Water and Sewer Study

Iqaluit

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MAY 2002

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Executive Summary

The City is experiencing high growth. It anticipates that the population will rise from the current 5,510 to the 20-year design of 11,300 in 2021 and will ultimately reach 12,000. This growth will increase the demand for water and sewer services.

The demand for water was evaluated. An average consumption rate of 123 L/c/d was used for trucked service demand. The average historical consumption rate on piped services was estimated as 277 L/c/d based on plant production records. Consumption rates will likely increase with population growth and with the extension of piped services. Demand on the piped systems was projected using the City's design standard of 400 L/c/d.

The major infrastructure components that were evaluated included the raw water source and storage, water treatment and storage, transmission, distribution, freeze protection, and sewage collection. Sewage treatment was not evaluated as it is under separate review.

Lake Geraldine is the raw water source. The City is currently consuming 28 percent of the average annual precipitation in the Lake Geraldine watershed. The actual amount of water that runs off into the lake is unknown. A study is recommended to determine the actual watershed yield. A dam on Lake Geraldine stores the raw water. The last dam extension was designed to serve a population of 6,202, which will be reached in 2005 at projected growth rates. An additional 402,000 cubic metres of storage capacity will be required to serve the 20-year design population. The method of obtaining this storage capacity requires further study.

An inlet line transmits raw water to the water treatment plant. The treatment plant occasionally operates beyond its capacity. A program to upgrade the capacity of the plant is underway. Earth Tech (2002) reports that the expanded plant will serve a population of 11,300 to the year 2021. The inlet line is included in the scope of work. A main reservoir and four tanks store the treated water. Upgrades in storage capacity will be required as early as 2003. At that time, an increase in fire storage should be evaluated.

A network of watermains and recirculation lines and a booster station distributes water to the City. The pressure limits of this distribution system are given in Figure 2 of the report. The condition of the system appears to be satisfactory. Consideration should be given to replacing the segments of above ground asbestos cement piping. The performance of the system was analysed using the Cybernet model provided by the City. The water system appears to provide adequate domestic pressures. The distribution system has the capacity to provide fire flows of 2,200 L/min. Additional fire protection may be required in areas of higher risk such as at the airport. A watermain extension to the airport will improve the fire flows in this area.

Freeze protection is required to ensure the integrity of the distribution system is not compromised by water freezing in the mains. Freeze protection is achieved through constant circulation, heat input, and reliable circulation patterns. The system contains four re-heat stations. The stations must have sufficient capacity to replace heat loss and to move sufficient water to prevent freezing. The heat loss in each service area was determined. The boilers and pumps have sufficient capacity for current needs and will tolerate some growth.

The sewage collection system consists of a network of sewers, two dumping stations (only one in operation), two pumping stations, and forcemain. The servicing limits have been determined. The condition of the sewers was assessed. The above-ground asbestos and corrugated steel piping should be considered for replacement. The flow in the sewers was determined. Generally, the sewers have sufficient capacity. The capacity in some sewers is critical. The sewer between AV-243 and the dumping station may require upgrades as early as 2002. Findings regarding the condition of the sewage pumping stations are presented. The capacity of the stations has been evaluated. Station 1 will serve 400 additional persons and Station 2 will serve 600 additional persons at 400 L/c/d. The timeframe for upgrades will depend on development. Station capacity can be upgraded with new pumps. Beyond that, major station modifications or replacement is required. The remaining capacity in the sewage system should be monitored and reviewed as development advances.

An inventory and assessment of 250 access vaults (AVs) and manholes (MHs) has been prepared under separate cover. Based on field data from the fall of 2001, 85 of the AVs and MHs were in good condition, 102 were in fair condition, 36 were in poor condition, and 27 could not be assessed. A list of common characteristics for these categories is given in Table 15 of the report.

Previous system expansions have occurred, which were assessed by RCPL (1989). Some phases proposed by RCPL (1989) are complete. Missing phases have had implications on service and performance. The existing system can expand north of Airport Road and west of Apex Road to the Federal Building Complex, in the Uivvaq Loop area, and in the Lower Base area. Four phases of expansion are proposed. It is recommended that phasing proceed as shown. Lower Iqaluit has limited potential for infilling given the lack of vacant space. Redevelopment at higher densities should be considered to accommodate growth.

Development beyond the existing servicing limits will require major infrastructure. Two potential development areas that were previously identified by the City for evaluation by Trow (1999) are presented in the report. The cost for expanding services into these areas is estimated as $49,064 per lot for 130 lots and $55,263 per lot for 98 lots. At a density of four persons per lot, these areas cannot accommodate future growth. Development at higher densities should be considered. Development off the Road-to-Nowhere will also require major infrastructure including a booster station with re-circulation and re-heat capabilities. Development in this direction may impair the quality of the raw water source. It is recommended that no development occur within the watershed of Lake Geraldine.

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1 Introduction

1.1 Background

The City of Iqaluit (the City) is currently experiencing a high growth period associated with becoming the Capital City of Nunavut. This growth will increase the demand for water and sewer services, which will have a significant impact on the existing water and sewer infrastructure systems.

The City engaged Trow Consulting Engineers Ltd. (Trow) to conduct a water and sewer study. The purpose of the study is to investigate the ability of the existing water and sewer system to accommodate current and future needs and to identify required upgrades in response to growth. The study is a tool designed to provide background information needed for planning and managing the City's growth over the next twenty years.

The study includes a separate evaluation of the impact on the water and sewer systems from the short-term influx of visitors during the 2002 Arctic Winter Games.

1.2 Scope of Study

The study objectives are:

1. to review the ability of the existing water and sewer system to respond to current and future demands,
2. to identify the required upgrades, and
3. to identify potential expansion and development alternatives.

This investigation consisted of the following tasks:

- Determine requirements for water supply, treatment, and storage.
- Conduct an inventory and evaluation of the capacity, utilization, and the maximum service population of the existing infrastructure and a timeframe for upgrades.
- Prepare a graphical presentation of servicing limits of the existing water and sewer systems.
- Conduct a hydraulic analysis of the existing water system at current and future demands and graphically show existing water pressures and available fire flows.

- Prepare a description of the freeze protection system including schematics of each of the loops and conduct an analysis of the current re-heat and re-circulation capabilities.
- Prepare a phased plan for upgrading the current system to expand the current service area and improve system performance.
- Identify servicing requirements for potential development areas.

The following is a list of the major infrastructure components that were evaluated:

- raw water source and storage,
- water treatment and storage,
- water distribution,
- freeze protection,
- sewage collection, and
- access vaults and manholes.

An inventory of the water and sewer system, a list of the potential fire flows and calculations of sanitary sewer capacity and heat loss are presented under separate cover in the Technical Annex.

The Technical Annex also includes an inventory and assessment of the physical condition and characteristics of the City's access vaults and manholes, which is presented under separate covers in two volumes.

An evaluation of sewage treatment is not included in the scope of this study as it is undergoing a separate review.

2 Background

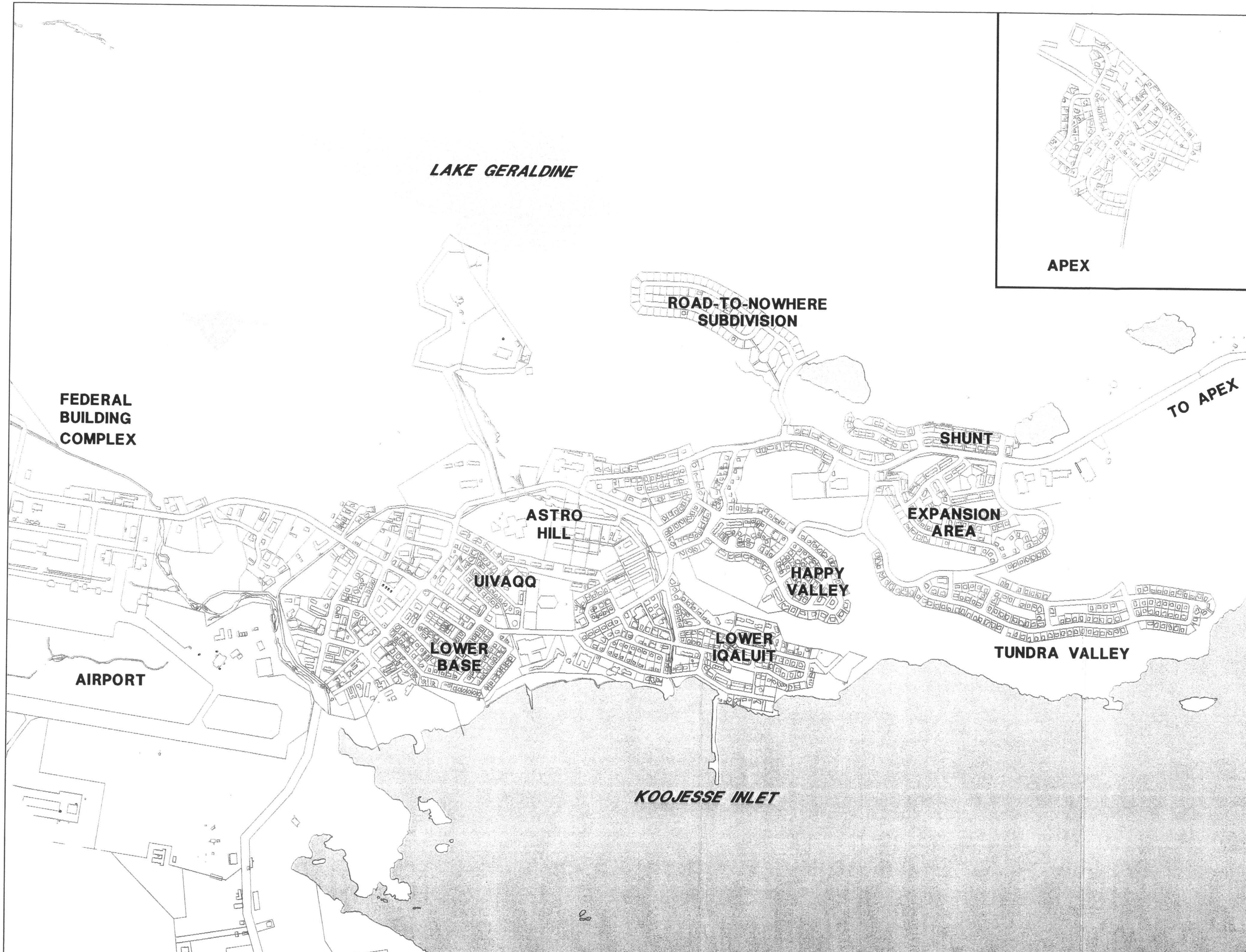
2.1 General

The City of Iqaluit, formerly known as Frobisher Bay, overlooks Koojesse Inlet on the south coast of Baffin Island and is an area of continuous permafrost.

On April 1, 1999, the City of Iqaluit became the capital of the Nunavut territory. This designation has spurred growth in the City. The estimated population of the City is currently 5,510 persons. The projected population of the City for the year 2021 is 11,300 persons and the ultimate projected population is 12,000 persons. Figure 1 shows the extent of development in the City as of 2001. Development of the City requires careful planning and management to not compromise the integrity of the water and sewer systems.

The infrastructure system in the City was first installed in the 1960's. It now consists of: a raw water supply dam, a water treatment plant, a main water storage reservoir, a water booster station, a water distribution system, 4 re-heat and re-circulation stations, a gravity sewer system, 2 sewage pumping stations, 2 sewage dumping stations, a sewage lagoon, and a sewage treatment plant.

Lake Geraldine supplies raw water to the City. During the spring and summer, water flows fills the lake from the surrounding watershed. During the winter, there is no overland flow so there must be sufficient storage for over-winter consumption. Water is stored for over-winter consumption by a dam on Lake Geraldine. From the dam outfall, water is transmitted by gravity to the water treatment plant where it is treated by sand filtration, chlorination, and lime stabilization. Treated water is stored in clear wells, filtered water tanks, and a main storage reservoir at the plant prior to entering the main distribution system. Networks of pipes or trucks deliver water. To prevent the water from freezing in the distribution system, re-heat stations continuously circulate and temper the water. Bleeders also maintain circulation. Either gravity sewers or trucks then collect the sewage (i.e. wastewater). The sewage lagoon treats the sewage prior to being disposed in Frobisher Bay. After commissioning, the new sewage treatment plant will be used instead.



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CLIENT: CITY OF IQALUIT

TITLE: CITY OF IQALUIT - 2001 (Pop. 5,510)

SCALE: 1:12,500

DATE: APR.2002

DRAWN: M.M.R.

JOB: MP14882a

FIG. 1

2.2 Previous Reports

This study required consultation of reports from several previous investigations. The key reports are summarized as follows:

- **Municipality of Iqaluit - Water and Sewer Study (RCPL (Reid Crowther and Partners Ltd.), 1989)**

  RCPL (now Earth Tech) (1989) is the last comprehensive water and sewer study conducted in Iqaluit. It was undertaken to provide an evaluation of the existing infrastructure services at the time and to identify the expected development of water and sewer services over the subsequent 20 years based on directions of growth identified in the General Development Plan By-Law (UMA Engineering Ltd., 1987).

  The study included: an evaluation of infrastructure requirements for water supply, treatment, and storage; an hydraulic analysis of the existing water systems; an inventory and evaluation of the major infrastructure components and their capacity and utilization; a phased approach for development of the water and sewer systems; and cost and sensitivity analyses for future extensions and projects.

  The Town Council had identified three principal directions of growth including the New Expansion Area, redevelopment of Lower Base area, and development and redevelopment in Apex Hill.

  The study includes an evaluation of the potential effects of this development for extension of piped and trucked service development and a proposal of seven phases of work for the extension of piped services to Lower Base.

  Two of the seven phases are completed, three are partially completed, one is in preliminary design, and the remaining one is still proposed.

- **Municipality of Iqaluit - Water Treatment Plant and Treated Water Storage Expansion - Planning Brief - Third Draft (RCPL, 1994)**

  This report supercedes the 1991 draft (not available as a reference for the current Water and Sewer Study) and incorporates revised demand projections and a fire flow of 6,000 l/min for 2 hours. The study recommends the construction of a new reservoir and expansion of the treatment plant to meet needs to the year 2013. The study recommends three phases of work. Phase 1 consists of the design and construction of the first increment in treated water storage and the planning of the plant expansion by the fall of 1996. Phase 2 consists of the design and construction of the plant expansion by the fall of 1998. Phase 3 consists of the design and construction of the second increment in storage, if required, by the fall of 2003.

- **Municipality of Iqaluit – Iqaluit Water Reservoir – Design Brief (RCPL, 1995)**

  This design brief was prepared to reconsider the size of the reservoir given the Nunavut impact and a shortfall in funding. This design brief replaces the 1994 brief by RCPL. RCPL recommended constructing the main reservoir to 2,280 m^3 to meet requirements for a population of 4,955 persons to the year 2006.

  Construction of the main storage reservoir occurred in 1996.

- **Municipality of Iqaluit - Lake Geraldine Storage Study Report (OMM (Oliver, Mangione, McCalla & Associates Ltd.), 1995)**

  OMM (now Trow) conducted an investigation of twenty-year water storage requirements, and presented a design to address this need and its implementation. OMM determined that over-winter consumption requirements were approaching the available capacity in Lake Geraldine. OMM evaluated alternatives for increasing the available storage and recommended a 1.5-m extension of the Lake Geraldine dam to provide sufficient over-winter storage to a population of 6,202 to the year 2015.

  Extension of the dam on Lake Geraldine occurred in 1996.

- **Water and Sewage Services - Subsidy Policy Review – Draft Final Report (CECL (Camillus Engineering Consultants Ltd.), 1996)**

  CECL and others reviewed the Water and Sewage Services Subsidy Policy for MACA.

  CECL (1996) presents a trucked service consumption rate for the City of Iqaluit, which is useful for current study purposes.

- **Municipality of Iqaluit - Water Treatment Plant - Design Brief – Draft (RCPL, 1998)**

  The Municipality retained RCPL to review the recommendations identified in the 1994 planning by RCPL and to prepare a pre-design brief for the expansion of the treatment plant.

  The revised design for expanding the plant incorporates the growth impacts from Nunavut. The design for the proposed expansion will meet needs to a design year of 2017 and a design population of 8,500 persons.

  The plant has not been expanded to date.

  A revised design brief for the plant expansion has been produced.

- **Municipality of Iqaluit – Review of 1999 Subdivision Development (Trow, 1999)**

  The Municipality of Iqaluit retained Trow in 1999 to provide preliminary engineering and planning services for the development of a 100-lot subdivision. The Municipality had identified three areas for consideration including: (i) area north of the New Expansion Area and southeast of the New Middle School and the New French Language School, (ii) area east of Apex Road off the Road to Nowhere, and (iii) area north of the Arctic College and west of the water treatment plant.

  Trow prepared road and lot patterns, water and sewer systems, major infrastructure requirements, and Class D cost estimates. Trow determined that the most cost-effective area to develop was off the Road-to-Nowhere, development of which has occurred as the Road-to-Nowhere Subdivision.

- **Municipality of Iqaluit – Evaluation and Design of the Uivvaq Recirculation Loop (Trow, 2000)**

  The Municipality of Iqaluit retained Trow to evaluate improvements to the Uivvaq Recirculation Loop, hazardous piping materials, the proper disposal of these materials, and extension of piped services to the area. Trow examined seven alternatives to meet design requirements by the Municipality of Iqaluit. To date, the preferred alternative has not been implemented.

- **City of Iqaluit - Water Treatment Plant Pre-Design Brief (Earth Tech, 2002)**

  The City retained RCPL to prepare the latest pre-design brief for the plant expansion.

  The 2002 design brief supercedes the design brief prepared in 1998. The new design year is 2021 and the new design population is 11,300 persons. At a design consumption rate of 400 L/c/d, the intended design capacity is 9,500 m^3/d.

3 Population and Demand

3.1 Population

The rate of growth in the City has increased since becoming the capital of Nunavut. Population projections have consequently changed to reflect this impact. The most recent projections indicate that the City anticipates its 2001 population to be 5,510 persons, which is a 22% increase from that projected for 2001 used by RCPL (1994).

The City has provided population projections. The following is a summary of the population assumptions used for this study:

- An existing population of 5,510 in 2001;
- Anticipated growth to 11,300 by 2021; and
- An ultimate population of 12,000.

Table 1 gives various projected populations.

3.2 Demand

The City's demand for water is an essential component in evaluating the utilization of the current infrastructure system.

3.2.1 Historical Consumption

Production records from the water treatment plant were used to estimate historical consumption rates and the current demand. The City provided production records from 1999 and 2000. The production record from 2001 was not available. Data from the months of December 1999, and January, June, and December 2000 were not included in computations, as they were not available. Data from November 1999 were not included, as they appeared to be in error.

Production records are a measure of water usage at the plant. Data includes usage from piped and trucked services and from unaccounted for usage such as bleeders. Estimates of consumption rates include unaccounted for water usage as the system will always have inherent unaccounted for uses that will grow with population.

Average day demand is equal to total plant metered consumption divided by the number of metered days. Average per capita consumption is equal to the average day demand divided by the population. A summary of plant production and average daily demands for 1999 and 2000 is given in Table 2.

Table 1 - Population Projections

	Previous Projections		Current Projection
Year	1993 Projection[1]	1998 Projection[2]	2001 Projection[3]
2001	4,525	5,061	5,510
2002	4,608	5,228	5,711
2003	4,692	5,400	5,920
2004	4,778	5,578	6,137
2005	4,865	5,761	6,361
2006	4,955	5,951	6,594
2007	5,045	6,147	6,835
2008	5,137	6,350	7,085
2009	5,231	6,559	7,344
2010	5,327	6,775	7,612
2011	5,425	6,998	7,891
2012	5,524	7,229	8,179
2013	5,625	7,467	8,478
2014		7,713	8,788
2015		7,967	9,110
2016		8,229	9,443
2017		8,500	9,788
2018		-	10,146
2019		-	10,517
2020		-	10,901
2021		-	11,300
Beyond 2021		-	12,000

[1]G.N.W.T. Bureau Statistics from December 1993 (after RCPL (1994, 1995)).

[2]No source mentioned – likely based on 1996 census (after RCPL (1998)).

[3]Provided by the City of Iqaluit.

Table 2 - Water Treatment Plant Production Records for 1999 and 2000

Month	1999	2000
January	25,038	N/A[2]
February	26,892	27,779
March	26,738	26,534
April	29,581	24,919
May	38,706	26,646
June	40,993	N/A[3]
July	38,748	46,726
August	37,968	44,164
September	33,443	44,363
October	24,647	44,962
November	(15,180)[1]	42,694
December	N/A[2]	N/A[2]
Metered Consumption (m^3)	322,754	328,787
Number of Metered Days	304	272
Estimated Population	5,114[3]	5,308[3]
Average Day Demand (m^3/d)	1,062	1,209
Average per Capita Consumption (L/c/d)	208	228

[1] Does not include November 1999 data, as it appears to be in error.

[2] December 1999 and January, June and December 2000 data were not available.

[3] Populations for 1999 and 2000 were interpolated assuming 3.66% annual growth from 1999 to 2001.

3.2.2 Current Demand

Average per capita consumption for 2001 is 218 L/c/d, which is the average of the historical consumption rates between 1999 and 2000. For a population of 5,510 persons at 218 L/c/d, the estimated average day demand is 1,201 m^3/d.

3.2.3 Trucked Services

The plant production records include water usage from piped and trucked services. Trucked services currently occur in five main areas: Lower Base, Uivvaq Loop, Expansion Area, Tundra Valley, and Apex. The City has plans to convert Lower Base and Uivvaq Loop to piped water service. For this study, it was assumed that this would occur by 2005. It was also assumed that Tundra Valley, Apex, and the trucked portion of the Expansion Area will remain on trucked services.

There are 423 units on trucked services, as identified using existing plans of the City. At a density of five persons per household, this represents a trucked population of 2,115 persons. The density is equal to average historical water records per household divided by the MACA per capita consumption rate. Approximately 62% of the City's population are currently on piped services and 38% is on trucked services.

Trucked services demands are projected using a consumption rate of 123 L/c/d as per CECL (1996) and discussions with the City. The estimated demand for truck services is 260 m^3/d based on 2,115 persons at 123 L/c/d.

