: ____________________

5.3.1.2 Rated: ______kW(______HP) at______RPM

5.3.1.3.1 ______dm^3/s(______CFM)free air)

5.3.1.3.2 ______kPa (______INCHES) mercury vacuum

5.3.1.3.3 ______kPa (______PSI)pressure

5.4 Heavy duty universal joints with needle bearings.

5.5 Slip-join at P.T.O. end of shaft.

5.6 Heavy walled, 31.75mm (1.25 inches) minimum, steel tube drive shaft.

5.7 Drive train enclosed with approval guards if any component such as universal joints, drive belts or sheaves are accessible to operator.

5.8 Screw type adjustment provided for adjusting drive belt tension.

5.9 Pump gear case fill and drain plugs readily accessible for maintenance.

6.0 PIPING AND VALVES

6.1 Float type primary shut-off valve installed to prevent tank overflow into vacuum system.

6.2 Secondary water trap installed in vacuum line to prevent moisture being drawn into pump. Water trap equipped with sight glass.

6.3 Pressure safety valve, fixed at 103.42kPa (15 PSI).

6.4 Fill outlet:

6.4.1 Positioned on rear end bell, or manhole cover if so equipped, at a maximum height of 137.16cm (4.5 feet) above ground level.

6.4.2 Three (3) inch swing type check valve installed with female cap and keeper chain.

6.4.3 Lever operated, quick opening gate valve, three (3) inch pipe size.

6.4.4 Quick coupling, male hose adapter installed with female cap and keeper chain.

6.5 Discharge outlet:

6.5.1 Positioned adjacent to fill outlet on rear end bell, or manhole cover if so equipped.

6.5.2 To be six (6) inch pipe size.

6.5.3 Lever operated, quick opening gate valve, six (6) inch pipe size installed.

6.5.4 Quick coupling, male hose adapter installed with female cap and keeper chain.

6.6 All valves, adapters and piping of a type approved for water service.

6.7 Compound guage installed to be visible from pump operator's position.

6.7.1 Range: 101.59kPa (30 inches) of mercury vacuum to 344.74kPa (50PSI) of pressure minimum.

6.8 Flexible rubber hose coupled to pump exhaust/intake, discharging under tank body, away from operator. Hose end located as high above ground level as possible to prevent dust intake.

7.0 EQUIPMENT

7.1 Four (4) 2.44m (8 feet) lengths of three (3) inch suction hose equipped with quick couplers. Three (3) lengths to have one (1) female and one (1) male quick coupler, One (1) length to have female quick coupler both ends. Hose to remain flexible at -50°C (-58°F).

7.1.1 Make: Uniroyal

7.1.2 Style: P-1193

7.2 All quick couplers supplied for hose, discharge valve and fill valve, to be of the same make: EVERTITE, or compatible type.

7.2.1 STATE: Make:______________________

8.0 CONTROLS - POWER TAKE-OFF(P.T.O.)

8.1 Transmission mount;

8.1.2 Two gear, single speed, internal hydraulic shift. Constant mesh hot shifter;

8.1.3 Rated 11.93kW (16HP) at 800RPM output minimum;

8.1.4 Output rated at 75-80% of engine speed;

8.1.5 3-way remote shifting valve to be mounted on dash;

8.1.6 U-joint set screws to be counter sunk (Allen head type);

8.1.7 Slip join lube fitting to be removed and fitted with counter sunk Allen head pipe plug;

8.1.8 "P.T.O. ENGAGED" warning light in cab.

8.2 Truck tachometer labelled with maximum pumping RPM.

8.3 Valve control easily accessible;

8.4 Pump operating instructions to be printed on side of tank near operator's position. Use permanent type decal or engraved plastic or metal plaque. (DYMO TYPE EMBOSSED LABELS ARE NOT ACCEPTABLE).

9.0 ELECTRICAL

9.1 Armoured type clearance lights, tail lights, stop lights, turn signals and back-up lights installed.

9.2 Floodlight installed on rear of tank to illuminate rear work area. Switch installed convenient to operator, wired to operate only when vehicle lights are on.

9.3 Wiring equipped with trailer type disconnect between tank body and chassis to allow easy removal of body from chassis. Disconnect to be of the type with spring loaded weather cover.

9.4 All wiring covers to be SAE approved.

10.0 PAINT AND MARKINGS

10.1 Interior of tank coated with a rust and corrossive preventative material.

10.2 All surfaces fully primed before painting.

10.3 Finish coat to be white gloss enamel.

10.4 Wheel fenders painted to match cab, if separate from tank body.

11.0 GENERAL

11.1 Deviations from specifications are to be explained in full, accompanied by drawings/ sketches where applicable.

11.2 Unit to be designed and constructed for continuous or intermittant operation over ambient temperatures ranging from -50°C (-58°F) to +30°C (+86F).

11.3 The total weight of the tank body, associated equipment, load and chassis with fuel and operator, is not to exceed the Gross Vehicle Weight (GVW) rating of the chassis supplied, and the individual loads on front and rear axles are not to exceed the respective Gross Axle Weight Ratings (GAWR).

11.4 Unit is to be prepared for shipping by draining all water from tank and piping and by storing suction hose and chassis spare tire and wheel inside tank, and vacuum pump is to be filled with the correct grade of oil.

11.5 The following attachments form part of this specification:

11.5.1 Schedule 607-S1 - Weight Distribution

11.5.2 Schedule 607-S2 - Equipment Data

12.0 LITERATURE

12.1 All literature to be in English;

12.2 All literature to show vehicle fleet number;

12.3 Literature to be neatly bound;

12.4 Two (2) copies each of the following are required:

12.4.1 Parts Catalogue

12.4.2 Repair and Service Manual

12.4.3 Operation Manual

12.4.4 Equipment Data/Weight and Balance Sheet

12.4.5 Certified Test Data

12.5 Literature to apply to all installed equipment associated with tank body;

12.6 Mail both copies by **DOUBLE REGISTERED MAIL** to:

Head, Equipment Management,
Operations Division,
Department of Public Works
and Highways,
Government of the Northwest Territories,
Yellowknife, N.W.T.
X1A 2L9

13.0 WARRANTY

13.1 State terms of warranty when tendering.

APPROVED:

James Pierce,
Equipment Technical Officer,
Operations Division,
Department of Public Works
and Highways.

14.1 SCHEDULE 607-S1

WEIGHT DISTRIBUTION SHEET

14.1.1 - TANK CAPACITY:________LITRES (_______GALLONS)

14.1.2 - TANK MANUFACTURED BY:_________________________

14.1.3 CHASSIS INFORMATION

MAKE		PAYLOAD-FRONT	kg lb
MODEL		PAYLOAD-REAR	kg lb
GVW		TOTAL PAYLOAD	kg lb
GAWR-FRONT	kg lb	C.A.	cm in
GAWR-REAR	kg lb	W.B.	cm in
CURB WEIGHT-FRONT	kg lb	ENGINE	
CURB WEIGHT-REAR	kg lb	TRANSMISSION	
TOTAL CURB WEIGHT	kg lb	TRANSFER CASE	

14.1.4 WEIGHT DISTRIBUTION TABLE

	AXLE LOAD					
	Front		Rear		Total	
	kg	lbs	kg	lbs	kg	lbs
CAB & CHASSIS						
TANK & EQUIPMENT						
LOAD @1 KG (10lbs/Gal)						
TOTALS:						

14.1.5 REMARKS

____

____

14.1.6 PREPARED BY: ________________________ DATED:__________

14.2 SCHEDULE 607-S2

VACUUM INDUCTOR SEWAGE TANK BODY

EQUIPMENT DATA

14.2.1 - TANK CAPACITY:__________LITRES (_________GALLONS)

14.2.2 - TANK MANUFACTURED BY:______________________________

14.2.3

PART	MAKE SIZE/MODEL/PART #
P.T.O.	
U-JOINT (front)	
U-JOINT (rear)	
DRIVE SHAFT	
JACK SHAFT	
PILLOW BLOCKS	
SHEAVES-DRIVE	
SHEAVES-DRIVEN	
V-BELTS	
VACUUM PUMP	
FILL VALVE - 3"	
CHECK VALVE - 3"	
DISCHARGE VALVE - 6"	
MALE COUPLER - 3"	
FEMALE COUPLER - 3"	
DUST CAP - 3"	
MALE COUPLER - 6"	

VACUUM INDUCTOR SEWAGE TANK BODY

EQUIPMENT DATA - Continued:

14.2.4

PART	MAKE	SIZE/MODEL/PART #
FEMALE COUPLER - 6"		
DUST CAP - 6"		
SUCTION HOSE		
LEVEL GAUGE		
FLOOD LIGHT - FIXTURE		
FLOOD LIGHT - LAMP		
COMPOUND GAUGE		
SHEAVES-DRIVEN		

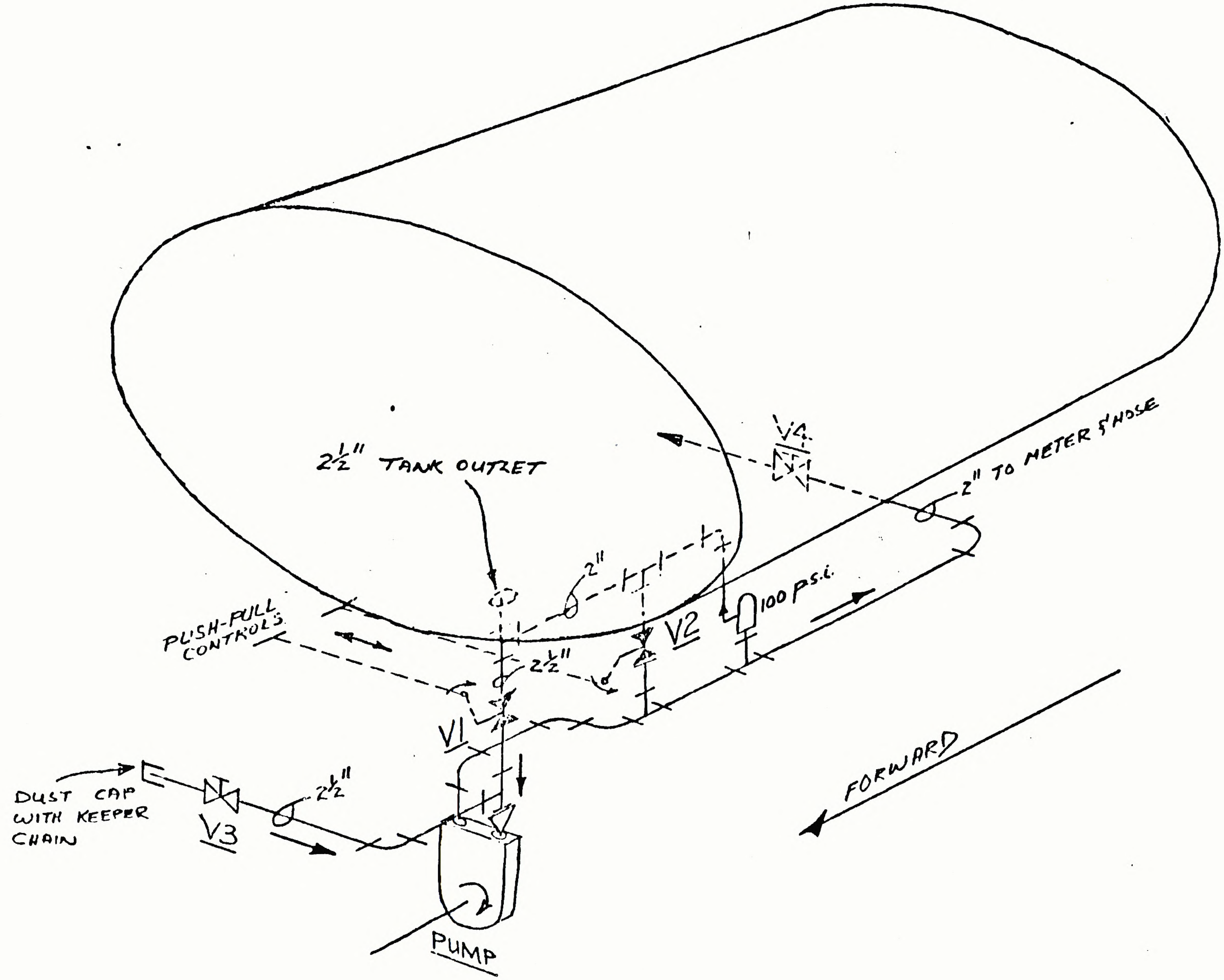
14.2.4.1 NOTE:

Equipment Data Sheets to be completed and included in Parts Manual. DO NOT COMPLETE WHEN TENDERING.

14.2.5

DATA SHEET PREPARED BY:____________________

____________________ DATED:__________


2½" TANK OUTLET
V4
2" TO METER & HOSE
2"
V2
100 psi
PUSH-PULL CONTROLS
2½"
V1
DUST CAP WITH KEEPER CHAIN
V3
2½"
PUMP
FORWARD

ANNEX J

ANNEX J

PART 1 - GENERAL

1.1 Work Included

.1 Provide all labour, materials and equipment for the work, including but not limited to:

- fine grading of side slopes
- placing of granular liner bedding
- placing of reservoir liner
- placing of granular liner protection
- installation of overflow

1.2 Related Work

- Excavation & embankment Reservoir	Section 02162
- Excavation and Berming, Ditches	Section 02164
- Filler pipe	Section 02410
- Subdrains	Section 02411
- Fencing	Section 02468

1.3 Quality Standards and Assurances

.1 Products, workmanship and testing shall conform to standards specified in this section.

.2 All products and workmanship will be inspected by the Engineer.

.3 Perform all tests required by the specification and by authorities having jurisdiction.

.4 Notify the Engineer and authorities in ample time before testing to permit inspection and allow tests to be witnessed.

.5 Do not cover any work before inspection and testing unless authorized by the Engineer in writing.

.6 Remove or repair defective products or work which fails to meet specified requirements as directed by Engineer, at no additional cost to Owner.

1.4 Examination

.1 Examine drawings and visit site to determine existing conditions. No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.2 Examine previously constructed work. Notify Engineer in writing of any conditions which may prejudice proper completion of this work. Commencement of work implies acceptance of existing conditions.

1.5 Elevations and Lines

.1 Reference points for elevations and lines will be set by the Engineer. Establish all other required lines and grades from the Engineer's reference points.

.2 One set only of reference points will be established for any one stretch of line.

.3 Do not disturb reference points. Pay for re-setting if displaced or removed.

.4 Give forty-eight (48) hours notice of need for reference points and ensure that line for reference points has been cleared.

.5 Supply all stakes, batter boards, pins, templates, etc. required for the work.

.6 Be satisfied as to the meaning and correctness of all reference points. Discontinue work and advise Engineer immediately if any error is suspected in drawings, specifications, reference points, grade sheets, etc.

1.6 Protection

.1 Protect all monuments, bench marks, stakes and lines located on site. Protect existing structures, services and appurtenances.

.2 Repair or replace items damaged by this work to Engineer's approval at no extra cost to Owner.

1.7 Co-operation

.1 Co-operate with other trades and other contractors to reduce interference with other work.

PART 2 - MATERIALS

2.1 Granular Bedding and Liner Protection

.1 Sand or a well graded mixture of sand and gravel, containing no particles larger than 6 mm with not more than 12% by weight passing the 75 um sieve.

The material shall be free of organic material or other debris.

.2 Coarse gravel is the designations of the materials remaining after the screening of the native material to obtain the granular material specified in Section 1 above.

.3 Pit run material is the material as excavated from the reservoir or as obtained from the Hamlet pit. This material shall be free of rocks larger than 150 mm in diameter.

2.2 High Density Polyethylene Liner

.1 The liner material shall be 80 mil unsupported high density polyethylene membrane. The liner shall be manufactured of new materials, designed and manufactured specifically for storage of potable water.

.2 Raw materials shall be tested prior to manufacturing and shall include density (ASTM D1505-68)) Melt Index (ASTM D1238-79 Procedure A, Condition P) Tests.

.3 Samples of the production run shall be taken and tested according to ASTM D638.82 to ensure that tensile strength at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

3 random samples shall be taken from the rolls upon delivery to the site. The samples shall be tested to ASTM D638.82 by an independent testing agency.

2.2 High Density Polyethylene Liner (Continued)

.4 All welding material shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers - each with a legible label bearing the brand name, manufacturer's mark number, and complete directions as to proper storage.

.5 The liner material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any such defect shall be repaired using the extrudate welding technique in accordance with the manufacturer's recommendations.

.6 The lining material shall be manufactured to a minimum 6 metre seamless width. Labels on the roll shall identify the thickness, length, width, and manufacturer's mark number.

.7 The manufacturer of the lining material described shall demonstrate his ability to produce this membrane by having successfully manufactured a minimum of .5 million square metres of similar liner material for hydraulic lining installations.

.8 The material shall be as manufactured by Gundle Lining Systems Ltd. or approved equal.

2.3 High Density Polyethylene Overflow Culverts

.1 The pipe shall be made from polyethylene resin compound qualified as Type III, Class C, Category 5, Grade P34 in ASTM D 1248. The minimum density of the base resin shall be 0.941 as determined by ASTM standard procedure for the measurement of density D792, Method B.

.2 The pipe shall be made from polyethylene resin compound as described in CGSB 41-GP-25M. This material shall have a hydrostatic design basis when tested and analysed by ASTM standard Method D 2837 of not less than 10.0 MPa (1450 psi)Table 1 of that standard not withstanding.

.3 The raw material shall contain carbon-black and an effective antioxidant as required by CSA Specification B137.1.

.4 The pipe and fittings shall contain no recycled compound except that generated in the manufacturers own plant from resin of the same specification from the same raw material supplier.

.5 The material shall be Sclairpipe as manufactured by Dupont Canada Inc. or approved equal

2.4 Gabions

.1 For Gabion Specifications, refer to Section 02164-2.6

PART 3 - EXECUTION

3.1 Subgrade

.1 The reservoir floor and slopes shall be graded and rolled just prior to placing the granular bedding. All stones larger than 150 mm shall be removed and the voids backfilled with select fill material.

3.2 Bedding

.1 A 300 mm granular bedding shall be compacted to 95% Standard Proctor Density and graded to the satisfaction of the Engineer and the liner installer. The bedding shall be smooth and free of all rocks, stones, roots, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed. The installation contractor shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

.2 Acceptance by the liner installer of the surface for laying the lining upon shall not constitute acceptance or approval of the subsurface conditions which could affect the functioning of the system, reservoir or liner which shall continue to be the responsibility of the General Contractor. The structural integrity of the work is the sole responsibility of the General Contractor.

3.3 H. D. Polyethylene Liner

.1 The liner shall be installed under the direct supervision of the manufacturer. The welding of the material shall be carried out by employees of the manufacturer. The manufacturer shall certify that all staff members used on the project are qualified and trained in the operation of the welding equipment.

3.3 Polyethylene Liner (Continued)

.2 Individual panels of liner material shall be laid out and overlapped by a minimum of 50 millimetres prior to welding. Extreme care shall be taken by the installer in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to the procedures laid down by the material manufacturer. All sheeting shall be welded together by means of a HOMOGENEOUS overlap EXTRUSION FUSION process which provides CONTINUOUS DYNAMIC INTEGRATION of the EXTRUDATE BEAD with the lining material. THE COMPOSITION OF THE EXTRUDATE shall be identical to the lining material.

.3 The welding equipment shall be capable of CONTINUOUSLY MONITORING and CONTROLLING THE TEMPERATURES of the EXTRUDATE and the zone of contact where the machine is actually fusing the lining material so as to ensure changes in environmental conditions will not affect the integrity of the weld. Only welding systems which utilize the extrusion process shall be used for bonding these lining materials.

.4 A minimum of two welding machines with qualified operators shall be used on the project. If, in the opinion of the Engineer the progress is too slow, additional staff shall be provided to operate the machines on a shift basis.

.5 No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap-extrusion weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of H.D.P.E. membrane.

3.3 Polyethylene Liner (Continued)

6. The installer shall employ on-site physical non-destructive testing on all welds to ensure watertight homogeneous seams.

A quality-control technician shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with the manufacturer's repair procedures.

A test weld 1 metre long from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld 7 to 15 mm wide shall be cut from the test weld and pulled in shear and peel. Seams should be stronger than the material. The weld sample shall be kept for subsequent testing by an approved laboratory.

The Owner reserves the right to test the field seams using destructive test methods including peel testing method D 1876 and shear testing - Method A of Method D 882 from samples cut from the installed liner. Random weld samples may be removed from the installed welded sheeting at a frequency of one sample for each 400 m of weld. The contractor shall patch the resultant hole with an oval shaped piece of sheet material and seam in accordance with the specifications. The cost for this shall be included in the price for the liner.

Each sample may be tested to determine the four parameters listed below. The acceptance criteria for each parameter is noted.

1. Shear Strength - Greater than 80-90 percent tensile yield strength of membrane.

2. Shear Elongation - Greater than 50-100 percent of single membrane length between grips.

3. Peel Strength - Greater than 80 percent tensile yield strength of membrane.

4. Peel Separation - Greater than 25 percent fused interface length followed by membrane failure.

Five shear/peel pairs will be tested from each sample. The cutout samples will be rejected if from the five shear/peel pairs tested:

One or more pairs fail due to peel separation.

One or more pairs fail due to low elongation.

One pair has low peel strength within a defined range and the two speciments on each side of it do not exceed the specified minimum peel strength: or

Two pairs have low peel strength within a different defined range and the mean of all five does not exceed the specified minimum peel strength.

The Contractor shall pay for any subsequent testing and corrective action as a result of the failure of any sample to meet these criteria.

The Owner also reserves the right to use ultrasonic (non-destructive) tests on the field seams.

.7 All seams shall be vacuum tested. A glass faced suction box 1 to 2 metres long and wide enough to cover the seam, shall be pulled along the seam which has been thoroughly wetted with a soap solution. A negative pressure of 10 to 15 psf shall be induced on the seam. At locations along the seam where bubbles are formed, repair shall be carried out. All repairs shall be retested.

.8 The method of fabrication and sealing of the liner around the subdrain cleanouts to be discussed at a site meeting. No work on these items will be allowed until the construction method is approved by the Engineer in writing.

3.4 Liner Protection

.1 Upon successful testing of the liner installation, a 300 mm screened granular layer shall be placed over the liner.

.2 A 300 mm layer of coarse gravel shall be placed over the 300 mm granular liner protection material. The gravel is to be placed starting at the top of the liner and shall extend down the slope as far as the available quantity of material allows.

3.4 Liner Protection (Cont'd)

.3 The remainder of the slope is to be covered with 300 mm of pit run gravel. This layer is to be placed over the 300 mm granular liner protection material.

3.5 Overflow and Filler Trough

.1 The trough shall be constructed as detailed. The trough liner material shall be identical to the reservoir liner.

PART 4 - MEASUREMENT FOR PAYMENT

4.1 Reservoir Liner

.1 The liner material shall be paid for on a square metre basis as installed. There shall be no claim allowed for wastage, extra material or restocking of material. The contract price shall be full compensation for all labour, materials and equipment and shall include all testing and repairs.

