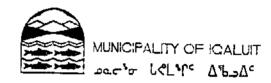
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MUNICIPALITY OF IQALUIT



WATER TREATMENT PLANT DESIGN BRIEF

INDIAN AND MORTHERN
AFFAIRS CANADA
MINIT. REGION
MAY 2 9 1998

IVATER RESOURCES
CIVISION
YELLOWKNIFE, NT

Prepared for:

Municipality of Iqaluit P.O. Box 460 Iqaluit, NT X0A 0H0

Prepared by:

Reid Crowther & Partners Limited
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May 1998

RCPL Project No. 49,507





May 12,1998

Municipality of Iqaluit P.O. Box 460 Igaluit, NT X0A 0H0

Attention:

Mr. Ian Mosher, P. Eng.

Dear Sir:

Re:

Raw Water Intake Design Brief

We are pleased to submit six (6) copies of the Design Brief for the above project. These incorporate the Municipality's comments received on the draft version.

Should you have any questions or comments, please contact the writer.

Yours Truly,

REID CROWTHER & PARTNERS LTD.

M.V. Cronk, P. Eng. Project Manager

MVC/gim

Enclosures

Municipality of Iqaluit

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1.0 INTRODUCTION

1.1 Background

Reid Crowther's involvement in the water treatment plant (WTP) upgrade began in 1989 when Reid Crowther conducted an assessment of present and future water demands for the Municipality of Iqaluit. In 1991 the first draft of the Planning Brief was released, but the project was put on hold pending a decision on the funding level for fire storage. Following the fire storage decision the Municipality requested the planning brief be updated and the third draft was released in January 1994.

The third draft of the planning brief recommended changes to both the water treatment plant and the treated water storage. Subsequent to the planning brief the Municipality elected to proceed with treated water storage expansion, and construction was completed in the fall of 1996.

In January 1998, the Municipality retained Reid Crowther to review the recommendations of the 1994 planning brief for the water treatment plant upgrade and to prepare a predesign report. The 1998 predesign report was to consider the impact of Nunavut, which impact was specifically excluded from the earlier Planning Briefs. This report details the predesign phase of the project.

1.1.1 Existing Facilities

The Municipality is supplied with raw water from Lake Geraldine. The source is generally of good quality, for those parameters recorded. Water from the lake flows by gravity through a 360m long 250mm diameter ductile iron pipeline to the treatment plant. The intake line is poorly insulated with a blown glass material and is partially protected

from freezing by a tempered water recirculation system. The treatment plant has a maximum design output of 1,296 m³/day and a useful output of 1,050 m³/day. The throughput of the treatment plant, in its present state, is limited by the capacity of the filters.

The treatment plant is comprised of the following major components:

- > the Lake Geraldine dam structure and valve chamber.
- > the raw water intake pipeline (Reid Crowther is currently reviewing this component under a separate contract with the Municipality),
- > the treatment plant inlet flow control valve,
- the prechlorination and pH control (through lime contact) system.
- > the settling tanks,
- > the filtration system,
- > the flouridation system.
- > the backwash system,
- > and the main treated water storage reservoir.

The original plant construction had a post filtration ozonation system but this has been abandoned and is currently being removed.

Treated water is stored in two (2) clearwells in the WTP with a combined capacity of 575m3 and in the main storage reservoir which holds 2.280m3. From the main reservoir the treated water flows by gravity to the distribution system. The clearwells and the main

reservoir operate as one large tank with the same free water surface height of 94.5m, neglecting pipe losses between the tanks.

The existing plant contains, or may contain, hazardous materials which will require disposal in a responsible manner:

- > asbestos piping insulation is known to exist in the NTPC utilidor;
- > asbestos piping insulation may be present on existing plant piping; and
- > given the age of the ozonation system, the standard of manufacture of transformers from that time period, and statements made by Municipality employees, the transformer in the ozontation assembly may contain PCB's.

1.1.2 System Deficiencies

The 1997 average Municipality demand for potable water, from plant records, is approximately 1,202m³/day.

At present, the maximum rated plant output is 1,296 m³. The treatment plant output will need to be increased to meet future demand, and in fact the plant is already being pushed over its design limits. The 1997 average demand of 1,202m³ exceeds the recommended plant output of 1,050 m³ by 15%.

The following will be addressed by the predesign report:

- > the existing chlorine room does not meet applicable code or functional requirements,
- additional pH correction is required to reduce corrosivity,

- > removal of taste and odours during spring breakup,
- > alum clarification to enhance colour and turbidity removal, and ensure removal of parasites.
- > many mechanical and electrical components have reached the end of their useful life and should be replaced,
- update chemical feed systems to take advantage of current technology,
- and improve plant safety.

1.2 Water Demands And Quality

1.2.1 Historical Water Demands

Historical water demands and populations, for the period 1978 to 1997, as well as projected values to 2017 are summarized in Table 2.1.

1.2.2 Future Water Demands

It can be seen that since 1987, the demand has been generally declining. This is considered to be attributable to the efforts of the Municipality to reduce leakage and the use of bleeders. As much of this work is now completed, it is anticipated that the average day demands will start to increase again with population growth.

Historically, from 1989 to 1990 the peak demands were recorded to be approximately 2,400 - 2,500 m3/day, giving a peak day factor of around 1.7, and this is expected to climb to 2.0 as additional system losses are eliminated. From the third draft of the

Planning Brief, the minimum night flows factor is approximately 0.1 and will adopted for this report.

For design purposes, a 20 year horizon has been assumed or a design year of 2017. The Municipality provided information, generated as a result of their work in sewage treatment, indicating some 8,500 persons and a 400 lpcd usage in 2017.

The GNWT Bureau of Statistics published population projection for the year 2006 is 5,203 vs 5,951 presented by the Municipality.

The Bureau uses relatively sophisticated techniques to account for migration birth/death rates and a host of other factors. The Bureau verbally indicated that their current 2006 projections are based on 1991 census figures that appreciably predate Nunavut impact assessments, and consequently, they intuitively feel their 2006 projections are likely low. The Bureau does not currently do projections beyond 2006 due to uncertainty in long term projections. We have, therefore, utilized the population projections received from the Municipality as these are, as far as we know, the only projections available.

The 1994 Planning Brief utilized a modified MACA formula to estimate average water demands. This formula was:

Q = $F \cdot P \cdot 225 \text{ lpcd } [(-1.0) + 0.323 \text{ (lnP)}]$

Where F = allowance for wastage, leaks etc. (1.15)

Where P = projected population

This modified MACA formula is based on the entire community being on "piped" water supply system. As a significant portion of Iqaluit's population is on trucked delivery, the MACA formula for piped systems would be expected to yield higher than actual demands.

Table 2.1 clearly shows that for 1995, the Municipality operated at 265 lpcd based on a known population of 4,156. This translates into 61% of what the modified MACA formula would predict and 66% of the 400 lpcd. Table 2.1 also shows that, in previous years, the usage had been above both the MACA formula and the 400 lpcd.

The 400 lpcd is, we believe, a realistic design demand; provided the piped system is well maintained, bleeders are controlled and, over the design life of the plant, some of the trucked service is converted to piped usage (i.e., such as Lower Base). For comparison, Yellowknife, with approximately 9% of the population on trucked usage versus Iqaluit's current 28%, has averaged between 418 and 467 lpcd over the past three years.

Table 2.1 - Historical and Projected Populations and Demands

Year	Pop.	Average Demand	Usage	Modified MACA Formula Ave. Day	Actual vs MACA Formula	Municipal 400 Ipcd Ave. Day	Actual vs Municipal 400 lped
		m³/day	lpcd	m³/day	%	m³/day	%
1978	2.490	932	374	983	95%	996	94%
1979	2.454	1,103	449	966	114%	982	112%
1980	2,475	1,269	513	976	130%	990	128%
1981	2,490	1,145	460	983	116%	996	115%
1982	2.558			1,016		1,023	
1983	2.626			1.048		1,050	
1984	2,694	1,350	501	1.081	125%	1,078	125%
1985	2.763	1,593	577	1,115	143%	1,105	144%
1986	2,947	1,629	553	1,205	135%	1,179	138%
1987	3.057	1,382	452	1,259	110%	1.223	113%
1988	3,171	1,363	430	1,316	104%	1,268	107%
1989	3,298	1,469	445	1.380	106%	1,319	111%
1990	3,419	1,334	390	1,440	93%	1.368	98%
1991	3.552	1,209	340	1,508	80%	1,421	85%
1992	3,694	1,239	335	1.580	78%	1.478	84%
1993	3.842	1,329	346	1.656	80%	1,537	86%
1994	3.996	1253	314	1,736	72%	1,598	78%
1995	4.156	1101	265	1.819	61%	1,662	66%
19 96	4,220	1292	306	1.852	70%	1,688	77%
1997	4,376	1202	275	1,934	62%	1,750	69%
1998	4,538			2,019		1.815	-
1999	4,706			2.108		1.882	
2000	4,880			2,201		1.952	
2001	5,061			2.298		2.024	· · · · · ·
2002	5,228			2.388		2.091	
2003	5,400			2.481		2,160	
2004	5,578			2.578		2.231	
2005	5,761			2.678		2.304	
2006	5,951			2,783		2.380	
2007	6,147			2.891		2,459	
2008	6.350			3,004		2,540	
2009	6,559			3.121		2.624	
2010	6,775			3.242		2.710	
2011	6,998			3,367		2.799	
2012	7.229			3,498		2.892	
2013	7,467			3.633		2.987	
2014	7,713			3,774		3.085	
2015	7,967			3.920		3,187	
2016	8.229			4.071		3.292	
2017 .	8,500			4.228	ļ	3.400	

1.2.3 Design Water Demands

Maximum Day and Peak Hour Factors of 2.0 and 3.0 respectively, are deemed appropriate and agree with current MACA standards. Consequently, the 2017 design flows are estimated to be:

Average Day

3,400 m3/day

Maximum Day

6,800 m3/day

Peak Hour

10,200 m3/day

Table 1.1 outlines the previous and current design parameters.

Table 1.1 - Comparison of Design Parameters

	1994 Planning Brief	1998 Predesign Report	% Change
Design Year	2013	2017	_
Design Population	5,626	8,500	51%
Design Maximum Day Demand	5,214 m³/day	6,800 m ³ /day	30%
Design Average Day Demand	2.607 m ³ /day	3,400 m³/day	30%
Nunavut Impact	Excluded	Included	

1.2.4 Fire Flows

As advised by the Municipality for the 1994 planning brief, a fire flow of 6.000 l/min for 2 hours has been utilized for this report.

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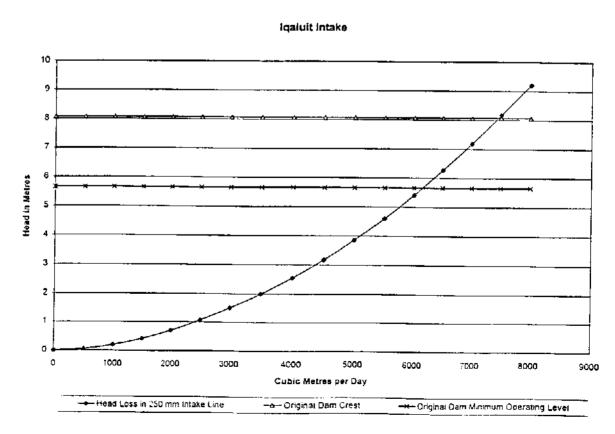
1.2.5 Water Supply System Capacity

A review of the original drawings of the Lake Geraldine dam structure revealed the following:

- Design Minimum Operating Level = 103.82m or 340.6 ft
- Design Maximum Operating Level = 106.22m or 348.5ft

The reader's attention drawn to the fact that the maximum level stated above predates the two (2) dam extensions and the current lake level, while not known, is anticipated to be above the original design maximum level of 106.22m.