3.2.4 Piped Services

The estimated average day demand for piped service is 941 m^3/d, which is 1,201 m^3/d, the current demand, less 260 m^3/d, the estimated demand for trucked water service. The estimated piped population is 3,395. The estimated average per capita consumption for piped service is 277 L/c/d, which is the average day demand for piped service divided by the piped population.

3.2.5 Design Demand

Demand for piped service were projected using an average per capita consumption rate of 400 L/c/d, which is the City's design standard. It was assumed that all new growth is on piped water and sewer services. Consumption rates will likely increase as the piped network grows.

Table 3 presents historical consumption and projected demands up to the ultimate population.

Table 3 - Historical and Projected Water Demand

	POPULATION			HISTORICAL CONSUMPTION			MACA FORMULA			Projected Demand Using Historical Consumption Rate			Projected Demand Using City Design Standard		
Year	Pipe	Truck	Total	Pipe (L/c/d)	Truck (L/c/d)	Average Day[1] (m^3/d)	Pipe (L/c/d)	Truck (L/c/d)	Average Day[1] (m^3/d)	Pipe (L/c/d)	Truck (L/c/d)	Average Day[1] (m^3/d)	Pipe (L/c/d)	Truck (L/c/d)	Average Day[1] (m^3/d)
Historical Demand															
1999	3,146	1,968	5,114	261	123	1,063	396	158	1,746	-	-	-	-	-	-
2000	3,268	2,040	5,308	293	123	1,210	398	159	1,825	-	-	-	-	-	-
Average	-	-	-	277	123	1,137	397	159	1,786	-	-	-	-	-	-
Projected Demand															
2001	3,395	2,115	5,510	-	-	-	401	160	1,701	277	123	1,201	400	123	1,618
2011	6,266	1,625	7,891	-	-	-	427	171	2,954	277	123	1,936	400	123	2,706
2021	9,418	1,882	11,300	-	-	-	450	180	4,577	277	123	2,840	400	123	3,999
Ultimate	10,087	1,913	12,000	-	-	-	450	180	4,884	277	123	3,029	400	123	4,270

[1] Average Day = Average Day Demand = ((Pipe Population x Pipe Consumption (L/c/d)) + (Truck Population * Truck Consumption (L/c/d)) /1000 l/m^3.

[2] City's design standard for piped users.

3.3 Summary

The following is a summary of design parameters and assumption used for this study:

- The current population in 2001 is 5,510 persons.
- The projected 20-year population in 2021 is 11,300 persons.
- The ultimate population beyond 2021 is 12,000 persons.
- The current consumption rate for piped services is 277 L/c/d.
- The design consumption rate for piped services is 400 L/c/d.
- The consumption rate for trucked services is 123 L/c/d.
- All new growth including will be served by piped water and sewer.
- Upgrade Lower Base and Uivvaq Loop from trucked to piped services by the year 2005.
- Apex, Tundra Valley, and the trucked portion of the Expansion Area will remain on trucked services.

4 Raw Water Source

4.1 Watershed Capacity

Runoff from the Lake Geraldine watershed, which has a surface area of 385 ha, feeds Lake Geraldine. Canadian Normals reports that the mean annual precipitation in the City between 1940 and 1990 was 424.1 mm. This represents a volume of 1,633,000 m^3 of precipitation per year over the watershed. The current demand requires 27% of this volume. Demand will increase to 89% of this volume for 11,300 persons in 2021.

Assurance of water supply is essential to the City. The watershed yield, that is, the amount of runoff that actually feeds the lake, is not known. If the watershed yield is 30% of the mean annual precipitation, which is more characteristic of southern watersheds, then its capacity will be reached by the year 2003 based on current consumption rates.

The amount of runoff that is contributing to the recharge of Lake Geraldine is not currently known. Experience in more southern climates suggests that current demands are potentially reaching the watershed capacity. It is recommended that a detailed watershed study be undertaken immediately.

4.2 Raw Water Storage

4.2.1 Description

Raw water is stored in Lake Geraldine by a dam constructed in the early 1960's. The dam was extended three times from its original crest elevation of 106.22 m to its current elevation of 109.33 m as summarized in Table 4.

Table 4 - Lake Geraldine Dam Extensions

Year	Extension	Elevation
1979	0.3 m	106.68 m
1985	1.15 m	107.83 m
1996	1.5 m	109.33 m

4.2.2 Winter Storage Period

During the winter, there is no lake recharge due to freeze-up. There must be sufficient storage capacity to sustain needs from mid-October to June, a period of 243 days. During the summer, water flows over the dam, suggesting that there is sufficient capacity to meet summer needs and to refill the lake prior to freeze-up.

4.2.3 Winter Storage Capacity

OMM (1995) reported that the last dam extension increased the useable winter storage capacity to 570,000 m^3. This volume does not include the volume of ice during the winter and the volume not accessible due to lake geometry. The volume of water located beyond the rock ridge is not accessible to the intake pipe due to the elevation of the rock ridge. This volume of water is 52,800 m^3 including the 16,200 m^3 of water situated below the intake pipe.

4.2.4 Maximum Population

OMM (1995) designed the last dam extension to serve a maximum of 6,202 persons. At the current growth rate, the City will reach this population in 2005. OMM designed the capacity using the consumption rate that prevailed in 1995, which is less than the current design standard. At the City's design standard for piped and 123 L/c/d for trucked services, the storage capacity will reach capacity in 2007.

4.2.5 Future Storage Requirements

Future raw water storage requirements were calculated over the winter storage period using the City's design standard for piped services and 123 L/c/d for trucked service. The required upgrade was calculated as the required capacity less the existing capacity. The storage requirements for 11,300 persons are given in Table 5.

Table 5 - Future Raw Water Storage Requirements

Year of Upgrade	2005
Design Year	2021
Design Population	11,300
Average Day Demand	3,999 m^3/d
Winter Storage Period	243 d
Required Storage Capacity	243 d x 3,999 m^3/d = 971,757 m^3
Existing Storage Capacity	570,000 m^3
Required Upgrade	971,757 m^3 – 570,000 m^3 = 401,757 m^3 ≈ 402,000 m^3

4.2.6 Potential Storage Options

OMM (1995) investigated three storage expansion alternatives. One of these alternatives was accessing the volume of water stored below the rock ridge. OMM (1995) reported that this volume is insignificant to meet any of the design requirements. It would only be useful as an emergency source if required. Based on the future storage requirements calculated above, if this volume were available, it would only delay upgrades for one 1 year.

OMM (1995) evaluated the alternative of increasing the volume of the lake by excavation. Although technically feasible, it would be extremely costly. OMM (1995) recommended that consideration of this alternative for the long term.

OMM (1995) reported that the 1996 extension of 1.5 m was the highest extension possible without requiring major works at the dam. OMM (1995) stated that Acres (1990) examined the stability of the dam structure and concluded that the factors of safety were low for the existing dam.

The dam's stability must be reassessed in detail prior to future extensions.

The shape of the lake is like a saucer and its edges are becoming increasingly flatter. The shape is such that additional increases in elevation will produce ice. The geometry of the lake does not lend favourably to an increase in dam height.

Furthermore, prior to expanding the raw water storage capacity, additional study is recommended to ensure that adequate natural water supply actually exists.

4.3 Summary

1. The watershed yield is unknown due to a lack of information.
2. Experience in more southern climates suggests that current demands might be reaching the watersheds yield.
3. Assurance of water supply is essential to the City.
4. The commissioning of a detailed watershed study should not be delayed.
5. The useable volume of the raw water storage reservoir is 570,000 m^3.
6. According to OMM (1995), the raw water storage reservoir will serve a maximum of 6,202 persons. The City will reach this population by the year 2005 at current growth rates.
7. An additional 402,000 m^3 of storage will be required beyond the existing raw water storage capacity to meet demands for 11,300 persons in 2021.
8. Further study is required regarding expansion options for raw water storage.

5 Transmission

Raw water leaves Lake Geraldine and enters the water treatment plant through a 360 m, 250-mm diameter cast iron intake pipe, insulated with 50 mm of foam glass and protected with a gauge metal jacket. The injection of tempered water from the plant protects this line from freezing.

In 1998 Pre-Design Brief, Earth Tech reports that the capacity of the intake pipe was sufficient to meet treatment plant capacity up to 7,200 m^3/d. Any upgrades in plant capacity beyond 7,200 m^3/d will require upgrades to the intake pipe as well.

The Pre-Design Brief prepared by Earth Tech in 2002 reports that the transmission line is included in the plant upgrades program.

6 Water Treatment and Storage

6.1 Background

The City began planning the treatment plant and treated water storage expansions in 1989.

RCPL produced the first draft of the planning brief in 1991. Subsequently, RCPL produced a third draft in 1994 that included an increase in fire storage and revised demand projections.

RCPL produced a design brief in 1995 for the treated water storage upgrade to decrease the size of the reservoir and adjust demand projections to reflect the growth rates for Nunavut. The revised design was to meet needs of 4,955 persons in the year 2006 based on MACA guidelines and the growth rate prevailing at the time. The final design was a reservoir of 2,280 m^3 in size. Construction of the main reservoir occurred in the fall of 1996 with a second phase planned for the fall of 2003 if required.

RCPL produced a design brief in 1998 for the plant expansion with revised demand projections reflecting the potential growth impacts of becoming the capital of Nunavut. Earth Tech (2002) supercedes the 1998 design brief. To meet the City's projected population of 11,300 persons in the year 2021, Earth Tech recommends the expanded plant have a gross design capacity of 9,500 m^3/d.

The City engaged Earth Tech to complete the Design Brief for the plant expansion. The expansion of the water treatment plant is a current project with construction expected to begin in 2002 and completion by 2003.

6.2 Treatment Plant

6.2.1 Description

The treatment plant contains the following systems:

- chlorination and lime addition,
- settling tanks,
- filtration,
- fluoridation,
- backwash,

- instrumentation and control, and
- treated water storage.

These systems, including the raw water intake pipeline and tempering line, are part of the scope of the upcoming treatment plant expansion.

6.2.2 Current Plant Capacity

The current gross capacity of the plant is 1,296 m^3/d including the useable capacity (i.e. net capacity) of 1,050 m^3/d and an allowance for in-house uses. Production records indicate that demand exceeded the gross capacity of the plant 67 out of 304 metered days in 1999 and 124 out of 272 metered days in 2000. On one occasion, July 10, 1999, demand exceeded gross capacity by 1,000 m^3/d.

Increases in treatment capacity are required immediately.

6.2.3 New Design Capacity

As noted above, an expansion program is underway. Earth Tech (2002) reports that the expanded plant will meet needs for 11,300 persons in the year 2021 and that the capacity required to serve maximum day demand together with internal plant requirements is 9,500 m^3/d.

6.3 Treated Water Storage

6.3.1 Description

Treated water storage is required for fire protection, equalization, and emergency allowances. Treated water is currently stored in two filtered water tanks and two clearwater wells located beneath the treatment plant, and in the main storage reservoir (a free-standing structure located adjacent to the treatment plant).

6.3.2 Storage Capacity

The last upgrade in treated water storage capacity occurred with the construction of the main storage reservoir. The treated water storage capacity is 2,967 m^3 including:

- 2,280 m^3 in the main storage reservoir,
- 577 m^3 in the two clearwater wells, and
- 110 m^3 in the two filtered water tanks.

6.3.3 Maximum Population

The current storage capacity will serve a maximum of 5,920 persons using the design standard for piped service and 123 L/c/d for trucked service. Upgrades in treated water storage capacity will be required in the year 2003 at current growth rates.

6.3.4 Current Fire Storage Allowance

During the planning of the main storage reservoir, the City selected a fire flow of 6,000 L/min for 2 hours, which is equivalent to a fire storage allowance of 720 m^3. This allowance is low compared with allowances in other jurisdictions. The level of fire protection is the decision of the City. It is recommended that the City consider increasing the fire storage allowance during the next storage upgrade.

6.3.5 Future Storage Requirements

Storage requirements were calculated for 11,300 persons using the City's design demand and 123 L/c/d for truck services. Storage requirements aside from fire storage but inclusive of storage for equalization, emergency, backwash, and in-plant uses are given in Table 6.

Table 6 - Future Treated Water Storage Requirements

Date of Upgrade	2003
Design Year	2021
Design Population	11,300
Average Day Demand	3,999 m^3/d
Maximum Day Factor	2.0
Maximum Day Demand	7,998 m^3/d
Equalization Storage (25% Maximum Day Demand)	1,999 m^3
Emergency Storage (30% Average Day Demand)	1,200 m^3
Backwash and In-Plant Uses (14% Average Day Demand)	560 m^3
Total Storage Required	3,759 m^3 + Fire Storage
Existing Storage Capacity	2,967 m^3
Required Upgrade	792 m^3 + Fire Storage

An additional 792 m^3 of treated water storage aside from fire storage will be required beyond the existing storage capacity to serve 11,300 persons.

Part of the future fire storage allowance may be comprised of the difference between capacity of the plant and demand at the plant. This can be considered at the time of upgrading treated water storage. The design criteria will be confirmed at that time.

6.4 Summary

1. The existing plant frequently operates beyond its design capacity. Upgrades in plant treatment capacity are currently planned for 2003. The upgraded plant will serve 11,300 persons.
2. The existing treated water storage capacity is 2,967 m^3.
3. The current fire storage is relatively low compared with other jurisdictions.
4. Treated water storage upgrades are required by the year 2003.
5. An additional 792 m^3 of treated water storage aside from fire storage will be required to serve 11,300 persons.

7 Water Distribution

7.1 Description

Treated water flows by gravity for 350 m in two 250-mm polyethylene pipes from the main storage reservoir to the water distribution system. The water distribution system is shown in the attached Drawing WM-1.

The water distribution system contains the following major components:

- watermains,
- re-circulation lines,
- a booster station,
- re-heat stations (boilers, heat exchangers, and circulating pumps),
- bleeders, and
- truck-fill stations.

Re-heat stations are considered in Section 8.0 of this report.

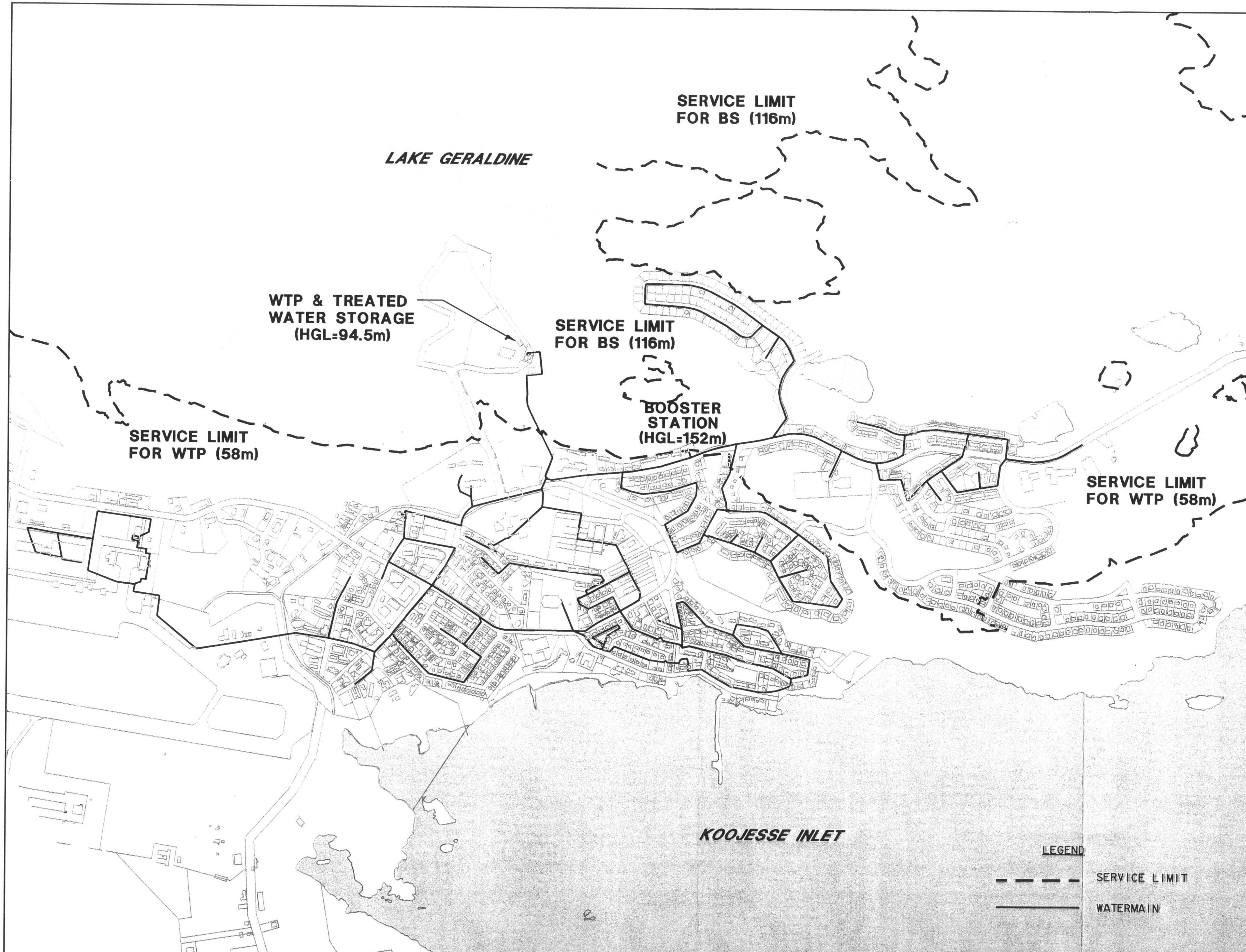
7.2 Existing Conditions

7.2.1 Service Limits

There are two pressure districts within the City. The HDGL (Hydraulic Grade Line) of the storage reservoir (94.5 m) governs one district and the HGL of the booster station (152.5 m) governs the other.

The reservoir provides suitable domestic pressures (e.g. 345 kPa) below an elevation of 58 m. Lower Iqaluit, Lower Base, Happy Valley, Astro Hill, Uivvaq Area, the Airport area, and the Federal Building area are situated below this elevation. The booster station provides appropriate pressure up to an elevation of 116 m.

The water distribution system and the service limits related to water pressure are given in Figure 2. Extension beyond these limits will require additional water booster stations.



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CLIENT: CITY OF IQALUIT

TITLE: EXISTING WATER SYSTEM & WATER PRESSURE SERVICE LIMITS

SCALE:	1:12,500
DATE:	APR.2002
DRAWN:	M.M.R.
JOB:	MP14882a

FIG. 2

7.2.2 Inventory of Pipes

The diameters and materials of all water distribution pipes that are part of the main distribution system (i.e. not including service connections) have been inventoried using the Cybernet water distribution model, as-built drawings, and Trow's internal knowledge of the system. This inventory is found in the Technical Annex and is summarized in Table 7.

Table 7 - Summary of Inventory of Watermain and Recirculation Line

Diameter (mm)	Material	Length
50	HDPE, Copper, Asbestos Cement, Steel	2,800 m
75	HDPE, Copper, Steel	1,900 m
100	HDPE, Ductile Iron, Asbestos Cement	300 m
150	HDPE, Ductile Iron, Asbestos Cement	6,100 m
200	HDPE, Steel, PVC	10,700 m
250	HDPE, Steel, Asbestos Cement	5,100 m
300	HDPE, PVC	500 m
	TOTAL LENGTH	27,400 m

1. HDPE (High Density Polyethylene), PVC (Polyvinyl Chloride)
2. The lengths of proposed Lower Base Phase II pipes are included here.

7.2.3 Condition of Watermains

Breakage and repair histories are normally used to identify locations where remediation or replacement is required. Watermain deterioration is generally not a concern as almost no breakages have been reported in the City. The watermains are generally in good condition. The oldest watermains in the City are made of Asbestos Cement and Ductile Iron. Neither has exhibited unusual amounts of breakage due to pipeline deterioration.

7.2.4 Above-Ground, Asbestos Pipe

Asbestos Cement piping will catastrophically fail if frozen. As the above-ground piping can be subjected to extremely low temperatures, it requires routine maintenance and inspection to ensure that the condition of the insulation and pipe covering are suitable. To improve system integrity and reliability, above-ground, Asbestos Cement piping, which extends from the Astro Hill complex through the White Row housing units should be replaced with underground, HDPE piping.

7.2.5 Municipal System Dependence on Non-Municipal Equipment

The servicing to the Brown-Row housing units situated behind the high school is currently dependent on the high school services. This system dependency will be addressed in the improvements in the Uivvaq area as discussed in Section 11.0.

7.2.6 Modeling of Domestic Flows and Fire Flows

The City's water distribution system has been evaluated using the Cybernet water distribution model developed by RCPL. The model was updated by Trow to include recent development areas including the Road-to-Nowhere Subdivision, Phases 5 and 6 of the Expansion Area, and Lower Base.

The system was modeled for current and future demands. Current demands were modeled based on 400 L/c/d (the City's design standard) and then were increased to simulate 10-year, 20-year, and ultimate demands. Current demands at each junction in the system were multiplied by a global factor in proportion to the estimated increase from the City's current to future demand.

Conditions were evaluated for peak hour and maximum day demand with fire flows. Conditions were also evaluated for low flow periods to ensure that flow patterns were predictable without variations in flow direction caused by changes in demand.

7.2.6.1. Water Pressure

Pressures under peak hour demand are illustrated in Figure 3. The model indicates suitable domestic pressures (i.e. 345 kPa) are provided to the City. All areas are above the minimum pressure that is normally recommended (i.e. 275 kPa). The lower parts of the City and immediately upstream of the booster station exhibit relatively high pressures (above 700 kPa). The pressures at each access vault and manhole are given in the Technical Annex.

7.2.6.2. Available Fire Flows

The Cybernet model was used to determine the ability of the distribution system in meeting fire flows. The model output provides the available fire flows, which is the capacity of the distribution system under maximum day demand conditions while maintaining a pressure of 140 kPa. The available fire flows are not the same as the actual fire flows provided from existing fire. Information on actual fire flows is generally available from the fire department.

The available fire flows are illustrated in Figure 4 and are given in the Technical Annex.

The model indicates that available fire flows are generally at or above 2,250 L/min during maximum day demand while maintaining a pressure of 140 kPa, which is considered to be satisfactory.