.2 Sealing around cleanouts shall be as per the contract unit price. This price shall include all liner material, labour, welding equipment and supplies required to make and seal the patch around the intake.

4.2 Granular Bedding and Liner Protection

.1 The granular material shall be paid for on the unit price basis, installed in place. It shall be full compensation for labour, equipment, and materials and shall include but not be limited to screening, raking, shaping and compacting.

4.3 Filling and Overflow Trough

.1 The price bid for this item shall be full compensation for constructing the trough up to the ditch at the outside edge of the reservoir berm. It shall include all labour, equipment and materials to construct the trough complete as detailed, including the overflow culverts and 300 mm filler pipe outfall and gabions.

4.4 Spare Reservoir Liner Material

.1 All surplus liner material shall be turned over to the Owner. The minimum quantity of material to be supplied to the Owner for future repairs shall be 200 m^2. The cost for the surplus material shall be included in the price for the liner.

PART 5 - WARRANTY

.1 The manufacturer shall provide a written warranty stating that the liner materials and workmanship specifically provided or performed under this project shall be free from any defects for a period of two years. Said warranty shall apply to normal use and service by the owner. Such written warranty shall provide for the total and complete repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the owner of the specific non-conformance of the lining material or installation with the project specifications. Such defects or non-conformance shall be repaired or replaced within a reasonable period of time at no cost to the owner.

ANNEX K

ANNEX K

TRIP REPORT : Key Lakes Mine Site, Saskatchewan

DATE : Friday, November 15, 1985

PARTICIPANTS:	Reg Andres	DPW&H, Gov't. of the NWT
	Bill Blakeston	DPW&H, Gov't. of the NWT
	Bruce Smith	Thurber Consultants, Calgary
	Bob Boon	Reid Crowther , Yellowknife
	Bill Notenboom	F.J. Reinders, Brampton
	James Cramer	Installation Supervisor,Nilex, Edm.
HOSTS :	Bernie Rosner	Engineering Manager, Saskatoon
	Josef Spross	Operations Manager, Saskatoon

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*** PREFACE ***

During the design of the reservoir in Pangnirtung in 1984 a number of details related to the lining of the excavation were the subject of significant discussion and differences of opinion.

eg.
- liner material selection
- cover over the liner vs. no cover
- the affect of ice on the liner
- the affect of wind on the liner
- the affect of wave action on the liner cover
- the slopes of the embankment
- etc.

Decisions for the design were taken based on these discussions and the details were put together on the best assessment of the various influencing factors.
A search of existing installations that best resembled the the proposed reservoir in Pangnirtung identified the Key Lakes mine site where a series of water handling ponds had been built in 1983. The climatic conditions of this site in northern Saskatchewan comes closest to the climatic conditions expected in Pangnirtung and where a pond lined with HDPE has been installed.

The design of the Pangnirtung reservoir was completed without a visit to the Key Lakes site. This year the GNWT is involved in the design development of 2 more reservoirs (ie. Pond Inlet and Eskimo Point) and the same questions are being brought forward that had been discussed during the Pangnirtung design. In order to gain a better degree of confidence in these design decisions and to ensure the best approach in terms of capital expenditures, O&M considerations, etc. it was felt a trip to the Key Lakes site would be valuable at this time.

RELATED PROJECTS AND PROJECT TEAM MEMBERS

Pangnirtung Water Reservoir :

Design consultant - F.J.Reinders and Associates (Bill Notenboom)

Geotechnical consultant - Thurber Consultants (Bruce Smith)

DPW&H Project Engineer - Reg Andres

Eskimo Point Reservoir :

Design consultant - Reid Crowther & Partners (Bob Boon)

Geotechnical consultant - Thurber Consultants (Bruce Smith)

DPW&H Project Engineer - Bill Blakeston

Pond Inlet Reservoir :

Design consultant - Reid Crowther & Partners (Bob Boon)

Geotechnical consultant - Thurber Consultants (Bruce Smith)

DPW&H Project Engineer - Reg Andres

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1. Summary of Trip Schedule :

14 November 1985 - participants arrive in Saskatoon, Sask.

15 November 1985 - 0830 Athabaska Airlines Hanger
- 0900 depart for Key Lakes mine site with mining company representative Dr. Bernie Rosner, Engineering Manager
- 1030 arrival at Key Lake site and drive to plant offices
- meet with Joe Spross, P.Eng., Operations Manager to review design and operation of their ponds
- 1130 tour of the various ponds around the mine site with discussions about their design and comparisons with the proposed reservoirs in the N.W.T.
- 1300 return to cafeteria for lunch with J. Spross, B. Rosner and the mine company president, John Nightingale.
- 1430 departure from mine site with J. Nightingale and J. Spross.
- 1600 arrival in Saskatoon where discussions continued as to what was learned on the trip in relation to the designs for the reservoirs in Pond Inlet, Pangnirtung and Eskimo Point while waiting for the various flights of the participants.

2. Information from Joe Spross about the ponds in Key Lake:
- the largest pond has a capacity of approximately 120,000 c.m
- the next largest pond is about 80,000 c.m. in size
- these ponds are about 3-4 m in depth (base to water level)

- there are 5 smaller ponds which are used for holding the processed water for final testing prior to release to the environment. The water level in these ponds is always changing and therefore these small ponds are not susceptible to icing and related ice damage like the larger ponds.
- the larger ponds contain collected groundwater and process water from the plant that is re-cycled through the plant. The water is treated in the plant prior to discharge into one of the 5 polishing ponds for a flow through system.
- all the ponds are lined with 100 mil HDPE installed by Schlegel Lining Systems of Housten, Texas.
- the pond side slopes are 2.5:1 with foundation materials of sands and gravels. No permafrost - some ice lenses.
- the ponds were initially constructed in 1982 with an exposed "Hypalon" liner. By 1983 this liner had deteriorated to the point that that the company decided to replace it with the 100 mil HDPE.
- the ponds were relined in 1983 and are now into their 3rd winter of operation.
- in their first winter of operation they experienced a major problem when the water level exceeded the max. HWL and caused a breach in the embankment. Because of the the inter-relationship of the two large ponds, the operations staff cut the HDPE liner in the cell that was not originally breached to allow equalization of the water levels to save the second cell. The failure was not attributed to a failure of the HDPE liner.
- the pond started the first winter full of water. It was operated such that water was slowly drawn down over the winter. As the water was drawn down the ice began to depress in the centre while it froze on to the side walls. When the water level dropped suddenly due the the failure the ice broke leaving a ring of ice approx. 0.8 - 1 m in thickness hanging to the perimeter of the liner. In order to carry out repairs the hanging ice was freed from the side walls by steam. Large chunks of ice were cut loose and these slid down the HDPE liner to the bottom of the reservoir. As the ice slid, it caught the folds in the liner and cut the liner like a knife. These slits in the liner were easily repaired in the field.
- the next season the water level was left up in the ponds to prevent the ice damage again. Floating ice has not been a problem.

3. During the day a number of opinions were expressed by the Key Lake's staff with regards to the the design,operation and mainteneance of the ponds as it impacts on the reservoirs being planned for the N.W.T. . The following are some of the opinions and observations noted:

3.1 HDPE is a good material to use. The ponds in Key Lake were originally lined with "Hypalon" and this material was considered a failure before it even went into service. It was , therefore, replaced with HDPE within a year of the initial installation.

3.2 Wind uplift has not been a problem on the uncovered liner.

3.3 Ice damage will be problem if the water level is lowered over the winter. The process of damage is described as above.

3.4 Vents were installed at the top of their liner for the escape of gases. They have not had a problem with the liner lifting due to entrapped air, etc.

3.5 The material is extremely slippery. As soon as the liner is installed the pond needs to fenced. They had problems with animals getting into the pond and not being able to get out. It could be dangerous for people if they accidently slid into the hole.

3.6 A liner on a 3:1 slope would probably not be able to hold a soil cover because it is so slippery.

3.7 One of the water containment ponds has been lined with HDPE supplied and installed by Columbia while the main processed water ponds have been lined with HDPE supplied and installed by Schlegel. The Columbia system was less expensive but they had some difficulties with failures in some of the welded joints. It had not been a major difficulty, but the opinion was expressed that depending on the sensitivity or critical nature of the integrity of the water containment requirements, the less expensive system had merit for certain installations where potential O&M costs for repairs were justified by the major capital savings. The quality control of the Schlegel system was clearly superior to the other system experienced.

(N.B. The difference in the basic approach to expenditures by private industry vs. government was noted. For private industry it makes good sense to keep initial capital cost to a minimum. Once the industry is in operation and a positive cash flow is established, a higher O&M cost or even complete replacement can be justified. This is an in house, private decision with no input from the general public. For government projects, high quality installations with associated higher capital costs are generally required since any repair costs or replacements required beyond normally expected O&M costs within the design life expectancy will be considered as poor workmanship or inadequate design.)

4. Design Considerations

In light of all the discussions and observations made during this trip and in consideration of the work that has already gone into the design of the reservoir facilities in the N.W.T., the following discussion on the factors affecting the design of the reservoirs and in particular the lining systems is noted.

a) Ice Damage - the processes involved in damage of the liners by ice has been made clearer. Although floating ice should not be ignored, it would appear it does not pose as much of a problem as built up ice that freezes onto the edges of the lining material and subsequently slides down the lined reservoir walls when thawing temperatures free the ice hanging on the liner and the water level in the reservoir has been lowered.

This becomes a problem when there has been sufficient drawdown of the reservoir over the winter months to cause the loss of the buoyancy support of the water to support the ice which will then crack and break under forces of its own weight. Experience shows the break takes place near the water line leaving a rim of ice frozen to the liner on the reservoir wall.

Soil cover over the liner would effectively eliminate damage to the liner from this mechanism. Soil cover can, however, be a costly item in terms of initial capital for installation and usually will require some maintenance over the life of the facility due to erosion.

b) Wind Uplift

This factor relates to the displacement of the liner material from its bedding as a result of the negative forces exerted on the surface of the liner by high winds.

This becomes a concern when the negative top forces exceed the forces holding the liner in place such as the weight of the liner, opposing air pressure under the liner, mechanical hold down mechanisms built into the design, etc.

This factor is downplyed by the suppliers but a calculation of the impact the high winds experienced in Pangnirtung would have on the liner was a key factor in deciding to cover the liner for this installation.

This factor should be considered for each installation based on the expected winds in the area and the risks and probabilities of damage due to wind action in deciding the amount of consideration to be given to it in the design details of the lining system.

Two methods of protecting against the problems related to wind action are -soil cover

-key in overlapping material at joints

c) Side Slopes

It has become apparent the slopes on which a lining is to be installed will be a factor in the selection of the lining material and the ablility to put a soil cover over the liner. HDPE has a very "slippery" surface which limits the slope on which a soil cover can be placed.

The Nilex representative has confirmed the information calculated and tested by the consultants that soil cover cannot be placed on HDPE that is on a 3:1 side slope.

Other liner materials such as "Hypalon", CPE, PVC, etc. are not as sensitive as HDPE with regards to the slopes on which soil cover can be placed. A 3:1 side slope with these other materials has a sufficient factor of safety against slippage of soil cover that this steeper slope may be successfully covered. A slope of at least 3.5 or

4:1 must be used with HDPE.
The selection of the side slopes will be affected by soil conditions of the site (eg. in Pangnirtung, the high ice content of the silty soils and the inherent internal angle of friction of the soils resulted in the recommended 4:1 side slopes by the soils consultant), expected quality control of compaction on the site during construction, etc.. In addition now, the consideration of liner materials and covering capabilities will be included in the selection of the most appropriate side slopes.

d) Soil Cover vs No Soil Cover
The question of whether a liner should be covered or not is a design detail that is dependent on the various factors noted earlier and requires careful consideration because of the high cost of covering a liner and the potential for equally high costs in damaged liner .
The obvious cost involved in covering a reservoir liner must be weighed against the risks of damage and shorter life span for any uncovered liner.
The final decision will be based on an overview of all the factors with the best compromise of the opposing conditions that dictate the use of a liner cover or not.

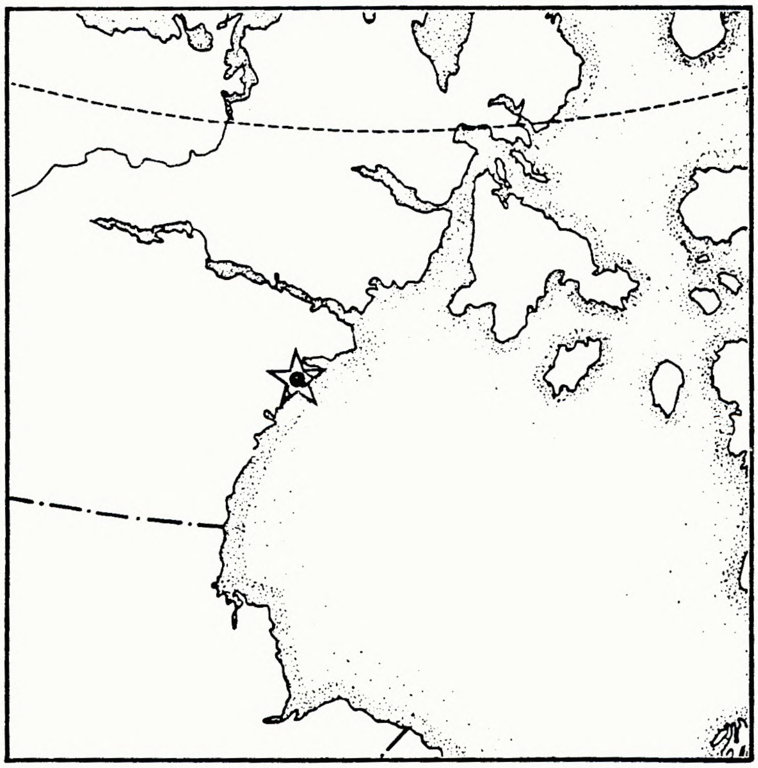
e) Liner Material
The choice of liner materials is a complex decision that is affected by numerous factors, often site specific.
Consideration of liner materials should include the following which is not necesarrily an exhaustive list but generally covers the concerns raised in the most recent reservoirs in the N.W.T. :

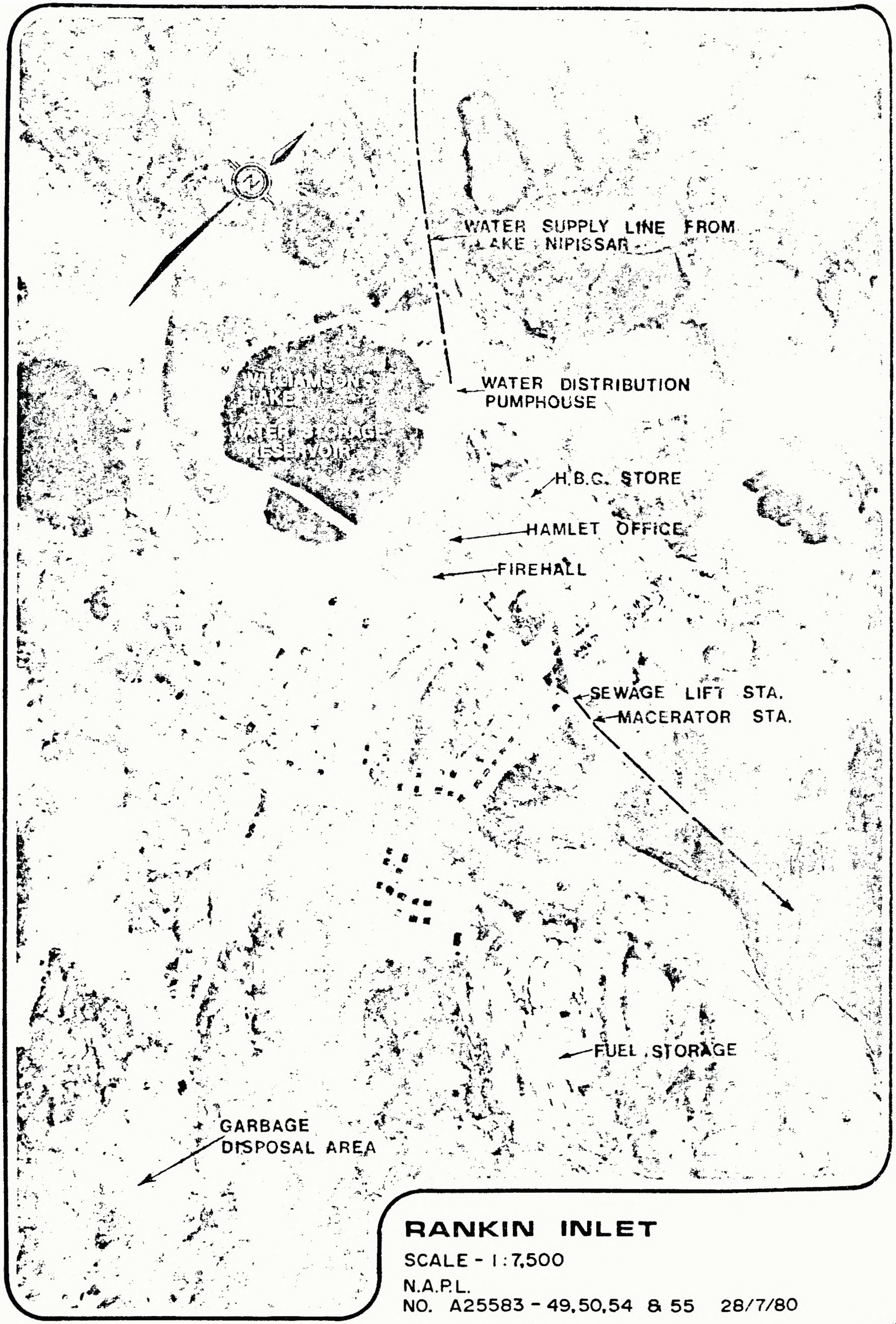
- cost of materials
- cost of transportation of materials
- quality control of manufacturing processes
- retention of physical properties in cold conditions
- retention of physical properties over time
- factors affecting physical properties (eg UV deterioration)
- ability of material to withstand differential movements (ie strength and stretch properties)
- ease of overall installation process
- ease and reliability of jointing system
- quality control of jointing process
- ease of making repairs
- history of performance

ANNEX L

ANNEX L

Rankin Inlet





RANKIN INLET

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N.A.P.L.
NO. A25583 - 49,50,54 & 55 28/7/80

A. GENERAL

A.1 Location

Rankin Inlet is located in a bay on the west coast of Hudson's Bay about 96 air km southwest of Chesterfield Inlet, and 1088 air km east of Yellowknife. The geographical co-ordinates of the community are 62°49'N latitude and 92°05'W longitude.

A.2 History

Inuit families have inhabited the bay area around Rankin Inlet for many years. The community proper was established as a result of North Rankin Nickel Mines Ltd., which came into production in 1957. Until the mine closed in 1962, a wage economy was the basis of the settlement.

During the past years the establishment of a cannery, arts and crafts facilities and a program of natural resource harvesting has assisted in creating a viable settlement.

A.3 Community Information

Rankin Inlet achieved Hamlet status on April 19, 1975. The community population appears to be relatively stable as shown by the following figures:

POPULATION	YEAR
978	1978
956	1979
1007	1980

The economy of the community was formerly based on wages from mining. Most of the non-Eskimo people are employed by various governmental agencies. Territorial Government offices for the Keewatin District were set up in Rankin. The harvest of natural resources and arts and crafts activities also contribute to the employment of people in the community.

A 1500 meter airstrip serves the community.

A.4 Geology and Terrain

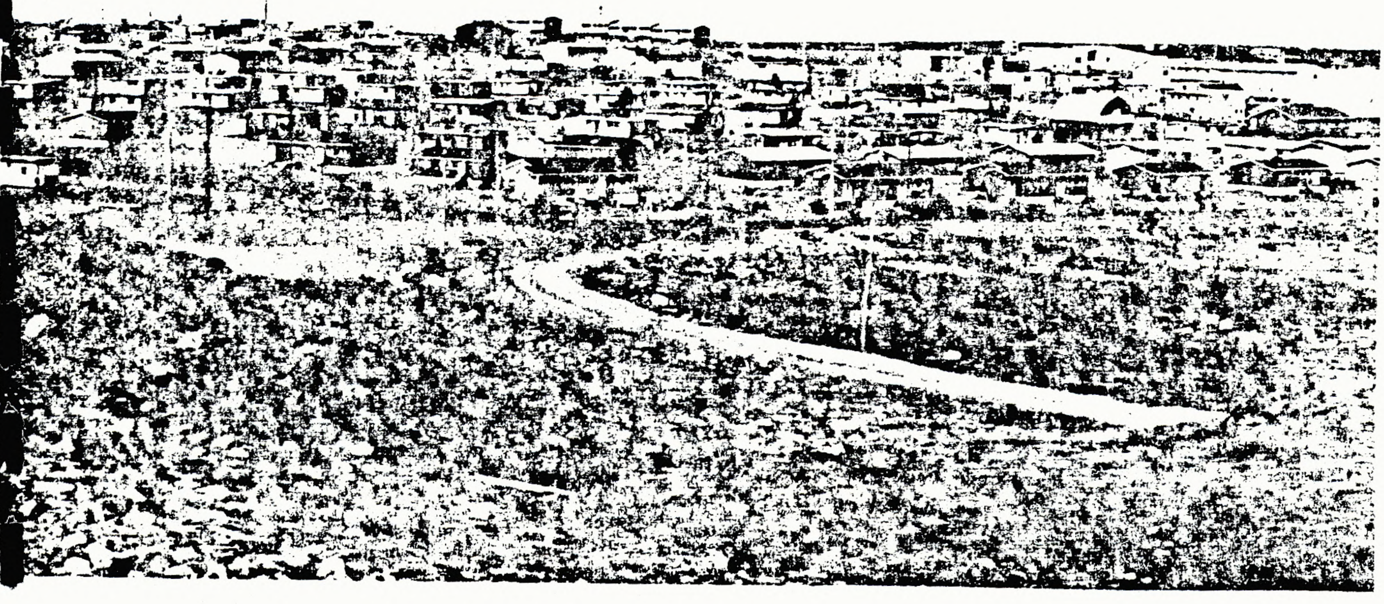
The surface material in the immediate vicinity of Rankin Inlet consists of exposed Precambrian Rock and various types of re-worked ground moraine, notably marine terraces. Material around the community is a mixture of organic material and fines. Numerous eskers close to the community can provide good sources of granular materials. The shoreline consists of recently deposited sands and silts. The active layer of permafrost is very shallow, extending to about 0.3 m below the ground surface.

A.5 Vegetation

Tundra vegetation is typical of the area. Hardy grasses grow in most of the soil covered areas while the rock outcrops support lichens. Clusters of small willow bushes grow in well sheltered locations.

A.6 Climate

The mean July high and low temperatures are 13.1°C and 4.5°C respectively. The mean January



Servicing

high and low temperatures are -27.9°C and -35.2°C respectively. Annual precipitation consists of 160.3 mm rainfall and 1181.1 mm snowfall. The prevailing winds are northerly at 20 km per hour.

B. MUNICIPAL SERVICES

B.1 Water Supply

B.1.1 Source

The source of water for the community is Nipissar Lake situated about 2 km northwest of the Townsite. It has a surface area of about 1 km² and has depths of up to 6 m.