Figure 2.4, below shows the flow of the intake related to the level of Lake Geraldine.



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Given that the current level of Lake Geraldine is higher than original maximum design level, the real intake capacity will be correspondingly greater than the 7,500m³/day, from the chart. Consequently, if Lake Geraldine water levels stay above 106.22m or the original maximum design operating level, the intake will provide sufficient raw water to feed the updated treatment plant in the design year.

1.2.6 Water Tempering

In 1992/93 the treatment plant was retrofitted with a new boiler room addition as part of the Municipality's high temperature system abandonment. Reid Crowther has been retained under a separate contract to review and recommend changes to the raw water intake and tempering system in response to the proposed treatment plant upgrade as well as the decommissioning of the NTPC raw water cooling system.

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2.0 WATER TREATMENT PROCESS

2.1 General

This section describes the basic water treatment processes and equipment proposed for the plant.

In general, the proposed systems are in accordance with the conclusions and recommendations given in the 1994 planning brief. As a result of the predesign meeting held in Iqaluit on 3 February 1998, various changes from the planning brief recommendations have been made.

2.2 Water Treatment Plant Design Capacity

As detailed in the planning brief, projected treated water demand for Iqaluit in the year 2013 was 2605 m³/d. It was agreed at the February 1998 meeting that the design life of the upgraded plant should be 20 years, that is, until the year 2017.

Revised population and treated water demand estimates for the extended design period are presented in the Introduction. Based on these figures, the revised demand estimate at the end of the 20-year design period is 3,400 m³/d. Assuming the same peak day factor of 2.0 recommended in the design brief, the net capacity of the water treatment plant would be 3,400 x 2 = 6,800 m³/d. Allowing an additional 5% for in-plant uses such as filter backwashing, the gross plant capacity would be $6,800 \times 1.05 = 7,140$ m³/d. Rounding this up gives a value of 7,200 m³/d, which is what we recommend as the nominal gross water treatment plant design capacity.

The design brief concluded that the existing plant had a useful design capacity of 1,050 m³/d. Clearly, a major capacity increase will be required.

2.3 Process Description

The 1994 Planning Brief discusses the various water treatment process options in some detail. The main conclusions were that the quality of the raw water drawn from Lake Geraldine was generally very good, but some treatment was required to ensure the treated water meets Canadian Drinking Water Quality Guidelines. The areas that needed to be addressed were:

Turbidity:

Goal of 0.1 NTU to ensure removal of parasites

Colour:

Generally not a concern, but may be an occasional problem.

Goal of 5 TCU.

Taste and odour:

May be a problem during spring breakup, requires

confirmation

Corrosivity:

Raw water is aggressive, and pH correction will be

required.

The main recommended process changes in the 1994 Planning Brief were as follows:

- 1. Increase the capacity of the plant by constructing three new filters, extending the existing building structure to house them, and installing a new backwash pump.
- 2. Provide additional backwash waste storage capacity by converting the existing filters to backwash waste storage tanks.
- 3. Provide facilities for dosing alum (or other coagulant) upstream of the flocculation chamber. Install coagulant mixing facilities.

- 4. Convert the existing sedimentation tanks into grit removal and flocculation units.
- 5. Provide powdered activated carbon dosing facilities.
- 6. Refurbish the existing lime handling system.
- 7. Upgrade the existing chlorine room to meet current standards.
- Provide a PLC-based control system and desktop computer, to automate certain plant functions and provide datalogging capability.

In general (with the exception of an increased plant capacity due to the addition of the Nunavut impact) little has changed since the Planning Brief was issued, and most of these recommendations are still valid. The following process description is therefore based on the planning brief recommendations, with some minor changes where appropriate to accommodate the increased plant capacity, recent discussions, and the various other considerations discussed below. We wish to emphasize here that these process recommendations are subject to change following the complete laboratory water treatability evaluations planned as part of this project.

During our site inspection in February 1998, it was determined that although most of the concrete structure was in good condition, essentially none of the existing process equipment (such as piping, pumps, and valves) was worth salvaging and reusing. The following discussion is therefore based on the assumption that the existing concrete structures will be reused to the extent possible, but none of the process equipment will be.

2.3.1 Raw Water Supply

Raw water enters the plant through an existing 250 mm main and a flow control valve. The estimated capacity of the inlet line is in excess of 7.000 m³/d, so the raw water supply

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capacity will meet the design treatment plant capacity of 7,200 m³/d. This work is included in the intake upgrading project which is currently in progress.

The existing flow control valve will be replaced with a new unit, capable of accurately controlling flows from present minimum demands of about 1,000 m³/d up to the plant design raw water flow of 7,200 m³/d.

pH Adjustment 2.3.2

The Igaluit raw water is aggressive (corrosive) and will be made more so by the use of coagulants such as alum. For most common coagulants to even react with the water to form a floc, some increase in its alkalinity will be required - in other words, some alkaline chemical (such as lime or caustic soda) will have to be added with the alum or other coagulant to adjust the pH.

The existing plant includes a limestone contactor, in which the raw water flows over a bed of crushed limestone. As the water trickles over the limestone, some is dissolved and increases the pH of the water. This system could possibly be retained, but it has the serious disadvantage that there is no control over the amount of limestone dissolved and the resulting pH (these could vary considerably depending on factors such as raw water flow and temperature). A more conventional pH adjustment system, with the capability of accurately controlling dosages, would be required whether the limestone contactor is retained or not. Accordingly, we recommend that the existing limestone contactor be abandoned.

Various chemicals can be used for pH adjustment. Lime is one of the most common, because it is inexpensive and relatively safe to handle. Unfortunately, the equipment needed for handling powdered lime is expensive to buy and maintain, and its operation is messy and labour-intensive.

An alternative to lime, and one which is becoming increasingly common, is caustic soda. This chemical is supplied as a solution in plastic drums, and is simply pumped from the drum to the process by a small chemical metering pump. The equipment is therefore much simpler and cheaper than would be required for lime, and operation of the system is much easier. Caustic soda is more expensive than lime, but less is needed so operating costs usually turn out to be similar.

We recommend the use of caustic soda at Iqaluit.

2.3.3 Coagulation

The purpose of coagulation is to cause the joining together of particles in the raw water that are so small they would otherwise pass through the filters. This is done by adding a chemical (such as alum) which reacts with the water to neutralize electrical charges on the particles and also to form precipitates called *floc*. The floc entraps smaller particles, and both are subsequently separated from the water in the filters. In most plants, there are two intermediate processes between coagulation and filtration: *flocculation*, in which the coagulated water is gently mixed to allow the floc to grow in size; and *sedimentation*, in which the floc is separated from the water by gravity settling in a large tank. In the case of Iqaluit, the raw water is of excellent quality and very little coagulant is needed. The resulting small quantities of floc can be removed in the filters, without the need for a sedimentation stage. This process, which is commonly used with high-quality raw water supplies, is known as *direct filtration*.

Various coagulants are available. The most commonly-used one, aluminum sulfate or alum, is available in dry (powdered) form in bags, or as a solution in drums (commonly called "fiquid alum"). Similar considerations to those discussed in Section 3.2 apply. Tentatively, we recommend the use of liquid alum at Iqaluit.

Other coagulants, such as PASS (polyaluminum silicate sulfate) or PACI (polyaluminum chloride) may well prove to be better than alum for use at Iqaluit. These coagulants are more expensive than alum, but lower dosages are needed and they do not depress the pH as much as alum. These and other coagulants will be evaluated during the treatability tests.

2.3.4 Flocculation

As already mentioned, flocculation facilities are usually provided to allow the floc particles to grow to a size that can easily be removed in the filters. This is done by gently stirring the flocculated water for periods of (typically) about 15 to 45 minutes. Usually, small amounts of *polymer* (flocculant aid) are added to increase the floc size and strength, and the speed of floc growth.

A flocculation chamber is provided in the existing plant, but its detention time (5 minutes at the new plant design flow) is much too low for effective flocculation. However, sedimentation facilities will not be required at Iqaluit, and the two existing settling tanks could therefore be converted to flocculators. The detention time in these tanks (about 18 minutes each) would make them well suited to the flocculation function. If all three of these tanks (existing flocculation chamber plus both existing settling tanks) were to be converted to flocculators, the total detention time would be about 40 minutes at the plant design flow.

The conversion would be relatively simple. The existing flocculator chamber would probably need some modifications to the baffles, and the existing settling tanks would require the addition of motor-driven mixers. We also recommend that the two existing settling tanks be operated in series, to improve the efficiency of the process and reduce short-circuiting. The necessary modifications would be minimal, and would basically

involve some modifications to the inlet system and a new interconnection between the two tanks.

We also recommend the installation of polymer dosing facilities. An appropriate polymer can greatly increases the effectiveness and flexibility of the pretreatment processes, and improve the quality of the treated water, particularly with low-turbidity, cold raw water supplies. The most effective polymers for this type of application are usually available only in powdered form. However, the quantities involved are very small (dosages of less than 1 mg/L) so the handling and feeding facilities are no particular problem. Generally, these consist essentially of a plastic mixing tank, a small motor-driven mixer, and a chemical dosing pump. Polymers are usually added to the second flocculator stage in this type of application.

2.3.5 Filtration

Additional filter capacity will be required for the upgraded plant flows. In the 1994 planning brief, the recommended course of action was to abandon the existing filters and construct three new units in an extension to the existing building. This recommendation is still basically valid, with the following exceptions:

1. The plant design capacity has increased from the 1994 report and, hence, requires a larger total filter area. At the current design plant capacity of 7,200 m³/d and a filter loading rate of 7.5 m/h (a commonly-used rate) a total filter area of 40 m² would be required. With this total area, three filters would result in each one being fairly large and requiring excessive backwash supply capability and backwash waste storage facilities. Therefore, we recommend the use of four smaller filters, each having an area of 10 m². These can be accommodated in the same building extension area originally envisaged. We recommend the prefabricated aluminum type of filter construction, available from several suppliers.

- 2. We recommend the installation of two new vertical turbine backwash supply pumps. This type of pump is normally very reliable, but there is no alternative source of backwash water and backwashing is essential to the production of treated water. Vertical turbine pumps have many advantages, including self-priming capability and minimal floor space requirements.
- 3. Backwash waste storage. Because backwashing produces large amounts of waste water for a relatively short time, and the capacity of the sanitary sewage system is limited, some form of surge or holding tank must be provided. Usually, provision is made to store the wastes from at least two filter backwashes, done at maximum rate. Two backwashes of a 10 m² filter, at a rate of 50 m³/h for 10 minutes, would result in a backwash waste volume of 167 m³. Within the existing building, this volume could most readily be provided by continuing to use the existing surge tank (55 m³), and converting the existing filtered water tank (115 m³) to function as a supplementary surge tank. The total available backwash waste storage capacity would then be 170 m³, which is adequate.

The existing filters themselves could also be converted into surge tanks, but considerable expense would be involved in removing the internal structures, and the volume gained would be minimal (less than 30 m³).