Some areas of the system have capacity to provide less than 2,250 L/min. The majority of Happy Valley provides approximately 2,200 L/min. Manholes 74 and 90 provide a maximum of 1,800 L/min and are the lowest available fire flows in the City. This area is comprised of single, detached homes and is therefore at lower risk of multiple fires and severity of damage compared to a high-density area.

Some areas may be at more risk due to the type of buildings. Access Vaults 2, 3, 4, and 5 in the Federal Building area have capacity to provide fire flows of 2,700 to 2,800 L/min. The New Arena and the New French Language School have fire flow capacity of 3,000 to 3,100 L/min. These flows may not be sufficient fire protection given the type of buildings in the areas.

The level of fire protection that is to be provided is the decision of the City. The characteristics of the area are usually a consideration in the decision. Higher fire flows are generally provided in the high-risk areas, such as downtown areas. It is recommended that the City, in conjunction with the local fire department, continue to test the actual fire flows provided by hydrants and calibrate the water model as required.

7.3 Water System Improvements

Two areas of water system improvements have been identified.

7.3.1 Replace Above-Ground Asbestos Pipe

The above-ground watermain in the Astro Hill area through the White Row Housing (from AV-305 to AV-9A) consists of asbestos cement pipe. The section from Point F to AV-9A (see Figure 5) is 150-mm piping. A large portion of the City including Astro Hill, White Row Housing, and Lower Iqaluit is dependent on this piping for servicing. Thus, the small pipe size and the risk of freeze damage have implications over a large area, both in terms of level of service and reliability. Replacing this with HDPE material pipe and at the same time increasing the pipe size will improve reliability and enhance system performance.

7.3.2 Extend Watermain to Airport and Federal Building Area

In conjunction with phasing proposed by RCPL (1989), it is recommended that a watermain be extended from AV-414 to the airport and federal building areas. Fire flows are currently provided to these areas from a single, 200-mm pipe. Fire flows estimated at 6,000 L/min would be provided from two pipes: the existing, 200-mm pipe and a larger proposed pipe. This extension would significantly improve the level of fire protection in the airport and federal building area and increase the size of the existing service area.

7.4 Summary

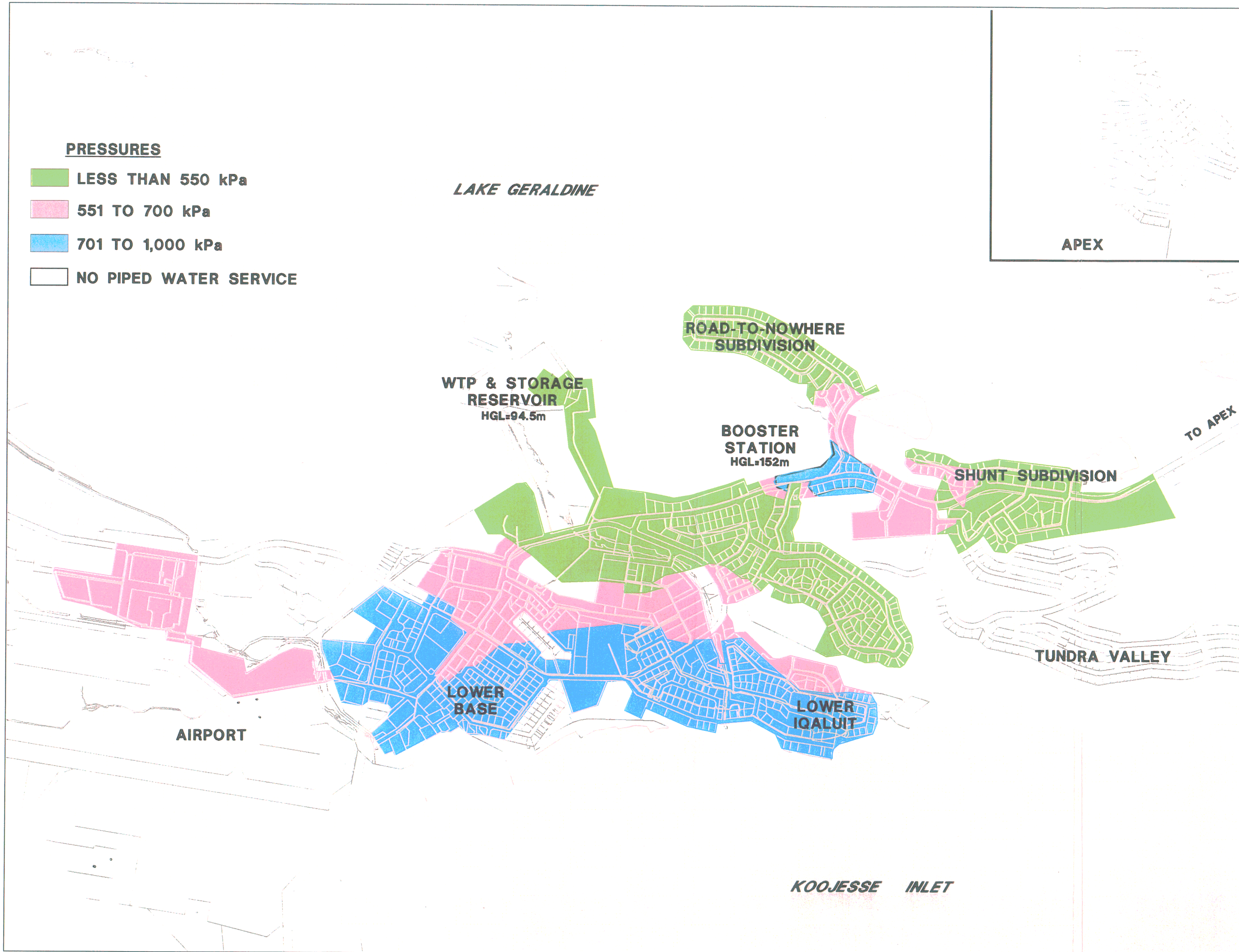
1. The model indicates suitable domestic pressures (i.e. 345 kPa) are provided to the City.

2. The model indicates that the distribution system has the capacity to provide fire flows of at least 2,250 to the majority of the City. Some areas of the system only have capacity to provide less than 2,250 L/min. The majority of Happy Valley has the capacity to provide approximately 2,200 L/min. Manholes 74 and 90 only have the capacity for 1,800 L/min and are the lowest available fire flows in the City.

3. In terms of fire protection, some areas may be at more risk due to the type of buildings. Access Vaults 2, 3, 4, and 5 in the Federal Building area have the capacity to provide fire flows of 2,700 to 2,800 L/min. The New Arena and the New French Language School have a fire flow capacity of 3,000 to 3,100 L/min.

4. It is recommended that the City, in conjunction with the local fire department, continue to test the actual fire flows provided by existing fire hydrants.

5. Two improvements are recommended on the existing water system. The locations of these improvements are shown in Figure 5.



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CLIENT: CITY OF IQALUIT

TITLE: EXISTING WATER PRESSURE

SCALE:	1:12,000
DATE:	APR.2002
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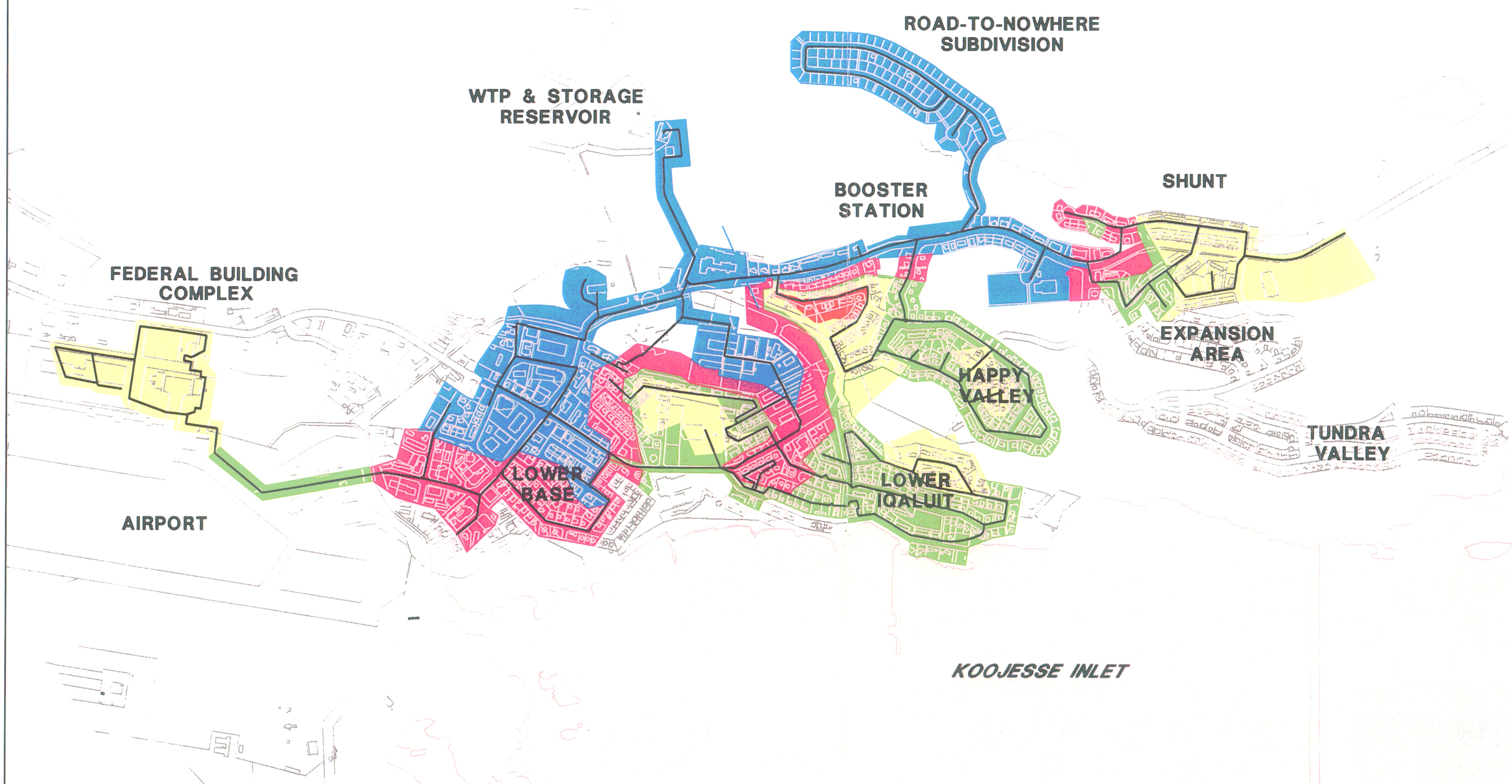
JOB:	MP14882a

FIG. 3

AVAILABLE FIRE FLOWS

- (red) LESS THAN 2,250 L/min
- (yellow) 2.250 TO 3,600 L/min
- (green) 3,600 TO 4,500 L/min
- (pink) 4,500 TO 6,600 L/min
- (blue) > 6,600 L/min

NOTE:
AVAILABLE FIRE FLOWS ARE NOT THE ACTUAL FIRE FLOWS FROM THE HYDRANTS. AVAILABLE FIRE FLOWS ARE THE POTENTIAL FLOWS IN THE SYSTEM UNDER MAXIMUM DAY DEMAND CONDITIONS, WHILE MAINTAINING A PRESSURE OF 140kPa.



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TITLE: AVAILABLE FIRE FLOWS

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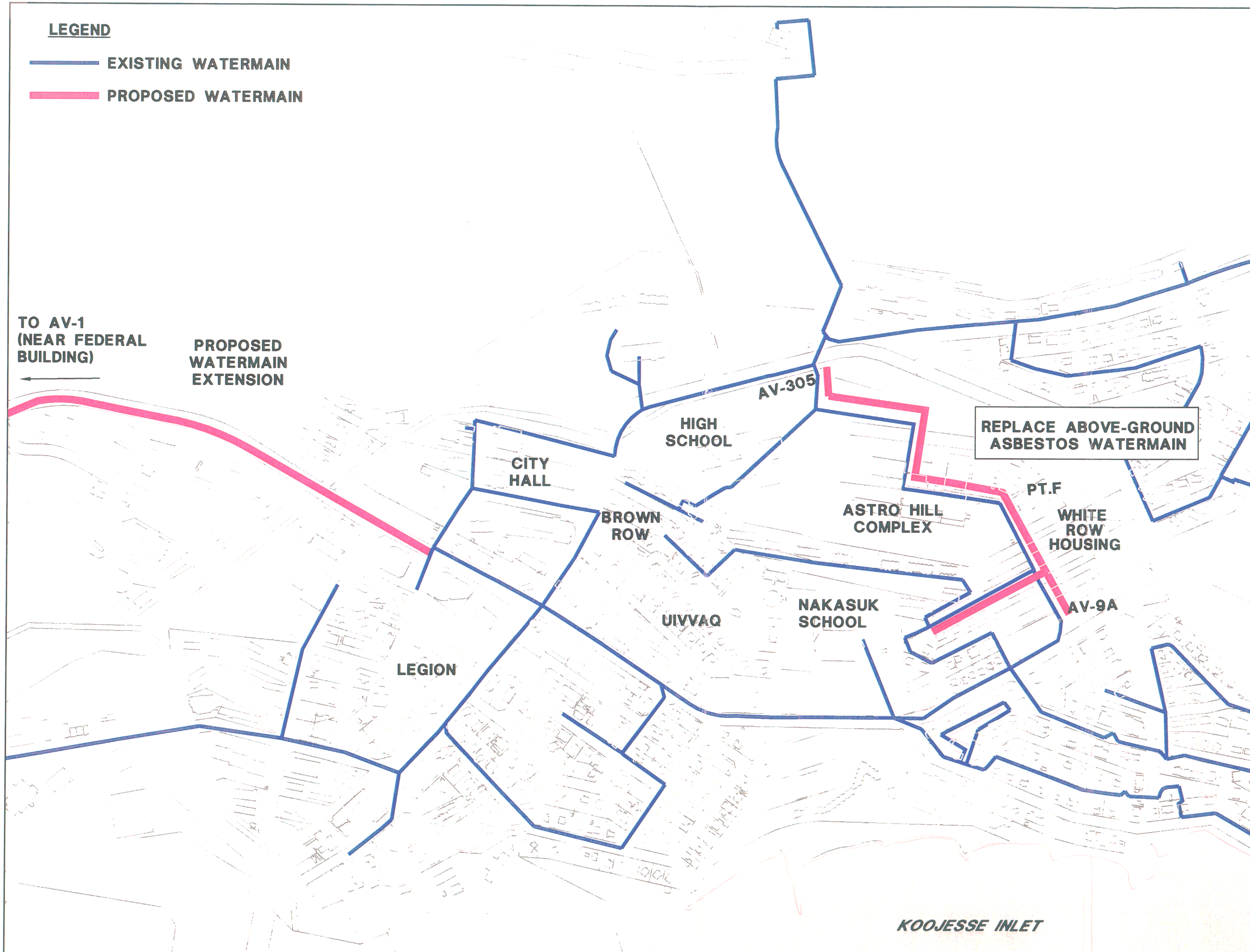
FIG. 4



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CLIENT: CITY OF IQALUIT

TITLE: WATER SYSTEM IMPROVEMENTS

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FIG. 5

8 Freeze Protection

8.1 Description

Freeze protection is needed to ensure that water does not freeze in the distribution system. Freezing of the water system would disrupt service and would potentially damage the piping system. Freeze protection is achieved through a combination of constant circulation, heat input, and reliable circulation patterns.

Water is first tempered within the water treatment plant such that it leaves the main reservoir at approximately 5°C. Water circulates to one of four re-heat stations to replace the heat lost from the distribution system and to maintain circulation. The re-heat stations typically contain boilers, heat exchangers, and circulating pumps. The four re-heat stations are located at the Trigram Building, Building 222, the Booster Station, and Re-Heat Station No. 1. A list of their major equipment is given in Table 8.

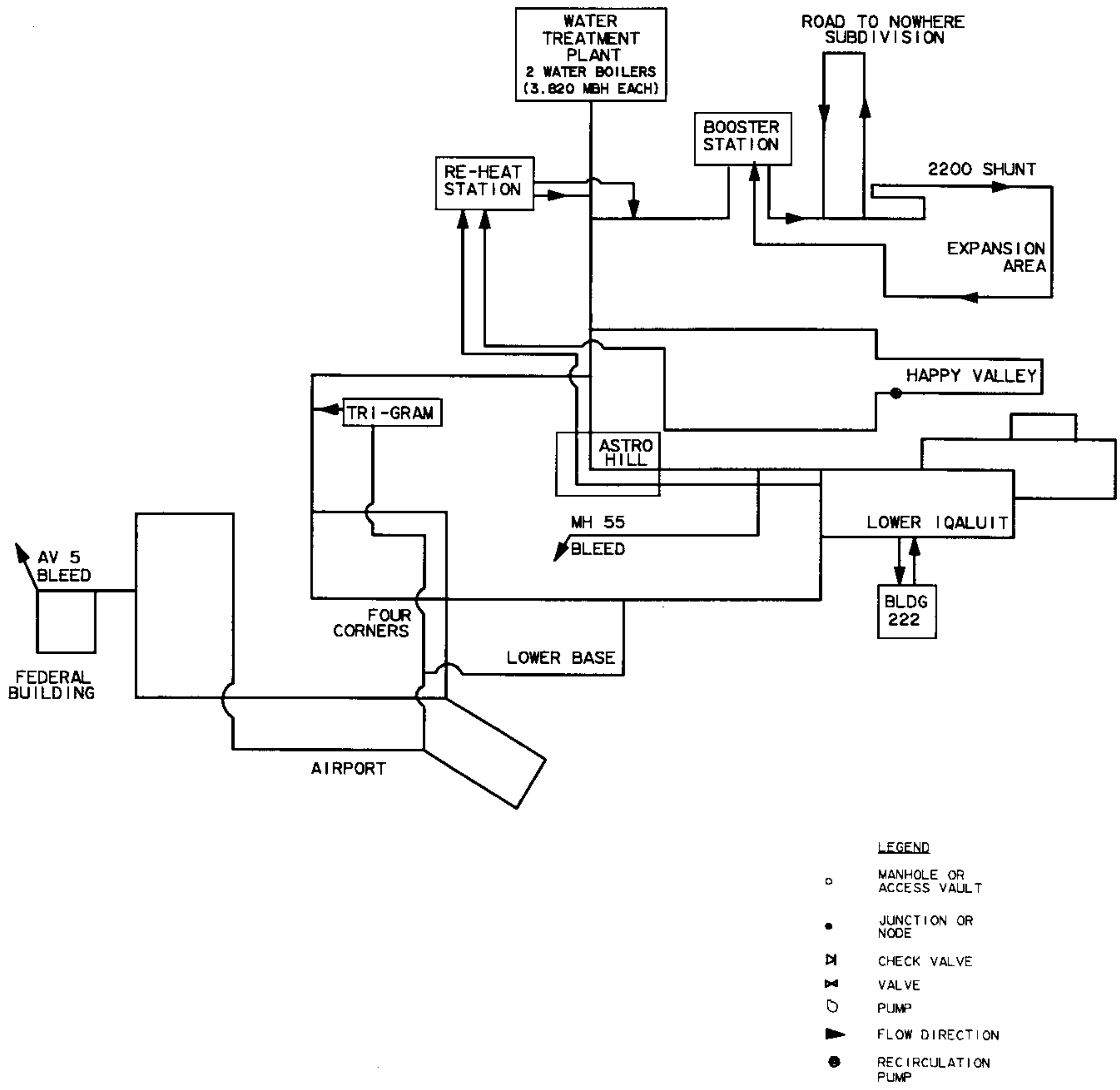
Table 8 - Major Equipment at Re-Heat Stations

Re-Heat Station	Major Equipment
Trigram Building	2 Steam Boilers, 2 Heat Exchangers, 2 Circulating Pumps
Booster Station	2 Water Boilers (With Tankless Heaters), 2 Circulating Pumps
Building 222	2 Water Boilers, 2 Heat Exchangers, 2 Circulating Pumps
Re-Heat Station No. 1	2 Water Boilers, 2 Heat Exchangers, 2 Circulating Pumps

Water is also discharged from bleeders to maintain continuous flow in some areas. Bleeders are small diameter, pipes attached to the end of a watermain. Bleeders allow water to constantly flow from the end of the watermain and into a sanitary sewer to prevent freezing. Bleeders are located in Lower Iqaluit at MH-63, in the Federal Building area at AV-5, in the Uivvaq area at MH-55, and in Happy Valley at MH-73.

The freeze protection system is designed to assure flow direction through looped systems. The older systems consist of interconnected loops. The newer systems use loops and pumps. Future designs must not disrupt circulation in the existing system with minimal use of additional pumps.

A schematic of freeze prevention in the main distribution system is presented in Figure 6.



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SCALE: N.T.S.	CLIENT: CITY OF IQALUIT	JOB NO. MP14882a
DATE: DEC,2001	TITLE: FREEZE PROTECTION IN MAIN WATER DISTRIBUTION SYSTEM	FIG 6
DRAWN: M.M.R.		

8.1.1 Astro Hill

Water is supplied from AV-305 through the Astro Hill Complex and returns in a 50-mm re-circulation line to Re-Heat Station No. 1 for heat input. Astro Hill shares the boiler capacity at Re-Heat Station No. 1 with Happy Valley.

Water is distributed through the White Row Housing to Access Vault 9A. The watermain beyond Access Vault 9A is the supply main for Lower Iqaluit and Lower Base. Demands in Lower Iqaluit and Lower Base form an integral component of freeze protection in Astro Hill.

A lateral from this system extends as a dead end to a bleeder at MH-55.

Water is distributed from Astro Hill to the high school and the houses beyond the high school. Freeze protection at the high school is achieved by water usage at the houses attached to the high school services.

A schematic of freeze prevention in Astro Hill is presented in Figure 7.

8.1.2 Lower Iqaluit

AV-9A supplies water through to AV-400, and into Building 222 for heat input. The main circulating pump in Building 222 moves the tempered water out to MH-22 to three distribution loops in Lower Iqaluit. A second pump in Building 222 supplies tempered water out to the Atco Loop, which is the fourth distribution loop in Lower Iqaluit.

A bleeder in MH-63 also maintains flow during periods of low demand.

AV-400 supplies water to Nakasuk School. Freeze protection at the School depends on the circulation pump at the School and heat input at Building 222.

A schematic of freeze prevention in Lower Iqaluit is presented in Figure 8.