The quality of water is excellent for domestic purposes as shown by the following chemical analysis: (All values in mg/l unless otherwise noted)

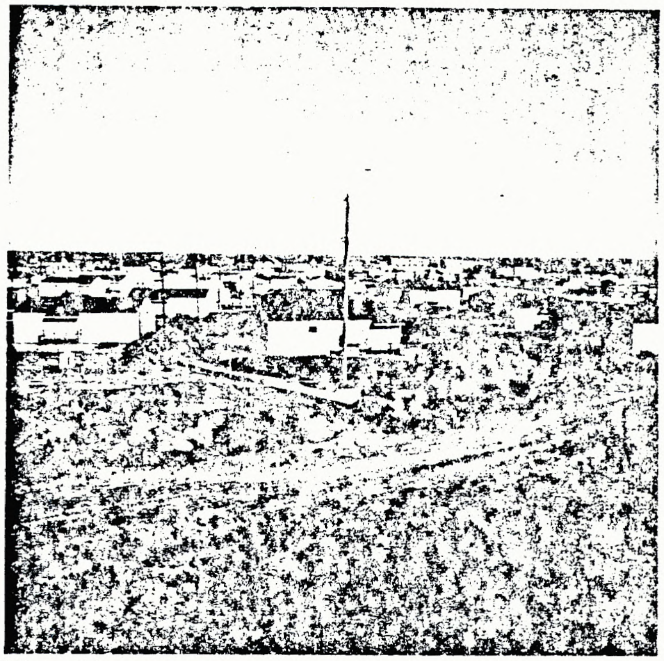
Parameter	Value
pH	7.1
Specific Conductance	238 umho/cm
Turbidity	3.3 JTU
Calcium (Ca)	20.0
Hardness ($CaCO_3$)	79.0
Alkalinity ($CaCO_3$)	60.3
Sodium (Na)	23.5
Chloride (Cl)	40.0

(sampled by DIAND Water Resources July 15, 1977)

B.1.2 Intake Facilities

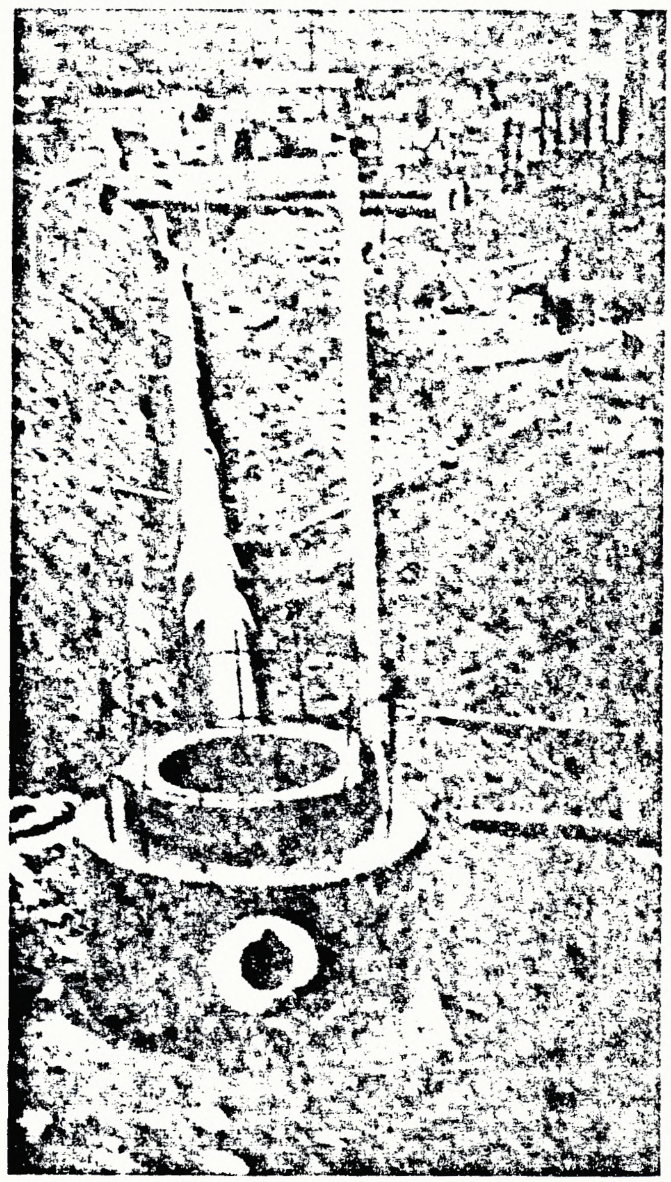
A suction type intake with foot valves is located at Nipissar Lake. The intake suction lines are installed inside insulated heated casings. The casings are heat traced and are also heated by hot water as a back-up system.

Two raw water submersible pumps each with a capacity of 12.7 L/s @ 328 kPa (167 igpm @ 110' TDH)



View of housing and servicing

HDPE sewer and manhole construction (1976)



Water is pumped through a 150 mm diameter transmission main to the treatment station with a 100 mm heating line. Specifications are as follows:

Length:	1830 m
Type:	Series 125 Dupont HDPE Sclair-pipe
Insulation:	Rigid Urethane foam, 60 mm thick on 150 mm pipe, 30 mm thick on 100 mm pipe

B.1.3 Storage
Water is stored in the Williamson Reservoir adjacent to the Town. It has a capacity of 286 x 10^8L when full and a catchment area of 14 ha (35 acres). This reservoir was designed to supply the community's winter needs and to supply peak domestic and fire demands.

B.1.4 Pumping Facilities
Intake and pumping facilities at the Lake Williamson Pumphouse consists of a gravity intake and wetwell system with vertical turbine pumps. Four pumps are installed in two wetwells and have a capacity of 25 L/s at 597 kPa (333 IGPM @ 200' TDH). Motors are 30 HP electric. This system is sized to provide for the maximum daily demand in 1989 plus 80 L/s (1050 IGPM) fire flow.

Four pairs of pumps circulate water, heating in a heat exchanger, to the 75 mm heating line running to Nipissar Lake.

Pump specifications are as follows:

Capacity:	2.8 L/s @ 209 kPa (50 IGPM @ 70' TDH)
Motor:	3 HP, 1750 RPM, 575 Volt, 3-phase, 60 cycle

B.1.5 Treatment
Treatment facilities in the pumphouse consists of two V-notch Wallace & Tiernan gaseous chlorinators located in the Nipissar Pumping Station.

B.2 Water Distribution
B.2.1 Piped System
The Williamson's Lake Pumphouse contains circulation pumps, a hot water boiler, chlorination equipment, a diesel standby generator, valves and controls. Four pumps supply water to the distribution mains for the maximum hour demands and a fire flow of 80 L/s. The piped water system consists of older utilidors and newer buried mains.

The utilidors consist of 150 mm P.V.C. water lines housed with 150 mm P.V.C. sewer mains in a 600 mm galvanized corrugated metal pipe. The utilidor is covered by 50 mm of urethane insulation and is shallow buried. Heating cables are not provided. Sewer mains are shallow buried to a depth of about 1 m. They consist of HDPE pipe with 50 mm to 75 mm of urethane insulation. Most of the lines are 200 mm in diameter. The primary heating system is provided by the continuous flow of heated water. Emergency heating is provided by thaw tubes.

Service connections to buildings consist of two 25 mm series 160 polyethylene water pipes for a recirculating water service and a 25 mm polyethylene heating cable conduit with a 13 W/m heating cable. A 100 mm series 60 polyethylene sewer line is also attached. This bundle of pipe is insulated by 75 mm of urethane.

B.2.2 Trucked System
Buildings not connected to the circulation system receive water by truck delivery system. Delivery is handled by the Hissarvik Co-Op. Water delivery is provided 5 days a week.

B.3 Sewage Collection
B.3.1 Piped System
The buildings connected to the utilidor and buried mains are served by 150 mm P.V.C. line in the utilidors, and by 150 mm HDPE insulation lines in the buried mains.

B.3.2 Bagged Sewage Pick-Up
All of the housing units not serviced by the utilidor or buried mains are equipped with chemical toilets utilizing polyethylene disposable containers. The bagged sewage is collected by truck in conjunction with garbage collection, and disposal is in the solid waste landfill.

B.4 Sewage Disposal
A macerator is located at the eastern edge of the community by the shore. A 250 mm diameter outfall extends 425 m into the ocean. The outfall is insulated by 25 mm of urethane foam. The macerator is manufactured by Chittenden and Howard Ltd. and is capable of handling up to 35 L/s (460 IGPM).

B.5 Solid Waste
B.5.1 Collection
Refuse is deposited in 205 L drums located in front of the housing units for pick-up by truck on a regular basis. Plastic sewage bags are generally placed on the ground beside the drums.

B.5.2 Disposal
The garbage dump is located about 1 km to the south of the settlement in an area of till material. Garbage is regularly burned and covered. The present site is well situated from the point of view of distance from the settlement, prevailing winds and surface drainage. Larger solid wastes such as metals are separated from the rest of the garbage material.

B.6 Roads
The majority of the roads in the Town are adequate for the present traffic being carried.

B.7 Surface Drainage
Site drainage is relatively good with a strong pattern directly east to the bay and also to the north and

south to stream systems also leading to the bay. Wet surface conditions throughout the summer occur due to permafrost conditions. Seepage losses from Williamson's Lake Reservoir cause severe site drainage difficulties, particularly during the early winter.

B.8 Fire Protection

Fire protection in Rankin Inlet consists of the following:

- multi-zone system consisting of call boxes connected to an annunciator panel in a central building;
- one 1976 wheeled triple combination pumper capable of pumping over 34 L/s (450 IGPM); and
- 18 volunteers.

B.9 Other Services

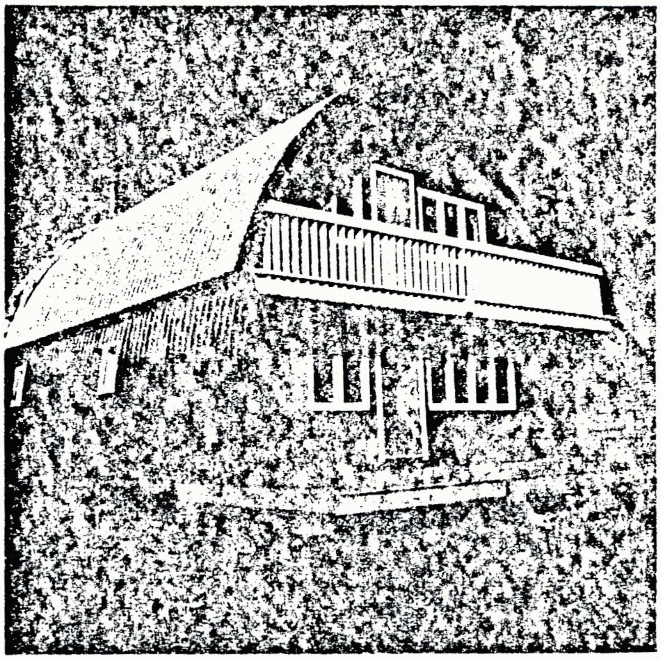
Other services include 2 R.C.M.P. costables, a nursing station, a community centre and a bank. Power is provided by NCPC using diesel generating facilities.

INFORMATION SOURCES

1. Underwood McLellan (1977) Ltd., *General Development Plan, Rankin Inlet, N.W.T.*, February, 1977.

2. Underwood McLellan & Associates Ltd., *Existing Water Supply and Sewage Disposal Facilities with Proposed Improvements*, January, 1977.

3. Underwood McLellan (1977) Ltd., *Study of Sewage Treatment and Disposal at Rankin Inlet*, January, 1979.

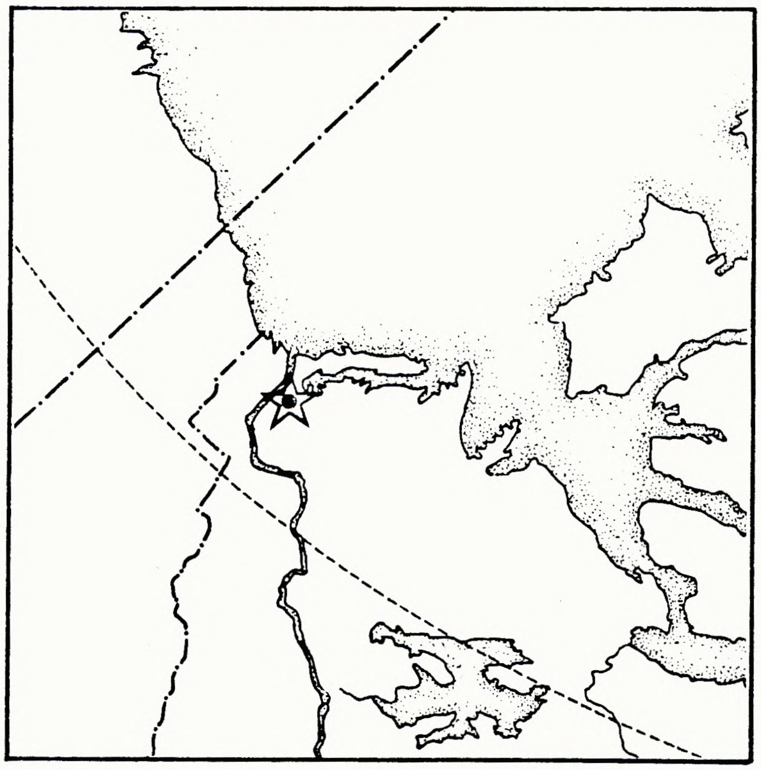


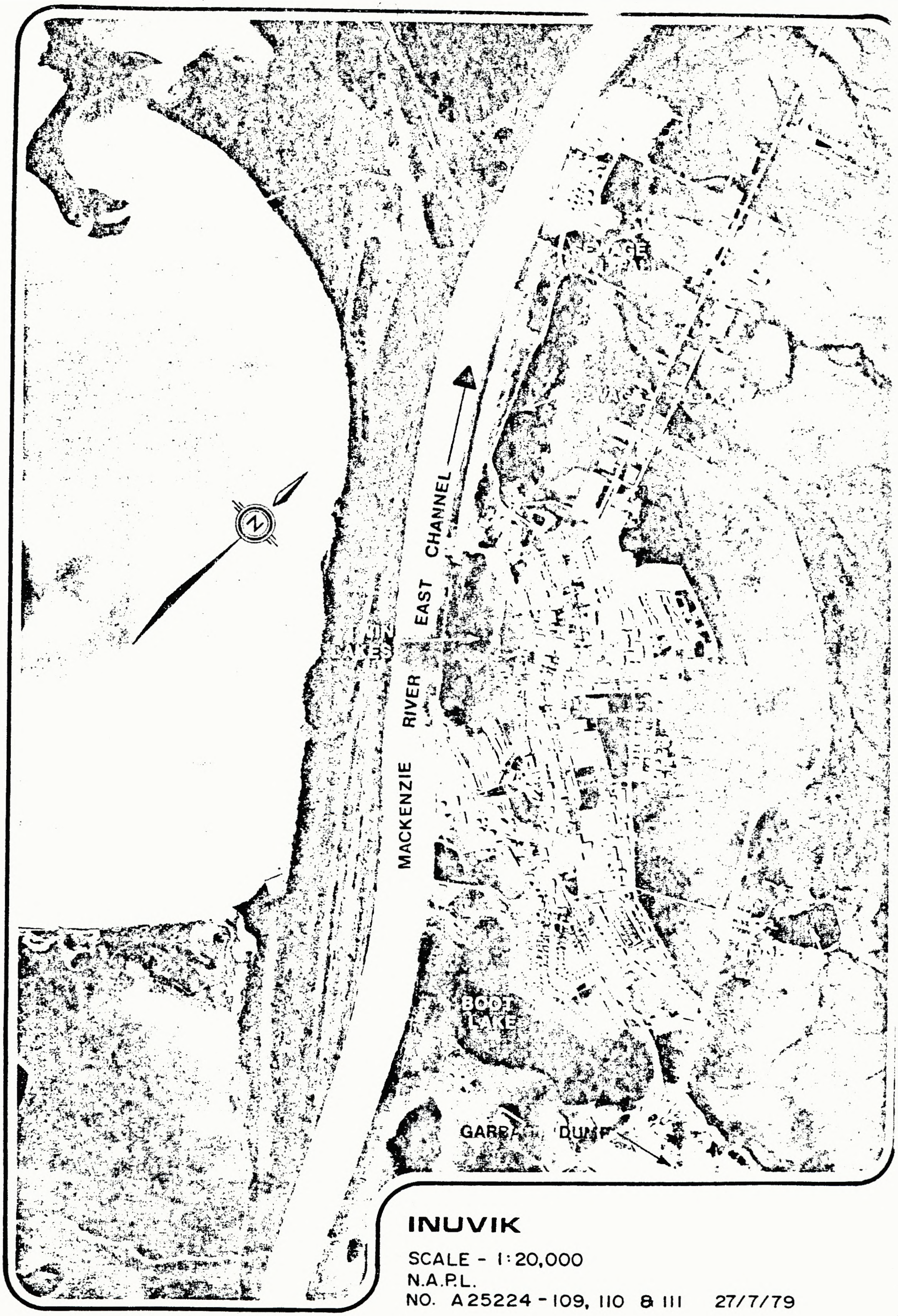
Unique residence

ANNEX M

ANNEX M

Inuvik





INUVIK

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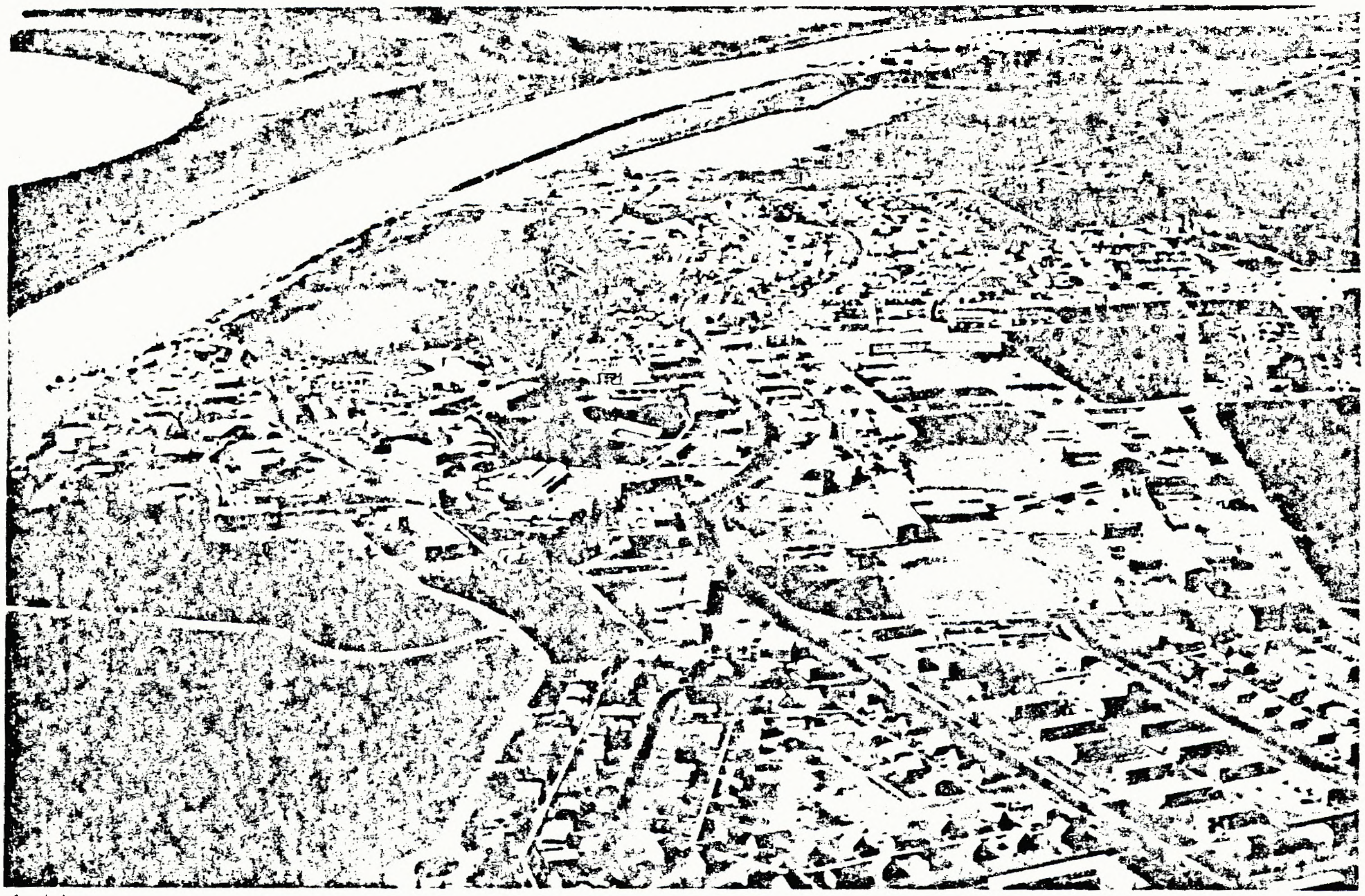


Aerial view

A. GENERAL

A.1 Location

Inuvik is located at 68°21'N and 133°43'W on the East Channel of the Mackenzie River. It is about 1,000 km by air northwest of Yellowknife on the eastern edge of the Mackenzie Delta. The Town is about 195 km north of the Arctic Circle and situated in the transitional area between the arctic forest and tundra.

A.2 History

Inuvik means 'place of man' in Inuktitut. The site of Inuvik was seldom visited until 1954 when the Federal Government decided to create a new administrative centre for the Mackenzie Delta to replace the existing settlement of Aklavik. The site was selected mainly because of the large, level area, well above flood levels, the presence of good gravel materials for construction, location on a navigable waterway and the opportunities for modern airport facilities. Construction of Inuvik lasted from 1955 to 1961.

Inuvik has grown from a government centre to become a communications and staging centre for oil and gas explorations activities in the region. It also provides major transportation, health, educational, and administrative services to the region.

A.3 Community Information

Inuvik has grown in the past twenty years from about 1,200 persons in 1961 to about 3,000 today. The population increased significantly in the mid-seventies along with major gas and oil exploration activities taking place early that period in the delta region. When the exploration activity declined somewhat in the late seventies, the population also declined as shown in the following estimate for the years 1976 to 1980.

POPULATION	YEAR
3,115	1976
3,127	1977
2,938	1978
2,892	1979
2,929	1980

The population is expected to grow gradually again, with the influence of increased petroleum exploration activities in the Beaufort Sea region and due to increased tourism, and natural growth.

The population consists of approximately 7% Dene, 17% Inuit, and 76% other.

The Town has an elementary and high school serving the region. The 1979 enrollment was 459 and 396 for each school respectively.

The Inuvik hospital, owned and operated by Health and Welfare Canada, has a capacity of 120 beds.

Many denominations have maintained places of worship in the community.

A 15 member detachment of the RCMP provides police services. The Department of National Defence presently employs 243 persons of all ranks in Inuvik.