2.3.6. Taste And Odour Control

Occasional taste and odour problems at water treatment plants can usually be best controlled by the use of powdered activated carbon (PAC). This is a finely-divided form of carbon which has been specially treated to adsorb taste- and odour-producing compounds from the water. It is simply added to the water at some stage in the process sequence, and removed in a later stage. At Iqaluit, the most appropriate location for the addition of PAC would be the inlet to the flocculators. It would then be removed in the

filters. PAC is supplied in bags, and is mixed with water before use to form a slurry which is then pumped to the process. PAC is somewhat messy to handle, but since its use at Iqaluit is expected to be relatively infrequent, this is not considered to be a major problem. The PAC feeding system would consist basically of a plastic drum, a motor-driven mixer, and a chemical dosing pump.

Potassium permanganate (KMn0₄) is sometimes used to control certain types of taste and odour problems. Its use is very situation specific and insufficient data is available to permit us to recommend for or against its use in Iqaluit. KMn0₄ is predominately used to remove iron and manganese from the water, and Iqaluit's water supply does not contain problematic levels of these minerals.

The PAC (powdered activated carbon) is generally extremely effective in treating taste and odour problems, and is our preferred choice.

2.3.7 Disinfection

Although not specifically mentioned in the planning brief, we recommend installation of a chlorine residual analyzer and control system to automatically control the chlorine residual in the treated water. This type of system ensures that the desired residual is maintained at all times, thus ensuring proper disinfection. It also reduces the operator's workload to some degree.

2.4 Controls And Instrumentation

As discussed in the planning brief, various improvements to the plant process control and instrumentation systems are recommended. These remain essentially unchanged.

3.0 ARCHITECTURAL/STRUCTURAL

3.1 Proposed Renovations

It is proposed to upgrade the existing water treatment plant to provide for a significant increase in the population of Iqaluit and that the plant service life be extended by at least 20 years.

Part of the upgrade program will include the addition of four (4) new filters. Along with a gallery, these will be placed on the existing concrete structure forming the roof of the exterior clear water well.

The roof elevation of the clear water well matches the level of the existing pump floor at elevation 313'-0" (95.4 m). At present, approximately 2.0 metres of earth fill covers this roof structure at the exterior of the building.

The proposal would be to remove this fill and construct new 250 concrete walls on two sides of the clearwell matching the existing well perimeter (see drawings in Appendix of this report).

A new timber superstructure would be constructed on top of the concrete walls. The new roof would connect to the existing concrete beams at the level of the existing roof, elevation 335'-0" (102.108 m).

At completion of roofing and waterproofing the wall, fill material would be replaced against the new wall structures.

The new wall structures would be designed for the earth fill pressure and the roof would be designed for snow loads applicable at this site (2.4 kPa).

3.2 Existing Conditions

The existing water treatment plant structure was inspected by Jim Patrick of Reid Crowther on February 2, 3 and 4, 1998. Original engineering drawings of the plant were available for review. These drawings were dated April 1962, so the plant is presumed to be approximately 35 years old.

The existing plant is a cast-in-place concrete structure. Drawings show the required concrete strengths of 3000 psi with intermediate grade reinforcing steel (40 ksi).

It consists of three primary levels, with an exterior superstructure covering the upper level. The tank walls, upper levels and roof are cast-in-place concrete.

Construction consists of one way slabs spanning between concrete beams and column supports.

The building is supported by walls and pedestals bearing on bedrock. The reservoir floors are elevated over a crawlspace. The elevations of the reservoir floor is 300'-0" (91.440 m). The other primary levels are the pump floor and the filter floor.

A visual inspection of the entire structure was completed and it is considered to be in good condition. Neither materials testing nor other non-destructive testing was undertaken, however the structure was reviewed for cracking, movement or other distress. The well structures were full and thus the inside of the tanks could not be inspected.

The floor structures of the reservoirs could be inspected from the crawlspace, although a complete inspection was limited by the presence of free water in the crawlspace. This is from minor leaking, condensation and melt water from the exterior of the building. Nevertheless the foundation and floor structures are considered to be in good condition, and no significant cracking or sign of movement was noted. There is some minor

cracking in the reservoir walls and we recommend a coating of Xypex on the inside of all wet surfaces during the plant upgrade.

The roof structure of the clearwell is a 10 inch (250 mm) thick one way slab spanning approximately 10'-6" from the exterior wall to an interior column and beam line, and then 10'-6" to the demizing wall between the two clearwells.

The drawings show the exterior wall to be 18 inches thick with the centre beam (18" x 28") supported on two 18" x 14" interior columns within the clearwell. The drawings also showed the reinforcing steel detail, so the structure was checked for load capacity.

The structure has ample reserve capacity for new superimposed loads, and thus no reinforcing is necessary.

The building was not constructed in strict accordance with the engineering drawings. We believe that the insulated exterior wall was intended to be constructed on the demizing line between the two wells, down to the elevation of the pump floor. Instead, the centre wall was constructed up to the level of the filter floor and the columns supporting the filter floor and roof superstructure were built as pilasters within this wall. This enabled the placement of about 2.0 metres of fill over the exterior clearwell roof and up against this wall.

3.3 New Construction

It is proposed that the new 250 mm thick walls be constructed with 30 MPa concrete and 400 MPa reinforcing steel. They will be placed directly on top of the two exterior clearwell walls and constructed to a height of approximately 3050 mm, matching the elevation of the filter floor. Above this would be 38x184 wood stud walls constructed to match the elevation of the existing adjacent roof.

The new concrete walls will be connected to the existing walls at the bottom and sides with epoxy set dowels. Reglets on each side of the wall will allow the installation of sealants.

These concrete walls will be waterproofed with a bituthene membrane carried 300 below the base of the wall. This will prevent groundwater penetration through the replaced fill. The top of this fill will be at approximate elevations 97400. The exposed upper section of the wall would be covered with 50 mm styrofoam and treated plywood protection board up to the elevation of the filter floor. Exterior wood stud walls would be filled with 300 mm of batt insulation and covered with prefinished metal cladding to match existing construction.

The new roof structure over the filter floor would consist of pre-engineered 300 mm timber truss joists, spaced at 305 mm o.c. and sheeted with 20 mm plywood. They would be insulated with 200 mm of rigid roofing insulation (R40) and covered with a single ply torch applied membrane. The joists would span 6.4 m (21'-0") between the new outside wall and the existing wall and would slope down to match the slope of the existing roof. The new wall structure would be designed to restrain the fill pressure and wind pressure against the new exterior walls and support snow loads. To accommodate additional load from the new roof structure, the existing concrete beam roof structure would be reinforced with steel columns, one per bay. The total area of new roof structure would be approximately 6.85 metres x 13.4 metres (91.8 m² or approximately 990 ft.²).

Access from the existing pump floor into the newly created filter space would be provided by a new opening in the existing exterior wall. This would require an 1880×2100 mm opening cut into the existing concrete wall. This will not require any reinforcing of the wall.

Maintenance catwalks would be placed around the new filters at the elevation of the existing filter floor. To provide access to the catwalks and to facilitate connecting the new roof structure to the existing roof structure, the existing filter floor exterior wall panels would be removed

3.4 Building Shell Retrofit

The existing building walls do not meet current energy efficiency requirements and we are recommending a complete envelope upgrade.

The existing building sandwich panel walls will be covered with a 10 mil vapour barrier secured with 19 mm x 89 mm vertical strapping at 600 o/c. 9.5 mm exterior sheathing and 100 mm Type II rigid insulation will follow the interior strapping. The final wall components will be an air barrier, followed by 19 mm x 89 mm horizontal strapping at 600 o/c, and finally, metal siding coloured to match the existing water reservoir. New flashings will be provided as required. This wall system will provide at least R-20. The R-value of the existing sandwich panels is not known at this time.

In addition to the upgraded wall system, we recommend all exterior doors and windows be replaced with units suitable for cold climate conditions.

The roof appears to have been retrofitted as the original drawing indicate a flat roof while the existing structure has a low slope peaked roof. The details of this retrofit are being investigated, and will dictate the need or lack there of, for another upgrade. Our cost estimates include for a new R-40 rigid insulation roofing system, with a new torch-on membrane.

Typical wall and roof sections are presented in the Figures SK-2 and SK-3, in Appendix A.

4.0 MECHANICAL

4.1 Introduction

4.1.1 General

The mechanical systems serving the Iqaluit Water Treatment Plant have, for the most part, reached the end of their useful service life. One notable exception are the two new glycol heating boilers installed in 1993 which remain in good repair. The new heating and ventilation system components installed will be expected to have a service life in excess of 20 years.

This report will address mechanical replacement strategies for heating, ventilation, safety and miscellaneous mechanical systems. The recommended components will meet all applicable codes, will meet the intended function of the facility, will be selected to meet the project budget while retaining the standards of quality and reliability required for this remote facility.

4.1.2 Codes And Standards

The following list of codes and standards have been utilized in the preparation of this report:

- National Building Code 1990
- National Plumbing Code 1995.
- National Fire Code 1995.
- > CAN/CSA B-139 Oil Burning Equipment Code.
- > Public Health Act General Sanitation Regulations

> Notes of the Water Treatment Plant Inspection performed by the Baffin Region Health Services Office in October of 1997.

4.1.3 Existing Services

The existing mechanical building services include two oil fired glycol heating boilers located in the Boiler Room, distribution pumping, glycol unit heaters and baseboard radiation throughout the facility and localized exhaust fans for ventilation. Poor ventilation has resulted in extensive corrosion of exposed mechanical components throughout the facility.

4.2 Heating

4.2.1 Reservoir Level

This level is heated by three existing glycol unit heaters located around the perimeter. All of these heaters and exposed piping are exhibiting corrosion. Coupling the observable corrosion to the age of the equipment, it is recommended that the equipment be replaced.

Three new glycol unit heaters will be provided with new insulated steel piping connected to the building glycol heating loop. The unit heaters will be provided with stainless steel components where possible for corrosion resistance.

* ...

4.2.2 Pump Floor Level

This floor area is presently served by four glycol unit heaters and one force flow heater in the stairwell. All of these mechanical items are beyond their useful service life and exhibit corrosion which is a result of the poor level of ventilation on this floor.

Four new glycol unit heaters are proposed with one glycol forced flow heater in the stairwell all connected to the building glycol heating loop.

4.2.3 Filter Floor Level

This floor is presently heated by six unit heaters and one strip of radiation in the washroom area. All of these mechanical items are beyond their useful service life and exhibit corrosion which is a result of the poor level of ventilation on this floor.

Five new glycol unit heaters will be provided for the revised filter floor plan including the chlorine storage room and chemical storage room. Radiation will be provided for the office/laboratory room and the washroom.

4.2.4 Reverse Return Hydronic Piping

To maximize system efficiency and minimize the need for system balancing, the hydronic heating system will be designed as a reverse return (first supplied – last returned) system.

4.2.5 Valve Chamber at Dam

An electric unit heater on a thermostat will maintain the chamber above 0° C. This will assist in reducing the dangerous level of condensation observed on the existing non-vapour proof equipment.

4.3 Ventilation

4.3.1 Reservoir Level

This area is presently not provided with mechanical ventilation.

Useful ventilation by mechanical means cannot cost effectively be provided. Therefore, the mechanical equipment installed will have durable finishes to extend the useful service life in this environment.

4.3.2 Pump Floor Level

The inadequate ventilation on this floor has been noted in the Baffin Regional Health Services Report. This floor is not equipped with mechanical ventilation.

A new glycol heated make-up air unit will be provided for general ventilation of the filter and pump floor levels. This system will be sized to provide 6 continuous air changes per hour on the pump floor level. The Baffin Regional Health Service recommended that normal and emergency ventilation should be provided for this floor due to the potential danger of a chlorine gas leak from above. In order to provide a cost effective and physically possible solution, continuous ventilation of 6 air changes per hour only will be provided to the pump floor. The addition of the chlorine alarm will notify operators that SCBA equipment and protective clothing should be worn to safely enter the pump floor level.