8.1.3 Happy Valley

Happy Valley was originally a loop from Apex Road to MH-96. It now extends to AV-231. Water is distributed through Happy Valley and returned for heat input at Re-Heat Station No. 1. Re-Heat Station No. 1 shares boiler capacity with Astro Hill. Water from Happy Valley and Astro Hill is circulated independently.

A circulation pump in AV-223 maintains flow in the newer part of the loop. A check valve in MH-96 prevents short-circuiting in the newer part of the loop during periods of low demand. Bleeders in MH-73 and MH-76 also promote circulation.

A schematic of freeze protection in Happy Valley is given in Figure 9.

8.1.4 Airport Loop and Federal Building Loop

Water is supplied from AV-305 out to the airport terminal and the Federal Building area.

Freeze protection is achieved by returning water in a 75-mm re-circulation line from AV-262 past the Airport Terminal to the Trigram Building for re-heat. Water also re-circulates to the Trigram Building from Lower Base at AV-207. Lower Base does not receive tempered water from the Trigram Building.

Freeze protection at the Federal Building and BCC is achieved by using a bleeder in AV-5 to maintain circulation through the dead end watermain servicing those buildings.

Freeze protection in the supply main between AV-305 and AV-200, which is adjacent to the Trigram Building, is achieved through constant circulation. Circulation is maintained in the supply main by demands from the Airport and Federal Building areas and by a bleeder in AV-200.

A schematic of freeze protection in the Airport Loop and Federal Building Loop is given in Figure 10.

8.1.5 Lower Base

Water is supplied to Lower Base from AV-9A at AV-404. Freeze protection in the supply main between AV-9A and AV-404 is achieved through demands in Lower Iqaluit and Lower Base. Water flows from AV-404 through Lower Base and into a jumper in AV-207 before it returns with flow from the Airport Loop in the 75-mm re-circulation line to the Trigram Building for heat input. Tempered water from the Trigram Building is not re-circulated back to Lower Base for distribution.

AV-404 contains a 50-mm jumper and a pressure-reducing valve. The jumper pulls flow from AV-205 to AV-404 to prevent freezing.

A schematic given in Figure 11 shows freeze protection for Lower Base.

8.1.6 Shunt Subdivision and Expansion Area

Water is pressure boosted at the booster station to AV-326 on Apex Road. Water is supplied to the Shunt Subdivision and the Expansion Area from Apex Road. Water is looped around the Shunt Subdivision and the Expansion Area. At AV-334 on Apex

Road water enters a 200-mm re-circulation line. Water returns to the booster station for heat input. Tempered water returns to the main supply line at AV-326.

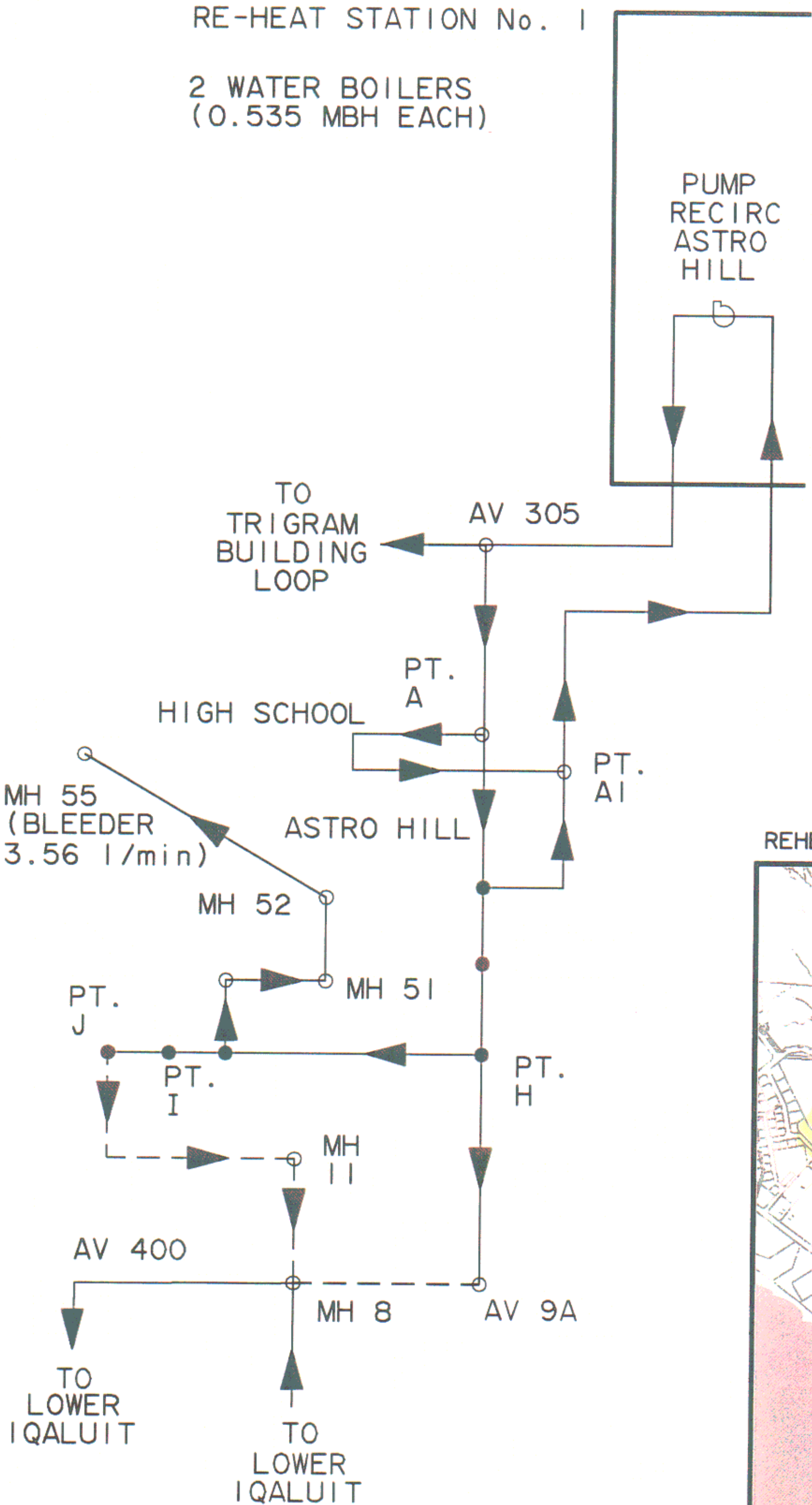
A schematic of freeze protection in the Shunt Subdivision and the Expansion Area is given in Figure 12.

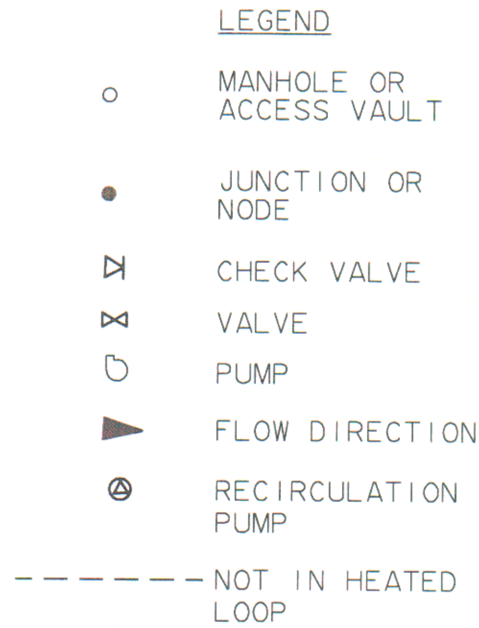
8.1.7 Road-to-Nowhere Subdivision

Freeze protection in the Road-to-Nowhere Subdivision is achieved through heat input, circulation and reliable circulation patterns. Water is pressure boosted at the Booster Station and then supplied to the Road-to-Nowhere Subdivision at AV-500 on Apex Road.

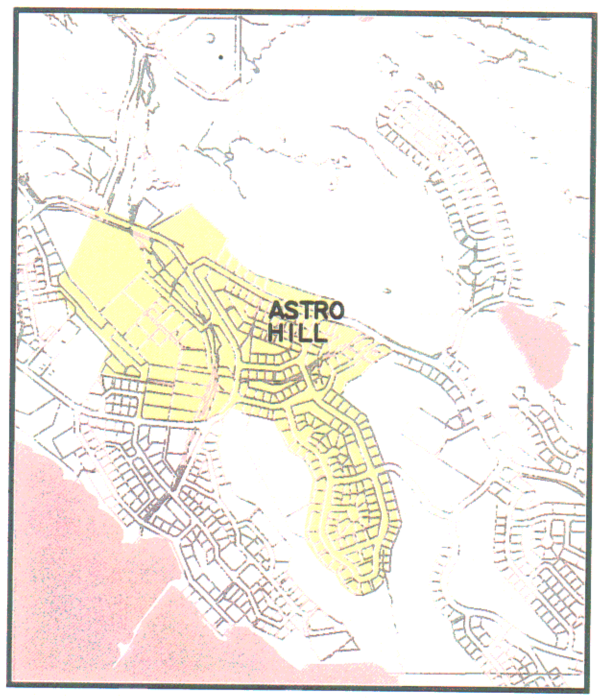
AV-500 contains a circulating pump on a 75-mm jumper on the watermain that tees from the header main on Apex Road. The pump circulates water around the Subdivision. Water is returned to the header main on Apex Road through a 75-mm jumper in AV-500. Water is distributed the Shunt Subdivision and the Expansion Area before returning to the booster station for heat input.

A schematic of freeze protection in the Road-to-Nowhere Subdivision is given in Figure 13.





REHEAT STATION No. I SERVICE AREA



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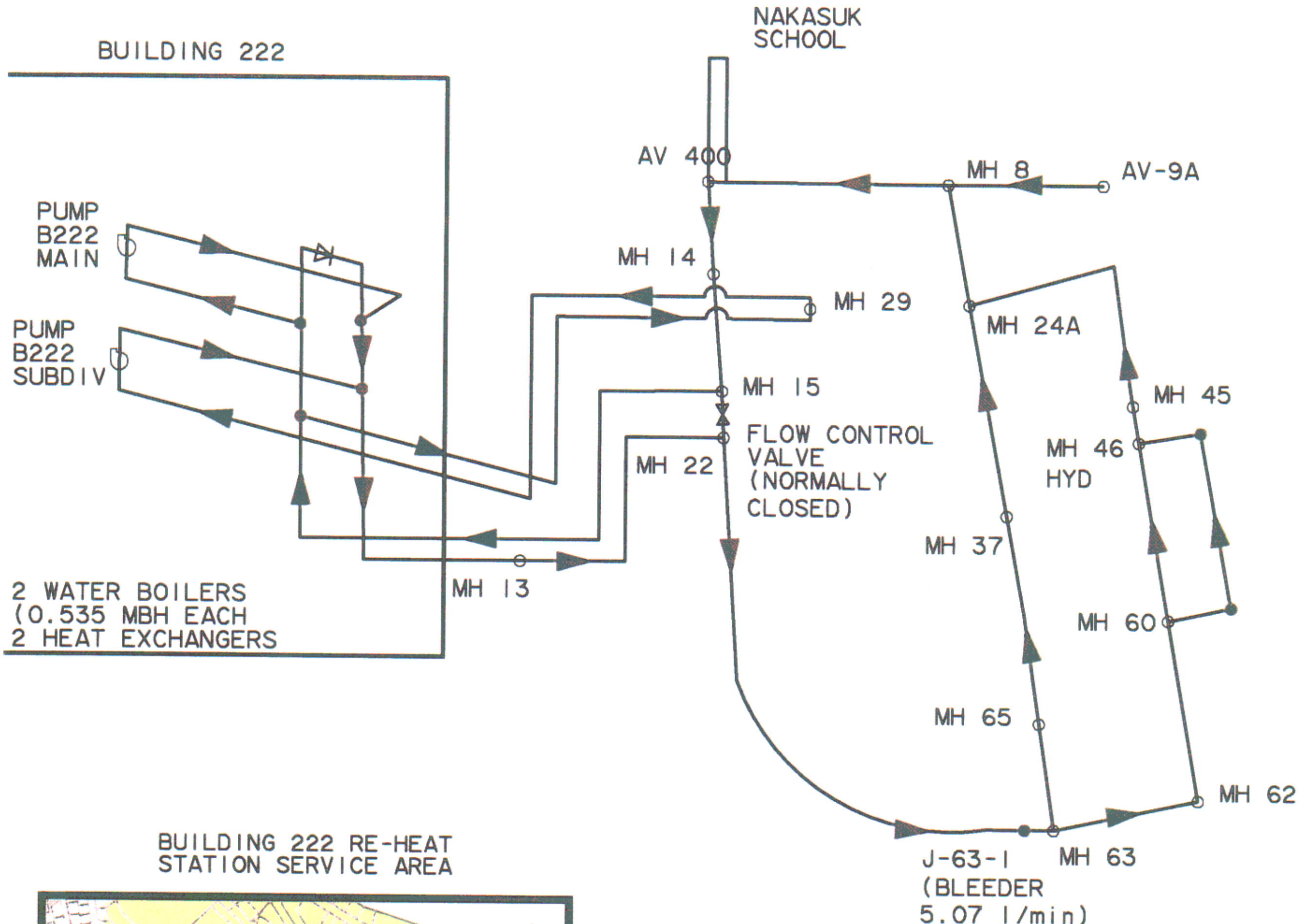
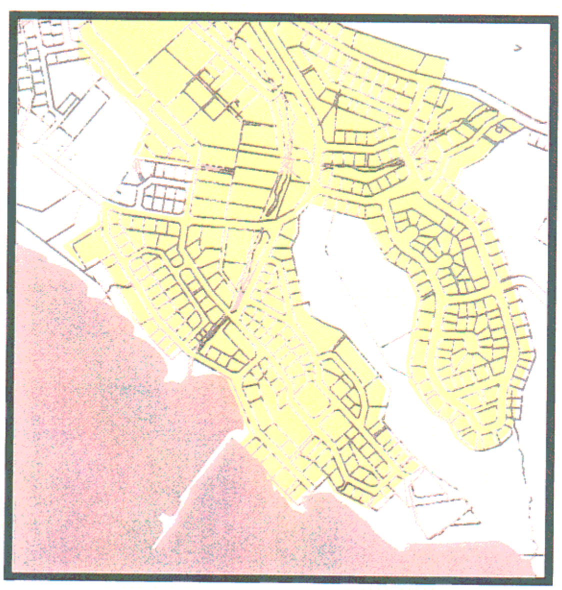
SCALE N.T.S.	CLIENT: CITY OF IQALUIT		JOB NO. MP14882
DATE: DEC,2001			
DRAWN: M.M.R.	TITLE: FREEZE PROTECTION IN ASTRO HILL		FIG 7



BUILDING 222 RE-HEAT STATION SERVICE AREA



LEGEND

- ○ MANHOLE OR ACCESS VAULT
- ● JUNCTION OR NODE
- ⊳| CHECK VALVE
- ⋈ VALVE
- PUMP
- ▶ FLOW DIRECTION

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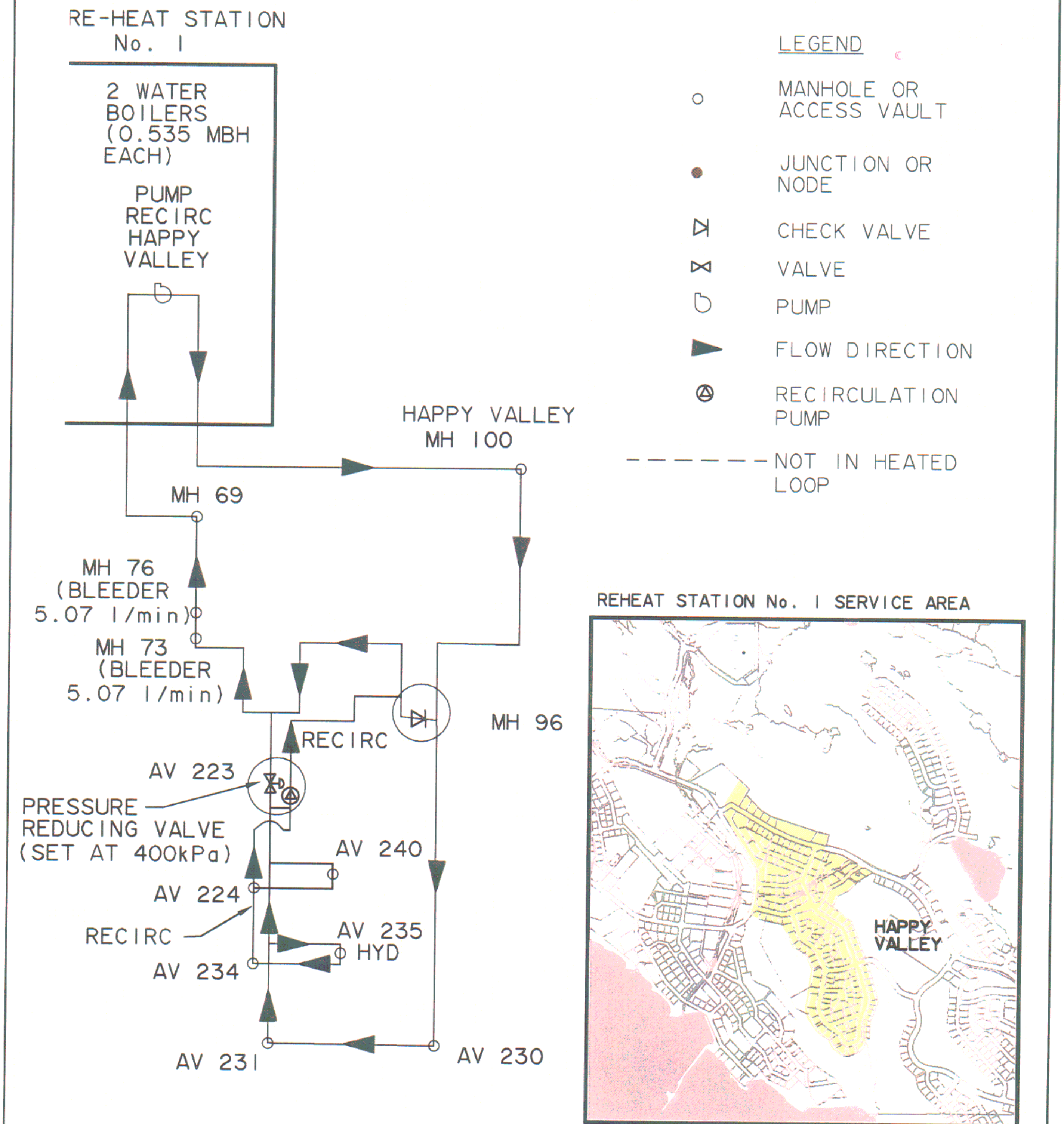
SCALE N.T.S.	CLIENT: CITY OF IQALUIT	JOB NO. MP14882
DATE: DEC,2001	TITLE: FREEZE PROTECTION IN LOWER IQALUIT	FIG 8
DRAWN: M.M.R.		



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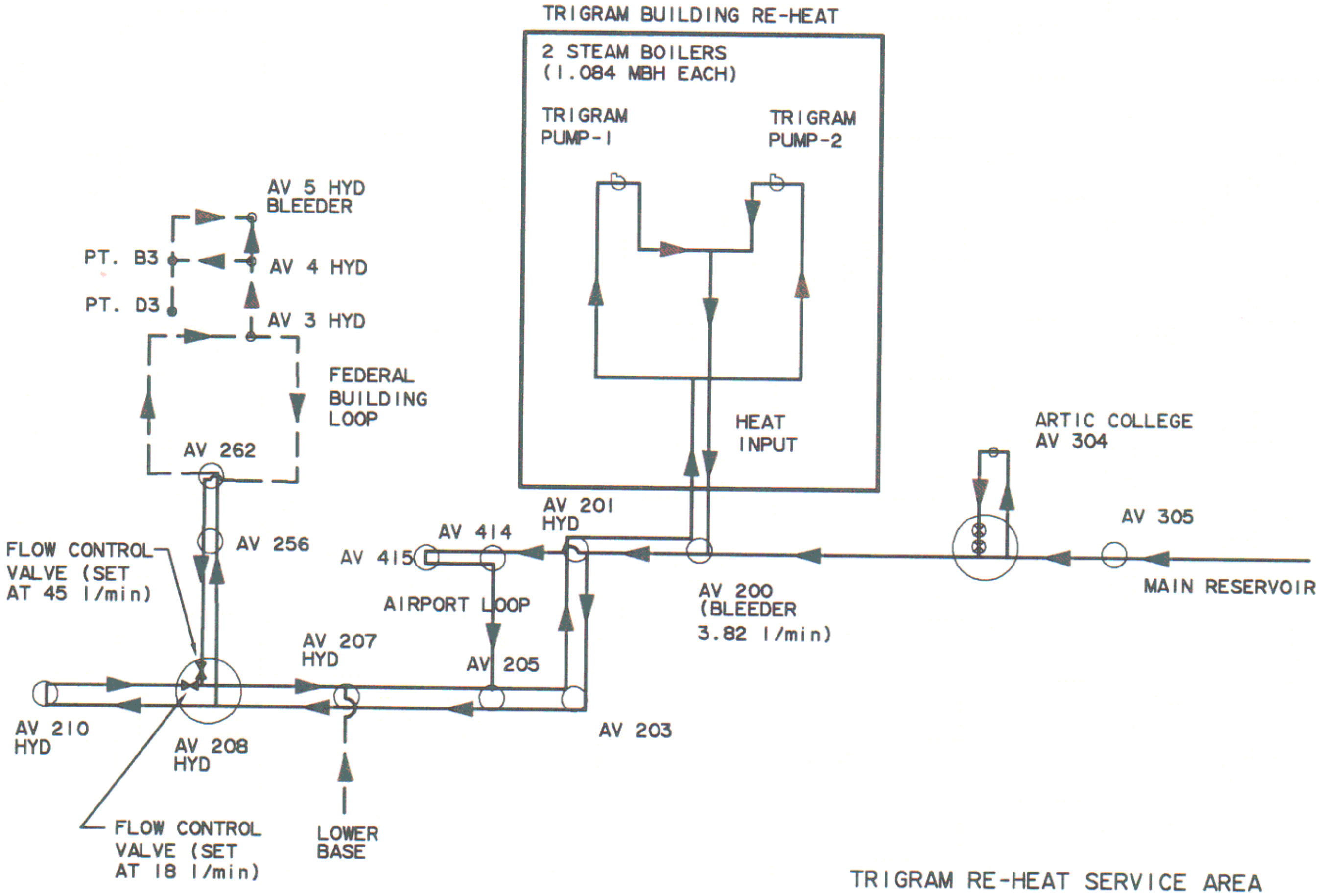
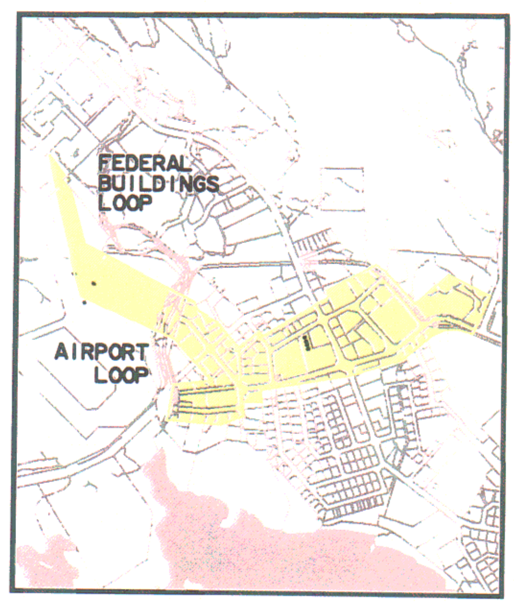
SCALE: N.T.S.	CLIENT:	CITY OF IQALUIT	JOB NO. MP14882
DATE: DEC,2001	TITLE:	FREEZE PROTECTION IN HAPPY VALLEY	FIG 9
DRAWN: M.M.R.			