Other government agencies operating out of the Town include the Department of Indian and Northern Affairs (Renewable and Non-Renewable Resources as well as the Inuvik Research Laboratory) and the Government of the Northwest Territories.

A controlled airport is located about 7 km east of the Town which has a 9,600 m x 240 m asphalt runway. PWA provides regular scheduled air service to the community. Other scheduled and charter aircraft companies operate from Inuvik. A small gravel surfaced runway located in the Town is used by small and private aircraft. Float planes use Shell Lake located about 2.5 km east of Town during the summer.

The Dempster Highway, officially opened in 1979 provides an important all weather road link to Inuvik.

A.4 Geology and Terrain

There are three major physiographic regions in the Inuvik area; the Mackenzie Delta, the Caribou Hills and the Anderson Plains. Inuvik itself is situated on a river terrace in the Delta Region. The land rises gently to the northeast and is characterized by fine-textured, sandy silty clay which is underlaid by a silt-clay with gravelly material. It is in a continuous permafrost region and ice lensing is common. The active layer varies in thickness from 45 to 75 cm.

The Anderson Plains region, to the east, is an area of gentle undulations, knolls, hummocky hills which was modified extensively by glaciation. Paleozoic rocks underlie Quaternary sediment deposits in this area and bedrock cover is generally thin.

The Caribou Uplands, north and west of Inuvik are composed of Quaternary sediments, generally thin, which cop gravels, sands and tills. Granular materials are quarried in this area for use by the Town.

A.5 Vegetation

In the Inuvik region, white spruce along with birch, alder and poplar are common on open slopes and hilltops where drainage is good. Black and white spruce occupy gentler slopes and lower areas. In low, poorly drained areas, lichens, sedges, cottongrass and sphagnum are found in association with black spruce.

A.6 Climate

The July mean high and low temperatures are 19.7°C and 8.2°C respectively. The January mean high and low temperatures are -26.1°C and -35.7°C respectively. The average temperature is -9.6°C. The total yearly precipitation averages 276.1 mm with 110 mm of this occurring as rainfall.

B. MUNICIPAL SERVICES

B.1 General

The level of servicing provided in Inuvik is relatively high for a northern community. Essentially, all of the development within the townsite is serviced with a piped water and sewer utilidor system.

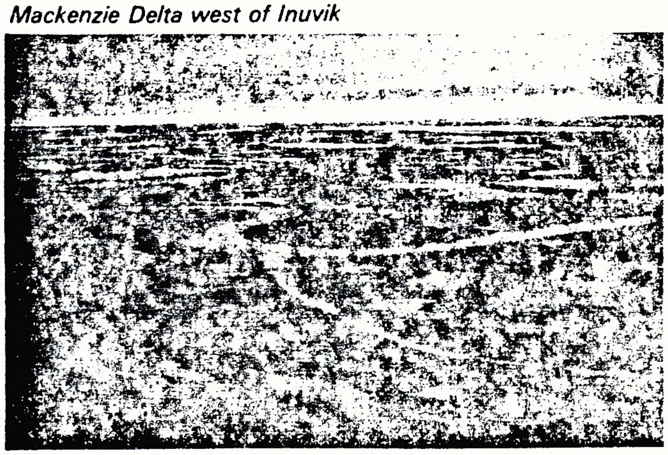
During the winter months, potable water is pumped from the East Channel of the Mackenzie River using a portable intake system. During the summer, the supply is 'Lake B'. Water is pumped from this lake to Hidden Lake near Town which is used as a storage reservoir. Additional storage tanks are provided at this elevation which 'float' on the distribution system to maintain gravity pressure.

Water from the East Channel source is also pumped to the storage tanks after treatment prior to distribution during the winter. Inuvik presently has access to good supplies of water during winter and summer, however, during spring break-up and fall freeze-up, either facility can be used. The Town relies on water stored in Hidden Lake as a raw water storage reservoir during those periods.

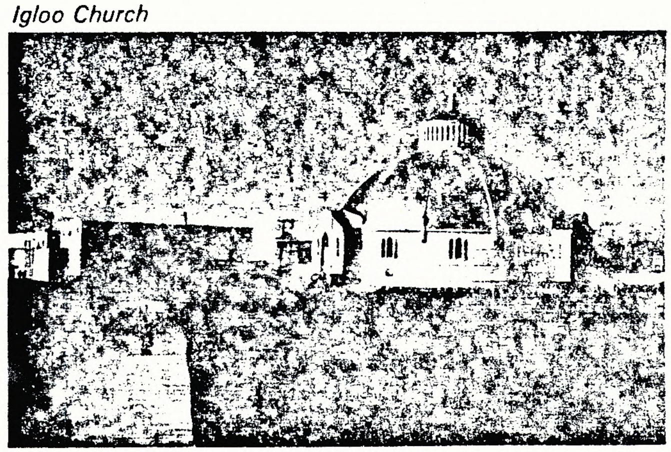
Sewage is collected by a gravity sewer system discharging to a lagoon which ultimately discharges into the East Channel following retention.

NCPC owns and operates the water, sewer and district heating utilities as well as the power genera-

Mackenzie Delta west of Inuvik



Igloo Church



tion and distribution system. NCPC sells the utility services on a consumption basis.

B.2 Water Supply

B.2.1 Winter Source

The East Channel of the Mackenzie River as it passes by the townsite is about 215 m wide and during the winter reaches a maximum depth of approximately 3.5 m at mid-stream. During the period from December to mid-May when it is used as the potable water source, the chemical quality of the water is satisfactory for use. During this period normal levels of turbidity, colour and hardness are 5-15 JTU, 0-5 TCU, and 135 mg/l respectively. During the open water period, and in particular at spring break-up, river flows increase as well as turbidity and colour levels, making it unsuitable for direct use as a potable supply. Following are some typical water quality characteristics. (All values in mg/l unless otherwise noted)

Parameter	Value	
	Open Water	Ice Cover
pH	8.0	8.1
Hardness (as $CaCO_3$)	102	135
Alkalinity (as $CaCO_3$)	31.2	40.4
Calcium (Ca)	5.4	11.0
Sodium (Na)	80	100
Potassium (K)	0.9	1.2
Sulphate (SO_4)	23.2	35.0
Chloride (Cl)	5.9	13.0
Total Phosphorus (PO_4)	0.15	0.017
Total Nitrogen (N)	0.67	0.48
Turbidity	110	7.0 JTU
Colour	50	10.0 TCU
Total Organic Carbon (TOC)	10	6.0

(AESL - 1978)

B.2.2 Summer Source

Lake 'B' located about 4.8 km northeast of Inuvik, is used as the summer water source. It is one of the many small lakes occupying small valleys in the range of hills which form the Delta's eastern margin. It has a surface area of 176 ha (0.68 square miles) and a catchment area of about 1660 ha (6.4 square miles).

Its maximum depth at normal high water is about 9 m. It has been estimated by the Arctic Hydrology Section, Environment Canada, that the Lake 'B' watershed might be expected to produce 0.83 to 1.67 million m^3 of water in an average year. Inuvik's total yearly water demand in 1977 was 0.8 million m^3 for the purposes of comparison. It is expected that Lake 'B' will be adequate for Inuvik's summer requirements for some years to come. Lake 'B' provides a naturally clean soft water having little colour.

B.2.3 Intake and Treatment Facilities

Winter Operation

During winter, water is pumped from the East Channel using a portable intake pumphouse situated on the ice and pumps to the newly constructed water treatment plant situated immediately north of Duck Lake (see figure). The intake facility is a Flygt submersible pump having a capacity of 20 L/s @ 18.3 m TDH (267 igpm @ 60 ft. TDH).

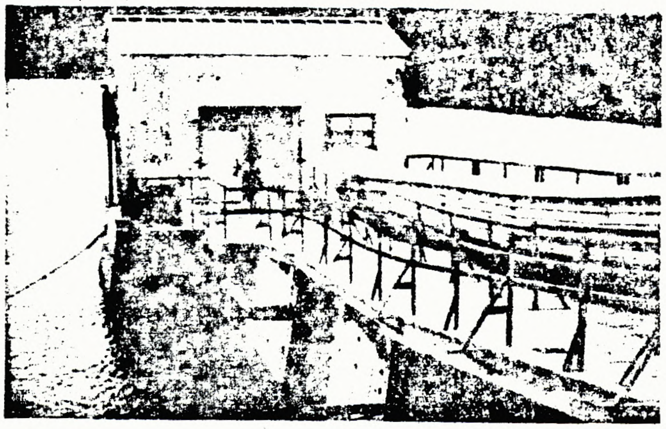
The water is pumped from the plant through 1,585 m of 100 mm diameter pipe in a utilidor raw water line directy to Hidden Lake. Alternatively, the water is heated, filtered, chlorinated and fluoridated and pumped directly into the distribution system. The raw water pipeline system includes a booster station at the bottom of Hidden Lake Hill capable of supplying 20 L/s @ 72 m TDH (267 igpm @ 235 ft. TDH).

The new water treatment plant (filter/booster pump stage) has a capacity of 5,230 m^3/day (1.15 million imperial gallons per day) and is reported to be adequate to serve the requirements of Inuvik's population to 8,000. The plant includes water preheating facilities, gravity filters, chlorination and fluoridation equipment, chlorine contact tank and distribution pumps, metering, controls, alarms, connections to the existing booster stations and to the water distribution system as well as a backwash discharge line.

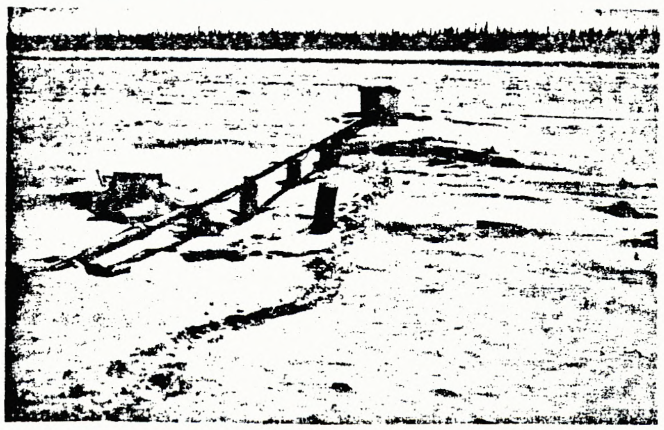
Summer Operation

During the summer, Lake 'B' water is discharged into Hidden Lake and is then pumped through a

Intake pumphouse at Hidden Lake



Winter intake in east channel



microstrainer plant. It is chlorinated and fluoridated prior to entering the distribution system.

The intake at Lake 'B' extends from the intake pumphouse 39 m into the lake and is supported on piles. A catwalk in the pile line permits access to the intake for maintenance.

The screened intake is situated in about 1.2 m of water and can be raised out of the water prior to winter each year. The intake pumphouse, approximately 3 m x 4.3 m contains a single pump with the following specifications:

Make and Model: Peerles Model 4AD18.5-6x4 Series 5200 single stage double suction
Motor : 75 HP, 1800 RPM

The pipeline to Hidden Lake is about 4.9 km long and consists of 200 mm diameter pipe for the first 3.4 km and 150 mm diameter for the remaining section. The pipe is uninsulated welded steel pipe laid directly onto the ground. Every 122 m a right angle offset of 2.1 m is provided for expansion and contraction. The pipeline delivers in the order of 3,600 m^3 per day to Hidden Lake during the summer.

The intake pumphouse at Hidden Lake contains four pumps:

- (1) 10 HP electric motor driven distribution pump
- (2) 40 HP electric motor driven fire pumps
- (1) gasoline engine driven fire pump

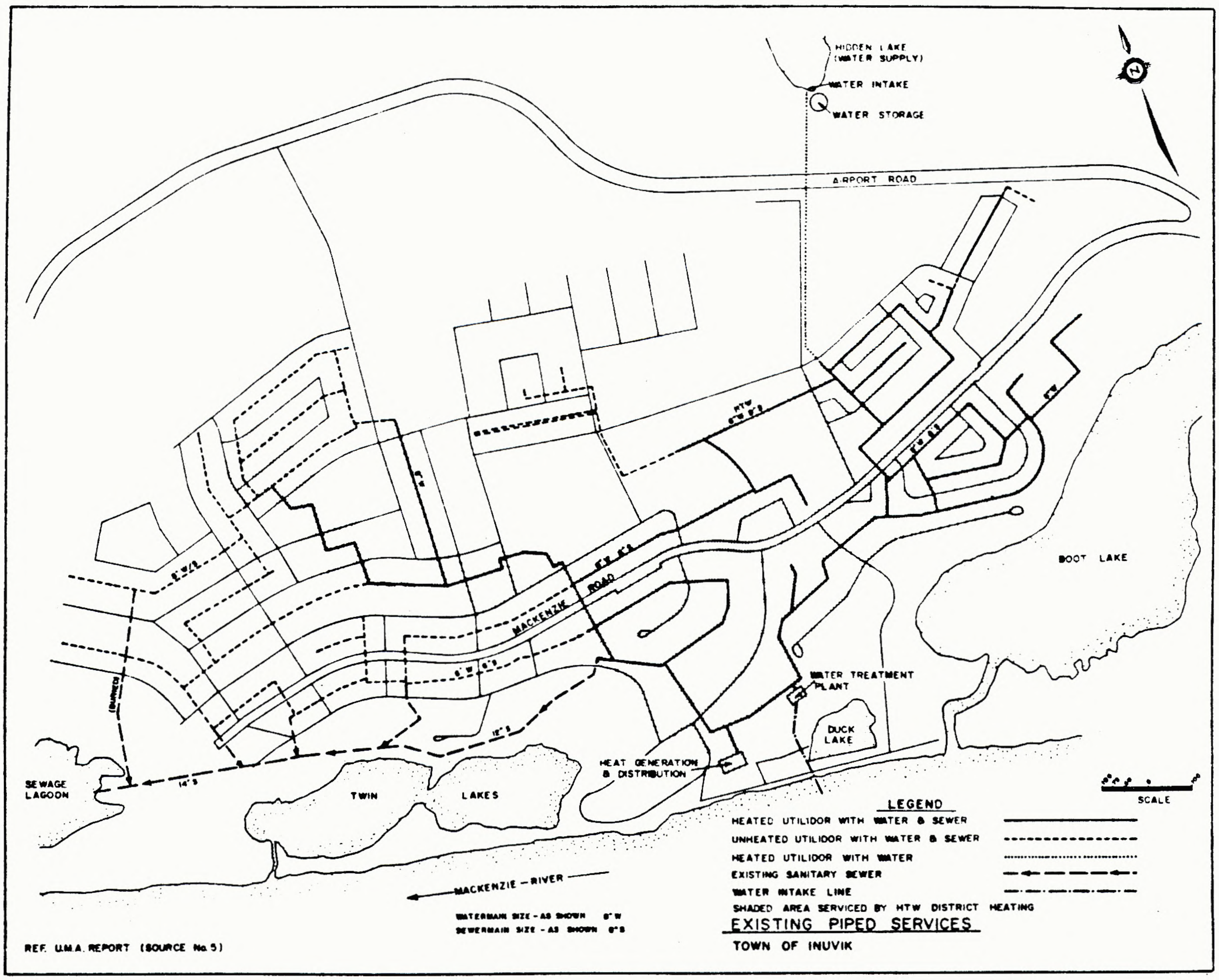
The microstrainer plant located at the high point between Hidden Lake and Inuvik has a capacity of 11.4 L/s (150 igpm) and has an automatic bypass which permits any excess demands to be met.

Water from the microstrainer is chlorinated and fluoridated prior to entering a 409 m^3 (90,000 igal) storage tank in the microstrainer building and a recently added 2,275 m^3 (500,000 igal) storage tank located at the high point of the system near Hidden Lake. These tanks 'float' on the distribution system and provide for peak consumption and fire flow demands.

B.2.4 Distribution System

B.2.4.1 Piped System

The distribution system consists mostly of asbestos-cement pipe ranging in size from 100 mm to 300 mm in diameter within the utilidor system (see figure

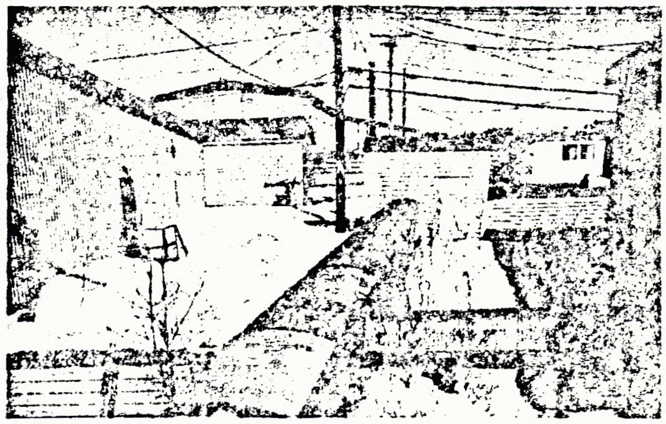


showing existing piped services). The consumption rate for the Town is approximately 705 lpcd (155lgpcd) at present.

Since Inuvik was established in 1956, numerous utilidor designs have been used. Experimentation has occurred mainly due to the high capital cost of utilidor construction (see figure showing cross-sections of utilidors). A major portion of the utilidor system carries piping of Inuvik's central heating system. Utilidors which carry high temperature water (HTW) lines, are heated by loss from these lines. The HTW steel lines vary from 32 to 200 mm in size. The supply water temperature is about 193°C (380°F) and returns at approximately 121°C (250°F). Heat is provided by NCPC's 900,000 BTU/hr. Bunker C fired boiler during winter and 300,000 BTU/hr. boiler maintains heat during the summer for the various types of customer heating loads on the system (including buildings). The remaining utilidors are designed to be kept from freezing by insulation, heat added directly to the water at selected locations and by circulation. Circulation flows in all unheated utilidors are generally above 0.03 m/sec throughout the normal range of demand levels.

B.2.4.2 Trucked Services

At present (1981), there are about 22 housing units which still require trucked service. These units are mainly small sub-standard houses located in the west end. The service is operated by the Town



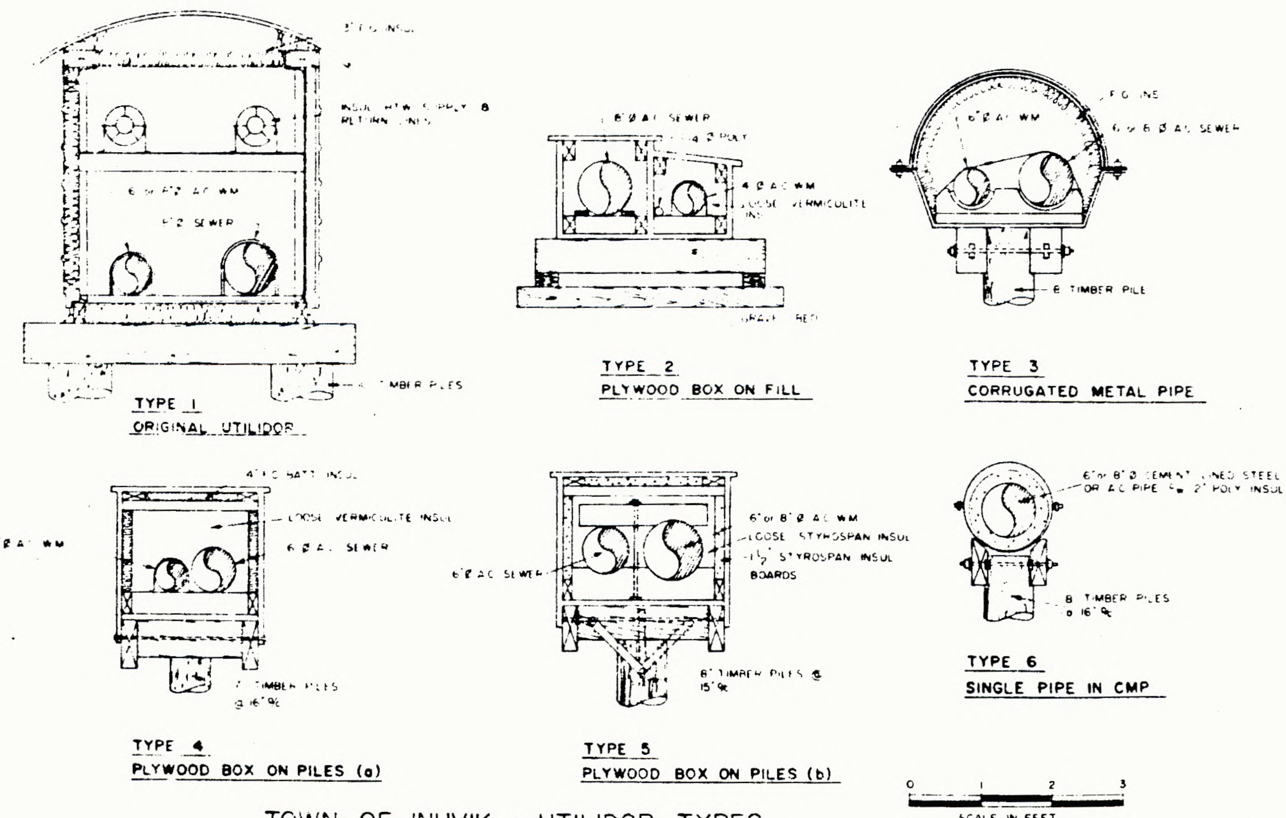
Utilidors

which provides delivery three times per week. The cost to consumers is government subsidized.

B.3 Sewage Collection

The gravity sewage collection system consists mainly of asbestos cement pipes ranging in sizes from 100 to 350 mm in diameter. An insulated 200 mm diameter above ground outfall line discharges to a sewage lagoon located beside the East Channel, west of the Town.

As mentioned earlier, about 22 homes are on a trucked system. The Town provides a bagged sewage pick-up service for these units.



TOWN OF INUVIK - UTILIDOR TYPES

B.4 Sewage Treatment
Since 1957, Inuvik's domestic sewage has been discharged to a lagoon located west of the townsite as shown in the aerial photo. The lagoon is about 20 ha in size and was formed by constructing berms along three sides of a low lying area. It has an average depth of about 1.2 m. It discharges over a weir at the west end of the lagoon, through a ditch directly to the East Channel after treatment. The facility does not conform to normal design criteria for sewage lagoon operation, however, it has provided an acceptable level of treatment over the years. Studies have indicated 85% reduction in suspended solids (SS) levels and a 70% reduction in Biochemical Oxygen Demand (BOD_5) during winter with higher reduction levels, up to 90% during the summer months. During the summer, long hours of sunlight and warmth promote high levels of algae growth and dissolved oxygen which allow for a relatively high level of sewage treatment, similar to southern lagoon installations. Some problems with the present facility include nuisance from odours due to sludge build-up near the raw sewage outfall, and a potential health risk as it is unprotected and in close proximity to the community. The Town and Territorial Governments are presently examining various alternatives to determine an acceptable standard of treatment for Inuvik's wastewater prior to discharge to the East Channel and to examine various practical alternatives to provide a level of treatment which will meet the Town's needs.

B.5 Garbage Collection and Disposal
Garbage collection and disposal is carried out by the Town's Public Works Department. The garbage is deposited in 205 L (45 igal) drums outside the homes along the sides of the streets. Burning in the barrels is carried out by many residents.