One exhaust fan will be provided to remove contaminated air on both the pump and filter floor levels.

4.3.3 Filter Floor Level

This floor is provided with one exhaust fan in the washroom and one natural ventilation opening in the exterior wall. The present system does not provide adequate ventilation for this floor.

The new glycol heated make-up air unit and central exhaust fan will provide 6 air changes per hour on a continuous basis to this floor.

4.3.4 Chlorine Room

This room will be provided with a dedicated heating and ventilation system which has been successfully used in other northern climate chlorine room designs.

Heating will consist of a glycol unit heater ducted to and from the room. Fire dampers will be installed at the room wall penetrations. The unit heater is located outside of the room due to concerns of chlorine gas suppliers with respect to potential leaks of hot glycol melting fusible links on the cylinder valves.

Ventilation for this room will be through a ducted heating coil in the room connected to the outdoors by means of a wall louver. The duct connection to the heating coil will be sloped to the outdoors to prevent moisture from entering the room. A summer filter will be provided for this ducted coil.

Two exhaust fans will be provided for this room to meet the requirements of the Public Health Act, Public Water Supply Regulations. Section 15, Clauses 12 and 13. One fan will provide a continuous 3 air changes per hour while the second fan starts on a chlorine alarm condition to provide 30 air changes per hour of mechanical ventilation. The second fan is also to be activated by personnel ten (10) minutes prior to entering the room.

The exhaust fans draw air in through the ducted heating coil which tempers the outdoor air to 18°C. If the room temperature drops below 15°C, the unit heater turns on to heat the room. The unit heater is sized to maintain 10°C under emergency ventilation operation. If the room temperature reaches 2°C, an alarm will be enunciated to the building operators through a remote dial out.

The chlorine room will be physically altered to have the entry point located on an outside wall. A ramp will be installed with a landing at the door to provide an easy means of egress to the room. A switch is located at the outside door which will start the emergency ventilation system in operation. This system should be run by operators for ten minutes prior to entering to completely purge the room of chlorine. The buddy system should be used for entering the room; an observer should always be present with the operator and equipped with a SCBA to provide emergency assistance if required. If the alarms outside the room are enunciated, entry should only be attempted by personnel with complete personal protective equipment.

Electric heating of the chlorine room was considered but is not considered practical. During emergencies or occupancy operations, the room will experience thirty (30) air changes per hour and the size of service required to feed an electric heater capable of maintaining 10° C, is not practical in this situation.

Further, demand charges resulting from power draw of an electric heater of the size required, would be very costly.

4.3.5 Chemical Storage Room

The Baffin Regional Health Service Report recommends this room be provided with identical forced mechanical ventilation systems as in the chlorine room. Since this room

will no longer contain chlorine storage, continuous ventilation of 6 air changes per hour only will be provided. Heat will be through a glycol unit heater.

4.4 Safety Issues

4.4.1 Personal Protective Equipment

As noted in the Baffin Region Health Services report, the following items will be included to improve workplace safety:

- > Standard Operating Procedures for safe us and handling of controlled products.
- > Emergency procedures for protection of workers in the event of a controlled products spill.
- > Instruction to workers on work and emergency procedures for controlled products.
- > Chlorine detectors and alarms will be provided for the chlorine room, chemical storage room and the pump floor level. These will enunciate both inside and outside the building.
- > Responder "Level A" vapour protective clothing will be made available on site for chlorine emergencies.
- > Four Self contained breathing apparatus' (SCBA's) will be provided on site. Two will remain operational at all times while two can be out of the building for service.

4.4.2 Asbestos Removal

The existing NTPC tunnel piping is covered with asbestos fibre insulation and should be removed according to asbestos abatement standards and disposed of according to code and municipality regulations.

Existing piping within the water plant may also have asbestos insulation which, again, should be removed and disposed of prior to construction of the plant. This cost for both items is not included in the estimates and is not part of this contract.

4.5 Miscellaneous

4.5.1 Fuel Oil Day Tank Dike

The existing indoor fuel oil day tank is not equipped with a dike to meet code requirements.

A new fuel oil dike sized for 110% of the capacity of the day tank will be provided.

4.5.2 Chlorine Room and Chemical Storage Room Construction

The existing structure in these rooms will be upgraded to include fire rated drywall and fire dampers for mechanical penetrations. A new exterior door will be installed with a window for observation from the exterior. This window will be plexiglass over georgion (wired) glass to deter vandalism. The chlorine room will be increased in size to accommodate 16 full chlorine bottles and 6 empty bottles. The room construction will be air sealed. New bottle racks and a new double bottle scale will be provided.

4.5.3 NTPC Domestic Water Service

Remove and replace existing 80 mm water service supply and return to NTPC with new standard municipal domestic water service.

DESIGN BRIEF

4.5.4 Removal of Previously Abandoned Equipment

Remove various pumps, piping, compressors, and other equipment no longer in service or required in the treatment plant.

5.0 ELECTRICAL

5.1 General

The electrical systems and devices installed in the building have reached their life expectancy. Components required to repair or replace are non-existent or hard to come by. It is the intention that new systems be installed to replace most if not all electrical systems and devices. New systems and devices installed will have a life expectancy of at least twenty-five years. Where possible existing conduit systems will be reused and new wire installed. Some conduits installed in the concrete slabs may have to be re-routed overhead due to the conduit having rusted away.

The purpose of this report is to outline the proposed electrical systems for the Iqaluit Water Treatment Plant.

The selection of these systems is based on following criteria:

- > National Building Code of Canada 1990
- Canadian Electrical Code, CSA C22.1-94
- > CAN/ULC S524, Standard for the Installation of Fire Alarm Systems
- > CAN/ULC S537, Standard for the Verification Testing of Fire Alarm Systems
- > Local Authorities having Jurisdiction

The selected electrical systems will:

- > Meet the functional and environmental requirements of the facility through effective lighting, power and communications.
- Meet the present capital budget

- > Reduce operating costs by utilizing low maintenance energy efficient systems where practical within the present budget.
- > Provide reliable system operation with technology backed by proven service agencies.

5.2 Site Services

At present the power service for the Water Treatment Plant—runs from the NTPC Powerhouse through the tunnel and into the existing switchgear located on the Pumps Floor. NTPC has indicated that the present power service to the building should be taken out and a new pole mounted transformer bank be installed. A new overhead power service along with a new telephone service will be provided to feed the Water Treatment Plant.

Initial discussions with NTPC indicate they will "contribute" this work and materials. This will be finalized during the design phase and any work remaining outstanding will be incorporated into the Tender Documents at that time.

5.3 Power Distribution

The existing electrical service for the building is located on the Pumps Floor. It is a 400 amp 600 volt Westinghouse CDP type. Due to the age of the CDP and NTPC requirements to refeed the building a new MDP/MCC lineup is proposed to be installed on the Filters Floor.

The main electrical service will be sized at 400 amperes, 600 volts, 3 phase, 3 wire. To accommodate future expansion requirements, spare capacity will be allowed for in the circuit breaker lineup.

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The main distribution centre will be provided consisting of the following:

- > A main circuit breaker with adjustable solid state tripping.
- > A feeder breaker section utilizing thermal/magnetic trip molded case circuit breakers.
- > A MCC section comprising of motor starters, hand off auto switches and indicating motor run, off, trip lights.
- > Transformer cubicles built in to the main distribution to eliminate conduit runs to separate transformers and to ease maintenance requirements.
- > A 120/208 Panelboard to provide branch circuit wiring to the Filters Floor.

A new Panelboard utilizing bolt-in circuit breakers will be provided on the Pumps Floor replacing the two existing panels

5.4 Mechanical Equipment Connection

Existing motor control starters comprise of a 600 volt disconnect and a 600 volt starter with two overloads. Current code requires that 3 phase motors be protected with three overloads. It is proposed that the existing motor starters and disconnects be removed and new motor starters housed in the proposed MDP/MCC lineup be utilized along with new isolation disconnects mounted next to the motors.

Power connections to mechanical equipment will be completed as follows:

Motors .373 kw and less

Manual motor starter. A relay will be provided

if automatic operation is required.

DESIGN BRIEF

Motors .56 kw or more	A magnetic motor starter installed in a Motor Control Centre (MCC) and isolation disconnects.
Packaged Units c/w integral	Circuit breakers installed in the MCC controls/motor starters

The MCC will incorporate low voltage and single phase protection relays that will disconnect equipment under poor power conditions.

5.5 Branch Circuit Wiring

> Rigid Galvanized Conduit

All conductors will be copper, RW-90 insulation, minimum size # 12 AWG. Wiring methods will be:

Exposed conduit subject to mechanical injury.

		Emposed conduit subject to incending injury.
>	EMT Conduit	General concealed and surface runs.
>	BX Cable	Horizontal single circuit runs in partitions; drops to luminaire from the conduit system.
>	Liquid Seal Conduit	Connections to mechanical equipment and transformers.
>	Teck Cable	Connections to mechanical equipment, panelboards, exterior devices

Electrical devices installed in specific use areas will be recessed or protected with wire guards or lexan shields.

DESIGN BRIEF

Generally building utilization voltages will be as follows:

> 120 volts Small motors .373 kw or less duplex receptacles.

lighting

> 208 volts single phase Specific supplied equipment.

> 208 volts three phase Motors .56 kw and larger, specific supplied equipment.

> 600 volts Motors .56 kw and larger specific supplied

equipment.

5.6 Lighting

Existing lighting is 2 lamp florescent pendent mount fixtures. These fixtures utilize magnetic ballast's and F-40 T-12 lamps. Acrylic reflectors are broken and some are missing. It is proposed that new fixtures be installed with T-8 lamps and electronic ballast's. The new fixture will be totally enclosed and gasketed which will prohibit the entrance of environmental contaminants.

To ensure energy efficient installation that meets the functional requirements of the facility the following light sources will be used:

Lamp Source Areas of Utilization

HID-High Pressure Sodium exterior lighting

Fluorescent-Standard T-8 lamp throughout building interior

Fluorescent fixtures installed throughout the building will be two lamp vapour proof type with a polycarbonate refractor.

Exterior lighting will be provided by surface mounted High Pressure Sodium fixtures with lexan shields to deter vandalism.

Lighting control will be as follows:

Exterior

photocell/timeclock,

hand-off-auto exterior lighting

contactor cabinet.

Interior

line voltage switches.

5.7 Life Safety Systems

Existing emergency lighting units do not provide the required coverage if the electrical service was interrupted. New battery packs and additional remote heads will be installed to ensure proper coverage throughout the building.

5.8 Emergency Lighting Units

Emergency lighting will be provided by self contained, battery operated emergency lighting units at all exits and access to exits.

5.9 Exit Signs

Exit signs connected to the normal power supply and to the battery packs will be provided at all exit doors, and as required by the National Building Code. Exit signs will constructed of extruded aluminum and utilize LED type lamps.

5.10 Fire Alarm System

The existing fire alarm system will be upgraded and additional devices will be added. throughout the facility incorporating the following features:

- > A fire alarm control panel at the main entrance to the Water Treatment Plant.
- > Pullstations at all exit doors and where required by the National Building Code.
- > Thermal detectors installed where required by the National Building Code and local authorities having jurisdiction.
- > Duct detectors in all supply and return ducts of major HVAC units.
 - > Bell signal devices.