TRIGRAM RE-HEAT SERVICE AREA



LEGEND

- ○ MANHOLE OR ACCESS VAULT
- ● JUNCTION OR NODE
- ⊗ BALL VALVE
- ⋈ VALVE
- PUMP
- ▶ FLOW DIRECTION
- – – – – – NOT IN HEATED LOOP

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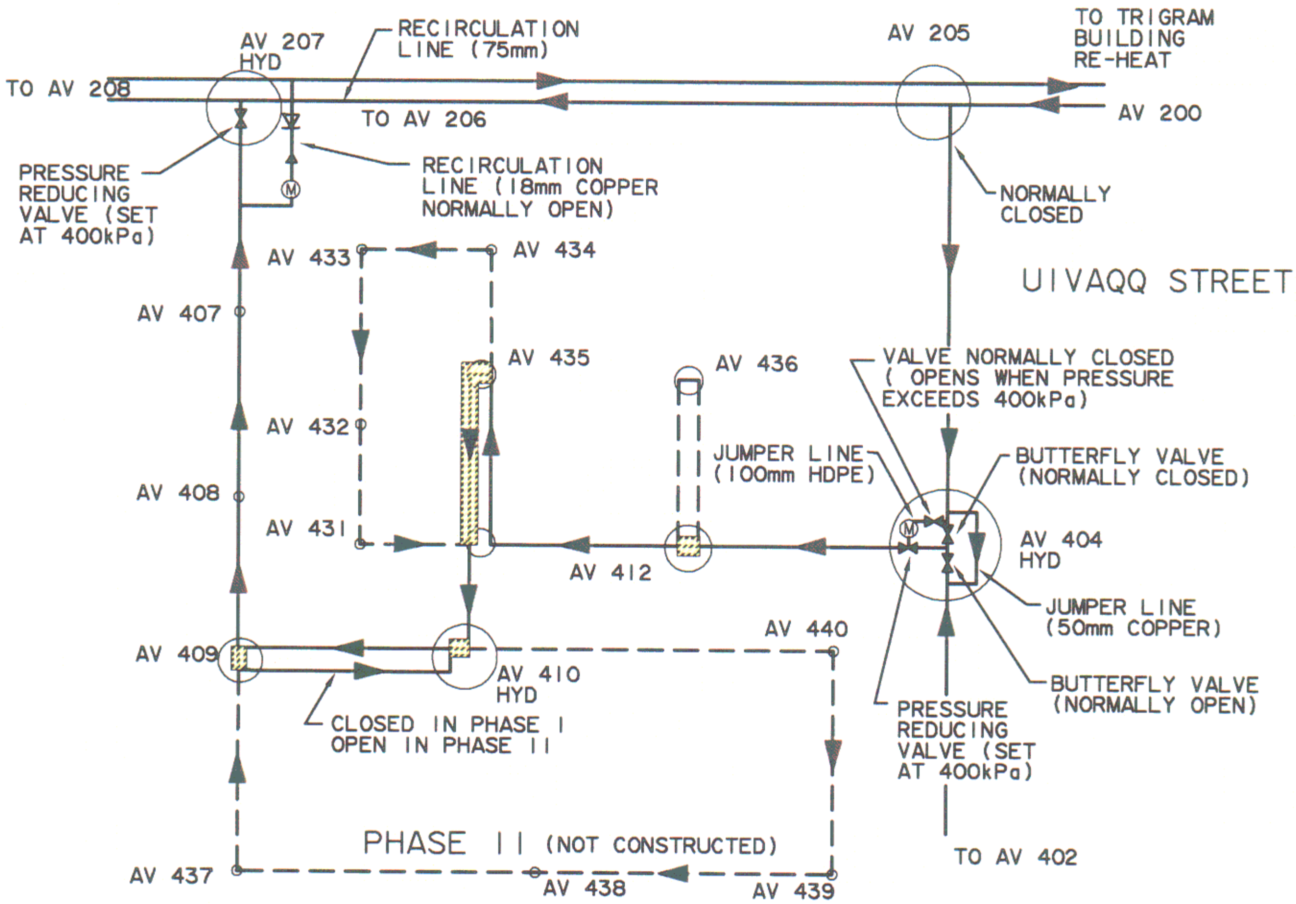
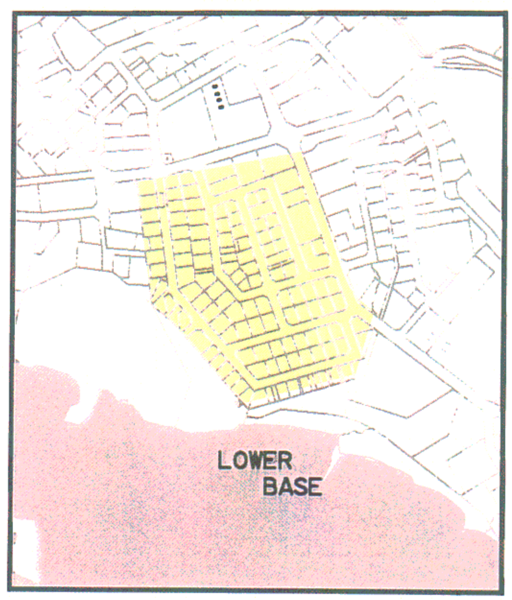
SCALE: N.T.S.	CLIENT: CITY OF IQALUIT	JOB NO. MP14882
DATE: DEC,2001	TITLE: FREEZE PROTECTION IN AIRPORT LOOP & FEDERAL BUILING LOOP	FIG 10
DRAWN: M.M.R.		



LEGEND

- FLOW METER/GAUGE
- CHECK VALVE
- MANHOLE OR ACCESS VAULT
- JUNCTION OR NODE
- VALVE
- FLOW DIRECTION
- TO BE CONSTRUCTED IN PHASE II
- TO BE REMOVED IN PHASE II



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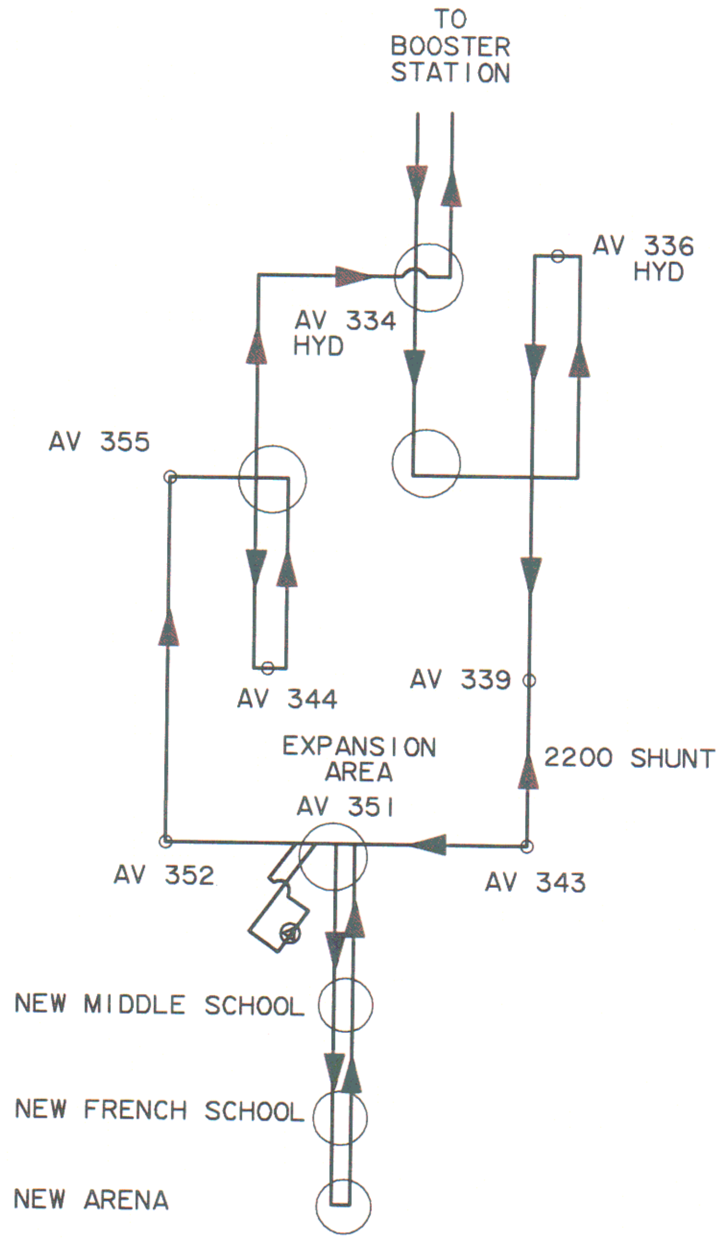
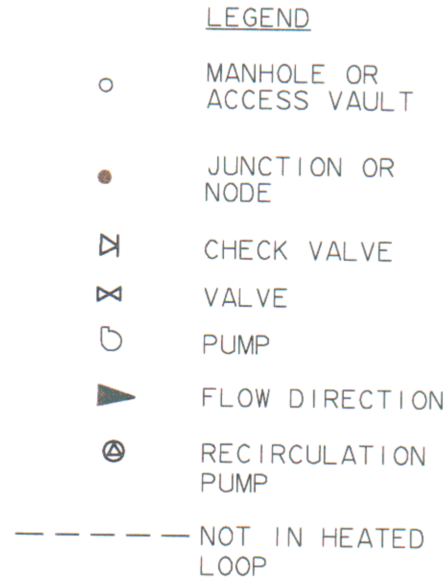
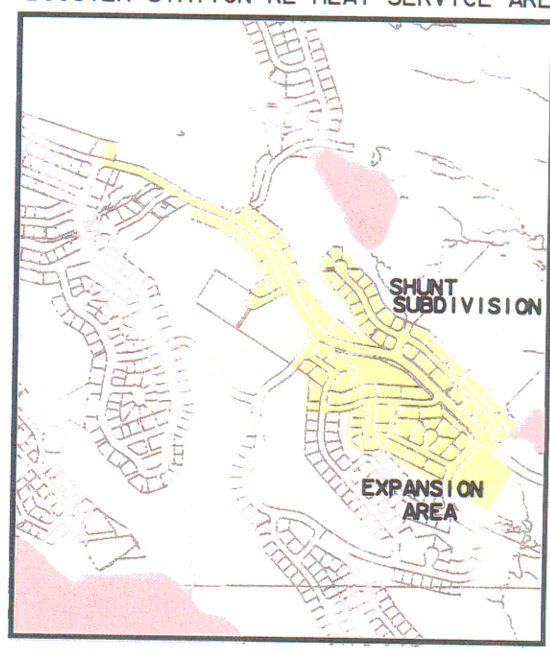
SCALE N.T.S.	CLIENT: CITY OF IQALUIT	JOB NO. MP14882
DATE: DEC,2001		
DRAWN: M.M.R.	TITLE: FREEZE PROTECTION IN LOWER BASE	FIG 11





BOOSTER STATION RE-HEAT SERVICE AREA



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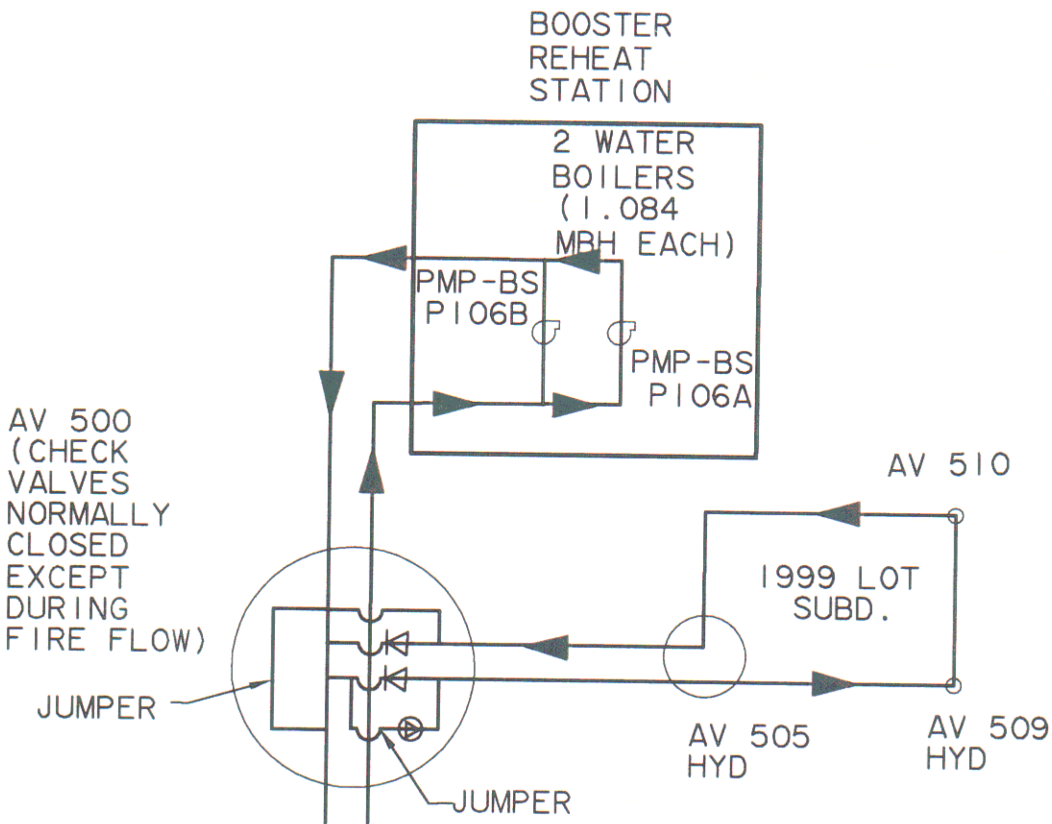
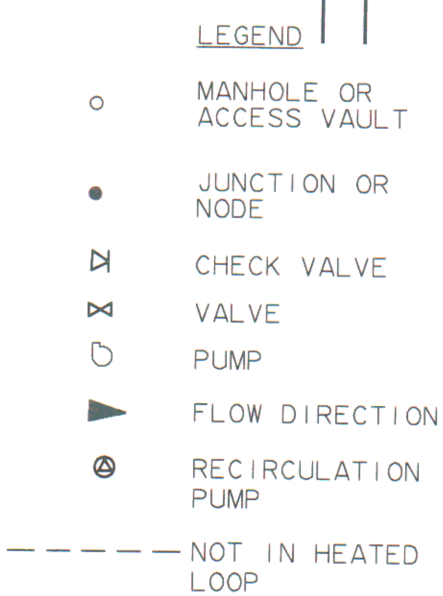
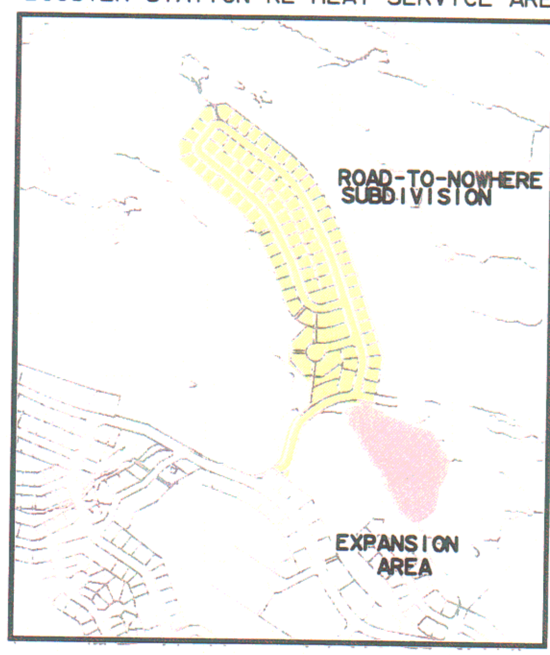
SCALE: N.T.S.	CLIENT: CITY OF IQALUIT		JOB NO. MP14882
DATE: DEC,2001			
DRAWN: M.M.R.	TITLE: FREEZE PROTECTION IN SHUNT SUBDIVISION & EXPANSION AREA		FIG 12





BOOSTER STATION RE-HEAT SERVICE AREA



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SCALE N.T.S.	CLIENT: CITY OF IQALUIT		JOB NO. MP14882
DATE: DEC,2001	TITLE: FREEZE PROTECTION IN ROAD-TO-NOWHERE SUBDIVISION		FIG 13
DRAWN: M.M.R.			

8.2 Capacity of Re-Heat Stations

The capacity of the re-heat stations must be sufficient to replace the heat loss in the distribution system and to ensure that the water is returned at a reasonable temperature.

8.2.1 Thermal Capacity

The capacity of the re-heat stations is governed by the thermal capacity of the boilers. The boilers should have sufficient capacity with one boiler out of service to replace the heat loss in the distribution system.

Several assumptions have been made in estimating heat loss. All pipes are assumed wrapped in 50-mm of polyurethane insulation. The pipes are assumed to have no resistance to heat loss; only the insulation is assumed to provide any resistance.

Outside pipe diameters were calculated based on schedule pipe sizes. Service connections typically consist of 25-mm service and re-circulation lines installed inside a 100 mm insulated HDPE duct. For heat loss estimates, the two lines were treated as a single 50-mm diameter pipe, 20 m in length.

Heat loss was calculated at ambient temperatures of −10°C and −15°C and three different K values (0.016, 0.024, and 0.048 W/m/°C) to simulate insulation deterioration. The heat loss was compared with the boiler capacity at the re-heat stations. Detailed heat loss calculations are given in Appendix C. As can be seen from Table 9, the boilers have sufficient capacity to serve current needs.

The remaining boiler capacity was determined as the difference between the current heat loss (at -15°C and K = 0.48 W/m.°C) and the boiler capacity. The remaining capacity was converted into an equivalent length of watermain and service connections. Equivalent pipe was determined using 200-mm diameter, pre-insulated HDPE pipe for watermain and by spacing the services by 12 m to account for servicing both sides of the street every 24 m (typical lot width). The equivalent pipe length represents the potential development than can be added to the re-heat station with the existing boilers.

As shown in Table 9, the existing boilers should have sufficient capacity to tolerate additional growth. The boiler capacity at Building 222 has the least remaining capacity for growth. A major expansion of the distribution system that affects one of the re-heat stations will require additional study to determine if additional boiler capacity will be required at the station.

The current heat loss and boiler capacities at each re-heat station are presented in Table 9.

Table 9 - Current Heat Loss and Boiler Capacity

Re-Heat Station	Service Areas	Boiler Capacity		Current Heat Loss (W) at T_a=-10°C			Current Heat Loss (W) at T_a=-15°C			Remaining Boiler Capacity at T_a=-15°C, k=0.048 W/m.°C		
		(MBH)[1]	(W)[2]	K=0.016 W/m.°C	k=0.024 W/m.°C	k=0.048 W/m.°C	k=0.016 W/m.°C	k=0.024 W/m.°C	k=0.048 W/m.°C	(W)	(MBH)	Length of Pipe (m)[3]
Re-Heat Station No. 1	Astro Hill Happy Valley	0.958	280,569	26,461	39,691	79,383	35,281	52,922	105,844	174,726	0.597	10,000
Building 222	Lower Iqaluit	0.535	156,685	21,070	31,604	63,209	28,093	42,139	84,278	72,407	0.247	4,000
Trigram Building	Airport Loop Federal Loop	1.084	317,471	19,519	29,278	58,557	26,025	39,038	78,076	239,395	0.817	15,000
Booster Station	Road-to-Nowhere Subdivision Expansion Area	1.084	317,471	35,166	52,749	105,499	46,888	70,333	140,665	176,806	0.604	11,000

[1] Million British Thermal Units per Hour.

[2] Watts.

[3] Estimated using 200-mm diameter, pre-insulated HDPE pipe plus a 20 m service connection every 12 m of watermain, at k=0.024.

8.2.2 Hydraulic Capacity

The circulating pumps at the re-heat station must be able to move sufficient tempered water to replace heat loss. The pumps must have sufficient hydraulic capacity to ensure that water returns to the re-heat station prior to cooling below 5°C. The discharge capacity of the pumps is sufficient to meet current needs in the system and can tolerate some additional development including infilling and redevelopment. A major expansion to the distribution system will require evaluation to determine if additional hydraulic capacity will be required.

8.3 Summary

1. Freeze protection is needed to ensure that the water does not freeze in the distribution system, which will disrupt service and potentially damage the system.
2. Freeze protection is achieved through constant and reliable circulation and heat input.
3. A description of the freeze protection system in each distribution loop is given above.
4. The system contains four re-heat stations. The stations contain boilers, heat exchangers, and circulating pumps.
5. The current heat loss in the system has been estimated for each service area. Detailed calculations are provided in the Technical Annex.
6. The capacity of the boilers and the pumps is sufficient to meet current heat loss needs and will tolerate some expansion of the piped service system.
7. For a major expansion that requires capacity from one of the existing stations, further evaluation of station capacity will be required.