An open truck is used for garbage pick-up and the dump site is located approximately 1.5 km south of the Town centre, east of Boot Lake. Disposal is carried out using a land fill method.

B.6 Roads
The road system in Inuvik has improved to a large extent over the past few years with a street improvement and surfacing program which began in 1976. As part of the street improvement program, several subgrade designs have been used in various streets including soil cement on Wolverine Road and 100 mm thick rigid styrofoam subgrade insulation on Mackenzie Road. The pavement designs include 75 mm of hot mix surface course over a 100 mm asphalt bound base on major streets. Due to the presence of permafrost, most roadways are built on imported granular fill varying in depth up to 3 m. Permafrost thaw can exceed 3 m in disturbed areas with certain soil types.

The construction work in 1981 will complete subgrade improvement work and cold mix asphalt surfacing to the majority of the streets in Inuvik and complete sidewalks on Mackenzie Road. The various designs will be evaluated to assist in future road designs in the community.

B.7 Drainage
Overland drainage runs in shallow road ditches generally in a south- westerly direction. Ditches generally grade to culverts across Mackenzie Road which drain to the East Channel of the Mackenzie River. Most of the drainage problems have been alleviated in recent years as a result of the street improvement program.

B.8 Fire Protection
Inuvik has a permanent fire hall with a fire chief and a number of volunteer firemen ranging from 18 to 24. Fire fighting equipment includes the following:

-Thibault Pumper (1970) 2,273 L tank and 47 L/s pump
- King Seagrave Pumper (1976) 2,273 L tank and 80 L/s pump
- Ford Creen Cals (1976) Fire Chief's truck c/w 136 kg dry chemical unit
- GMC Vandura Van (1974) support unit
- IHC (1975) 11,365 L tanker c/w 19 L/s pump
- 12 m and 18 m ground ladders The alarm system includes 53 pole and wall mounted alarm boxes.

B.9 Other Services
NCPC generates and distributes power to Inuvik by means of diesel engine driven generators. The present output capacity is 15,260 KW. Other services include telephone, CCNT (microwave), a local newspaper ('The Drum'), CBC radio and television and daily mail service.

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ANNEX N

ANNEX N

DAWSON CITY WATER AND SEWERAGE PROGRAM

AN OVERVIEW

By:

E.I. Shillington

W.M. Kiefer

N.J. Nuttall

prepared for

American Society of Civil Engineers

Conference on "The Northen Community

- A Search for A Quality Environment"

ABSTRACT

This overview presents the 1979 - 80 Dawson City Water and Sewerage program in a general, condensed fashion to inform and make aware to others the engineering and construction input to a sensitive northern project. There are considerable specific municipal and geotechnical engineering details on a project such as this but these were not discussed in this paper in detail.

Dawson City, Yukon's first sewer and water system was constructed in 1902 using wood stave pipe. By the middle 1970's the system had deteriorated and required replacement. Due to the northern location and the permafrost soil conditions, special engineering considerations were required. The system constructed during 1979 and 1980 consists of approximately 20,000 lineal metres of insulated polyethylene pipe buried in ice rich, organic, silt permafrost.

The water system consists of an infiltration well, an insulated reservoir, a pumphouse and six circulating loops varying in diameter from 150 to 250 mm.

The sewage system consists of insulated gravity sewer lines and a lift station. The sewage receives primary treatment by a rotoscreener and is then discharged to the Yukon River via a submerged outfall.

During the design of the project a philosophy to minimize degradation of the permafrost, minimize frost heave and prevent freeze-up of the system was foremost.

During the construction of this project special techniques and equipment were developed to deal with the distinct problems encountered in a remote and unique centre such as Dawson City.

The project is now complete and operational, with a construction cost of approximately nine million dollars Canadian for a design population of 2100.

In closing it should be noted that Dawson City is typical of a far northern community where municipal services, especially water supply and sewage treatment, must be assessed on an individual basis. One cannot assume that "southern" design or construction practices are applicable to these northern communities. Approach the solution to each community with caution.

DAWSON CITY WATER SEWERAGE PROGRAM

AN OVERVIEW

[I] By: E.I. Shillington

W.H. Kiefer

N.J. Nuttall

SECTION 1

INTRODUCTION

General

Dawson City is located approximately 1800 kilometers north and 800 km west of Seattle, Washington, in the Yukon Territory of Canada. At 64° 04 'North and 139° 25' West it is some 270 km south of the Arctic circle, at the confluence of the Yukon and Klondike Rivers. Dawson City is connected by an all-weather gravel road to the Alaska Highway, 500 km to the south, near Whitehorse.

The climate of Dawson City is characterized by long cold winters and short, warm summers with a mean yearly temperature of -4.7° Celsius. While summer temperature can approach 35° C and winter temperatures often drop to -60° C.

The total annual precipitation is typically 32.5 centimeters, of which 13.6 cm is in the form of equivalent snow melt. There is little wind.

Although spring usually arrives in mid April, the occasion is informally considered to be concurrent with the breakup of ice on the Yukon River in late April or early May. During the long winter months the surrounding mountains effectively prevent the sun from being visible for up to three months.

The present permanent year round population is approximatley 800 persons. This increases significantly during the months of May to October as the miners and tourist facility operators return from their "outside" location, (the "outside" is considered to be any point south of the 60th parallel). The influx of tourists during June to September can increase the population to 1500 - 2000 people. With the recent increases in world gold prices, mining activities have increased substantially in the Dawson area and it is estimated that there may be an additional 1000 or more miners working on the creeks.

[I] E.I. Shillington, P. Eng.; W.H. Kiefer, P. Eng.; N.J. Nuttall, P. Eng.;are Project Engineers with Stanley Associates Engineering Ltd. of Edmonton, Alberta, Canada

Most of the residents of the Dawson area are employed in either government services (three levels of government are represented), tourism or mining. Fishing, hunting, trapping and farming play only a minor role in the Dawson economy.

Situated on a sometimes active floodplain near the southern limits of the zone of discontinuous permafrost, the site conditions for municipal services are as bad as could possibly be conceived. Over top of a layer of gravel or bedrock at the 5 meter depth is an ice rich, organic silt permafrost. Such conditions are typical except for a narrow band of coarse-grained fluvial deposits that parallel the Klondike River at the southern extremities of the city and in which no permafrost is encountered.

The active layer, the soil stratum subjected to seasonal thaw and freeze conditions, varied in depth between 1.4 to 2.5 metres. Added to the poor soil conditions is a high water table in certain areas and poor drainage.

History

Prior to the discovery of gold on Rabbit Creek, 5 kilometers up-stream of Dawson City on the Klondike River on August 17, 1896, Dawson City did not exist.

As word of the discovery of gold spread up and down the creeks, miners who had drifted north into Alaska and the Yukon after the 1849 California gold rush headed for Dawson. When news of the discovery reached the outside in October, 1897 it started the world's greatest gold rush.

By summer, 1898, an estimated 20,000 people had made their way to Dawson only to discover that the creeks had been virtually completely staked out. By 1901 the population had decreased to 9,000 and in 1905 huge wooden hulled dredges began operating ground which could no longer be economically surface mined by more conventional panning and sluicing methods. By 1921 the population was below 1000.

Dawson was incorporated as a City in 1902 and was briefly known as the "San Francisco of the North" before beginning its inevitable decline. In 1899 Dawson boasted telephone service, electricity, dozens of hotels and even motion-picture theaters. There were vintage wines and fashions from Paris; dramatic societies and glee clubs; gambling halls and dance hall girls.

Piped water and sewer service was installed to select areas of the City as early as 1899 and continued to expand until it was capable of servicing a population of 10,000 people. In 1911 a power plant was built some 50 kilometers to the east to serve the electric powered dredges.

Water was obtained from the relatively clean and safe Klondike River and distributed in shallow buried wire wound wood stave pipes. Sewage was carried away in wood stave pipes and disposed of on the banks of the Yukon River. Pipes were buried from 0.3 to 3 metres below the surface, in the active layer above the permafrost.

As the population of Dawson City decreased, the utility systems gradually began to deteriorate and fell into a state of disrepair as frost heave and thaw degredation of the underlying permafrost began to take its toll. During the winter months the water would be heated and approximately 88 litres per second (1400 usgpm) would be pumped for a population of 800 persons. To prevent the water from freezing it was recirculated in the mains and the service connections were bled.

SECTION 2

SYSTEM DESCRIPTIONS

Introduction

By the mid 1970's it was becoming obvious that unless the existing water and sewer system was either extensively revamped or replaced entirely, it would soon be beyond repair. Operation and maintenance costs were spiralling. Wire wound wood stove pipe and parts were becoming increasingly more expensive and hard to come by. With only 31 stand-pipe type hydrants, fire protection was minimal at best. Water and sewer mains were often alarmingly close together and the danger of cross-contamination was ever present. Sewage was dumped indiscriminately into the banks of the Yukon River where it presented additional health hazards as well as aesthetic objections during low flows in the river when the outfalls were not submerged.

Matters were brought to a head in 1976, in a letter from the Yukon Water Board to the Director of Local Government, in which the community was given deadlines for the preparation and implementation of schemes to alleviate the unacceptable sanitary conditions in Dawson City.

Subsequently, the existing utility system was investigated and recommendations for its replacement and/or repair were made.

After the predesign was accepted in January, 1977, detailed design of an entirely new water and sewer system, began. Concurrent with this, extensive geotechnical work was undertaken to determine the exact soil conditions to be encountered.

A 600 metre test section of insulated polyethylene waterline was installed in the fall of 1977. The winter of 1977-78 also saw the construction of a 300 metre steel sewage outfall line into the Yukon River.

Detailed design, based on the lessons learned from the test section, continued through spring and summer of 1978. In the fall of that year work began on screening and stockpiling of the gravel products required to replace the frost susceptible silts that formed the majority of the soil types to be encountered.

Two major contracts were awarded in the fall of 1978. The first, at $CAN 1.5 M, was for the construction of a reservoir, pumphouse and sewage screening plant. The second, at $CAN 4.7 M, was for the installation of new water and sewer mains complete with service connections.

The Dawson City municipal utilities replacement system consists of five major components: an infiltration well as the water source; a reservoir; a pumphouse; insulated water and sewer mains and services; and, a sewage screening plant and outfall line.

Water System

Water is obtained from a 10 meter deep infiltration type well located about 60 m from the Klondike River in an area free of permafrost. The well capacity is rated at 2730 L/minute although it can be pumped at 3640 to 4450 L/min for shorter durations. An intake connected directly to the Klondike River can be used to supplement the well.

The water is pumped through a pumphouse, where it is heated and chlorinated, and then flows into a reservoir. The 900,000 litre reservoir is an insulated, steel structure founded on an engineered fill extending to an underlying gravel stratum.

The water distribution pumphouse contains three service pumps, a fire pump and a heat exchange system. The heat exchange system utilizing waste heat from the adjacent diesel power generating plant and is used to heat the building, the domestic water and a swimming pool (in summer). It was calculated that by utilizing waste heat from the power station a considerable operational cost would be realized.

Water is distributed from the pumphouse through a series of six circulating loops. The system consists of 11,000 lineal·metres of 150,200 and 250 diameter mains capable of serving an ultimate population of 2,100. The system provides fire flows of 3640 L/min to residential areas and 5450 L/min to commercial and historic sites.

All water lines are polyethylene pipe insulated with 50 mm of polyurethane insulation buried to a depth of 1-1.5 metres. The waterlines are graded to drain.

A control valve chamber is located in the system and the piping arranged so that water can be pumped in either direction through the loops during fire flows, thereby keeping pipe sizes to a minimum.

Water service connections are typically 20 mm polyethylene lines run in insulated ducts. All services are provided with 3 mm diameter bleeder overflows and heat tracing for backup freeze protection.

Sewerage System

Sewer services and sewer mains are also insulated polyethylene pipe, with approximately 8,600 meters of sewer mains installed. This is a gravity system with one lift station.

Water and sewer mains were layed in a common trench, with the water main being the higher pipe. All mains were joined by butt-fusion to reduce the risk of leakage, and to prevent infiltration. Polyethylene pipe was selected for its flexibility due to the permafrost conditions and also its water tightness thereby eliminating possible contamination between water and sewer pipe in the same trench.

Primary sewage treatment is provided by a roto-strainer with 0.75 mm screen openings. The screened effluent is transported through an outfall line extending into the Yukon River, which has a minimum flow of 218 m^3/sec.

SECTION 3

SITE AND DESIGN DIFFICULTIES AND CONSTRUCTION

Introduction

Dawson City's relatively isolated position in a harsh environment, presented complex problems in the design of municipal services.

Site Difficulties

Some of the site difficulties encountered were:

Dawson is underlain by an ice rich, silty permafrost. Due to Dawson's proximity to the southern limit of the zone of discontinuous permafrost, the permafrost tends to be very warm, with temperatures rarely droping below -3°C. As such, the introduction of even small amounts of heat into the ground can have devastating effects on the thin susceptible ice and silts. In this particular instance, the solution was four fold: (a) insulate the pipes such that the rate of heat loss from the warm pipes is as low as possible and, ideally, less than the rate of heat loss from the surrounding ground to the atmosphere; (b) keep the pipes as shallow as possible; i.e., in the active layer; (c) use of a flexible pipe system (polyethylene); (d) in those instances where it became necessary to place pipes below the active layer, the permafrost was overexcavated to the calculated maximum depth and width of the thaw bulb and replaced with clean, non frost susceptible sand and gravels.

Dawson's severe winter climate makes construction impractical for five months of the year (November to April). While construction could be carried out if absolutely necessary, productivity and efficiency during the remaining months are too low to justify undertaking a major construction project. Consequenly, it became necessary to do work during the months of April to October. This presented some potential for problems with disruptions to the tourism industry, thereby requiring careful planning and close co-operation between the Contractor and the various municipal and territorial agencies to keep disruptions to a minimum.

It was necessary to keep the existing water and sewer mains in service during construction. The somewhat random layout of the existing system made this very difficult. The problem was overcome by making emergency repairs to the old system and constructing temporary mains and service connections.

Surface drainage had been allowed to deteriorate over the years by non-maintenance of ditches. At the same time, most of the roads had been built up above the level of the surrounding lots. Consequently, surface runoff waters would pond and this speeded up the process of permafrost degradation and often had detrimental effects on house foundations. The problem was further complicated by a legal subdivision layout that opposed the natural topographical features. To overcome this problem, it was necessary to keep all the old major east-west sanitary sewer mains in operation/or use as a storm sewer system.

Insofar as the new design required the replacement of the existing water and sewer services from the main to within the buildings, access to individual building sites became a significant concern.

Due to the importance of the tourist industry large portions of the city have been declared an Historical Control Zone. As such, all structures were required to conform to the historically correct architectural treatment.

Design Difficulties

Many of the site difficulties manifested themselves as specific design problems.

One of the major difficulties encountered in the design was the lack of any accurate water flow records for the existing sytem. Nevertheless, it was determined that pumping rates varied from 38 L/sec. (500 igpm) in the summer to 88 L/sec (1160 igpm) in the winter. Winter consumption could go as high as 9000 litres per person per day. Unfortunately it was impossible to assess how much of those pumping requirements were due to leaks in the old wood stave system and how much was due to bleeding to keep the water and sewer lines from freezing. This distinction is very important as it reflects the resident's attitudes with respect to system dependability and their acceptance and judicious use of a new system.

The second major problem concerned the design of water service connections. Because of the ever increasing tendency of residents to go spend the winters "outside", water service is often not required for 5 months of the year. Consequently, the water service must be disconnected for this period and freeze protection provided. Historically, this has been done by disconnecting the service at the main and draining the water line. This method was continued in the design of the new system. It necesitated the installation of water service manholes at regular intervals. Due to the uniform rectangular lot and block layout it was possible to provide services for up to four lots with one manhole. In this manner, all 800 year round residents were serviced by the use of only 193 water service manholes.

3. The sewer system was designed as a shallow buried gravity system.

Still, it often became necessary because of flat topography for the mains to penetrate below the active layer into the permafrost, In these instances, the trenches were overexcavated and backfilled with non-frost susceptible material to minimize frost heave.

All mains (water and sewer) were installed within the travelled portion of the roadways such that the heat loss from the pipes would be more readily dissipated to the atmosphere. Only the on-line hydrants were located off the roads. All manholes were insulated below the active layer.

Construction

Two major contracts were awarded for the construction of the municipal utilities. Insofar as the reservoir, pumphouse and sewage screening plant were all located within that small portion of the city which benefits from no permafrost, the construction methods and practices used were not very much different from those of more temperate climates, except, of course for those considerations necessary due to the relative isolation of Dawson City.

Construction of the mains and services took place over the summers of 1979 and 1980. In the first year, two mainline crews using Caterpillar 235 hydraulic excavators were used and was reduced to one 235 in the second year.

The hydraulic excavators were especially modified by the contractor to cope with the permafrost and they worked exceptionally well, averaging approximately 50 meters per day. It was found that excavation into the gravel layer at about the 4.5 meter depth was the most difficult aspect of excavation.

With regards to construction the biggest problem encountered was in keeping the existing watermains in operation as they were replaced. The amount of leakage in the existing pipes was so great that when the last portion of old main was finally shut off, the amount of water being pumped immediately decreased by more than 50%.

The original contract called for the installation of 320 service connections. However, due to new service connections required as the result of the flood and the influx of residents to Dawson City due to high gold prices, 394 service connections were finally installed.

Conclusion

The replacement of the municipal water and sewer services in Dawson City involved the construction of a water reservoir, pumphouse, sewage screening plant, outfall line and the replacement of all water and sewer mains and service connections. It involved 12,000 lineal metres of trenching in discontinuous permafrost and the installation of 11,000 lineal meters of insulated polyethylene waterline, 8,000 lm of sewermain, 900 lm of forcemain, and 394 service connections. It involved 106 sewer manholes, 193 water service manholes and 61 fire hydrants.

The construction was carried out under the most adverse of weather conditions and with only a minimal disruption to the tourist industry. It was done in such a manner as to keep the existing system in operation while the new one was installed.

Cost of the entire program was approximately $9.0 million. Mainline costs were $325/lineal metre and service connections averaged $4,700 each.

COST SUMMARY, DAWSON CITY PROJECT

COST SUMMARY

Dawson City Project

Outlined below are cost summaries for the Dawson City project which was constructed in extremely difficult soil conditions. The soil conditions in Barrow are much superior for construction as compared to Dawson City.

1) Area serviced - 62 Ha.

2) Population served - 2100

3) Started construction April 1979.
Completed September 1980.

4) Capital Costs

Direct	Dist. & Collect.	27,500' @ $200/ft.	$5.5 million
	Services	394 @ $2200	0.9 million
	Structures		1.4 million
			7.8 million
		Engineering	1.2 million
	Total		**$9.0 million**
	9.0 million ÷ 2100 = $4286/capita		
Deferred	1981 Remedial Program		$ 200,000
	1982 Remedial Program		$ 180,000
	1983 Remedial Program		$ 80,000
	1984 Remedial Program		Normal
		Total Deferred	**$ 460,000**
		Total Capital Costs	**$9.5 million** $4524/capita

5) Operation and Maintenance Costs

1980 recorded $275,323

1981 projected in 1980 $291,000

300 services @ $77/mo/service for sewer and water - 2% of annual household income

These operational costs include a significant amount of start-up cost, i.e., repairs of failure which could not be attributed to poor workmanship or materials, but rather to very adverse soil conditions.

6) In 1981 about $200,000 was spent on remedial work, primarily on collapses in sewer pipes.

7) In 1982 about $180,000 was spent on remedial work.

8) In 1983 about $80,000 was spent on remedial.

9) In 1984 system was operating stably and no further extra ordinary costs.

POST CONSTRUCTION SUMMARY

DAWSON CITY PROJECT
POST CONSTRUCTION SUMMARY

The Dawson City system encountered serious problems in the form of sewer pipe collapse in the first three years of operation. All of these problems were attributable to ground movement, and were largely caused by failure of permafrost to recover. If machinery had been available to dig frozen ground economically so that excavation could be carried out during cold weather conditions, most of these problems could have been avoided. That is our area for research and development which could yield significant gains in underground construction in permafrost in unstable soils.

Two categories of failures were identified. Short failures occurred at pipe joints and service connections. The answer to this kind of failure is a rigid coupling clamp, of sufficient length to carry the earth loads well beyond the weakened pipe ends. Also a thicker pipe wall would eliminate these failures. Where series 100 pipe was coupled to Series 45, the thinner wall pipe collapsed and the thicker wall pipe did not.

There is no clear answer to long failures. These occur in conjunction with pipe settlement or heaving and appear to be due to radial compression at the bending points. The only sure remedy is to eliminate significant vertical (or horizontal) alignment changes in the ground. This is a problem of bedding and preventing recession of permafrost after the backfill load is applied. It is doubtful that a thicker wall will be effective in preventing long collapse failures.

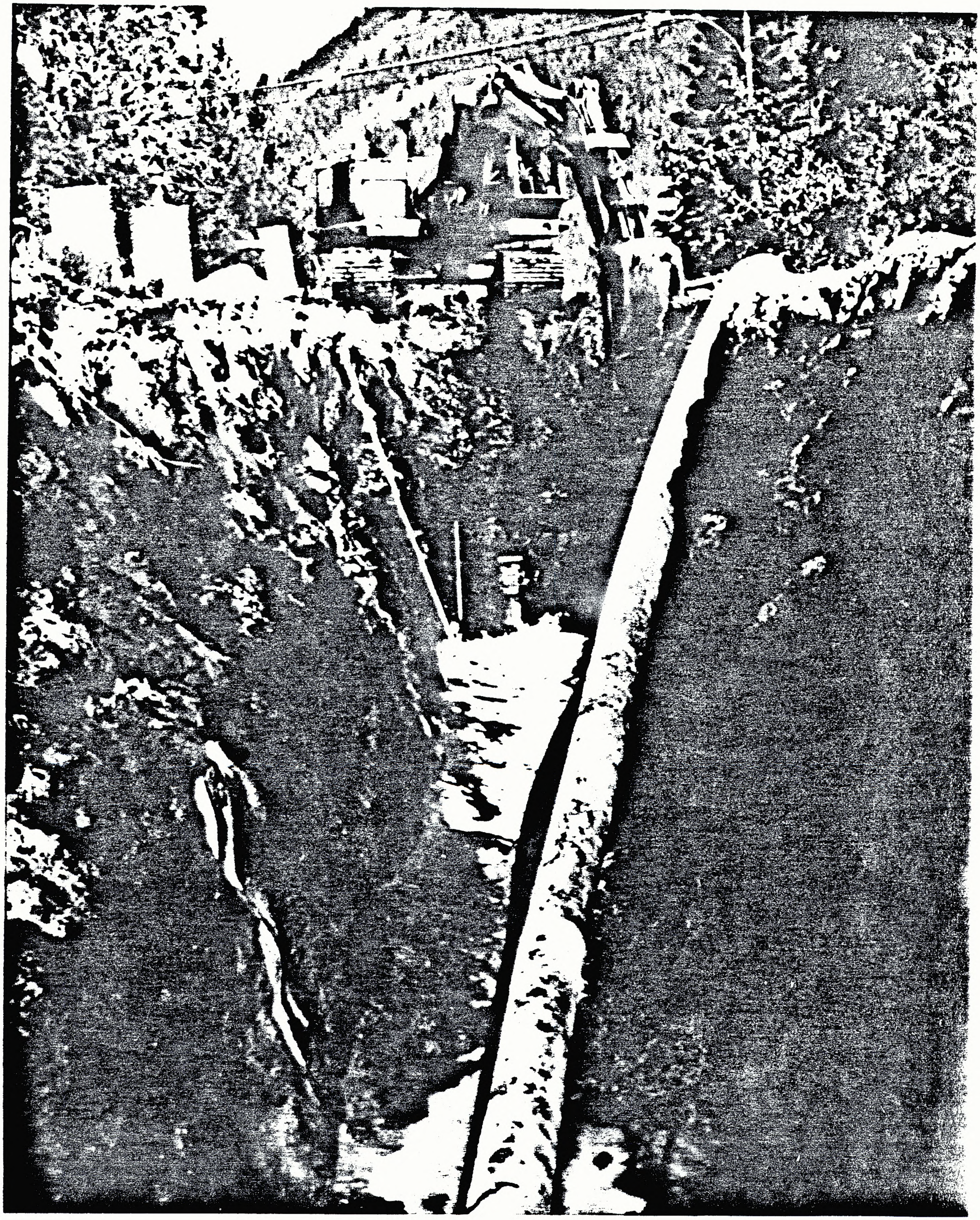
Water seepage into the trenches from the badly deteriorated existing system and from the poor drainage condition caused by a flood during break-up were also major factors. Movement of water must be prevented in the trenches.