5.11 Telephone System

A new telephone service will be installed in the building. The existing telephone located in the NWTPC tunnel will be abandoned. A new Telephone panel will be installed and a complete telephone wiring system shall be provided consisting of outlet boxes, conduit, cabling, and single jack outlets where required.

All telephone wiring will be run in conduit. All telephone conduit will be provided with ground bushings and bonded to ground. A ground bus will be provided at the Telephone panel.

7.0 PROJECT DOCUMENTATION

7.1 Record Drawings

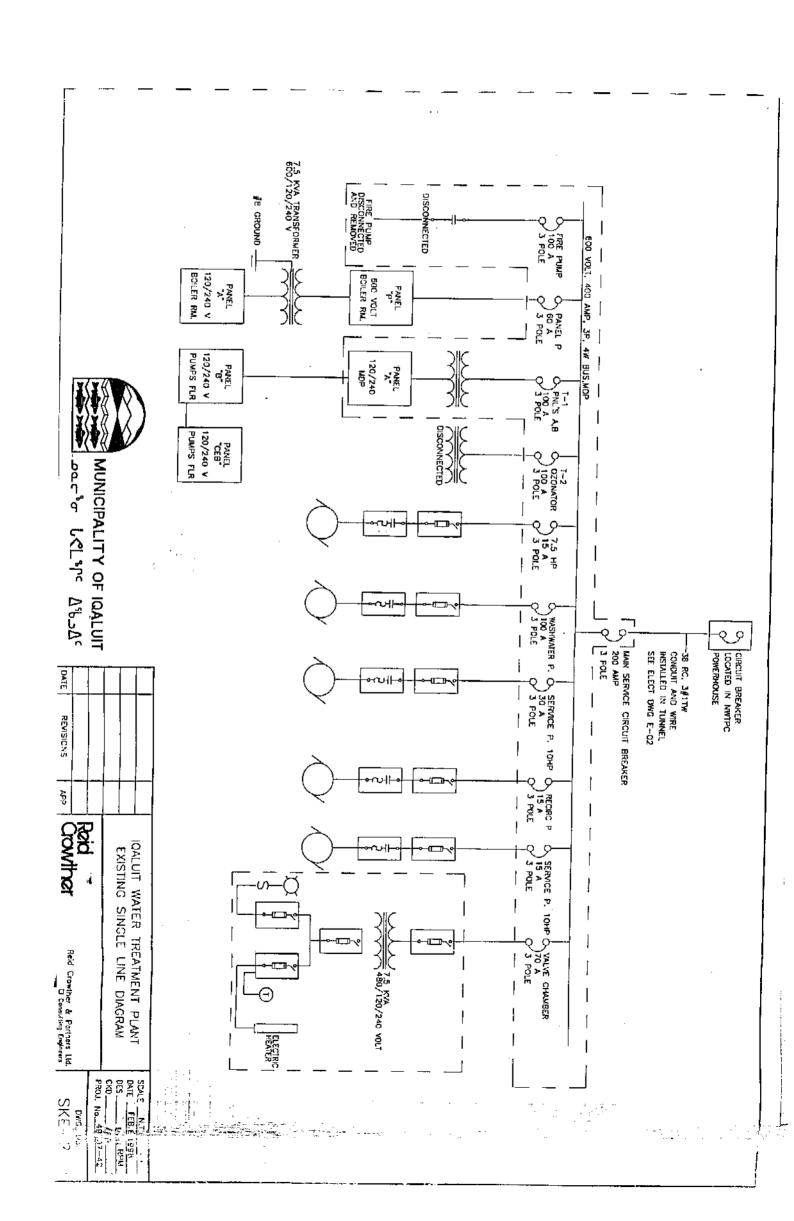
Full record drawings of the project will be prepared and submitted in both hard copy (mylar) and electronic form. Such drawings are essential for operations use as well as future plant upgrades.

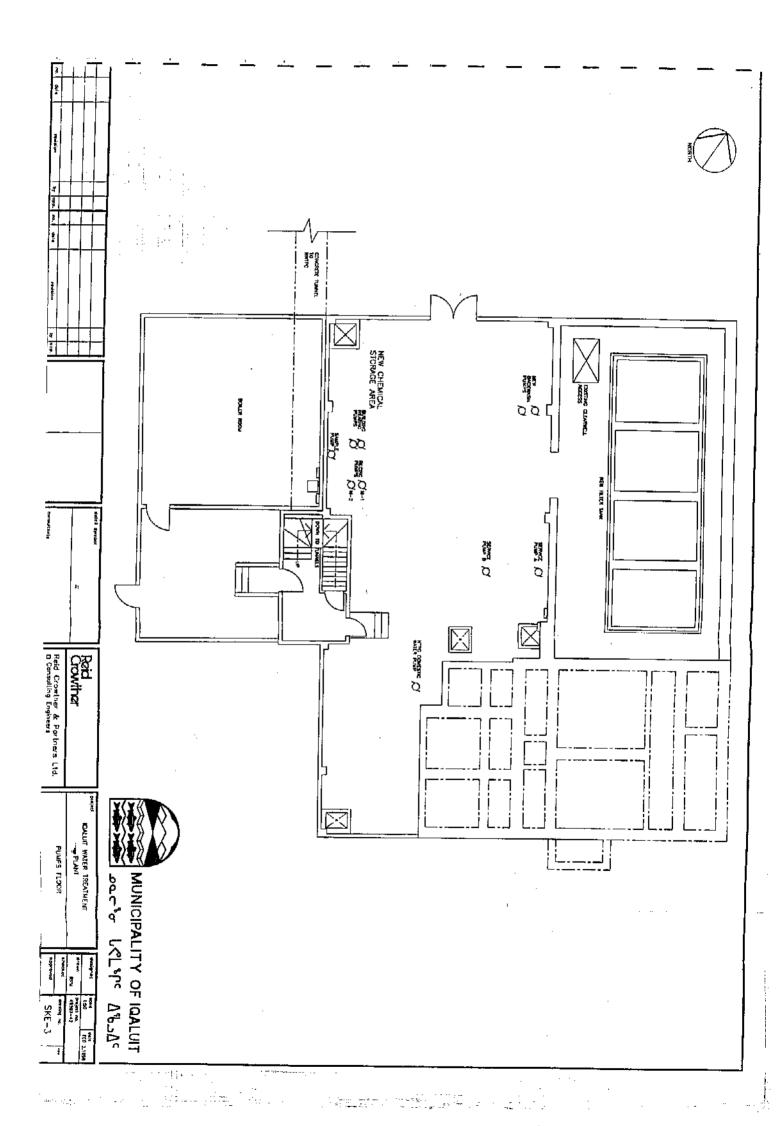
7.2 Operations and Maintenance Manuals

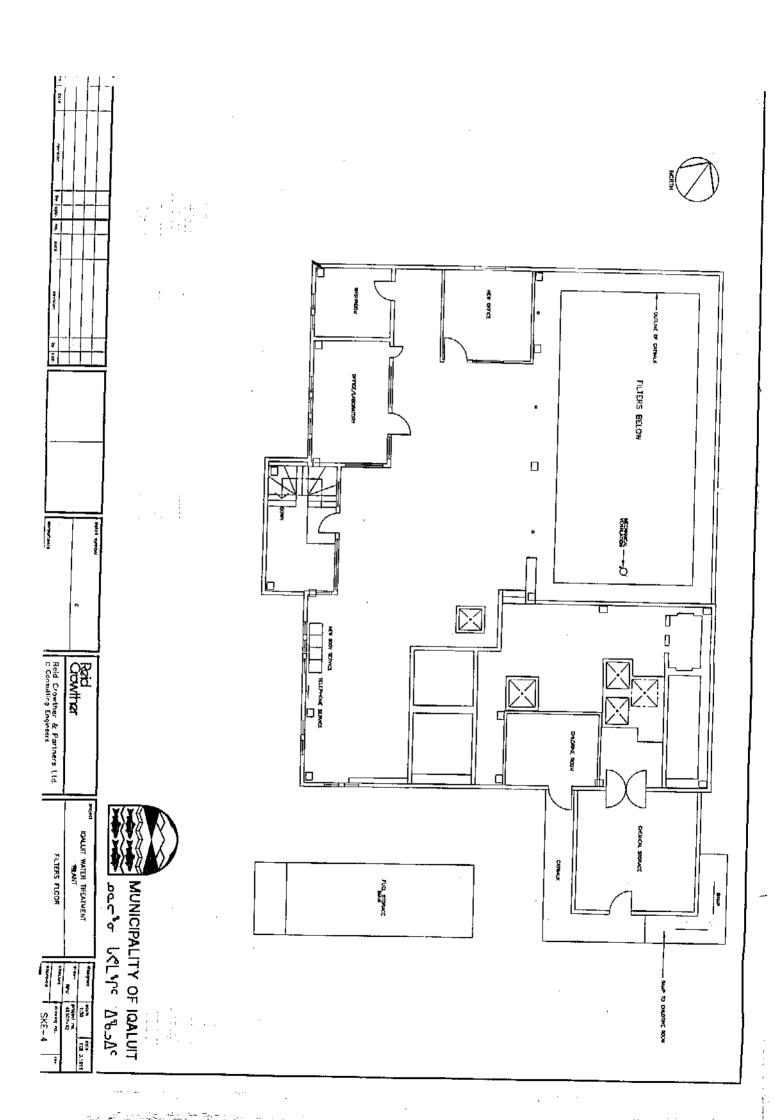
To assist in plant operations, all of the renovations, procedures, standards and safety standards will be documented and included in a new set of complete operating and maintenance manuals. All disciplines will be represented in these manuals in an organized fashion.

APPENDIX A

Preliminary Drawings/Figures







IQALUIT WATER TREATMENT PLANT

MCC SECTIONS

MCC SECTIONS

PROJ. No. 383507 422

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APP CIONITION

Reid Crowther & Pariners Ltd.