9 Sewage Collection System

9.1 Description

Sewers, forcemains, and pumping stations collect and transfer sewage from much of the City. Sewage hauling trucks collect and transfer the remaining sewage and discharge it at two sewage dumping stations (only one is currently in use) on the collection system. The sewer system is illustrated on the attached Drawing SAN-1.

All of the sewage flows into the sewage lagoon for treatment. The sewage treatment plant is currently not commissioned. The lagoon and the treatment plant are not included in the scope of this study.

9.2 Existing Sewer System

9.2.1 Service Limits

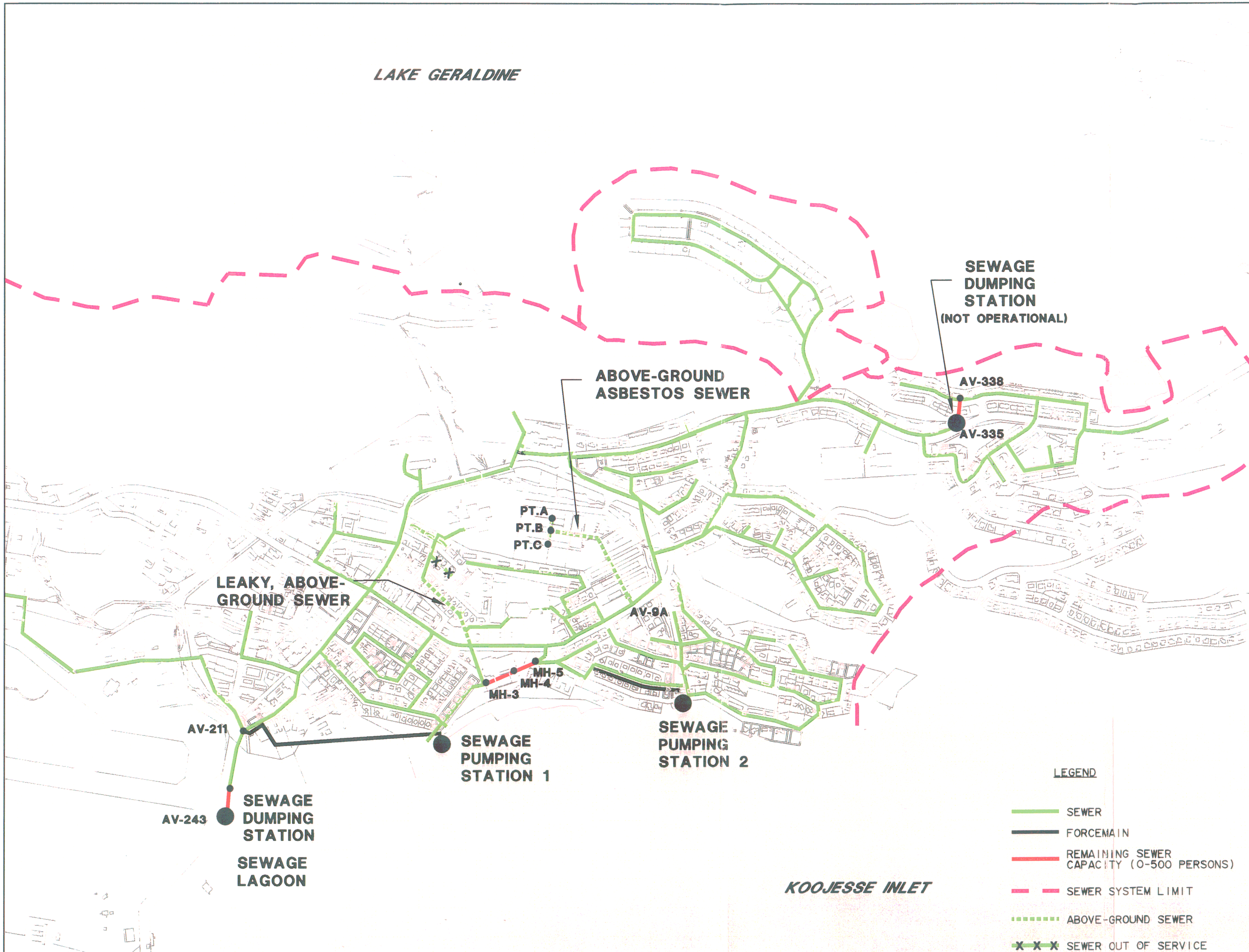
Sewage flows via gravity in the sewer system. The extent of the service limits, which is dictated by topography, is depicted in Figure 14. Extension beyond these limits will require additional sewage pumping stations.

9.2.2 Inventory

The sewage collection system consists of 19,100 m of sewer and forcemain, exclusive of service connections. The pipes range in size from 100 to 300 mm in diameter. An inventory of the pipes in the system including its year, material, diameter, and length is provided in the Technical Annex. A summary of the diameters and lengths of pipe is given in Table 10.

Table 10 - Summary of Inventory of Sewers and Forcemains

Diameter	Length
150 mm	2,200 m
200 mm	14,500 m
250 mm	2,200 m
300 mm	250 m
Total Sewer Length	18,300 m
Total Forcemain Length	800 m



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CLIENT: CITY OF IQALUIT

TITLE: EXISTING SEWER SYSTEM & SERVICE LIMITS

SCALE:	1:10,000
DATE:	APR.2002
DRAWN:	M.M.R.
JOB:	MP14882a

FIG.14

9.2.3 Condition

The extent of the above ground system is depicted in Figure 14. Many of these sewers were constructed using asbestos cement piping. In general, they are currently performing adequately. The asbestos cement piping should be considered for replacement, as it is prone to failure if frozen.

A section of sewer within the Uivvaq loop area from the Brown Row housing units to AV-402 consists of corrugated steel sewer as depicted on Figure 14. This piping should be considered for replacement as it is currently leaking in various locations and is generally in poor condition. In addition, because it is situated above ground it is a land use issue and maintenance challenge. This sewer is currently being addressed as part of the Uivvaq Loop improvements discussed in Section 11.0.

9.2.4 Current Demand

The estimated sewage flow for the current system was calculated based on population densities of 2 persons per apartment and 4.3 persons per single family home. Average flows were calculated using both the current consumption rate of 277 L/c/d and the City design standard of 400 L/c/d. Peak flows were calculated based on peaking factors calculated using the Harmon Formula for the residential population, a factor of 3 for office and commercial areas, and a factor of 2 for the hospital, sports facilities, schools, hotels, and residences. Flows and capacities of each segment of the sewer system are given in the Technical Annex.

9.2.5 Capacity

The remaining capacity in the sewer system was evaluated by estimating the current sewage flow in the system and comparing it to the design capacity of the sewers.

There are two sewage dumping stations (i.e. truck discharge stations) in the City. The station situated adjacent to the sewage lagoon is currently in use. The station situated in the Expansion Area is not in operation because the pipe cannot handle the sewage load. The capacity was determined for all sewers upstream of the truck dumping station near the sewage lagoon. The capacity of sewers downstream of the sewage dumping station were not evaluated as they will be decommissioned with the sewage lagoon upon commissioning the treatment plant.

In general, there is sufficient capacity in the system to meet current needs. Most sewers have sufficient capacity to handle flow from some future development.

Several of the existing sewers may constrain system expansion. Three segments of sewer are considered critical, as they will be impacted by growth due to their location and have limited remaining capacity (i.e. capacity for less than additional 500 persons at an average of 400 L/c/d).

The first critical sewer segment is the main trunk upstream from the dumping station located near the sewage lagoon. The main trunk receives all of the City's sewage flow and will be impacted by all future development that is an extension of the existing piped service system. The most critical sewer on the main trunk is that between AV-243 and the dumping station as it has the least capacity for growth. This sewer could reach capacity as early as 2002 based on peak sewage flows estimated using 400 L/c/d.

The second constraint is the sewer between MH-5 and MH-3. It cannot handle flows arising from the current population for an average day flow of 400 L/c/d. It has limited capacity for flows using the current consumption rate of 277 L/c/d. Its upgrade date depends on future consumption rates and the location and timing of future development.

The third constraint is the sewer located between AV-335 and AV-338 in the Expansion Area. It can handle existing flows but has little capacity for growth. Its upgrade date depends on future consumption rates and the location and timing of future development.

The remaining sewer capacities of these sewers are given in Table 11. The locations of the sewers with limited remaining capacity are given in Figure 14.

The ability of the sewage system to support growth must be reviewed when the locations of future development have been confirmed. Continued review of the ongoing ability of the system to meet demands is required as development advances.

Table 11 - Potential Constraints in the Existing Sewer System

Sewer			Sewage Flow Estimated using 400 L/c/d[1]			Sewage Flow Estimated using 277 L/c/d		
From	To	Design Capacity (L/s)	Flow (L/s)	Remaining Capacity (L/s)	Upgrade Date[1]	Flow (L/s)	Remaining Capacity (L/s)	Upgrade Date[1]
Sewers situated upstream of Sewage Dumping Station near Sewage Lagoon								
AV-211	AV-241	114.4	57.8	56.7 (3,600 pers.)	2014	45.8	68.7 (6,500 pers.)	At 12,000 persons
AV-241	AV-242	86.5	57.8	28.7 (1,600 pers.)	2008	45.8	40.7 (3,500 pers.)	2014
AV-242	AV-243	79.2	57.8	21.4 (1,200 pers.)	2006	45.8	33.4 (3,000 pers.)	2013
AV-243	Dumping Station	62.7	57.8	4.9 (250 pers.)	2002	45.8	16.9 (1,400 pers.)	2007
Sewers situated upstream of Sewage Pumping Station 1								
MH-5	MH-4	37.6	42.4	0 (0 persons)	Depends on future develop-ment.	31.4	6.2 (400 pers.)	Depends on future develop-ment.
MH-4	MH-3	37.6	42.8	0 (0 persons)		31.8	5.8 (400 pers.)	
Sewer situated in Expansion Area								
AV-335	AV-338	11.8	5.3	6.4 (300 pers.)	Depends on future develop-ment.	3.9	7.9 (600 pers.)	Depends on future develop-ment.

[1]Estimated year of upgrade based on current growth rate (3.66%) and current population (5,510).

9.3 Sewage Pumping Stations

9.3.1 Description

Sewage Pumping Station 1 is located downstream of MH-1 and AV-437. It receives sewage from Happy Valley, the Expansion Area, the Astro Hill Complex, and Lower Iqaluit. Sewage is pumped from the wet well at the station and into a 605 m long, 200 mm diameter polyethylene forcemain, discharging into the sewer from the Airport Loop and the Federal Building Loop at AV-211.

Sewage Pumping Station 2 is located downstream of Manholes 23 and 23B. It services much of Lower Iqaluit. Sewage is pumped from the wet well at the station and into a 360 m long, 150 mm diameter ductile iron forcemain to the gravity sewer at MH-22.

Each pumping station contains two self-priming centrifugal pumps. Ratings and models are presented in Table 12 for the pumps at both stations.

Table 12 - Sewage Pumping Stations - Pump Nameplate Data

	Sewage Pumping Station 1	Sewage Pumping Station 2
Manufacturer	Gorman-Rupp	Gorman-Rupp
Model	T6A3-B	T3A3-B
Size	6 "	3 "
Impeller Diameter	12 3/8 "	8 ½ "
RPM	1,250	1,350
Motor	30 hp	7.5 hp
Design Discharge	44 L/s (700 US GPM)	12.6 L/s (200 US GPM)
Head	17.7 m (58 ft)	11.6 m (38 ft)

9.3.2 Volume of Wet Wells

The volumes of the wet wells were estimated based on drawings supplied by the City of Iqaluit. The estimated volume of the wet well in Sewage Pumping Station 1 is 4.87 m^3 to the high water level and 13.8 m^3 to the top of the well. The estimated volume of the wet well in Sewage Pumping Station 2 is 0.79 m^3 to the top of the well.

9.3.3 Condition

The condition of Sewage Pumping Station 1 was assessed during a field visit. The following is a list of findings:

- The primary pump is fitted with a belt not specified for this pump.

- The primary pump is reported to have priming problems after power outages.
- The secondary pump is not operational (subsequently reported by the City as repaired).
- The alarm system requires testing to ensure it would alert Public Works when pumps fail.
- The electrical panel has experienced some deterioration due to high humidity.
- The trap door to the sewage tank was open, which creates a safety hazard as you enter the building.
- The building is starting to deteriorate.
- The building requires cleaning and improvement of the interior.
- The pumping station appears to be serving the current demand.

The condition of Sewage Pumping Station 2 was assessed during a field visit. The following is a list of findings:

- Both pumps appear operational.
- Short cycle times persist, which is related to the volume and draw down of the wet well.
- The pumps should be equipped with guards over pulleys and belts as these pose a safety risk as you descend into this area.
- The electrical panel appears in good condition.
- The pump area requires some cleaning. Spare parts, rags, and tools should be removed from this area and stored in the shed.
- The pumping station appears to be serving the current demand.

9.3.4 Capacity

Using the Hazen Williams formula, system curves were computed to confirm capacity at low wet well levels and high friction conditions (C = 120) and at high wet well levels and low friction conditions (C = 140). Pump curves were obtained from the manufacturer. System curves and pump curves are given in the Technical Annex.

The current capacity of Sewage Pumping Station 1 is 56 L/s at 16 m of head. The capacity could be increased to 71 L/s and 23.5 m of head with new 6" pumps (same size family, larger RPM) and minimal re-working of the station. These are the largest pumps the station can accommodate without major modifications. Upgrades beyond new 6" pumps will require substantial modifications to the station. At that date, replacement of the pumping station and forcemain should be considered. The timeframe until it reaches capacity depends on the location of future development. New pumps could be required as early as 2003 and a new station could be required as early as 2007 if all development is directed to this sewage pumping station.

The current capacity of Sewage Pumping Station 2 is 21 L/s and 8 m of head. The capacity could be increased to 26 L/s at 10 m of head with new 3" pumps and minimal re-working of the station.

The selection of new pumps requires further evaluation when the capacity is required.

The populations that can be served with existing and new pumps at both stations is given in Table 13 based on peak flows calculated using historical consumption rates and the City's design standard.

9.3.5 Upstream Sewer Capacity

Sewage Pumping Station 1 receives flow from AV-409 in Lower Base and from MH-1 situated downstream from MH-2 and MH-3. Sewage Pumping Station 2 receives flow from MH-23 (downstream from MH-19) and from MH-23B. The sewer capacity immediately upstream of the pumping stations is sufficient for existing demands. The sewer capacity upstream of the pumping stations is given below in Table 14.

Table 13 - Capacity of Sewage Pumping Stations

Location	Status	Station Capacity	Flows Estimated using 400 L/c/d		Flows Estimated using 277 L/c/d	
			Current Peak Flow	Remaining Capacity[1]	Current Peak Flow	Remaining Capacity[1]
Sewage Pumping Station 1	Current Pumps	56.0 L/s	47.3 L/s	8.7 L/s (400 Persons)	35.4 L/s	20.6 L/s (1,700 Persons)
	New Pumps[2]	71.0 L/s	47.3 L/s	23.7 L/s (1,300 Persons)	35.4 L/s	35.6 L/s (3,200 Persons)
Sewage Pumping Station 2	Current Pumps	21.0 L/s	8.9 L/s	12.1 L/s (600 Persons)	6.1 L/s	14.9 L/s (1,200 Persons)
	New Pumps[3]	26.0 L/s	8.9 L/s	17.1 L/s (900 Persons)	6.1 L/s	19.9 L/s (1,700 Persons)

[1] Remaining capacity is the difference between the station capacity and the peak flow.

[2] 6-inch pumps, 12 3/8 inch impeller, 1550 RPM.

[3] 3-inch pumps, 8 ½ inch impeller, 1550 RPM.

Table 14 - Comparison of Potential Station Capacity to Upstream Sewer Capacity

Location	Station Capacity (L/s)		Upstream Sewer Branch	From	To	Sewer Capacity (L/s)
	Existing	Potential				
Sewage Pumping Station 1	56.0	71.0	Lower Base	AV 409	Pumping Station 1	30.1
			Lower Iqaluit	MH 3	MH 2	74.4
				MH 2	MH 1	80.0
				MH 1	Pumping Station 1	80.0
Sewage Pumping Station 2	21.0	26.0	Lower Iqaluit	MH 23	Pumping Station 2	24.8
			Lower Iqaluit	MH 23B	Pumping Station 2	45.1

9.4 Summary

1. The extent of the gravity sewer system servicing is limited by topography. The current service limits are shown on Figure 14.

2. Some of the asbestos cement sewers are located above ground as shown on Figure 14. These sewers should be considered for replacement.

3. The corrugated sewer pipe shown on Figure 14 should be considered for replacement.

4. The capacity of the sewer system has been evaluated based on peak sewage flows calculated from average day consumption rates of 400 L/c/d and 277 L/c/d. Generally, there is sufficient sewer capacity to meet current peak sewage flows.

5. The sewer between AV-243 and the dumping station adjacent to the lagoon could reach capacity as early as 2002 using an average flow rate of 400 L/c/d.

6. The sewers situated between MH-5 and MH-3 and between AV-335 and AV-338 have limited capacity.

7. Various observations regarding the physical condition of the pumping stations are provided in Section 8.3.3.

8. The current capacity of Sewage Pumping Station 1 is 56.0 L/s. Station 1 currently receives peak flows of 47.3 L/s using the design standard of 400 L/c/d. The remaining capacity will handle flows from 400 additional persons. An ultimate station capacity of 71.0 L/s can be achieved with new 6-inch pumps and minimal re-working of the station, which would serve 1,300 additional persons in total. The timeframe for when upgrades will be required depends on the location and timing of future development. New pumps could be required as early as 2003 and a new station as early as 2007.

9. The current capacity of Sewage Pumping Station 2 is 21.0 L/s. Station 2 currently receives peak flows of 8.9 L/s using the design standard of 400 L/c/d. The remaining capacity will serve 600 additional persons. An ultimate station capacity of 26.0 L/s can be achieved with new 3-inch pumps and minimal re-working of the station, which would serve 1,200 additional persons in total.

10. The ability of the sewage system to support growth must be reviewed when the locations of future development have been confirmed.

11. Continued review of the ongoing ability of the system to meet demands is required as development advances.

10 Access Vaults and Manholes

An inventory of the access vaults and manholes is presented in two volumes under separate cover. The inventory includes an assessment of the material and size of pipes, modifications that have occurred since installation, the status of locks and clean-outs, the amount and cause of water entry, the condition of valves, and the overall condition.

The condition of the access vaults and manholes was assessed during a site visit in the fall of 2001. Access vaults and manholes were assessed and then were categorized as in good, fair, or poor condition. The condition of some access vaults and manholes was not assessed for various reasons. The condition is changing constantly for a variety of reasons. Thus, a regular review of the access vaults and manholes is required to maintain and update this inventory.

Approximately half of the access vaults were found to be in good condition. The majority of the remaining half were judged to be in fair condition and the remaining were considered to be in poor condition or were not assessed. Approximately half of the manholes were found to be in fair condition. The majority of the other half were either in poor condition as they typically contained sewage and debris or were not assessed as they could not be located or opened. Less than 10% of the manholes were in good condition. A summary of the inventory given below in Table 15 can be used in estimating the quantity of work that would be required for a repair and maintenance program.

The following is a summary of common deficiencies catalogued in the inventory:

- Access vaults and manholes should be covered and free of debris.
- Clean-out covers should be installed with a watertight seal.
- Access vaults and manholes that have had sewage back up must be cleaned and sterilized.
- Access vaults and manholes that contain excessive amounts of water should be pumped dry.
- Missing link seals around hydrants must be re-installed.
- Corrosion around penetrations must be sanded and repainted.
- Access vaults where the paint has started to peel from the surfaces of the interior must be sanded and suitably re-coated with epoxy paint.
- Access vaults should be equipped with locks that function properly.

Table 15 - Summary of Inventory of Access Vaults and Manholes

Condition	Characteristics	Number of Access Vaults	Number of Manholes[1]
Good	• Minimal amount of clear standing water and not above watermain. • Clean and free of debris • Valves appear operational	75	10
Fair	• Standing water or evidence of sewage back up • Clean-out covers not installed	48	54
Poor	• Standing water filled with solids/waste above watermain • Contain debris and garbage • Valves corroded • Clean-out covers missing • Paint peeling from wall of AV • Major pitting	15	21
Unknown/ Not Assessed	• Abandoned • Buried • Unable to locate • Unable to open lid (locked or no handle) • Unable to see pipes	5	22
	TOTAL	**143**	**107**

[1]Includes TACs (Thaw Access Chambers) and Pt. B2.

11 Infilling and Redevelopment

11.1 RCPL Water and Sewer Study (1989)

In 1988, RCPL was retained by the Municipality to investigate the expected development of water and sewer services in Iqaluit over twenty years in accordance with the General Development Plan By-Law (UMA Engineering, 1987). Development was to occur on piped services. Redevelopment was to occur by converting the areas on trucked water and sewer services to piped water and sewer services. RCPL initially identified three principal areas for the expansion of services including the New Expansion Area, Lower Base, and Apex in accordance with development priorities and directions provided in the Development Plan.

11.1.1 Lower Base

Lower Base was defined in the RCPL study as that area on either side of Apex Road, west of Nakasuk School. Redevelopment of Lower Base was planned for medium to high density residential buildings and commercial complexes on piped services. Uivvaq Street was planned to be a major commercial core to the City with high-density residential buildings.

In response to this plan, RCPL evaluated three alternatives for the extension of piped services in these areas. Alternative 1 was chosen based on circulation, fire flows and costs. Alternative 1 consists of seven phases illustrated in Figures 15 and 16. A description and status of each phase is given in Table 16.

One intent of the RCPL design was to cause a rational circulation arrangement. Phases 1 and 2 are complete, however, the remaining phases are not complete. The missing phases present implications to the system performance and integrity causing unreliable circulation patterns, which can make predicting problems more challenging. In Phase 3, the watermain from AV-414 to the Airport area and Federal Building Complex was never installed. Consequently, a single 200-mm pipe running a substantial distance and serving demands from a relatively large area may provide fire protection that is less than satisfactory. In Phase 4, water and sewer services were not installed from AV-414 through the Legion area to AV-271. This area remains on trucked services. In 1999, Phases 5 and 6 were initiated with the expansion of the piped system into those lands east of Apex Road and south of Uivvaq Street. Piped servicing is complete in some of this area while the remainder is on trucked services.