TYPICAL PROJECT PHOTOS

SEWER HOUSE CONNECTION - Dawson City

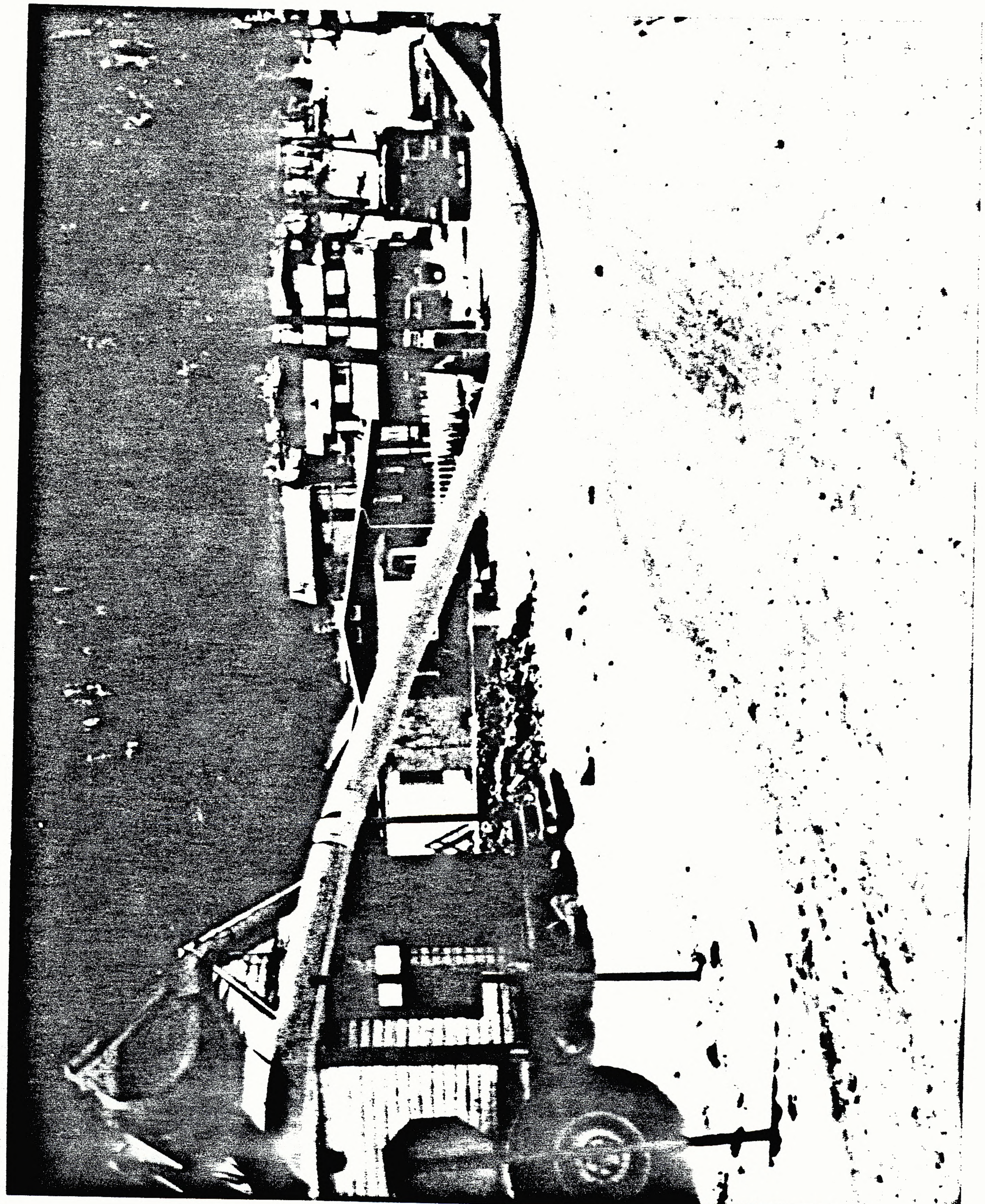
EXCAVATION IN PERMAFROST - Dawson City

LAYING P. E. SEWER PIPE - Dawson City



P.E. PIPE - Dawson City

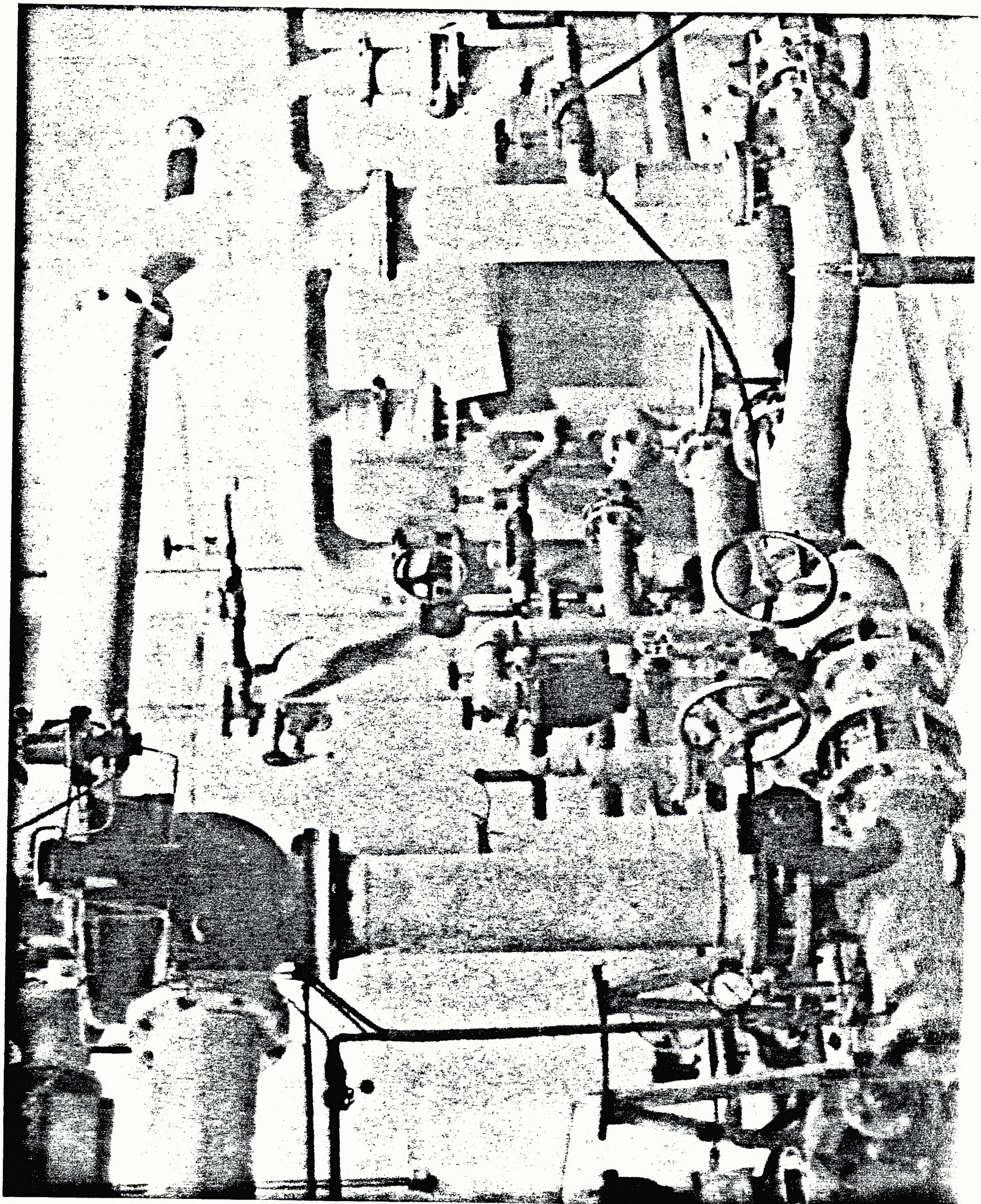
Stanley



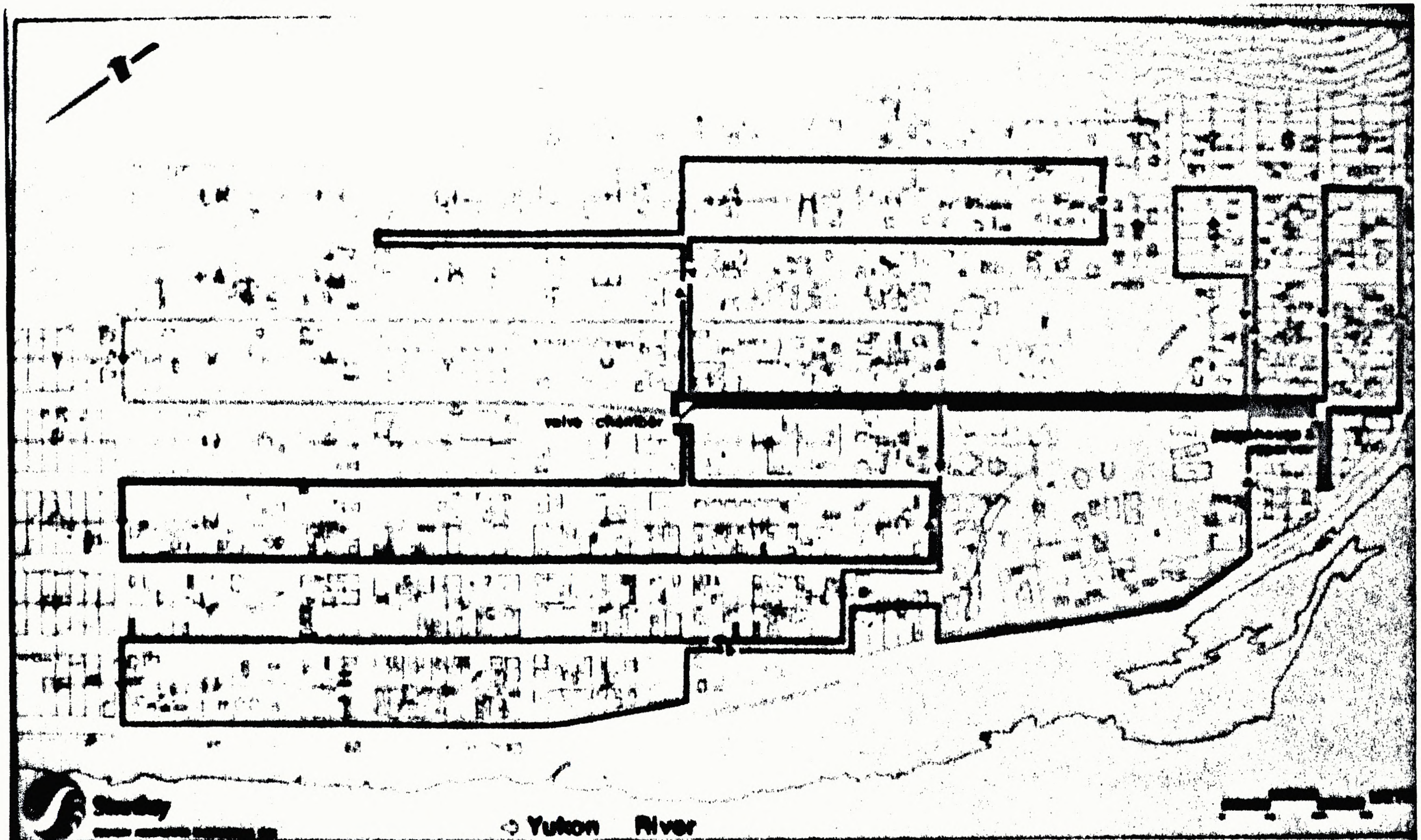
P.E. PIPE - Dawson City

Stanley

TYPICAL ICE LAYER - Dawson City



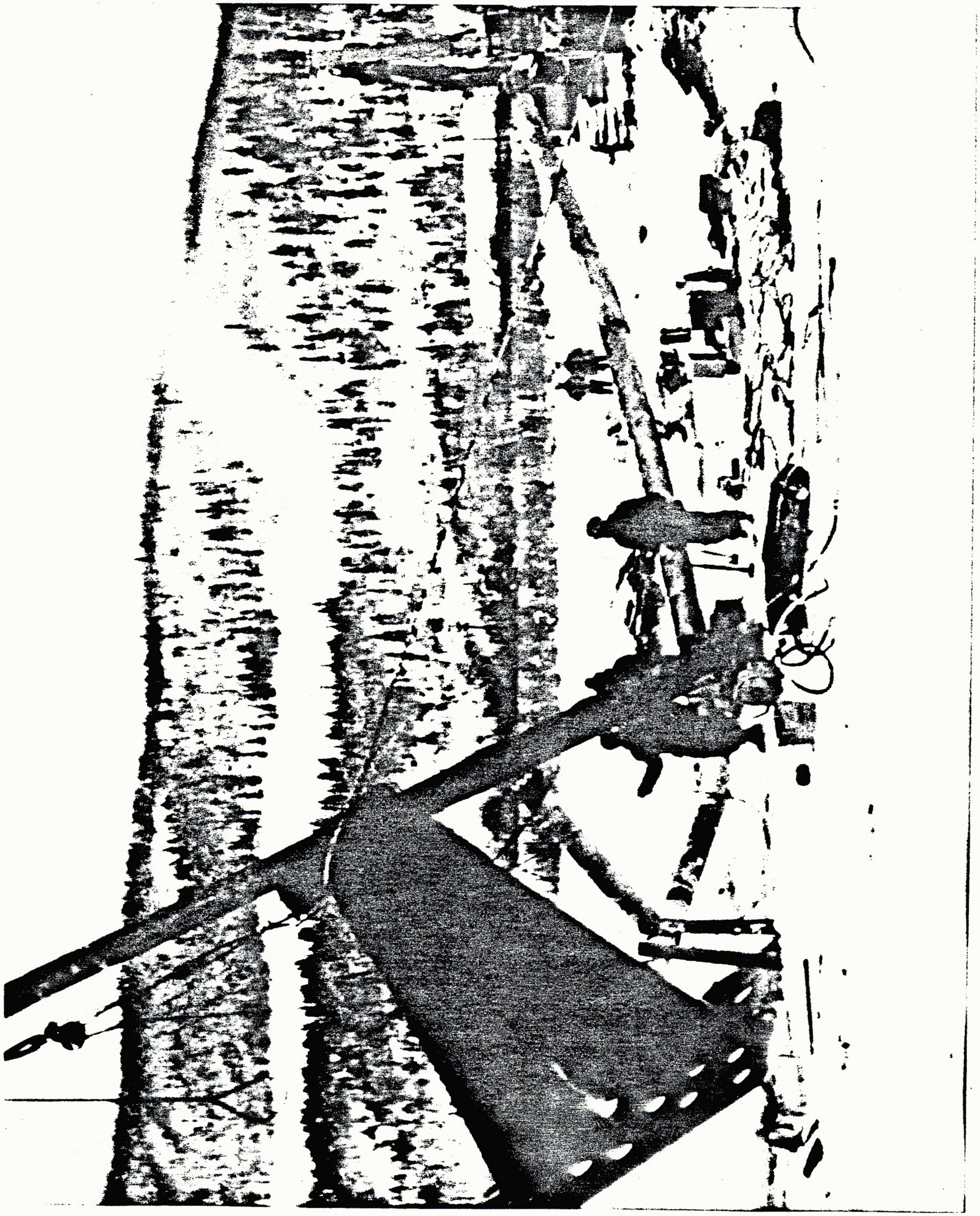
WATER DISTRIBUTION PUMPHOUSE – Dawson City