CIONITION

REVISIONS

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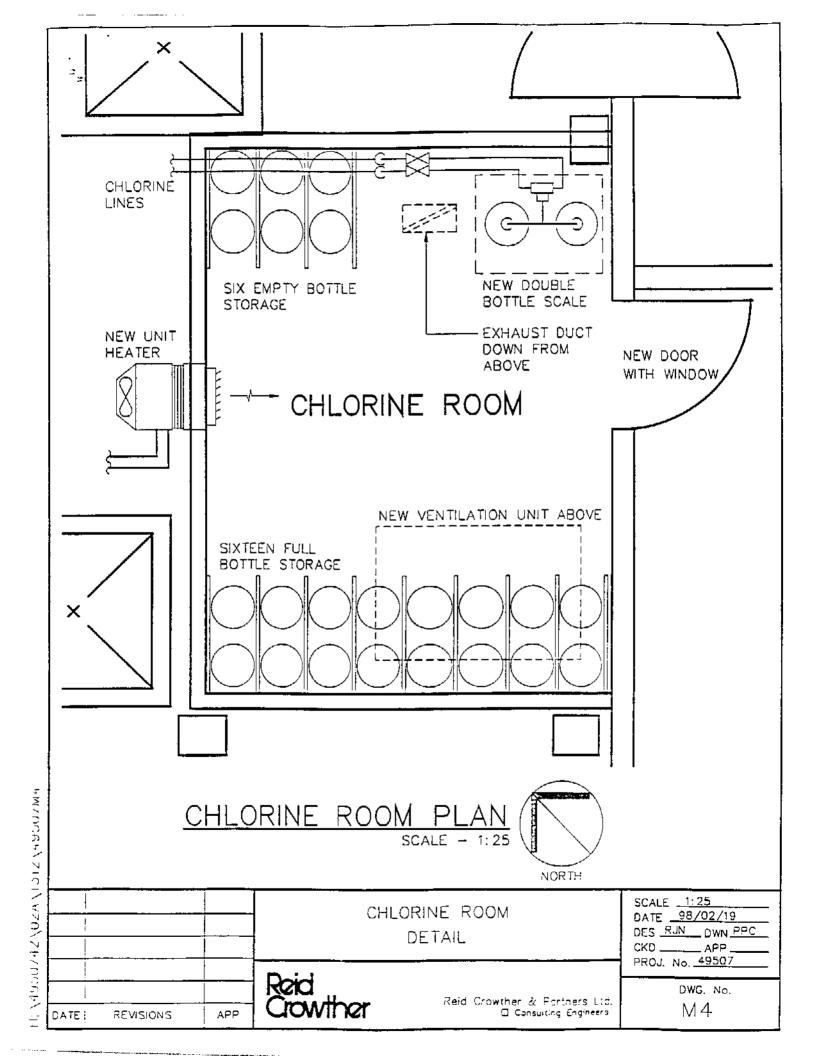
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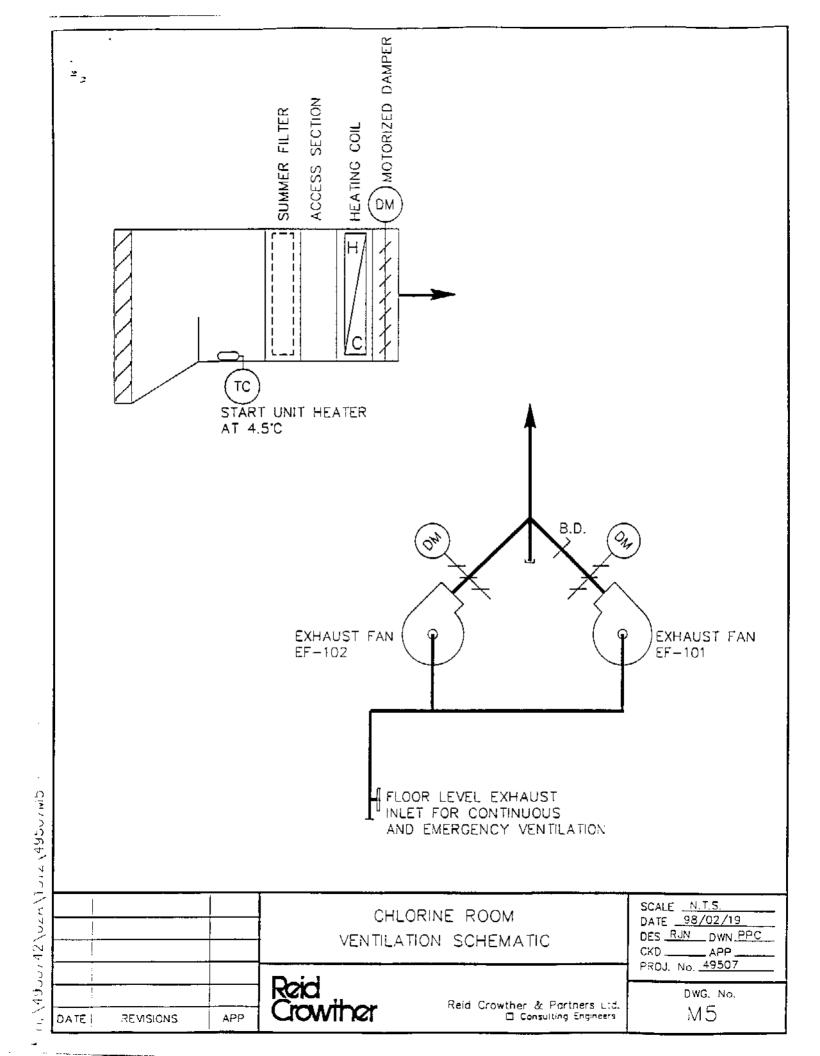
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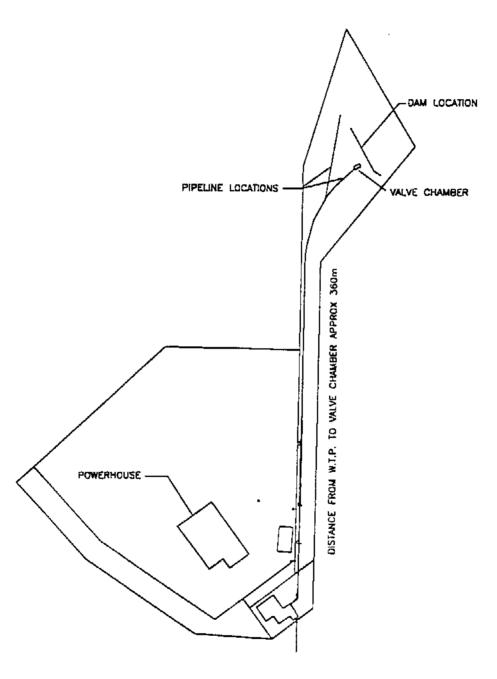
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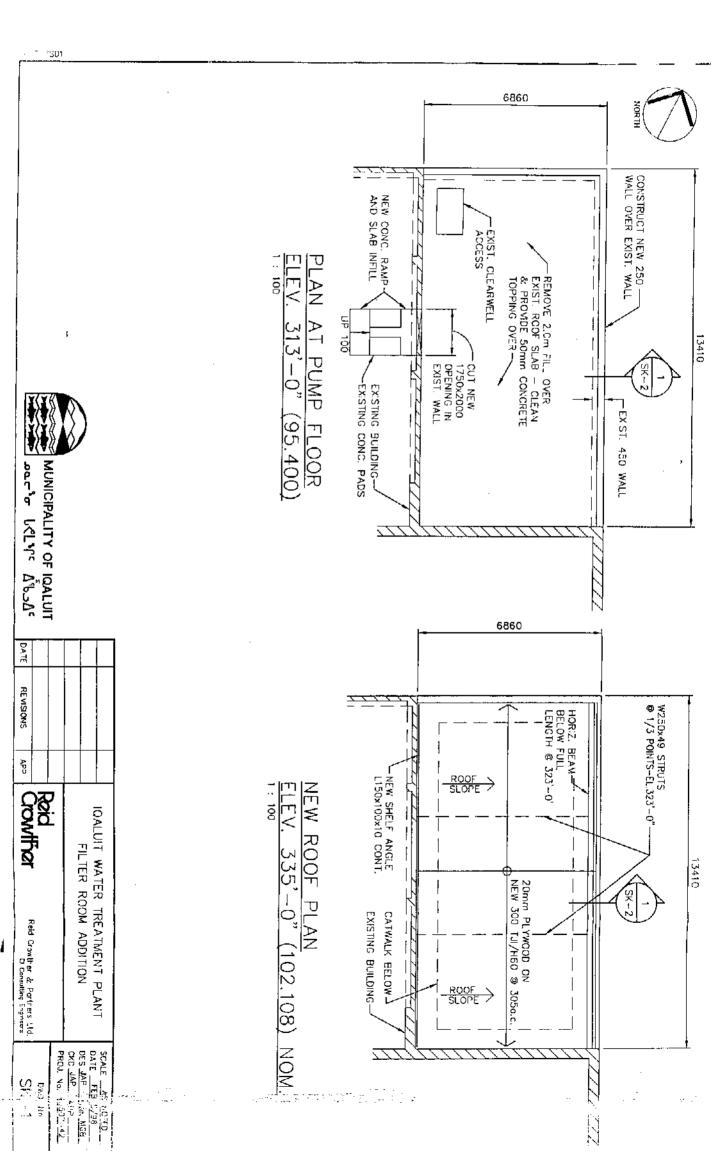
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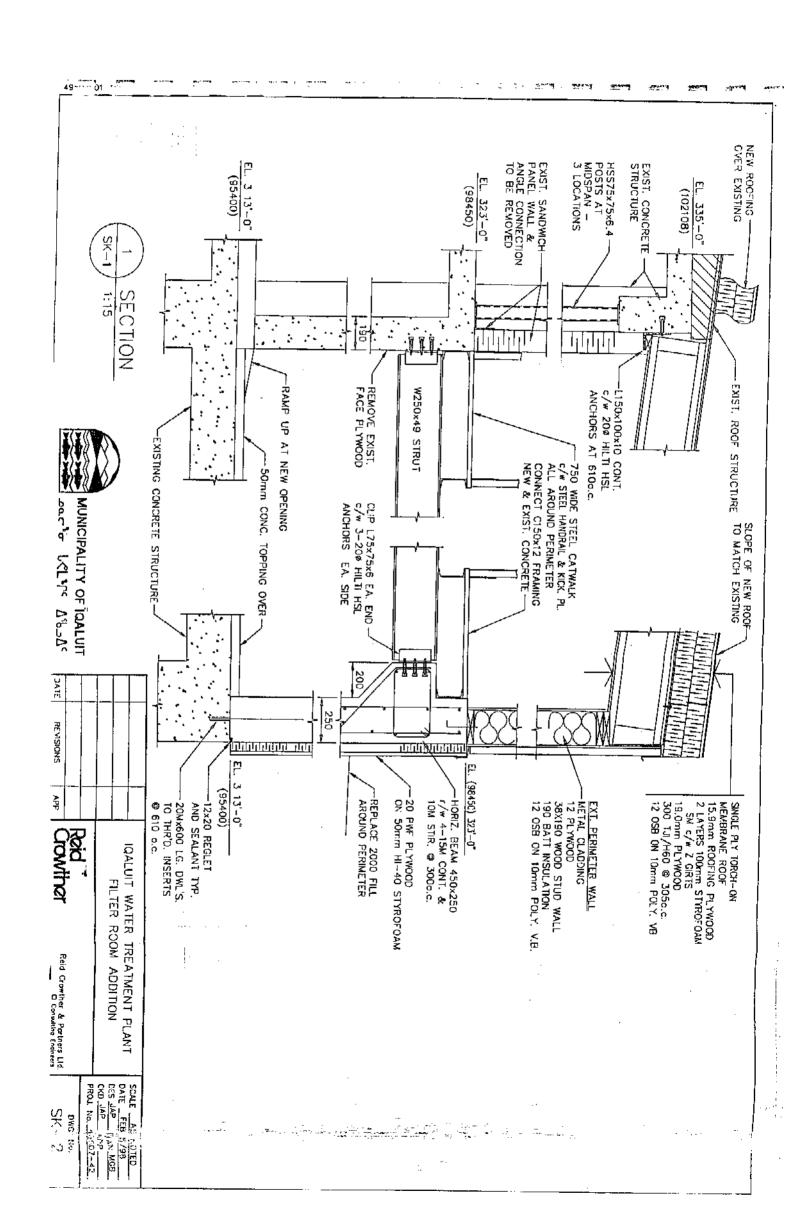
IQALUIT, N.W.T. Water Treatment Plant Upgrade Preliminary Drawings