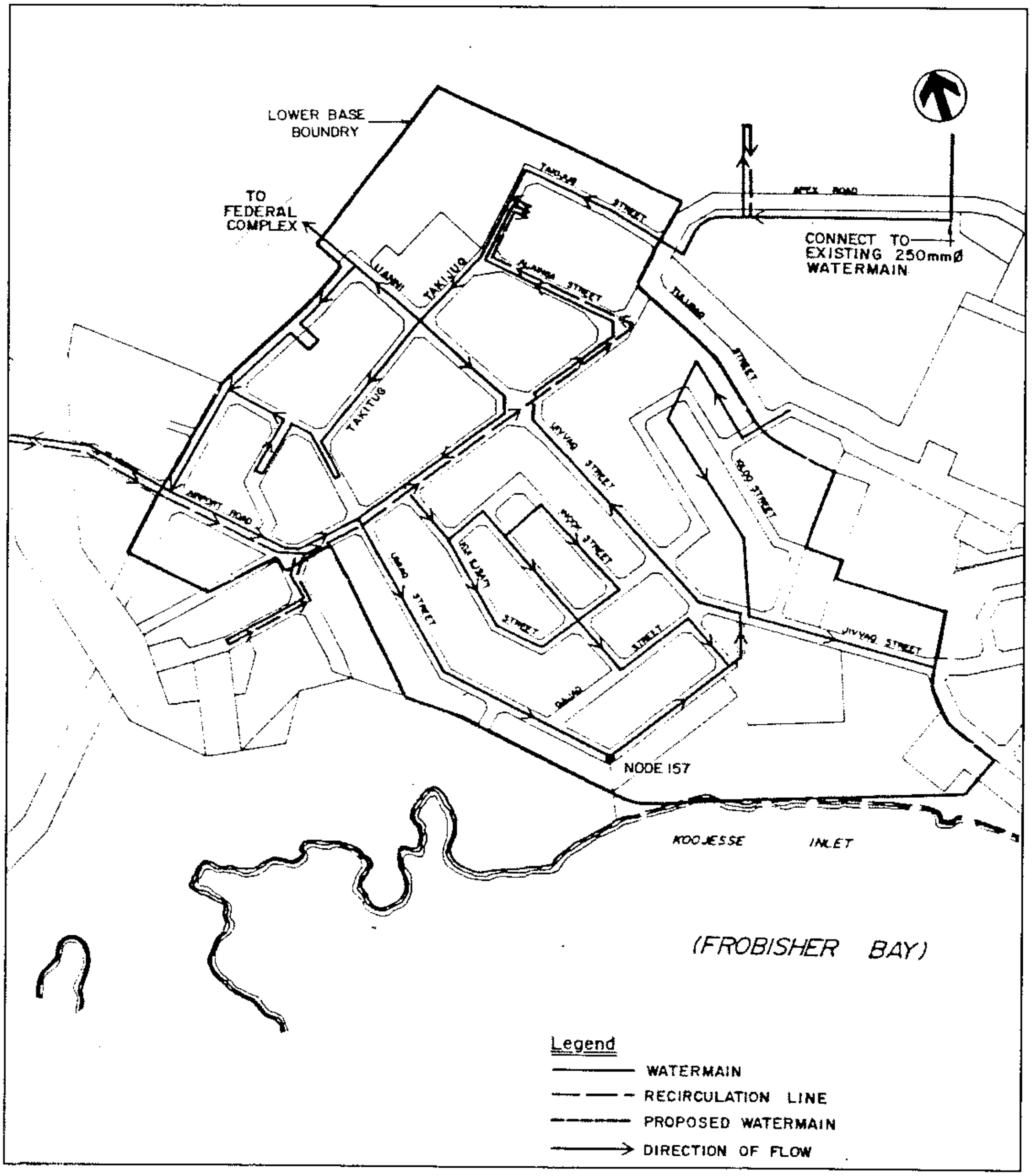


Figure 15 - RCPL Water Expansion in Lower Base (after Figure 7, RCPL (1989))

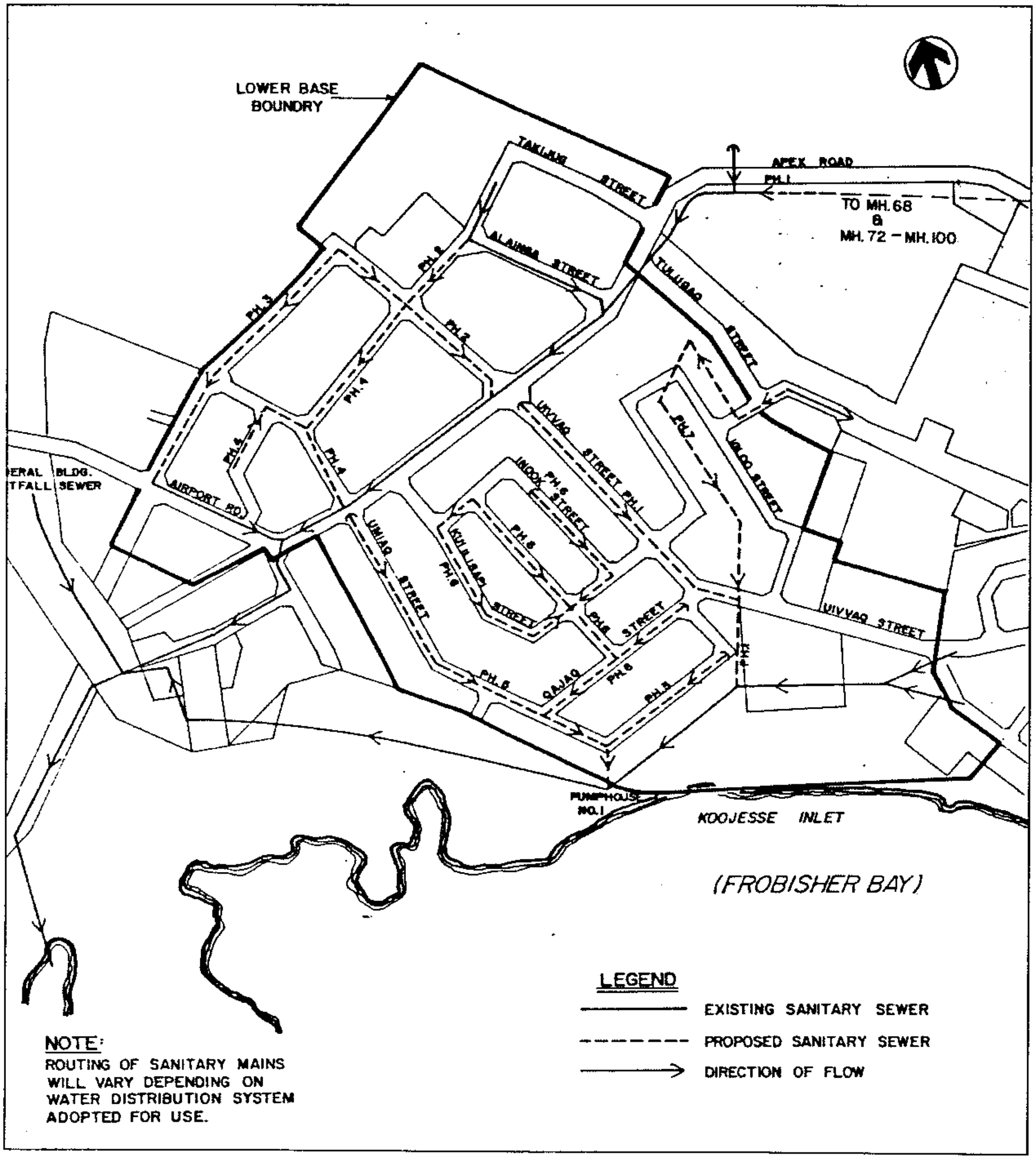


Figure 16 - RCPL Sanitary Expansion in Lower Base (after Figure 13, RCPL (1989))

Table 16 - Description and Status of RCPL's 1989 Phasing

Phase	Description	Status
1	Install circulation pump at Arctic College. Connect return to main at AV-301.	Complete
	Connect main to existing 250 mm watermain from AV-301 on Apex Road.	Complete
	Remove from service the recirculation line between AV-301 and AV-203.	Complete
	Remove from service the watermain between AV-300 and AV-203.	Complete
	Install AV-406. Install watermain along Takijug St. from AV-300 to AV-406.	Complete
	Install watermain and sewer along Uivvaq St. from AV-205 to new AV-400.	Complete
	Install jumper in AV-205 from watermain on Uivvaq St. to recirc on Apex Rd.	Complete
2	Install watermain and sewer from AV-201 to AV-414 to AV-205.	Complete
3	Remove from service the watermain between former truck fill station (near AV-406) and the Federal Complex.	Complete
	Install watermain from AV-406 to AV-201.	Complete
	Install watermain from AV-414 down Federal Road to AV-1 or thereabouts and watermain and sewer to AV-271.	Never Implemented
	Install watermain and sewer from AV-213 to AV-271.	Complete
	Install 15-mm jumper at AV-205.	Never Implemented
	Revisions to Trigram Building (formerly the Laundry Building).	Complete
	New Recirculation Building at AV-406.	Never Implemented
4	Install watermain and sewer from AV-414 to Legion area.	Not Complete. Only runs from AV-414 to AV-415
5	Install watermain and sewer from AV-207 to existing stub at AV-403 along Umiaq St.	Currently runs from AV-207, to AV-409, and to AV-404.
5	AV-205 (Four Corners) – Cut watermains across Uivvaq St. and Apex Road.	Never Implemented.
6	Lower Base - Install watermain from stub at AV-206 and sewer to remaining area. *Lower Base was not connected to AV-402. It was connected at AV-404.*	Currently runs from AV-207 to AV-404.
7	Uivvaq Loop – Water and sewer from MH-55 around Igloo St. to AV-403.	In Design
	Uivvaq Loop – Close valve on watermain in AV-402 to separate Lower Base from Uivvaq Loop.	In Design

11.1.2 Expansion Area

Medium density housing was planned for development in the Expansion Area. Servicing was to include the trunk watermain from near the Hospital, a Booster Station including re-circulation re-heating, a watermain extension from MH-100 to the Expansion Area, and a sewage dumping station in the Expansion Area. Upon full development, the area was expected to accommodate 2,202 persons in 572 units (UMA, 1988).

Since 1989, piped services have been extended as planned with the exception of the Tundra Valley and the Collector Loop (the road through the Expansion Area that connects to Tundra Valley). The extension of piped services to Tundra Valley is unlikely as this would require major infrastructure including a new sewage pumping station and approximately 5,300 m of watermain, 2,500 m of sewer, and 1,500 m of forcemain.

11.1.3 Apex Hill

Redevelopment and development in Apex was to be on trucked services. Since the report, Apex has proceeded as such. To date, there are no plans to extend the piped system to this area.

11.2 Proposed Areas for Infilling

Infilling is the extension of piped services to trucked service areas or to vacant areas within the existing service limits. Several areas have potential for infilling including the Airport Loop, the Legion area, Uivvaq Loop, and Lower Base.

11.2.1 Airport Loop and Legion Area

Lands west of Apex Road including the trucked service areas near the Legion, and extending to the Federal Building Complex have potential for infilling. The existing infrastructure will support some infilling. Freeze protection would be achieved in part by the boilers at the Trigram Building. The nearest sewers can support some growth. The sewer capacity between AV-208 and AV-211 must be reviewed and monitored as expansion advances as the Airport Loop and the Federal Building Complex share this sewer capacity with the backwash from the water treatment plant.

11.2.2 Uivvaq Loop

The Uivvaq Loop includes the water and sewer system servicing the Astro Hill Terrace, Igloo Street, and Uivvaq Street. In 2000, the City retained Trow to evaluate a system that would address the following issues in an attempt to improve public safety, system performance, and the level of service:

- The above ground pipe between MH-16 and White Row housing units under the boardwalk is asbestos insulated pipe. This was to be abandoned and replaced with underground, pre-insulated HDPE piping.

- The services to Brown Row housing units, located across from the Fire Hall, are dependent on the High School services. Services extended from Uivvaq Loop would remove the risk of loss of service caused by improper operation of the High School servicing.

- A section of housing on Igloo Street is on trucked water and piped sewer services. It has been reported that the above-ground sewer is leaking. An extension of piped water service would improve the level of service. Replacement of the above ground sewer would address issues of land use and leaking sewage.

- The current water service for Uivvaq Loop terminates at MH-55. The bleeder in MH-55 maintains sufficient flow to prevent freezing as mentioned previously in Section 8. Removing the need for the bleeder would reduce water consumption.

Trow (2000) evaluated seven servicing schemes. Since the report, the improvements that were completed have been the re-servicing of Nakasuk School to AV-400 and the abandonment of the asbestos pipe from service.

11.2.3 Lower Base

The current expansion has allowed for the majority of buildings in Lower Base to be connected to piped services. Completion of this expansion will permit the connection of the remaining buildings.

The local infrastructure will support an extension of piped services in Lower Base. The largest issue is the sewage system. An extension in Lower Base will impact Sewage Pumping Station 1, which has limited capacity as mentioned in Section 9, and already handles flow from a large portion of the City. As expansion and development advance, the capacity of Station 1 should be monitored.

11.3 Proposed Phasing

The proposed servicing extension is given in Figure 17. Four phases of work are proposed. This work is meant to proceed as shown. Proceeding out of sequence may have implications on re-circulation and re-heat capabilities.

11.3.1 Phase 1 – Airport Loop

Phase 1 includes the extension of a 300-mm water supply main from AV-406 to AV-414, with a new connection to Trigram Building, and from AV-414 to AV-1 or thereabouts near the Federal Building Complex. This extension will increase the service area and improve system performance in the Airport Loop and Federal Building Loop. The existing 50-mm recirculation line from AV-262 to AV-213 would be abandoned.

11.3.2 Phase 2 – Legion Area

Phase 2 includes the extension of piped services west of Apex Road and north of Airport Road. Phase 2 is intended to improve the level of service. Water supply will be from the existing watermain between AV-414 and looped around to the existing watermain at AV-207 near the Legion. The proposed watermain extends to the Legislative Building and then to the existing main at the Government of Nunavut Building. The re-circulation line between AV-271 and AV-213 and the watermain between AV-414 and AV-415 will ultimately be abandoned.

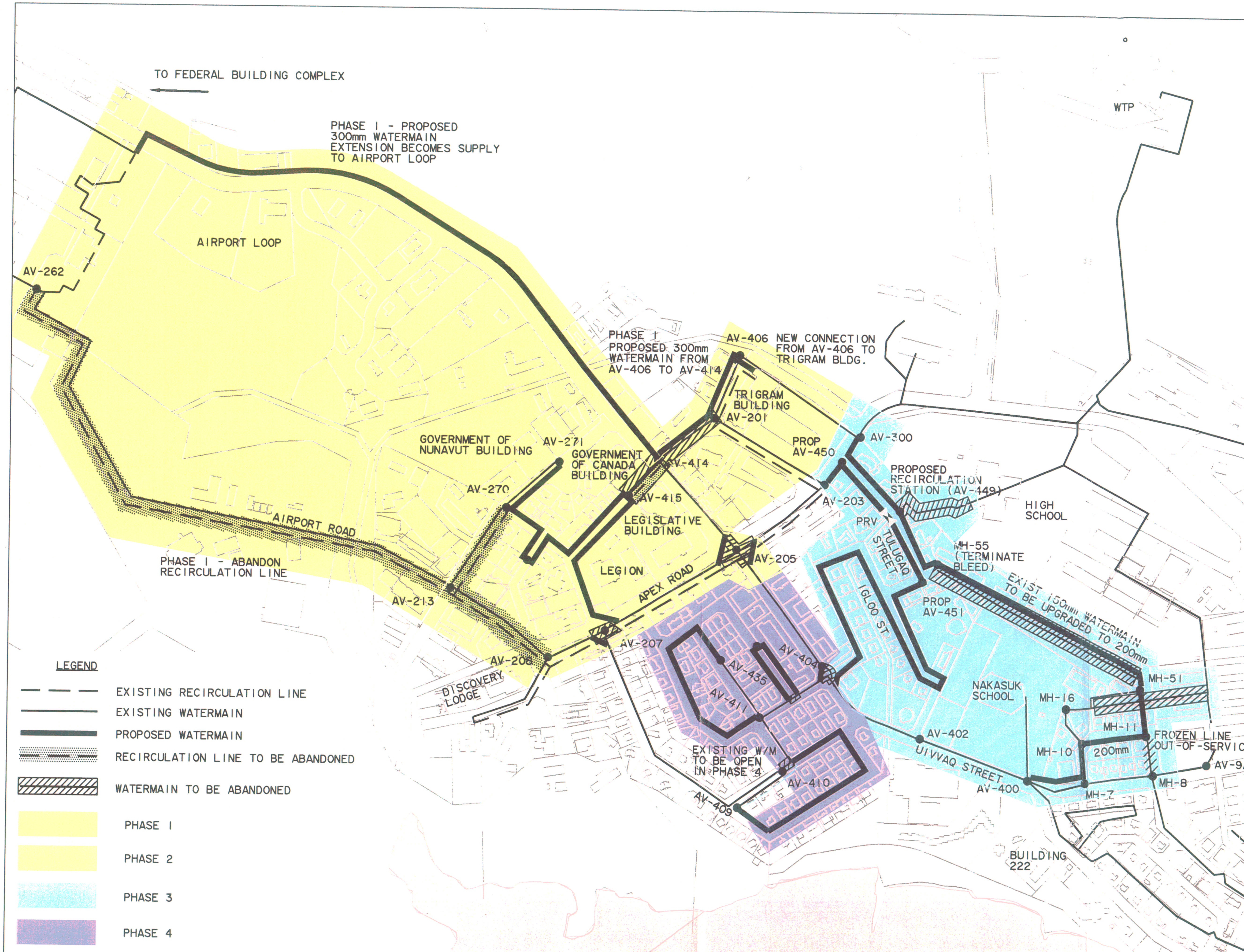
11.3.3 Phase 3 – Uivvaq Loop

Phase 3 includes improvements to the Uivvaq Loop. The proposed servicing scheme will improve service by transferring demand from trucked to piped services and will reduce the problem of system dependence on the High School. The proposed extension relies on water supply from AV-203. The proposed watermain extends from proposed AV-450 along Tulugaq St. in front of the houses serviced by the High School to proposed AV-449. Water then loops around Igloo St. and connects to the existing watermain on Uivvaq St. in AV-404. The proposed watermain connects at AV-400, extends to MH-11, and follows the alignment of the existing water distribution to MH-55 through the Brown Row Housing units on Tulugaq St.. The bleed at MH-55 will be terminated and moved to AV-404 to maintain sufficient flow. The bleed could be moved to a temporary location until completion of the extension.

11.3.4 Phase 4 – Lower Base

Phase 4 includes the extension of piped services to Lower Base. Phase 4 will improve the level of service in Lower Base. The proposed extension loops from existing AV-435 to existing AV-411. The proposed main then extends from existing AV-410 and loops around to the existing main at AV-409, which is currently closed and should be opened in Phase 4. The current water system in Lower Base takes supply from the main between AV-400 and AV-404 and returns to the re-circulation line at AV-207 on Apex Road. The proposed extension takes water supply from the main between AV-208 and AV-207 and returns to AV-404 up to AV-205 for eventual return to the Trigram Building.

In terms of the timing of Phase 4 relative to the other phases, Phase 4 is less of an issue, as it does not change the ultimate flow pattern of the system. Phase 4 can advance at any time during the phasing.



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CLIENT: CITY OF IQALUIT

TITLE: PROPOSED PHASING OF WATER SYSTEM EXPANSION

SCALE:	1:5,000
DATE:	APR.2002
DRAWN:	M.M.R.
JOB:	MP14882a

FIG. 17

11.4 Lower Iqaluit

Some limited space in Lower Iqaluit presents potential infilling opportunities; however, the space is very modest. The existing infrastructure can support some growth. The fire flows provided in Lower Iqaluit are marginal. Freeze protection is dependent in on Building 222, which has sufficient capacity to tolerate some infilling. Capacity would be required from Sewage Pumping Stations 1 and 2. The remaining capacity in Sewage Pumping Station 1 is limited and is shared by competing development areas. The remaining capacity in Station 2 has sufficient capacity to support infilling. Given the existing infrastructure and the available space, Lower Iqaluit can support limited infilling.

11.5 Redevelopment

Limited vacant space is available in the City for development. To accommodate the projected growth, redevelopment at higher densities within the extent of the exising piped services system might be considered instead of infilling the few remaining vacant spaces that are largely constrained by other issues.

11.6 Summary

1. RCPL's report has been reviewed. The status of RCPL's phased approach to development has been summarized. Some phases are complete. Missing phases have implications on the performance of the system and on the level of service.

2. Lands within Lower Base and lands near the Legion between Apex Road and the Government of Nunavut Building are currently on trucked service. To improve the level of service, the piped system should be extended to these areas. A plan for extending piped services to Lower Base is currently underway. A proposed servicing extension to these areas is given in Figure 17.

3. Improvements in service and in system reliability are required in Uivvaq Loop. There are inefficiencies and risks with this system including houses that are on trucked water service and houses that are dependent on the High School for water service. Improvements began recently but for the most part are not complete. To address the remaining issues, a proposed servicing extension is given in Figure 17.

4. Limited vacant space and existing infrastructure could accommodate some infilling in Lower Iqaluit.

5. Given the shortage in empty space, redevelopment to a higher density should be considered to accommodate long-term growth.