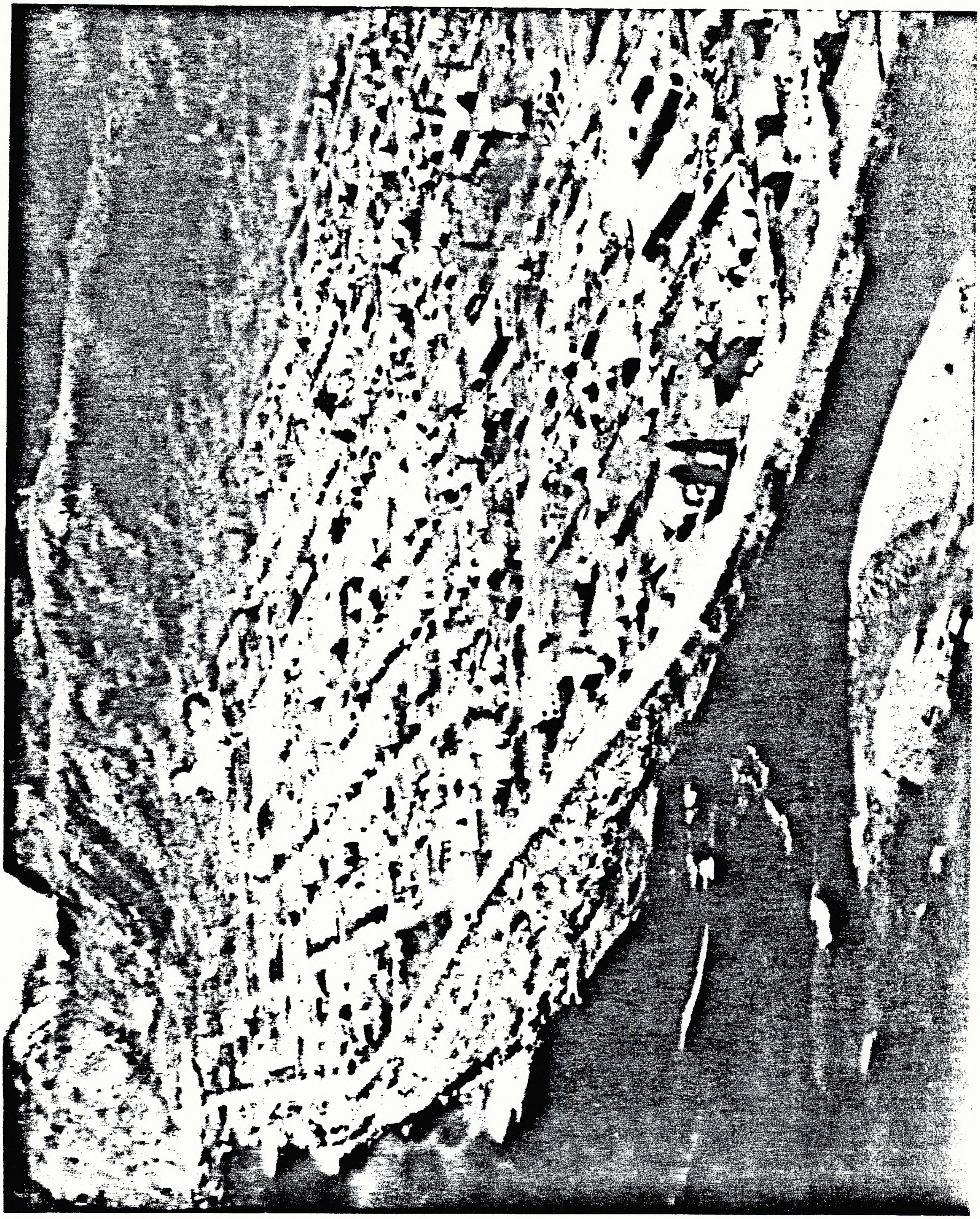
DAWSON CITY WATER SUPPLY SYSTEM

WATER SUPPLY LOOP SYSTEM – Dawson City

Stanley



SEWAGE OUTFALL – Dawson City



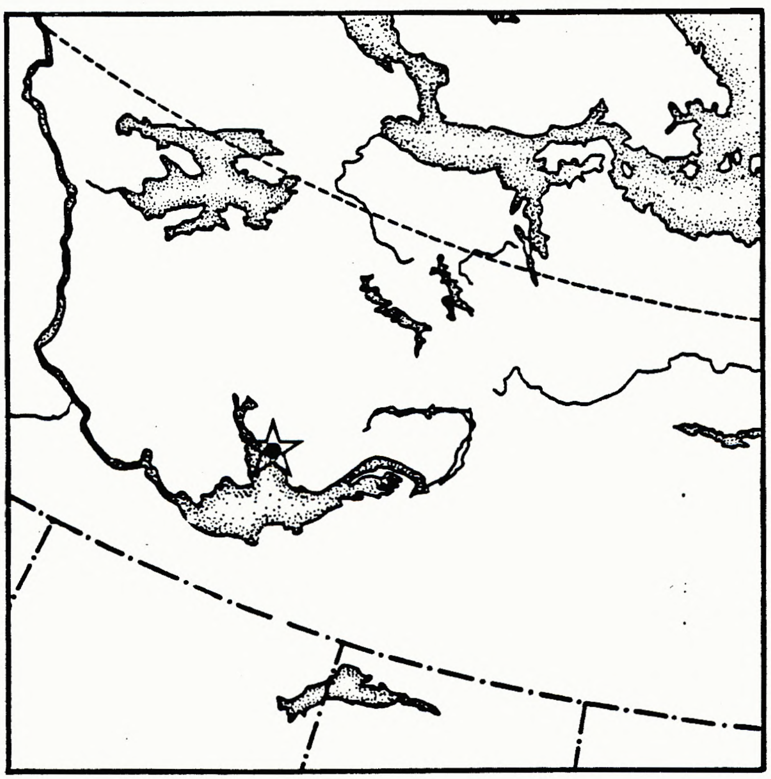
OVERVIEW – Dawson City

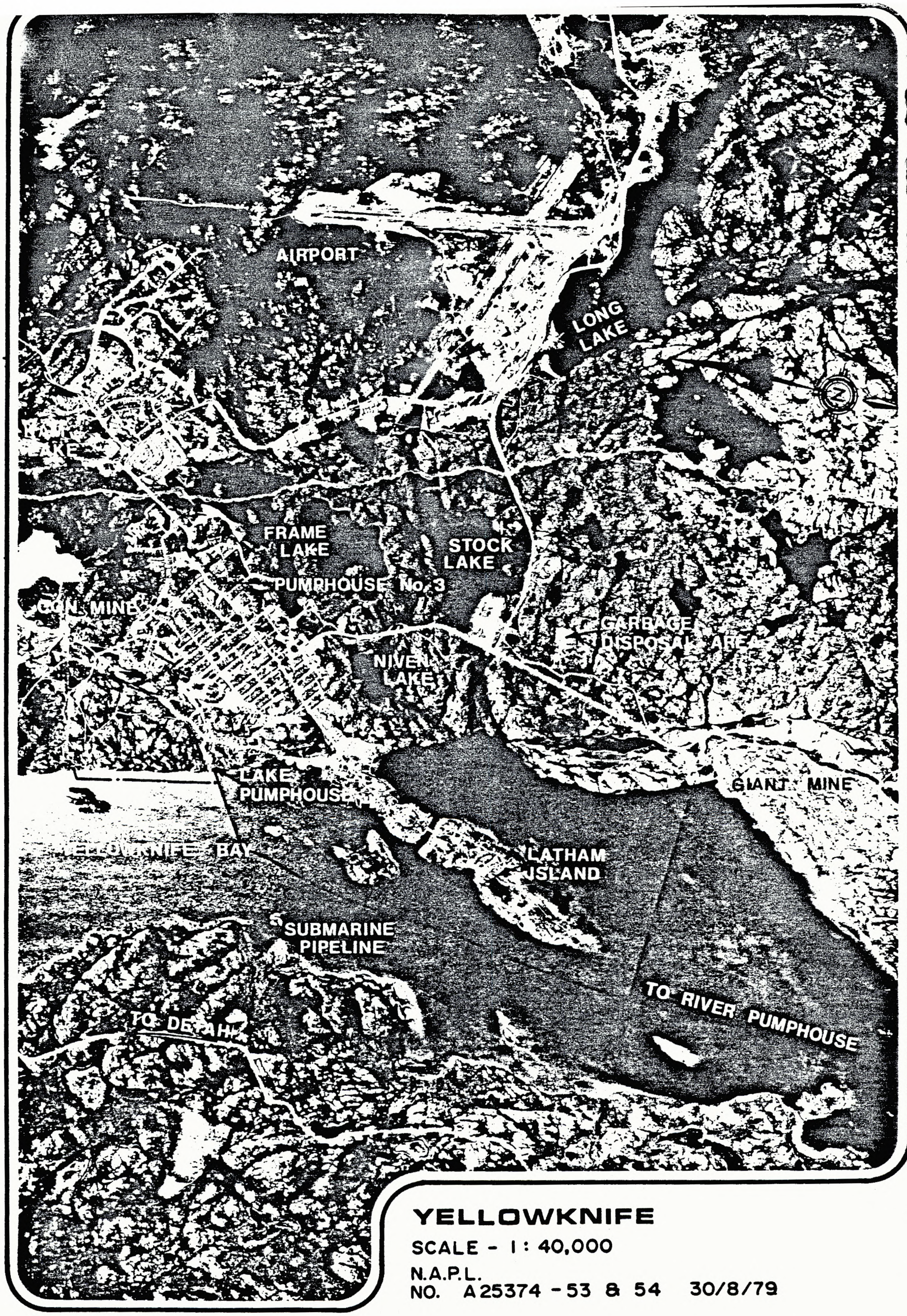
STANLEY ASSOCIATES ENGINEERING LTD. BROCHURES

ANNEX O

ANNEX O

Yellowknife





YELLOWKNIFE

SCALE - 1: 40,000

N.A.P.L.
NO. A25374 -53 & 54 30/8/79

Aerial view

A. GENERAL

A.1 Location

Yellowknife is located on the west shore of Yellowknife Bay, on the north arm of Great Slave Lake. It has co-ordinates of 62°28'N and 114°26'W and is about 960 km north of Edmonton by air. It is 1,524 km by road to Edmonton.

A.2 History

The name Yellowknife first appeared in Samuel Hearne's Journal of his travels to the Arctic Coast for the Hudson's Bay Company in 1771. The tribe of Indians inhabiting the area around Great Slave Lake were called Yellowknife Indians because he found them using utensils made of pure copper.

As a result of Sir Alexander Mackenzie's visit in 1789, a trading post known as Fort Providence was established near the mouth of Yellowknife Bay. This post was in existence when Sir John Franklin made his journey to the Coppermine River in 1820 but was abandoned shortly afterwards.

In 1934, visible gold was found on the shores of Yellowknife Bay. In 1936 and 1937, the Consolidated Mining and Smelting Company of Canada sank shafts and commercial gold production began. By 1940, Yellowknife was a 'boom-town' of about 1,000 people. Over the next few years, the population increased to about 3,000 on the peninsula which is called Old Town. In 1945 a new site was surveyed and occupied on the site where most of the City now exists. Also in 1945 a new rush started when Giant Yellowknife Mine opened. By the end of 1947, two mines were in large scale production. In the summer of 1953, Yellowknife became a Municipal District and the first mayor was elected. In 1967 Yellowknife was named capital of the Northwest Territories and on January 1, 1970 became the first City in the Territories. Yellowknife began as a gold mining town, and gold mining continues to be the major industry in the City at present.

A.3 Community Information

The population of Yellowknife has shown a drop of 3.7% between 1980/79 as shown by the following figures:

YEAR	POPULATION
1978	9,981
1979	9,918
1980	9,550

The population is about 10% native at present.

As the largest community in the Northwest Territories, Yellowknife has numerous schools, service clubs, organizations, churches and associations. It is the Territorial Government administrative capital of the N.W.T. as well as the base for many federal government departments and private companies operating in the Territories.

Yellowknife has a controlled airport with two paved strips, one being 2,286 m x 46 m and the other 1,524 m x 46 m. Numerous aircraft companies operate scheduled and charter air services from the airport and float bases located on Latham Island. Pacific Western Airlines provides regular air service from Edmonton, Winnipeg and Whitehorse to Yellowknife and other centres in the N.W.T.

A.4 Geology and Terrain

Yellowknife is located in an area that is typical of the Precambrian Shield. Four main rock types can be seen in the area namely, granites, volcanics, sediments, and late intrusions.

The topography is generally flat with many outcrops and small rocky hills in the area. The region is dotted with numerous lakes and much is covered with muskeg.

Permafrost is sporadic in the area and during the summer can be encountered 0.5 m below moss or muskeg, 3 m or more below the surface of sandy soils or non-existent in other areas.

A.5 Vegetation

Trees in the area are predominantly black and white spruce and pine with birch and poplar stands found in valleys and on occasional sand plains.

A.6 Climate

Yellowknife experiences mean high and low July temperatures of 20.4 and 11.3°C respectively. The January mean highs and lows are -23.4 and -32°C. The total yearly precipitation is about 254 mm and the prevailing winds are easterly at 8.9 knots.

B. MUNICIPAL SERVICES

B.1 Water Supply

B.1.1 General

Prior to 1969, the City of Yellowknife as well as Giant and Con Mines, obtained water directly from three separate intakes in Yellowknife Bay. Tailings entering the bay from mining operations were high in arsenic which made it necessary to obtain potable water from a point at the mouth of the Yellowknife River before it enters the bay.

In 1969 a new water intake was constructed on the Yellowknife River near its mouth and a 400 mm diameter submarine pipeline on the bottom of the Bay delivered water to serve the City and both mines. The Lake pumphouse was also upgraded to meet the City's increasing water demand and in 1971 a 2,273 m³ (0.5 Million Igal) reservoir was added to the system to meet demands in the westerly section of the City.

The water distribution is underground and for the most part can be considered conventional with systems similar to those in southern Canada except that recirculation and heating is provided for winter freeze protection.

B.1.2 Water Source

Yellowknife River water is of good chemical quality for use as a potable water source as shown by the values in the following chemical analysis obtained by DIAND Water Resources in 1979 and 1980. (All values in mg/L unless otherwise noted)

Parameter	Value	
	Dec. 13	June 26
ph	7.2	7.7
Colour	5	5 Units
Calcium (Ca)	4.4	4.8
Hardness (as $CaCO_3$)	15.3	14.1
Alkalinity (as $CaCO_3$)	13	8
Sodium (Na)	1.5	1.5
Potassium (k)	0.5	1.05
Chloride (Cl)	19.5	6.7
Sulphate (SO_4)	12.7	1
Nitrate (NO_3)	0.1	0.33
Phosphorous (P)	0.01	0.02
Arsenic (As)	0.005	0.005
Iron (Fe)	0.09	-
Lead (Pb)	0.05	-
Nickel (Ni)	0.05	-
Zinc (Zn)	0.02	-

B.1.3 Intake Facilities (Pumphouse No. 2)

The pumphouse at the river intake consists of the following pumping system:

1. Supply Pump (1)

   Type: Vertical Turbine
   Capacity: 114 L/s @ 909 kPa (1500 igpm @ 300 ft. TDH)
   Drive: 200 HP variable speed

Yellowknife River water intake (upstream of bridge)

Yellowknife River flowing into Bay

2. Supply Pump (1)
   Type: Vertical Turbine
   Capacity: 114 L/s @ 909 kPa (1500 igpm @ 300 ft. TDH)
   Drive: 200 HP constant speed

3. Standby Pump (1)
   Type: Vertical Turbine
   Capacity: 194 L/s @ 273 kPa (1283 igpm @ 90 ft. TDH)
   Drive: diesel engine

B.1.4 Submarine Supply Line
The 400 mm supply line from the intake pumphouse (Pumphouse No. 2) is 400 mm in diameter steel pipe with welded joints. It runs along the bottom of the bay to the Lake pumphouse as shown on the aerial photo. Both mines are served by the River Pumphouse through two branches from the main line. The branch line serving Giant Mine is 200 mm in diameter and the one serving Con Mine is 150 mm in diameter. In 1979 their combined consumption was 18.5% of the total water supplied from the River Pumphouse.

B.1.5 Lake Pumphouse (Pumphouse No. 1)
The lake pumphouse supplies water directly to the distribution system serving the whole City except for areas in the south end which are served by Pumphouse No. 3. The system at the Lake Pumphouse consists of the following:

1. Supply Pumps (2) (Added in 1979)
   Capacity: 63 L/s @ 630 kPa (833 igpm @ 208 ft. TDH)
   Drive: 75 HP electric

2. Supply Pumps (3)
   Type: Split case horizontal
   Capacity: 41 L/s @ 758 kPa (542 igpm @ 250 ft. TDH)
   Drive: electric motor

3. Circulation Pumps (2)
   Type: Split case horizontal
   Capacity: 23 L/s @ 185 kPa (300 igpm @ 61 ft. TDH)
   Drive: electric motor

A generator set of 150 KWA capacity supplies power to two supply pumps and the boiler or the three supply pumps during power failures.

For fire protection, the supply is drawn directly from the lake. The present fire pump is diesel driven with a capacity of 63 L/s @ 909 kPa (833 Igpm @ 300 ft. TDH). In 1982 new 600 mm (24 inch) diameter intake will be on-stream and the existing fire pump will be replaced with 2 new diesel driven, vertical turbine fire pumps each having a capacity of 19 L/s @ 876 kPa (250 Igpm @ 289 ft. TDH).

Prior to leaving the station, the water is heated to about 8°C during winter, by three boilers with a total capacity of 7,920 BTU/hr. The return flow from the water distribution system passes though the circulation pumps prior to re-entering the system. The water is also chlorinated at this point.

B.1.6 Pumphouse No. 3
Pumphouse No. 3 was designed to serve the southern end of the City including the areas known as Mattonabee, Forrest Park Stage 2, Northland Trailer Park as well as the Hospital and Correction Centre. The pump system consists of the following:

1. Supply Pumps (3)
   Type: Split case horizontal (electric motor driven)
   Capacity: 11.8 L/s @ 30.5 m TDH (142 igpm @ 10 ft. TDH)

Return flows from Mattonabee and the Correctional Centre are circulated through two circulating pumps prior to re-entering the line.

A diesel driven standby pump with a capacity of 63 L/s @ 70 m TDH (833 igpm @ 230 ft. TDH) is used for fire protection and also during power failures.

B.1.7 Pumphouse No. 4
Pumphouse No. 4 is located at the south end of the City beside the newly constructed 5,683 m³ reservoir. This station was sized to meet the ultimate design demand of the Frame Lake South Subdivision with a future population of 10,000 persons. It contains the following pumping equipment:

1. Supply Pump (1)
   Type: Vertical Turbine
   Capacity: 22 L/s @ 527 kPa (292 Igpm @ 174 ft. TDH)
   Drive: 25 HP electric
2. Supply Pump (1)
   Type: Vertical Turbine (variable speed)
   Capacity: 40.4 L/s @ 606 kPa (633 Igpm @ 200 ft. TDH)
   Drive: 50 HP electric
3. Supply Pump (1)
   Type: Vertical Turbine
   Capacity: 56.8 L/s @ 682 kPa (750 Igpm @ 225 ft. TDH)
   Drive: 75 HP electric

A 5 HP pump is used for recirculation of water in the system. The station is designed with provision for three more pumping systems to be installed as the demand increases.
It also provides heating of the water through the use of boilers.

B.2 Water Distribution
B.2.1 Piped System
Water distribution in the central business district and surrounding residential area consists mainly of 150 mm diameter ductile iron supply lines and 100 mm diameter single return lines. The lines are connected at the ends of blocks by 0.79 to 3.2 mm diameter orifices. The system includes two underground reservoirs. One is located at Pumphouse No. 3 and is 2,273 m³ (500,000 Igal) in capacity. The other reservoir completed in 1980, is 5,683 m³ (1,250,000 Igal) in size and is located in the relatively new Frame Lake Subdivision at the southern end of the City. These reservoirs provide equalization and fire protection storage.

A number of freeze protection methods for services have been tried over the past years. Ones that are still in use include Impedance heat tracing and other heat tracing types such as Pyrotenax, Thermon (13 watts/m) and Chemelex (26 watts/m). Pitorifices are used in some sections of the City when a single main circulation system is used. Almost all services are insulated. Approximately 98% of all water consumed in the City is metered.

Some bleeding still exists in certain sections of the City to prevent freezing during the winter.

B.2.2 Truck Delivery
About 140 residents are served by truck delivery. These are mostly located in the area of the City known as Old Town, including Latham Island. This area is very rocky and not considered to be cost efficient to be served by a conventional piped distribution system. During the summer months, much of the area is serviced by small diameter surface lines however. This truck delivery service is locally contracted.

Summer water lines in "Old Town"

B.2.3 Water Consumption
Following is a summary of the total water consumption within the City of Yellowknife for the year 1979.

	Million Litres	Million Imp.Gallons
1. Cominco Mines	146.8	32.3
2. Giant Mines	132.7	29.2
3. City of Yellowknife		
Metered	772.4	196.9
Un-Metered	15.9	3.5
Delivered	25.9	5.7
Surface Water Lines	25.0	5.5
Bleeders	181.8	40.0
Seepage, Water Breaks, Fires	90.9	20.0
	1,234.7	271.6
4. Total Water Pumped from River Pumphouse	1,513.8	333.0

B.3 Sewerage System
B.3.1 General
Sewage treatment for the City of Yellowknife began in 1948 with construction of a primary mechanical treatment plant which permitted settling and digestion of solids. This was located at the south end of the old townsite and it discharged into Niven Lake. This small, shallow lake (about 7.9 ha) overflowed into Yellowknife Bay. In 1962, use of the plant was discontinued and Niven Lake was used as a facula-

tive lagoon. In 1964 a primary short detention pond was added to the Lake to help overcome treatment inadequacy. At that time the level of treatment was relatively good with a calculated 99 day retention time and BOD_5 removal rates of about 77% being observed during the summer.

As the population increased, the removal efficiency of Niven Lake reduced drastically and alternate methods were explored. For the past half dozen years the majority of Yellowknife's sewage has been discharged to Kam Lake which overflows to a drainage system and ultimately to Great Slave Lake. Due to City expansion to the area of Kam Lake and the desire to preserve the water quality in the lake for possible future use, it was decided to pump all of the City's sewage into a drainage area west of Yellowknife. This drainage system consists of a series of small lakes and drainage channels which eventually discharges to Great Slave Lake.

B.3.2 Sewage Collection

B.3.2.1 Piped System

Most of Yellowknife's original collection system consists of corrugated metal sewers, largely 200 mm in diameter. Asbestos cement and ductile iron sewer pipes are also used in the City. Manholes are mostly of concrete block construction and are provided with 'frost covers' to help prevent heat loss from the system and thus prevent freezing.

The system is made up of several gravity sub-systems and four lift stations (i.e. School Draw Lift Station, Forrest Park Lift Station, Frame Lake South Lift Statin), and Mattonabee Lift Station. Construction will be completed in 1981 in Lift Station No. 5 located at the north end of Kam Lake. This station will be a split wet well type containing the following pumping system:

1. Main Pumps (2)

   Capacity: 158 L/s @ 485 kPa (2083 Igpm @ 160 ft. TDH)
   Drive: Electric (one 150 HP constant speed and the other 200 HP variable speed)

2. Standby Pump (1)

   Capacity: 253 L/s @ 394 kPa (3333 Igpm @ 130 ft. TDH)
   Drive: Diesel (200 HP)

An emergency overflow is provided at the station which will discharge to Kam Lake in station failure situations. This station is sized to handle all of Yellowknife's sewage and has a design peak capacity of 316 L/s (4167 Igpm). It will pump via forcemain to the Fiddler's Drainage Area for treatment.

This station will collect all of Yellowknife's sewage and discharge it through 8 km of HDPE, insulated forcemain (550 to 450 mm diameter) to the Fiddler's Drainage area west of the City.

B.3.2.2 Trucked System

About 140 residences mostly in Old Town are equipped with holding tanks and are on regular sewage pick-up service. The service is presently contracted locally. About 20 residences in Old Town remain on bagged sewage pick-up at this time.

B.4 Sewage Disposal

At present most of the City's sewage is discharged to Kam Lake which ultimately drains into Great Slave Lake. Some sewage still discharges to Niven Lake. The new system, expected to be operational by the fall of 1981, will utilize the Fiddler's Drainage Area west of the City. When operational, all of Yellowknife's sewage will be discharged into this series of lakes and drainages with ultimate discharge to Great Slave Lake. Work is being completed in the construction of dams to increase the capacity of holding ponds (to increase retention time and treatment capacity). Dams are also being constructed to divert the flow from Trappers Lakes into the Kam Lake drainage such that it will not enter the Fiddler Drainage Area. This drainage area has essentially been designated as a sewage treatment system. Over the following years, the system will be monitored to determine the effectiveness of treatment and if any modification or additions will be required in order to increase its efficiency.

B.5 Garbage Collection and Disposal

Garbage collection is contracted locally to Kavanaugh Bros. Ltd. who utilize a number of back loading type compactor units for regular garbage pick-up. Garbage is disposed at the dump area located about 2 km north of Yellowknife. The City maintains the dump area using a landfill operation.

B.6 Roads and Drainage

Most of the streets within the City are paved with asphalt. The roads outside the built-up area are gravel surfaced. Drainage is handled on the surface through the use of gutters, culverts and ditches. In the built-up areas, drainage is assisted through the use of gutters, catchbasins and storm sewers which ultimately discharge to Great Slave Lake.

B.7 Fire Protection

Fire protection in Yellowknife consists of the following:

2 fire halls

4 fire trucks (4 Triple Combination pumpers, one with aerial)

9 full time staff plus 26 volunteer firemen

Also included are a full time fire chief, emergency vehicle, patrol van, tanker and ambulance.

B.8 Other Services

Other services in Yellowknife include an RCMP detachment, Stanton Yellowknife Hospital, education facilities to grade 12, churches, community centre, library services, museum, 2 radio stations, Anik satellite and cable TV services as well as numerous communication, media, contractor, financial, professional, and property companies plus many local and branch retail and wholesale businesses. NCPC provides power from hydro generation facilities at the Snare Hydro Development north of Yellowknife augmented by diesel generation facilities within the City.

INFORMATION SOURCES

1. Reid, Crowther & Partners Limited, *The City of Yellowknife - Report on Water Distribution System -Volume I,* March, 1977.

2. Reid Crowther & Partners Limited, *The City of Yellowknife - Report on Central Business District Sewer System* - March, 1977.

3. Reid Crowther & Partners Limited, *City of Yellowknife - Sewage Disposal Study - Stage I Report,* January 24, 1978.

4. Reid Crowther & Partners Limited, *City of Yellowknife - Sewage Disposal Study - Stage II Report,* March 29, 1979.

5. Discussions with Mr. J. Kraft, Development Director and Mr. R. Walton, Engineering Supervisor, City of Yellowknife, Fall 1980.

6. DIAND Water Resources Staff - Water Quality Data.

7. Personal communication, Mr. R. Boone, Reid, Crowther & Partners, Yellowknife.

ANNEX P

ANNEX P PART 1 of 3

REGIONAL MUNICIPALITY OF OTTAWA - CARLETON

WORKS DEPARTMENT WATER SUPPLY DIVISION

BRITANNIA
WATER PURIFICATION PLANT

F.E. AYERS
WORKS COMMISSIONER

J.N. PRITCHARD
DIRECTOR OF WATER SUPPLY

REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

WORKS DEPARTMENT - WATER SUPPLY DIVISION

BRITANNIA WATER PURIFICATION PLANT

This plant was completed in 1961 on a 44 acre site at the foot of Deschenes Rapids on the Ottawa River. The plant process includes coagulation, sedimentation, filtration and chlorination, at a rated gross capacity of 245 500 m^3/d (54 m.g.d.). Principle design features include extensive automation, diesel standby facilities, provision for future doubling of capacity, and ability to shut down one-half of the plant for major maintenance works without interruption to the other half.

INTAKE

Raw Ottawa River water is conveyed into the plant from a depth of approximately 9 m (30 ft.) via 425 m (1400 ft.) of 198 cm (78 in.) and 168 cm (66 in.) concrete pipe, laid along the river bottom. At the main intake well, the two principle water treatment chemicals are added, aluminum sulphate for coagulation and chlorine for disinfection. The chemically-treated water then passes through travelling screens, having a mesh size of 1 cm (3/8 in.), and designed to remove any large foreign matter such as leaves, wood, etc.

LOW LIFT PUMPS

The low lift pumps draw the water from the intake well, discharging into twin 122 cm (48 in.) diameter lines which transport the water to the first phase of the treatment process, the mixing chambers. From that point, the water flow is totally by gravity to the termination of treatment. A total of five low lift pumps are provided, four at 600 m^3/d (14 m.g.d.) each, and one at 95 000 m^3/d (20,9 m.g.d.).

MIXING CHAMBERS

The mixing chambers are designed to provide the gentle spiral mixing action necessary to complete the coagulation process. Each chamber is 7.3 metres (24 ft.) deep and 5.3 m (17.5 ft.) square. The water passes through three chambers before discharging into the settling tanks. At rated capacity, detention time in this process is about 40 minutes. Activated silica is added at the first mixing tank to aid in floc formation during the slow-mixing process.