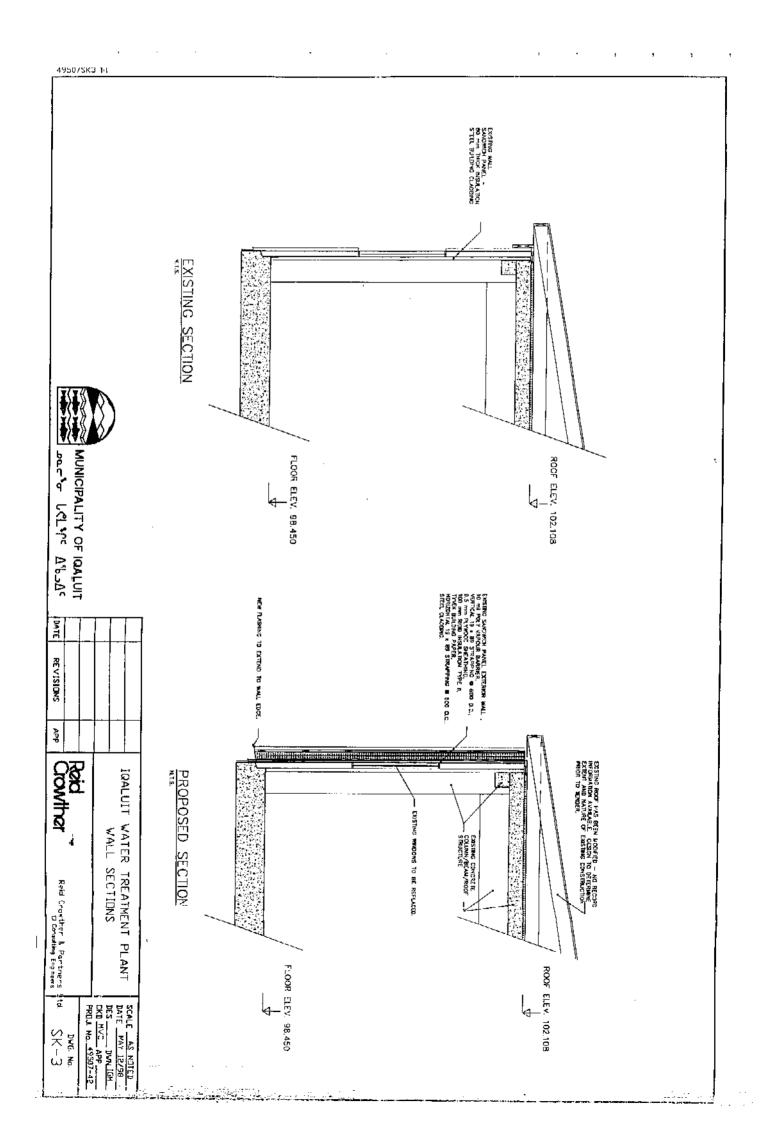
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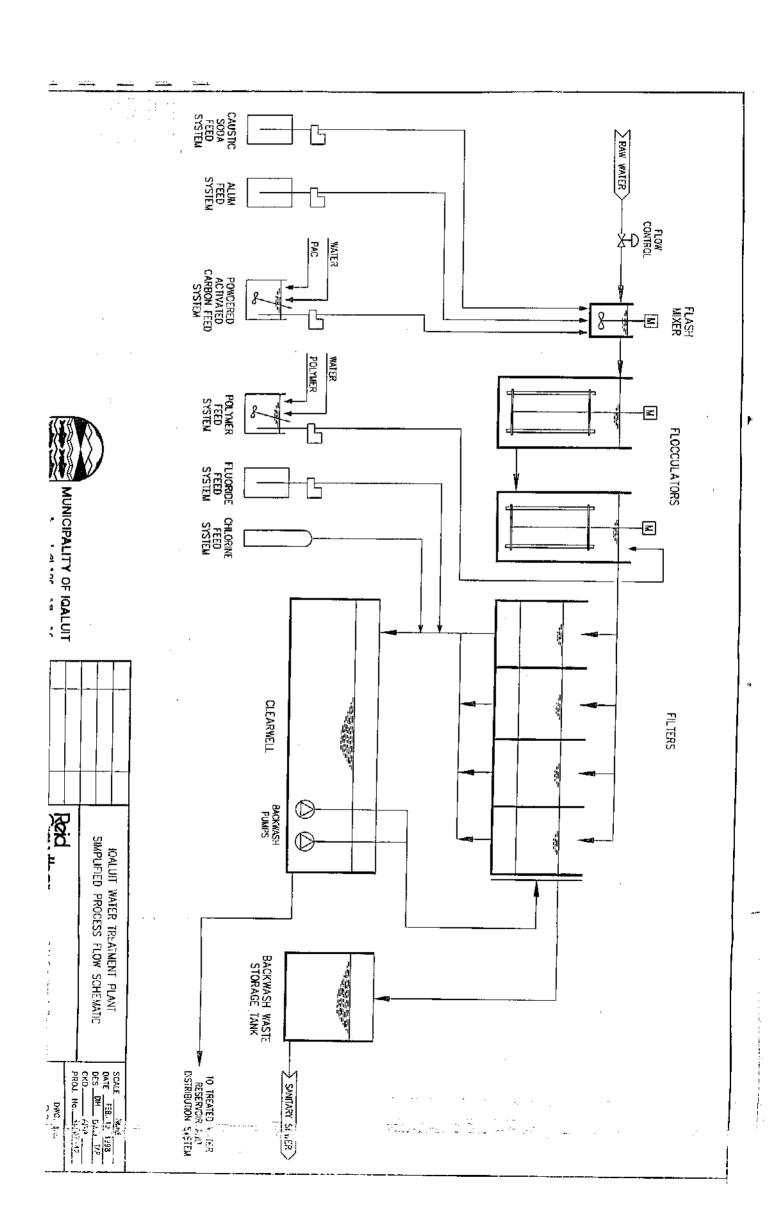
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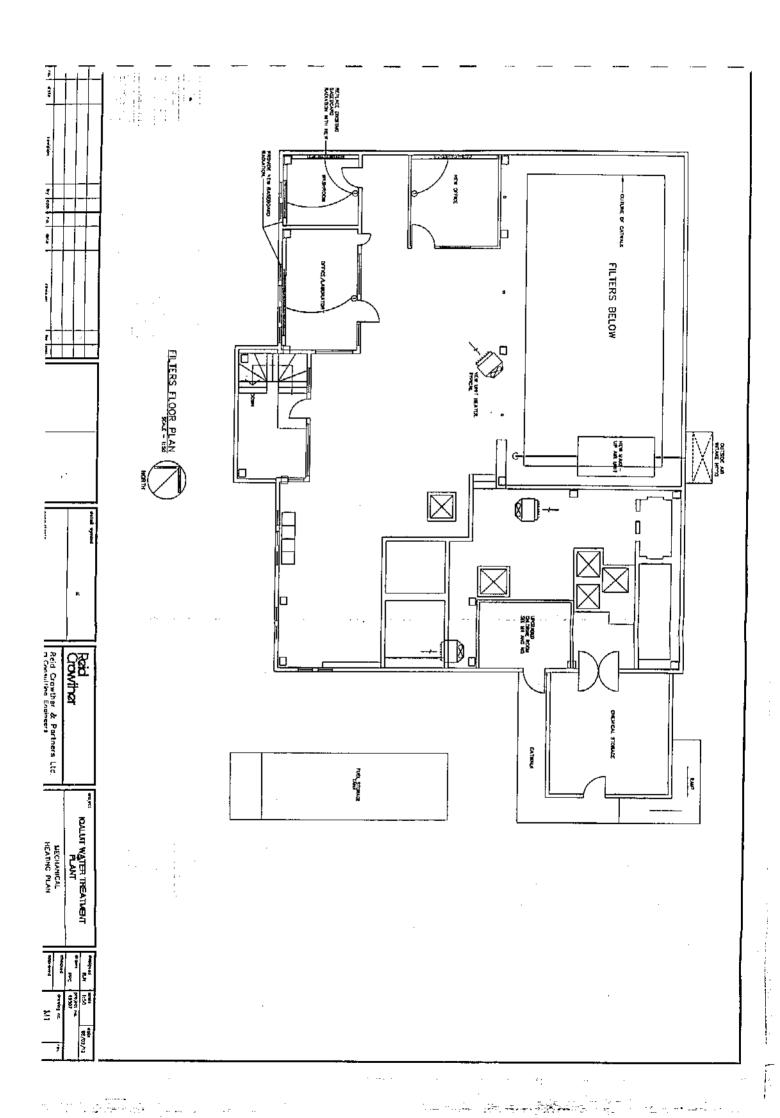
		LIST OF DRAWINGS	RE LEICH NUMBER
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	SK-2	SK-2 FILTER ROOM ADDITION	:
	5×S	WALL SECTIONS	.c
	P-01	SIMPLIFIED PROCESS FLOW SCEMATIC	2
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	М-2	HEATING & FUEL OIL PLAN	C 3-
	K-W	HEATING PLAN	ato.
	M-4	CHLORINE ROOM DETAIL	c ,
	M−2	CHLORINE ROOM VENTILATION SCHEMATIC	-
	SKE-1	SITE PLAN	142.
	SKE-2	EXISTING SINGLE LINE DIAGRAM	an i
	SXE-3	PUMPS FLOOR	
	SKE-4	FILTERS FLOOR	اقا
	SKE-5	SKE-5 MCC SECTIONS	ing i