12 Potential Development Areas

12.1 Constraints

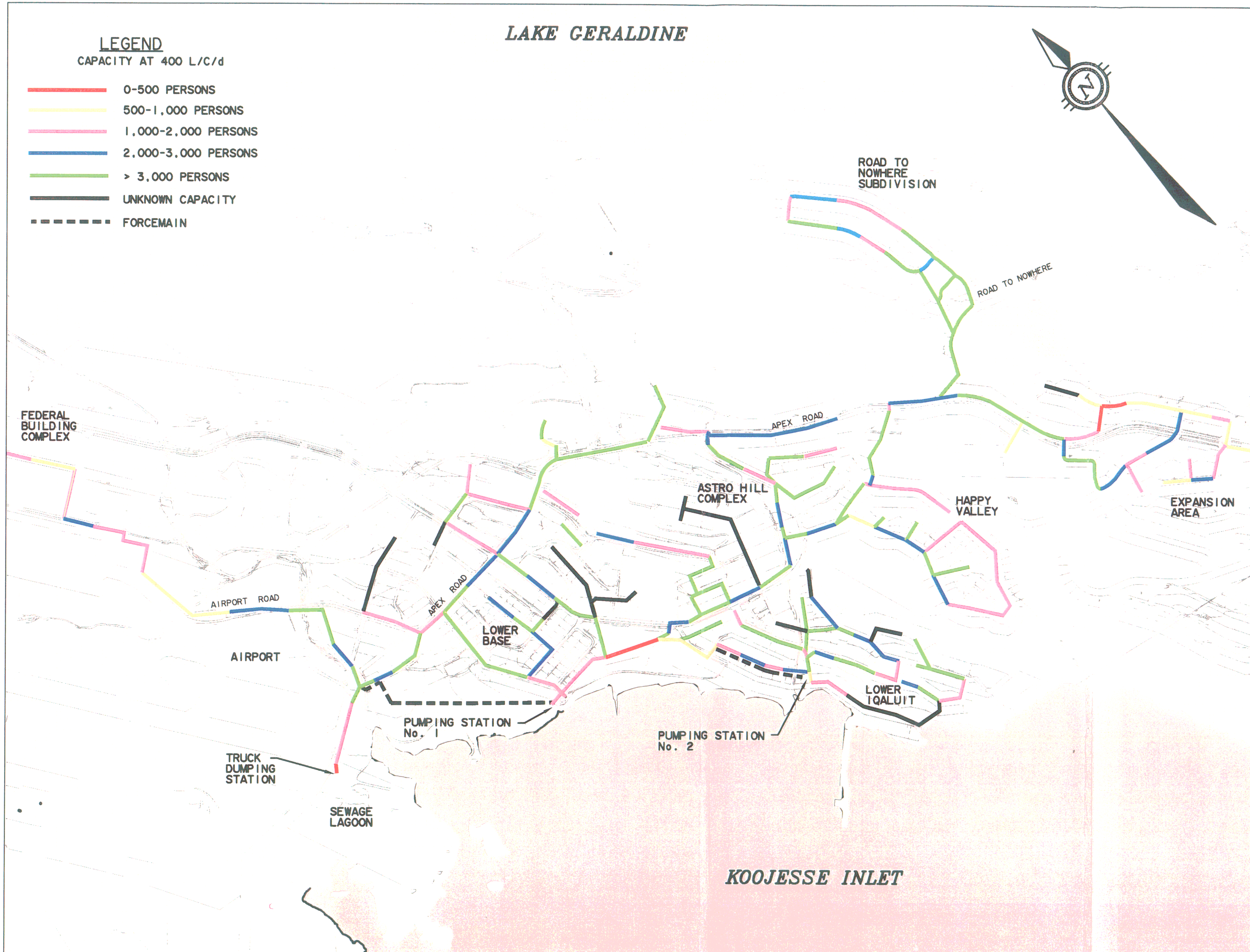
Development is limited by physical constraints such as existing infrastructure and roads, topography, and proximity to Frobisher Bay.

The service limits of the water system are provided in Section 7. Servicing beyond these limits will require a booster station.

The service limits of the sewage collection system are given in Section 9. Servicing beyond these limits will require a new sewage pumping station.

Sewer capacity will limit growth. The remaining sewer capacity of each sewer in the system is given in Figure 18 in terms of the number of persons that can be added to the system at an average consumption rate of 400 L/c/d, which is the City's design standard.

To develop on piped water and sewer services and to accommodate ultimate growth, the existing system may require expansion beyond its current servicing limits, which requires major infrastructure. Otherwise, development would advance on trucked services.



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CLIENT: **CITY OF IQALUIT**

TITLE: **REMAINING SEWER CAPACITY POTENTIALLY AVAILABLE FOR GROWTH**

SCALE:	1:10,000
DATE:	MAY, 2002
DRAWN:	M.M.R.
JOB:	MP14882a

FIG.18

12.2 Potential Development Areas 1 and 2

Trow was retained in 1999 to provide preliminary engineering and planning services for the development of a 100-lot subdivision. Three areas were identified by the City. Road and lot patterns were developed. Terrain analyses were conducted. Preliminary design and cost estimates were prepared.

Since that report, one of these areas has already developed as the Road-to-Nowhere Subdivision. Development Areas 1 and 2 (referred to as Areas 2 and 3A by Trow (1999)) remain available for development. Area 1 lies north of the Expansion Area and southeast of the New Middle School. Area 2 lies north of Arctic College and west of the water treatment plant. Area 1 contains 98 lots. Area 2 contains 130 lots. Their locations are given in Figure 19.

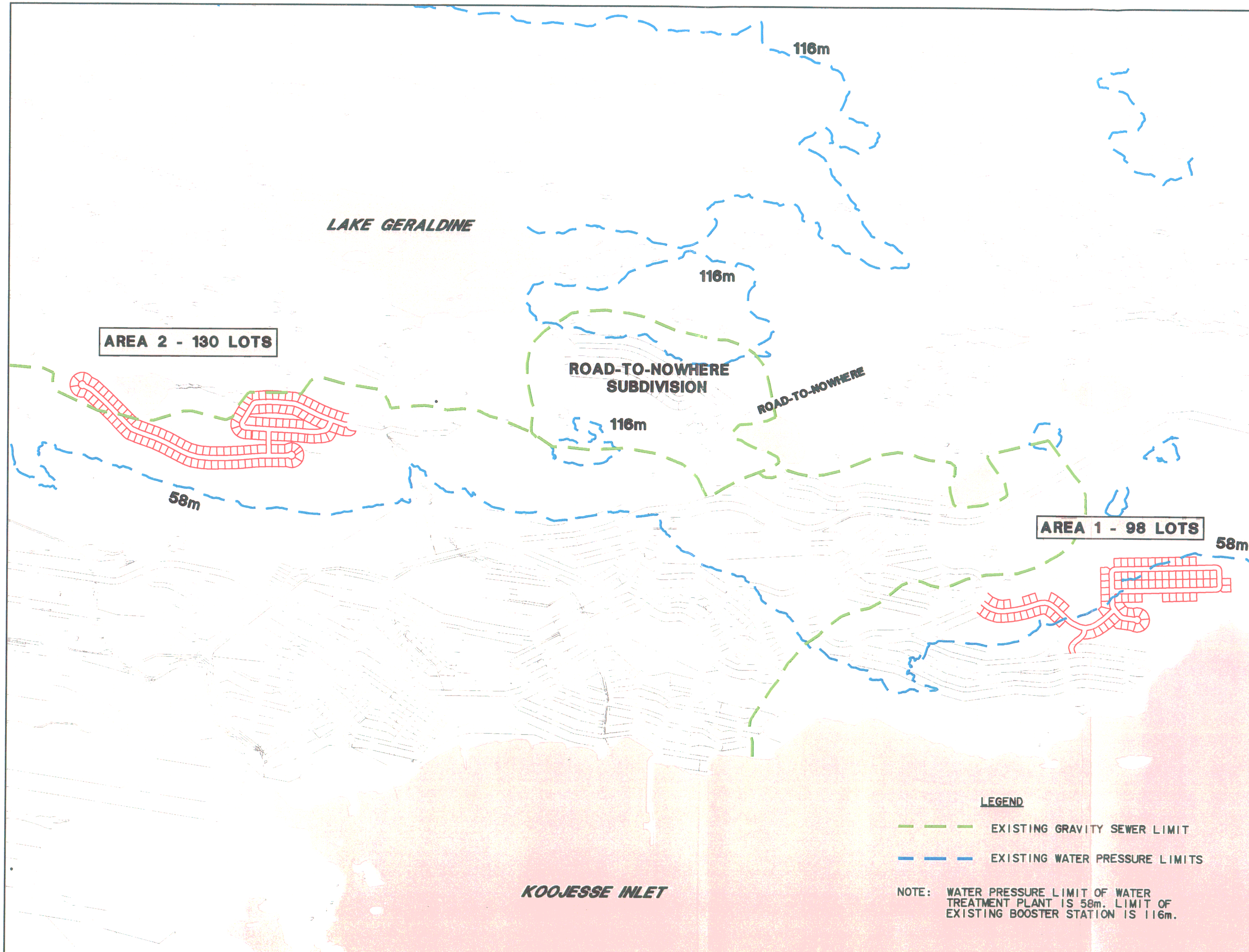
Trow (1999) proposed concepts for water and sewer layouts connected to the City's existing water and sewer systems. In terms of major infrastructure required to connect to the existing system, Area 2 requires two sewage pumping stations and forcemain and Area 3A requires a water booster station with re-heat and re-circulation capabilities.

Preliminary cost estimates were prepared for each area in three categories: utilidor, roads, and major infrastructure. Cost estimates were based upon historical data from similar developments. The costs are summarized in Table 17.

Table 17 - Estimated Cost of Servicing in Development Areas 1 and 2 (after Trow, 1999)

Construction	Development Area 1	Development Area 2
Utilidor	$3,583,350	$4,360,200
Roads	$866,250	$961,750
Major Infrastructure	$700,000	$750,000
Total	**$5,149,600**	**$6,071,950**
Number of Lots	98	130
Cost Per Lot in 1999	$52,600	$46,700
Cost Per Lot in 2002[1]	**$55,263**	**$49,064**
[1] 2002 costs were estimated assuming an annual increase of 2.5% from estimates by Trow in 1999.		

Assuming a density of four persons per lot, these areas would accommodate 912 persons. This is not sufficient to meet long-term needs. The City should consider advancing future development at higher density. Accommodation of the 20-year design population requires further study.



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CLIENT: CITY OF IQALUIT

TITLE: POTENTIAL DEVELOPMENT AREAS (AFTER TROW (1999))

SCALE:	1:12,500
DATE:	APR.2002
DRAWN:	M.M.R.
JOB:	MP14882a

FIG. 19

12.3 Potential Development off Road to Nowhere

The City has not identified a preferred area of development off the Road to Nowhere.

Development up the Road to Nowhere would be situated beyond the water service limits. A new booster station would be required with facilities for re-circulation and re-heat. Sewage would flow by gravity into the existing sewer system.

Development in this direction may impact the Lake Geraldine watershed. It is recommended that development be avoided within the boundaries of the watershed. Development within the watershed boundaries would potentially contaminate the raw water supply. Assurance of healthy water is vital to the City.

12.4 Expansion of Trucked Services

Trucked water and sewer services are required in areas where extension of piped services is not feasible. Trucked services are most beneficial areas beyond the servicing limits of the existing infrastructure system.

12.5 Summary

1. Future expansions may have to proceed beyond its current servicing limits to accommodate development.

2. Development beyond the current servicing limits will require major infrastructure to connect to the existing piped water and sewer system.

3. Trow (1999) identified infrastructure requirements for three potential development areas. One of these areas was developed as the Road-to-Nowhere Subdivision. The location of the other two areas are given in Figure 19.

4. Servicing costs were estimated as $55,263 per lot for the 98-lot subdivision and $49,064 per lot for the 130-lot subdivision.

5. Development off the Road to Nowhere will also require major infrastructure. Development in this direction may impact the Lake Geraldine watershed while deteriorating the quality of the raw water supply. It is recommended that no development be situated within the boundaries of the watershed.

6. Future development at higher densities should be considered.

13 Summary

- **Population and Demand**

1. The City provided population projections. The current (2001) population is 5,510, the 20-year (2021) population is projected to be 11,300, and the ultimate population is projected to be 12,000.

2. The current demand for water was estimated using plant production records from 1999 and 2000. Plant production records are a measure of both piped and trucked water usage. The average per capita demand for trucked service was assumed as 123 L/c/d based on Camillus (1996) and as per discussion with the City. The current average per capita consumption rate on piped service was estimated as 277 L/c/d. The City's design standard of 400 L/c/d was used in projecting demand for piped water service.

3. Prediction and assessment of all future upgrades is dependent on the accurate estimating of population and consumption.

4. It is recommended that accurate recording of population and consumption for both piped and trucked services continue.

- **Raw Water Supply and Storage**

5. The City's raw water source is Lake Geraldine. The Lake Geraldine watershed receives 1,633,000 m^3 of precipitation per year over the watershed. The City currently requires 27% of this volume and will require 89% of the volume by the year 2021.

6. The amount of runoff that is actually contributing to the recharge of Lake Geraldine is not known due to the lack of information.

7. Assurance of water supply is essential to the City.

8. It is recommended that a detailed watershed study be undertaken immediately.

9. OMM (1995) reported that the last dam extension increased the useable raw water storage volume to 570,000 m^3 to serve a maximum population of 6,202. At current growth rates, the City will reach the maximum population by the year 2005.

10. It was estimated that an additional 402,000 m^3 of raw water storage capacity is needed to meet demands of 11,300 persons.

11. It is recommended that a study be undertaken on expanding the raw water storage capacity.

- **Water Treatment and Storage**

12. RCPL (now Earth Tech) (1998) reports that the transmission capacity, that is, the capacity of the inlet line between Lake Geraldine and the water treatment plant, is 7,200 m^3/d. Upgrades in treatment capacity beyond 7,200 m^3/d will require that the transmission line be upgraded as well.

13. Earth Tech (2002) reports that the transmission line is part of the current program of plant upgrades.

14. The current gross capacity of the plant is 1,296 m^3/d, which includes the useable capacity of 1,050 m^3/d and an allowance for in-plant uses. Production records indicate that demand regularly exceeds capacity. Increases in capacity are required immediately.

15. The current program for increasing the treatment capacity is reported by Earth Tech (2002). Earth Tech reports that the expanded plant will meet needs for a population of 11,300 in the year 2021. The gross capacity of the expanded plant will be 9,500 m^3/d

16. Treated water storage is currently provided in two wells and two tanks at the plant and in the main reservoir adjacent to the plant.

17. The current treated water storage capacity is 2,967 m^3.

18. The current treated water storage capacity includes a fire storage allowance of 720 m^3, which is low compared to allowances in other jurisdictions.

19. It is recommended that the City re-evaluate the fire storage allowance during the next treated water storage upgrades.

20. The current treated water storage capacity will serve 5,920 persons.

21. It is recommended that the treated water storage capacity be upgraded by the year 2003.

22. An additional 792 m^3 of storage plus fire storage will be required to meet needs for 11,300 persons.

- **Water Distribution**

23. The water distribution system consists of watermains, re-circulation lines, a booster station, re-heat stations, bleeders, and truck-fill stations.

24. Adequate domestic pressures (i.e. 345 kPa) are provided to development situated up to a vertical elevation of 58 m. Beyond this elevation, the booster station provides adequate pressure up to an elevation of 116 m. Service limits are presented in Figure 2.

25. Extensions beyond the current service limits will require additional pressure boost (i.e. additional booster stations).

26. An inventory of the diameters and materials of watermains and recirculation lines is given in the Technical Annex.

27. Watermain deterioration is generally not a concern as almost no breakage has been reported.

28. There are segments of above-ground Asbestos Cement piping in Astro Hill. Asbestos Cement piping will fail if frozen. It is recommended that this piping be replaced.

29. The City provided a model of the water distribution system using Cybernet. The model was updated to include recent development areas.

30. The system was modeled under current and future demands under maximum day demand and peak hour conditions.

31. The model results indicate that suitable pressures (i.e. > 345 kPa) are provided.

32. The model indicates that the distribution system generally has the capacity to provide fire flows of 2,250 L/min under maximum day conditions while maintaining a pressure of 140 kPa. The available fire flows are given in Figure 4 and in the Technical Annex.

33. Some areas of the system cannot provide 2,250 L/min. In Happy Valley, Manholes 74 and 90 provide 1,800 L/ min.

34. Due to the nature of the area and the buildings, some areas may need additional fire protection. The distribution system at the Airport and the New Arena has capacity for providing 2,700 and 3,000 L/ min respectively.

35. The level of fire protection is the decision of the municipality.

36. It is recommended that the City, in conjunction with the local fire department, continue to test the fire flows.

37. It is recommended that a large diameter watermain be extended to the airport if fire flows are to be improved in this area as shown on Figure 5.

- **Freeze Protection**

38. Freeze protection is needed to ensure continued services and to avoid system damage.

39. Freeze protection is achieved through a combination of constant circulation, heat input, and reliable circulation patterns.

40. Schematics of freeze protection in each distribution loop are provided in Figures 7 to 13.

41. The system contains four re-heat stations that contain boilers, heat exchangers, and circulating pumps. The capacity of the re-heat stations must be sufficient to replace the heat loss in the distribution system and to ensure that the water is returned at a reasonable temperature. Station capacity is governed by the thermal capacity of the boilers.

42. The remaining capacity of the boilers was determined by calculating the heat loss in each service area. Detailed heat loss calculations are given in the Technical Annex.

43. The existing boilers have sufficient capacity to serve the existing system and to tolerate some additional growth depending on future development.

44. The existing circulating pumps have sufficient discharge capacity to meet current needs in the system and can tolerate some additional infilling and redevelopment.

45. It is recommended that the boiler and pump capacity be re-evaluated prior to a major expansion to determine if additional capacity will be required.

- **Sewage Collection System**

46. The sewage collection system consists of 19,100 m of sewer and forcemain, two pumping stations and two sewage dumping stations, of which only one is in use (the second station has problems with sewage back-up).

47. The extent of the service limits is depicted in Figure 14.

48. Extension beyond the service limits will require additional sewage pumping stations.

49. An inventory of the diameters and lengths of the sewers and forcemains is given in the Technical Annex.

50. The extent of the above-ground system is given in Figure 14. Many of these sewers were constructed using asbestos cement piping and are prone to failure when frozen. The section from the Brown Row housing to AV-402 consists of corrugated steel and is leaking. It is recommended that these sections be considered for replacement.

51. Sewage flow and sewer capacities are given in the Technical Annex using the historical consumption rate of 277 L/c/d and the City design standard of 400 L/c/d.

52. In general, there is sufficient capacity in the current sewer system. Most sewers have sufficient capacity to handle flows from some infilling and development.

53. Several sewers have limited capacity (i.e. capacity for less than 500 persons at 400 L/c/d) and are constraints to growth and future development as shown on Figure 14.

54. The sewer between the sewage dumping station and AV-243 has limited capacity and will be impacted by all development. This sewer will reach capacity as early as 2002.

55. The sewer between MH-5 and MH-3 does not have sufficient capacity to handle flows arising from the current population using the design standard of 400 L/c/d. The upgrade date will depend on development.

56. The sewer between AV-335 and AV-338 can handle current demand but has little capacity for growth.

57. The physical condition of the two sewage pumping stations was assessed during a site visit. Details of findings are given in Section 8.3.3.

58. The capacity of the sewage pumping stations has been evaluated. Pump curves and system curves are given in the Technical Annex.

59. The current capacity at Sewage Pumping Station 1 is 56.0 L/s. The current peak flows at Station 1 are estimated as 47.3 L/s. The remaining capacity at Station 1 can accommodate flows arising from 400 additional persons using 400 L/c/d. The capacity can be increased to serve 1,300 additional persons in total with new 6-inch pumps and minor station modifications.

60. The current capacity of Sewage Pumping Station 2 is 21.0 L/s. The current peak flows at Station 2 are estimated as 8.9 L/s. The remaining capacity will serve 600 additional persons at 400 L/c/d. The capacity can be increased to serve 1,200 additional persons in total with new 3-inch pumps and minor station modifications.

61. Upgrades beyond new pumps would require major station modifications.

62. The timeframe for upgrading the sewage pumping stations depends on the location and timing of future development.

63. If Station 1 is impacted by all future development, it may require new pumps as early as 2003 and a new station as early as 2007.

64. It is recommended that the ability of the sewage collection system to meet demands be reviewed as development advances.

- **Access Vaults and Manholes**

65. An inventory of the AVs (access vaults) and MHs (manholes) is presented under separate cover.

66. AVs and MHs were assessed and categorized as in good, fair, or in poor condition.

67. The condition of some AVs and MHs was not assessed for reasons such as they were locked and could not be opened or they could not be located.

68. Approximately half of the AVs were in good condition, the majority of the other half was in fair condition, and the remainder were in poor condition or were not assessed.

69. Approximately half of the MHs were in fair condition, the majority of the other half either was in poor condition or could not be assessed, and few were in good condition.

70. A summary of the inventory given in Table 15.

71. Recommendations regarding the condition of the AVs and MHs are given in Section 10.

72. It is recommended that a regularly review of the AVs and MHs be conducted and that the inventory be maintained and updated.

- **Infilling and Redevelopment**

73. The description and status of RCPL's phased development approach in Lower Base is presented in Section 11. The phasing is not complete.

74. The level of service and the performance of the system can be improved in some areas with system extensions. These areas include lands north of Airport Road and west of Apex Road to the Federal Building Complex, Uivvaq Loop, and Lower Base.

75. Four phases of piped services is proposed. The proposed extension is given in Figure 17.

76. It is recommended that this phasing proceed in sequence so as to not compromise the re-heat and re-circulation capabilities.

77. Limited growth in Lower Iqaluit is possible with the space and the existing infrastructure.

78. Given the shortage of vacant space within those areas served by the existing piped utilities, redevelopment at higher densities should be considered.

- **Potential Development Areas**

79. Future development beyond the existing water and sewer servicing limits will require major infrastructure to be connected to the existing systems.

80. Potential development areas that were previously evaluated by Trow (1999) are presented now as Potential Development Areas 1 and 2 as shown on Figure 19.

81. Areas 1 and 2 can advance on piped services with major upgrades to the existing system or these areas can advance on trucked services.

82. Trow (1999) prepared preliminary cost estimates for servicing. The estimates were increased to reflect current value. The servicing costs in Area 2 are estimated to be $49,064 per lot for 130 lots and in Area 1 are estimated to be $55,263 per lot for 98 lots.

83. At typical residential densities (e.g. 4 persons per lot), these potential development areas will not accommodate long-term growth.

84. It is recommended that development be advanced at higher density.

85. Development along the Road-to-Nowhere would require major infrastructure including a new booster station with both re-circulation and re-heat facilities.

86. Development within the Lake Geraldine watershed should be avoided.

14 Limitations

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