SETTLING TANKS

The water now passes very slowly through three settling basins, during which 80% to 90% of the coagulated material settles out. At the discharge end, settled water is drawn from the surface and transported to the filter building. Each settling basin is 7.5 m (24.5 ft.) in depth, 16.5 m (54 ft.) in width and 66 m (217 ft.) in length, and has a water holding capacity of 7 700 m^3 (1.7 m.g.). The detention time in this process at rated capacity is about 3 hours. Accumulated sludge is removed from the settling basins at approximately 6 week intervals.

FILTERS

The filter building houses twelve anthracite/sand filters, each having a capacity of 20 500 m^3/d (4.5 m.g.d.). Settled water passes by gravity through a filter bed consisting of 56 cm (22 in.) of anthracite coal and 30 cm (12 in.) of sand. In the process, virtually all remaining coagulated material is removed, and the filtered water is collected by an underdrain system and piped to a clearwell (reservoir) which is located beneath the filter building. This clearwell has a capacity of 10 000 m^3 (2.2 m.g.).

FILTER BACKWASH

After a variable time of operation (24 - 96 hrs.) filtration efficiency is lowered to the point where the filter must be taken out of service for backwashing. In this process, which takes only 8 - 10 minutes, clearwell water is pumped upward through the filter at a high rate of up to 118 000 m^3/d (26 m.g.d.). This removes all material collected during filtration and discharges it into wash water troughs for disposal to waste. High pressure water jets incorporated in rotary agitators sweep across the surface of each filter bed to aid the cleansing process. Each washing procedure consumes approximately 450 m^3 (100,000 gals.) and total washwater consumption averages 2% - 3% of plant production.

CHEMICAL MIXING TANK

Filtered water from the clearwell passes through a baffled chemical mixing tank where final treatment chemicals are added, hydrated lime for pH correction, sodium silicofluoride for fluoridation, and chlorine for disinfection.

HIGH LIFT PUMPS

The final treated water now is pumped into the distribution system via two sets of high lift pumps, one set operates at a total head of 65.5 m (215 ft.) supplying Pressure District 1W, and consists of one 31 800 m^3/d (7 m.g.d.) and one 63 600 m^3d (14 m.g.d.) pump. The other set operates at a total head of 78 m (256 ft.) supplying a higher Pressure District 2W, and consists of one 45 000 m^3/d (9.9 m.g.d.) and one 90 000 m^3/d (19.8 m.g.d.) pump.

Two diesel-driven high lift pumps having capacities of 90 000 m^3/d (19.8 m.g.d.) and 95 500 m^3/d (21 m.g.d.) are on emergency standby.

STANDBY POWER

In the event of hydro power failure, plant operations can proceed up to a capacity of 185 500 m^3/d (40.8 m.g.d.). The use of a 1 305 kW (1750 H.P.) diesel-generator set for low lift pumping and auxiliaries and the two diesel-driven high lift pumps makes the plant self sustaining.

CHEMICAL HANDLING/FEEDING

The treatment process uses large quantities of bulk chemicals, requiring extensive storage and feeding facilities. Aluminum sulphate is supplied in a liquid form and is stored in an outdoor insulated tank. Chlorine is supplied in steel cylinders, each containing one ton of liquid chlorine. Pebble quicklime is stored in concrete silos and is slaked on site to produce a hydrated lime solution. Sodium silicofluoride is a dry granular material, available only in a bagged form. Activated silica is produced on site using liquid sodium silicate from bulk storage tanks and liquid alum for activation. Chemical feed systems are duplicated, one in operation with the other on stand-by. Chemical feeders are designed for high accuracy feeding, and rate of feed is precisely paced with water flow. Verification of proper dosage rates is carried out by constant monitoring of weights and volumes used, and testing of various key water quality parameters.

GENERAL PLANT CONTROL

The main control room houses the principle hydraulic/electric control elements for the plant. From this control room pumps are actuated and flows and pressures are monitored. Throughout the plant a multitude of pneumatic and electronic devices control or monitor processes such as filtration rates, water levels, filter effluent turbidity, and chlorine residuals.

LABORATORY

A completely equipped water analysis laboratory is located in the Administration Building. Quality control is performed on bulk chemicals received at the plant and on both raw and treated water for physical, chemical, bacteriological and radiological characteristics. Tests to determine the amount of chemicals required for treatment, and chemical analyses pertinent to the plant's operation are performed routinely.

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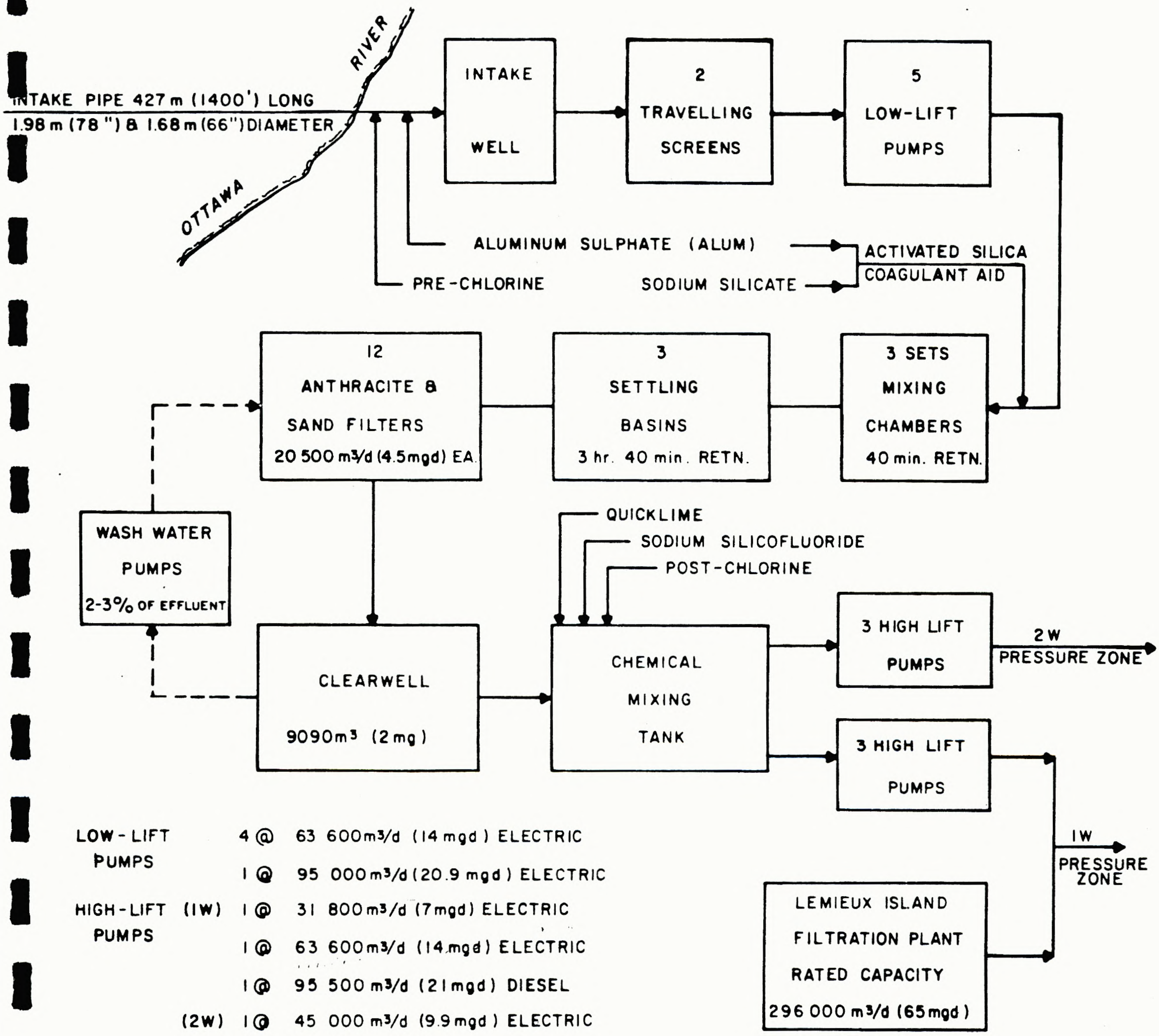
REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

WORKS DEPT. WATER SUPPLY DIVISION

FLOW DIAGRAM

BRITANNIA WATER FILTRATION PLANT AND PUMPING STATION

RATED CAPACITY - 245 000 m³/d (54 mgd)



LOW-LIFT PUMPS		4 @	63 600 m³/d (14 mgd) ELECTRIC
		1 @	95 000 m³/d (20.9 mgd) ELECTRIC
HIGH-LIFT PUMPS	(1W)	1 @	31 800 m³/d (7 mgd) ELECTRIC
		1 @	63 600 m³/d (14 mgd) ELECTRIC
		1 @	95 500 m³/d (21 mgd) DIESEL
	(2W)	1 @	45 000 m³/d (9.9 mgd) ELECTRIC
		1 @	90 000 m³/d (19.8 mgd) ELECTRIC
		1 @	90 000 m³/d (19.8 mgd) DIESEL
GENERATOR			1305 KW (1750 H.P.) DIESEL

REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

WORKS DEPARTMENT

WATER SUPPLY DIVISION

Water Purification and Chemical Treatment

Treatment Process

General

The Ottawa River is the main supply of raw water for the Ottawa-Carleton Region, being the source for both the Lemieux Island and Britannia Water Purification Plants. The water is typical of Eastern Canadian surface waters, being high in colour, low in turbidity, and relatively soft.

Treatment at both purification plants is designed to remove most of the colour, which originates from decayed vegetation throughout the heavy forested Ottawa River water-shed. It also destroys all disease-producing bacteria and viruses, removes suspended particles, and provides a sparkling clear water which is both aesthetically acceptable and desirable to the consumer. The object of a water treatment plant is to use the most effective process and equipment in removing undesirable impurities, and to render a finished water which is odourless, colourless, and bacteriologically safe for human consumption.

Pre-chlorination

Chlorine gas is continuously dissolved in a stream of water and the resultant solution added to the incoming raw water just prior to the intake well. The pre-chlorination step destroys algae, bacteria and viruses; oxides certain taste and odour causing materials; prevents growth of biological slimes within the plant; and retards sludge decomposition in the settling basins.

Coagulation/Alum

The addition and rapid dispersion of liquid aluminum sulphate (alum) to produce a jelly-like pinpoint floc with the incoming water. This insoluble floc attracts and enmeshes colour particles, bacteria, and suspended solids during its formation.

Coagulant Aid/Silica

To assist in forming a tough floc with improved size and settling characteristics, activated silica is added shortly after the main alum addition. Liquid sodium silicate is continuously "activated" with a small amount of alum to form a fine silica colloid. Increased silica dosages are required during cold water conditions or when high pumping rates are necessitated.

Flocculation/Slow Mix

A process in which the small pinpoint floc particles, along with "activated silica", are mixed in a series of spiral flow mixing chambers. The gentle mixing promotes collisions and attractions to form larger, more dense floc particles, which are easier to settle under quiescent conditions.

Settling/Sedimentation

The flocculated water is passed through large settling tanks at a very slow rate, in order to allow most of the floc to settle out. This slow passage allows 70 to 90 per cent of the floc and other suspended matter to be removed by gravity. The cleaner "surface water" is then collected by a weir system and conveyed through a "settled water" duct to the filters.

Filtration

Fine suspended particles not removed by settling, are removed by passage down through a dual media filter consisting of a bed of sand and anthracite. The water passes first through a layer of relatively coarse anthracite coal during which the majority of suspended particles are removed. The next layer of fine sand acts as a "polishing" filter and removes virtually all of the remaining suspended matter. The filtrate is collected as a sparkling clear and colourless product in a "clear well" reservoir.

pH Correction

Since the alum treatment produces an acidic water (pH 5.5 to 6.0), it is necessary to correct this condition to control corrosion throughout the distribution system. Lime is slaked in the plant to produce a dilute lime solution. This is added to filtered water in controlled quantities to give a slightly alkaline finished water with a pH of approximately 8.5.

Post Chlorination

Since most of the chlorine added in the pre-chlorination step is consumed within the plant, further (post) chlorination is required to provide disinfection properties for the finished water as it passes through the distribution system. Continuous monitoring and recording of the effluent assures a constant chlorine residual of 0.90 mg/l in the finished water.

Fluoridation

Fluoridation of all finished water to a level of 1 mg/L of fluoride ion (F) is accomplished by the controlled and precise addition of either sodium silicofluoride (a dry granular product) or fluosilicic acid (a liquid). Monitoring of final fluoride residual is conducted on a continuous basis at the purification plants.

Water Characteristics

Water is the most prevalent compound on the planet earth, and is called both the "universal solvent" and the essential "fluid of life". Approximately 97% of the earth's supply is tied up in the oceans as salt-water, 2% is in the form of glaciers at both the north and south poles and the remaining 1% constitutes the fresh-water contained in rivers, lakes, and underground reservoirs. Most fresh water sources contain varying amounts of dissolved and suspended compounds, since chemically pure water does not exist in nature. Some of the compounds may impart a slight taste to water; whereas, chemically pure "distilled water" is normally found to be "flat" and "unpalatable" to humans.

Certain water quality criteria have been established for the production of a "pure drinking water". These criteria are based on specified limits of contaminants or minerals which will provide a palatable water, free from disease-causing bacteria, and aesthetically acceptable to the consumer. Limits for drinking water quality are based on physical, chemical, microbiological, and radiological measurements.

Physical

The physical measurements which affect the water quality are: colour, odour, taste, temperature, turbidity and pH. These parameters have the most direct influence on the consumer, although other health-related factors are more important when producing a potable drinking water. Colour and turbidity are removed from the Ottawa River water through the process of coagulation. In this process the natural colour colloids and suspended particles are absorbed into floc particles, and subsequently removed by the settling and filtering process.

Objectionable odours and tastes are rarely encountered, but when evident, a slurry of fine activated carbon is applied to the incoming raw water. The carbon absorbs some of the objectionable compounds, and then is removed via the settling process.

Water temperature is strictly dictated by the seasons, whereas pH is controlled over a range of 5.5 to 6.0 through addition of the aluminum sulphate (alum).

Chemical

The chemicals found in drinking water may consist of both dissolved and suspended impurities. They may be inorganic, organic organometallic or heavy metals, and usually find their way into the water-course via rain water. As rain falls it removes gases and particulates from the air, washes the surface of land and roadways, and percolates through the ground and rocks to nearby streams and lakes. Many fine silts and clays, as well as calcium, magnesium, iron, chlorides and sulphur compounds are commonly carried into surface water supplies. Numerous organic pesticides, herbicides petroleum compounds and heavy metals such as lead, cadmium, mercury and silver could present a health hazard if found in excessive concentrations.

To assure a safe supply of water for drinking purposes, both the raw and finished waters are tested for chemical constituents. Some chemicals are monitored continuously such as residual chlorine and fluoride content, whereas others are checked on a less frequent basis as required. Trace metals and specific chemicals which are of extreme low concentration or of minor health significance, are only analyzed occasionally in both raw and finished waters.

Microbiological

The bacteriological quality of drinking water has been a major consideration because of its association with waterborne diseases. Typhoid fever, diptheria, cholera and several other intestinal diseases which are known to be transmitted by water, have been decreased by over 98 per cent in Canada during the last 50 years. This is primarily due to chlorination, and to the strict supervision and control over quality of public water supplies. A group of non-pathogenic bacteria called "coliforms" are used to evaluate the adequacy of treatment within the purification plant, and as well in assessing the quality of the treated water throughout the distribution system. The absence of "total coliform" organisms and the more specific pollution indicators "fecal coliforms", is confirmation of a bacteriologically safe drinking water. Samples of raw river water, filtered water, and finished water are taken daily at both plants to confirm treatment efficiency, and at 18 locations throughout the central supply distribution system to verify that a coliform-free drinking water is reaching the consumer.

Viruses do not lend themselves to routine quality control, whereas the coliform group of bacteria are an excellent routine indicator of the sanitary protection provided. Twice weekly testing is also carried out for the general bacterial population which, although not specifically harmful to humans, may indicate any deterioration of water quality within the distribution lines or reservoirs. Algae determinations are made frequently on both raw and finished water. Certain algae can produce raw water taste and odour problems which may be described as grassy, weedy or fishy, while others having a branch and star-shaped configuration may cause filter clogging.

Radiological

Radioactivity in water supplies originates from either naturally occurring or man-made radionuclides. Tritium and radium - 226 are the most common of the natural occurring compounds, with strontium - 90, iodine - 131 and cesium - 137 originating from nuclear energy and weapons testing programs.

To provide a general background of man-made radioactivity and a routine screening technique, the raw and finished waters are examined monthly for gross beta activity. The results are given in picocuries per litre of water, and fall within the desirable limit of 100 pc/L established by the Ministry of Environment of Ontario.

PHYSICAL, CHEMICAL AND BACTERIOLOGICAL CHARACTERISTICS OF

OTTAWA RIVER WATER, RAW AND TREATED, OTTAWA, ONTARIO

ALL ANALYTICAL RESULTS FROM SAMPLES TAKEN DURING 1984
AT BOTH BRITANNIA AND LEMIEUX ISLAND WATER PURIFICATION PLANTS

Constituent	Raw Water			Treated Water		
(mg/L unless otherwise noted)	Min.	Max.	Mean	Min.	Max.	Mean
Physical						
Temperature, C	0	24.2	10.0	1.5	24.1	11.8
Colour, Hazen Units	32	75	42	2	6	4
Turbidity, N.T.U.	1.1	25.0	2.8	0.11	2.3	0.37
Threshold Odour, T.O.N.	1.0	2.0	1.3	1.0	1.4	1.1
Chemical						
pH	6.9	7.5	7.2	8.3	9.4	8.8
Total Alkalinity, CaCO3	12	33	19	15	39	24
Total Hardness, CaCO3	14	60	31	32	64	51
Calcium Hardness, CaCO3	8	32	20	24	58	40
Magnesium Hardness, CaCO3	2	28	11	4	24	10
Spec-Cond., Microhos/cm at 25 C	42	103	71	62	152	116
Suspended Solids	0.8	19.4	3.8	--	--	--
Dissolved Solids	41.2	124.2	63.0	--	--	--
Total Solids	43.8	127.2	67.3	55.6	136.0	81.7
Dissolved Oxygen, O_2	6.5	12.8	9.4	7.0	13.1	9.6
Stability Index	--	--	--	7.7	8.7	8.5
Chloride, Cl	1.5	5.0	2.9	2.5	6.0	4.3
Fluoride, F	0.05	0.05	0.05	0.55	1.20	1.00
Aluminum, Al	0.120	0.190	0.150	<0.01	0.72	0.055
Ammonia Nitrogen, N	0.01	1.04	0.26	<0.01	1.23	0.19
*Arsenic, As	<0.001	0.001	(<0.001)	<0.001	0.001	(<0.001)
*Barium, Ba	0.010	0.015	0.013	0.008	0.015	0.012
*Cadmium, Cd	<0.0002	0.005	(0.0008)	<0.0002	0.005	(0.0008)
Calcium, Ca	3.2	13.0	7.7	13.0	23.0	16.3
*Chromium, Cr	<0.001	<0.003	(0.002)	<0.001	<0.003	(0.002)
*Copper, Cu	0.018	0.072	0.033	0.002	0.034	0.009
Iron, Fe	0.11	0.96	0.33	0	0.59	0.07
*Lead, Pb	<0.003	<0.003	(<0.003)	<0.003	<0.003	(<0.003)
Magnesium, Mg	0.92	6.4	2.6	0.92	5.5	2.3
*Mercury, Hg(ug/L)	0.05	0.70	0.31	0.06	0.75	0.36
*Nickel, Ni	<0.001	<0.003	(<0.002)	<0.001	<0.003	(<0.002)
Nitrate Nitrogen, N	0.07	0.30	0.19	0.02	0.29	0.18
*Phenols, (ug/L)	<0.2	1.2	0.7	<0.2	1.0	0.6
*Phosphate (Total), P	<0.01	<0.04	(<0.02)	<0.01	<0.03	(<0.02)
*Potassium, K	0.65	0.90	0.75	0.65	0.80	0.70
Silica, SiO_2	3.2	6.4	5.0	2.3	5.9	5.0
*Silver, Ag	<0.005	<0.005	(<0.005)	<0.005	<0.005	(<0.005)
*Sodium, Na	1.2	2.4	1.7	1.4	2.4	1.9
Sulphate, SO_4	8	14	11	14	30	24
*Zinc, Zn	0.002	0.004	0.003	0.002	0.005	0.003
Microbiological						
Standard Plate Count/ml. at 37C	20	2300	640	<10	1600	40
Total Coliforms (x10/L)	5	7400	155	0	0	0
Faecal Coliforms (x10/L)	2	335	30	0	0	0
Algae, A.S.U./ml.	14	372	61	0	<1	<1
Radiological						
Gross-Beta Radioactivity(Bq/L)	0.03	0.12	0.065	0.02	0.09	0.05

( ) Estimated value due to limited absolute results
* Analysis performed three times during 1984
** Geometric mean of daily samples

CENTRAL SUPPLY SYSTEM - 1984 OPERATING STATISTICS
LEMIEUX ISLAND AND BRIATANNIA FILTRATION PLANTS

	Metric	British
Total Water Production (1)	112 171 708 m^3	24,675 m.i.g.
Total Filter Backwash Water	1757.475 m^3	386.59 m.i.g.
Average Day Consumption	306 421 m^3	67,405,000 i.g.
Maximum Day Consumption (2)	442 728 m^3	97,388,000 i.g.
Maximum Hour Consumption (3)	688 400 m^3/d	151.43 m.i.g.d.
Average Daily Per Capita Consumption	595 L	131 i.g.
Population Served (1)	515,000	
Hydro Power Consumption	23 756 400 kWh	
Chemical Consumption (Average Dosages)		
Aluminum Sulphate (31 mg/L)	3 608 289 kg	7,954,782 lbs.
Chlorine, Pre- (1.57 mg/L)	181 230 kg	399,537 lbs.
Post-(1.04 mg/L)	116 378 kg	256,565 lbs.
Sodium Silicate (0.92 mg/L as SiO_2	347 076 kg	765,159 lbs.
Quicklime (13 mg/L as Ca O)	1 505 073 kg	3,318,062 lbs.
Hydrofluosilicic Acid (0.86 mg/L as F)	456 111 kg	1,005,536 lbs.
Sodium Silicofluoride (0.86 mg/L as F)	6 235 kg	13,746 lbs.

(1) Supply to Cities of Gloucester, Kanata, Nepean, Ottawa and Vanier, Village of Rockcliffe Park and Townships of Cumberland and Goulbourn.

(2) 23 June, 1984

(3) 3 July, 1984

METRIC CONVERSIONS

1 Million Gallons (m.g.)	-	4 546 cubic metres (m^3)
1 Gallon (g)	-	4.546 litres (L)
1 Pound (lb.)	-	0.4536 kilograms (kg)
1 Foot (ft.)	-	0.3048 metres (m)
1 Pound Per Square Inch (p.s.i.)	-	6.89 kiloPascals (kPa)

11 April 85