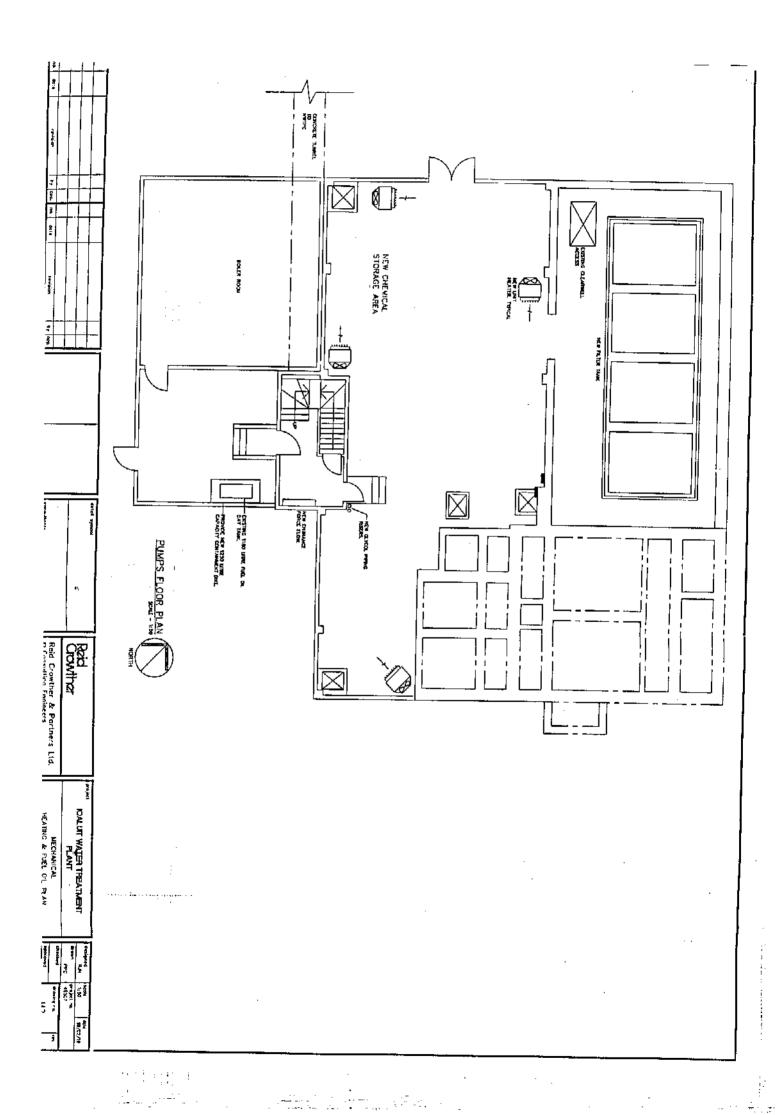


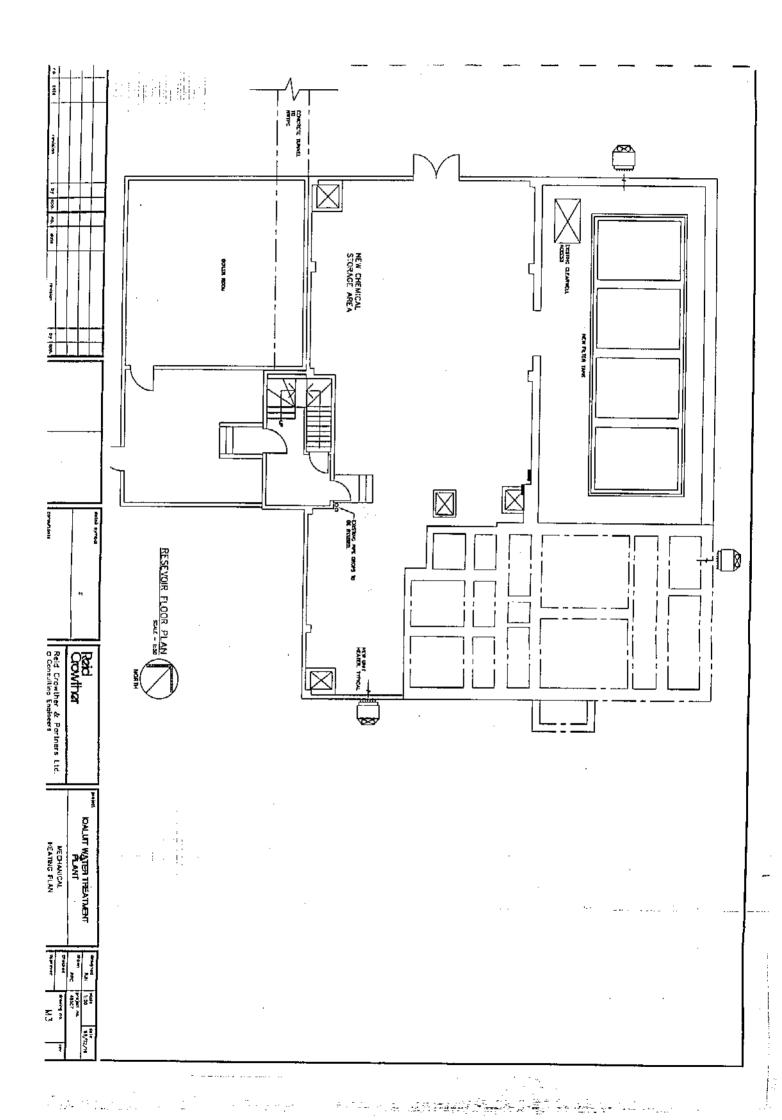












APPENDIX B

Initial Treatability Analysis

MUNICIPALITY OF IQALUIT - WATER TREATMENT PLANT RAW WATER TREATABILITY EVALUATION

1 GENERAL

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This report summarizes the results of an initial water quality and treatability assessment of the Iqaluit raw water. A 20 L sample was taken by plant staff on 20 February 1998 and shipped by air to RCPL's Edmonton laboratory. The sample was received in Edmonton on 24 February 1998.

2 RAW WATER CHARACTERISTICS

A portion of the raw water sample was submitted to Norwest Labs, Edmonton, for detailed potability analysis. Results are shown in Appendix 1.

In general, the raw water was of excellent quality and met all GCDWQ¹ objectives for the measured parameters. On this basis, the water could, after disinfection, be sent directly to the distribution system without further treatment. However, there are three factors that make some form of treatment desirable:

- The raw water colour (13 TCU) was just below the 15 TCU objective. This level of colour is very definitely noticeable to consumers. Although colour is an aesthetic objective and is not in itself detrimental to health, many consumers tend to associate colour with unsafe water and may turn to other sources which may or may not be safe. Together with taste and odour problems, colour is one of the most frequent causes of consumer complaints.
- The raw water quality at other times of the year, particularly during spring breakup, is likely to be inferior to that of the February sample. A treatment process capable of providing acceptable treated water under more adverse raw water conditions should be provided.
- Current trends in the potable water supply industry are towards a "multi-barrier" approach to the
 removal and/or inactivation of microorganisms that may be present in the raw water. For
 example, even though disinfection (chlorination) may be fully capable of destroying potentially
 harmful microorganisms, a second barrier such as filtration is also desirable. The second
 barrier would provide at least some protection in the event of failure of the first.

¹ Health Canada, Guidelines for Canadian Drinking Water Quality, Sixth Edition (1996)

3 TREATABILITY

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The raw water contains very low levels of dissolved and suspended substances, which is essentially what makes it a high quality source. However, this means that the raw water can be difficult to treat by common methods such as coagulation, solids separation, and filtration. There is little to react with acidic coagulants such as alum, so additional chemicals such as lime or caustic soda must often be used. Similarly, the lack of suspended particles means that there are few solid particles to act as a "nucleus" for the formation of floc, or to weight the floc so that it can be separated by gravity settling.

The most appropriate process for these types of waters is often one known as direct filtration. Alum or some other coagulant is added to the water, sometimes with a second chemical (such as lime or caustic soda) to counteract the acidity of the coagulant. The coagulated water is then flocculated in the normal way, to allow the precipitated floc particles to grow in size; sometimes, a polymer is added to assist in the flocculation process. The flocculated water is then passed directly onto the filters, without the usual intermediate solids separation step (sedimentation).

Direct filtration is practical only where relatively small doses of coagulant are used. This is normally the case with high-quality sources such as the Iqaluit raw water, and - as discussed in the planning brief and later reports - direct filtration is the recommended process at Iqaluit. The prime objective of this present treatability evaluation, therefore, was to confirm that direct filtration would be suitable for treatment of the raw water and to determine some of the design parameters involved.

RESULTS

Detailed results of the various tests carried out for the treatability evaluations are shown in Appendix 2. Conclusions to be drawn from these results are:

- 1. The pH of the raw water could be adjusted using either lime or caustic soda (Figure A2.1). The dosages required were similar, and very low (less than 10 mg/L to increase the pH to above 10).
- 2. The water could be readily coagulated using aluminum sulfate (alum) at dosages of 10 to 20 mg/L, with or without pH adjustment.
- 3. Coagulation with alum reduced true colour to very low levels (less than 5 TCU).
- 4. After coagulation, the pH of the water could be adjusted (to reduce its corrosiveness) with small dosages of caustic soda. Dosages of about 5 mg/L were sufficient to increase the pH to the desired levels.
- 5. Based on visual observation of floc formation, flocculation times of about 10 minutes were adequate at room temperature (20°C). At lower temperatures (about 5°C) the required time increased to about 20 minutes. In the full-scale plant, additional time should be allowed to

provide some margin for factors such as even lower temperatures, more adverse raw water conditions, and non-ideal flow patterns in the flocculation tanks. Therefore, based on these results and considerations, the 40 minutes suggested in the predesign report would be appropriate.

- The floc formed was very small (pinpoint size) but would probably be easily removable by direct filtration. Unfortunately, granular media filtration cannot easily be simulated on a bench scale so this could not be confirmed.
- 7. Addition of a small amount of anionic polymer (0.1 mg/L) resulted in a significant increase in the size of the floc particles. Although a large floc is not required for direct filtration (and is in fact usually undesirable) polymer dosing facilities should be installed at the plant to provide additional operating flexibility and the ability to control the floc size.

5 CONCLUSIONS AND RECOMMENDATIONS

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The February 1998 sample of Iqaluit raw water could be readily coagulated and flocculated using 10 to 20 mg/L of alum, to form a floc that should be suitable for direct filtration. pH adjustment before coagulation was not necessary.

Raw water colour was reduced to less than 5 TCU by coagulation.

pH readjustment after coagulation and solids separation (to reduce the corrosiveness of the treated water) could be achieved using less than 10 mg/L of caustic soda.

Essentially, this evaluation confirmed, as far as is reasonably possible using bench-scale procedures, that the processes recommended in the planning brief and predesign report will be appropriate for use at Iqaluit.

The above results are relevant only to the particular sample tested, and raw water conditions at other times of the year will almost certainly be different. We recommend that additional raw water samples be taken times of seasonal change, such as spring breakup, summer and fall for full chemical analysis. If a sudden change in the raw water is noticed - particularly a deterioration - then a larger sample should be taken and a treatability evaluation done.



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QAVE HARRIS 49507-42-4100 24 02 98

SAMPLE		1
		IQALUIT RAW
		WATER
BOUTINE WATER		
рн		6.81
ELECTRICAL COM	0 us/cm	38.0
CALCIUM	πα/L	4.2
MAGNESIUM	mg/L	0.9
SODIUM	mg/L	1.3
POTASSIUM	mg/L	<1.00
SULPHATE	mg/L	1.5
CHLORIDE	mg/L	1.0
BICARBONATE	mg/L	26
FLUORIDE	Ing/L	0.05
T ALKALINITY	mg/L	21
HARDNESS	mg/L	14.0
T DIS SOLIDS	mg/L	22
IONIC BALANCE	*	-74.9
WATER NUTRIENTS		
AMMONIA-N	mg/L	<0.05
NO 2 & NO 3 - N	mg/L	(0.05
ORGANICS		
TOT ORG CARBON	mg/L	2.3
ICP METALS, EXTR		
IRON	mg/L	0.10
MANGANESE	mg/L	0.10 0.009
		0.009
HYSIC ANALYSIS		
COLOUR TRUE	CO.UNITS	14
TURBIDITY	NTU	0.68
PACE ICP, DISS		
ALUMINUM	mg/L	0.034
	J	0.034

Lab Manager:

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APPENDIX 2 IQALUIT RAW WATER TREATABILITY EVALUATION DETAILED RESULTS

Sample date: 20 Feb 98

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Evaluation dates: 24 to 27 Feb 98

Run No. 1 - Raw water quality

Objective: Determine basic raw water characteristics.

Parameter	Value
рH	6.4
Turbidity, NTU	0.5
Apparent colour, ACU	14
True colour, TCU	13
Iron, mg/L	0.11
Manganese, mg/L	0.005

Conclusions: Apparently, an excellent quality raw water source. Colour is below objective but definitely noticeable.

Run No. 2 - pH adjustment

Objective: Determine caustic soda and lime dosages needed to increase pH.

CAUSTIC		LI	ME
mg/L	рН	mg/L	pН
0.0	6.40	0.0	6.36
0.5	6.40	1.3	6.44
1.3	6.44	2.5	6.64
2.5	6.58	5.0	8.31
3.8	6.88	7.5	9.76
5.0	7.34	10.0	10.11
6.3	8.46	12.5	10.31
7.5	9.27		
8.8	9.71		
10.0	9.98		
11.3	10.11		

Caustic soda and lime stock solutions added to 1 t, raw water samples mixed on jar tester. Above results shown graphically in Figure A2.1,

Conclusions: pH can be increased with low dosages of either caustic soda or lime (as would be expected).

Run No. 3 - Initial alum coagulation trial

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Objective: Determine approximate caustic and alum dosages for coagulation.

Add 8 mg/L caustic then 10 mg/L alum to 1 L jars on jar tester. Rapid mix for 1 min after alum addition, then flocculate at 60 rpm. Done at room temperature (~18°C).

10 min floc time: pH = 7.2, no visible floc. Add another 10 mg/L alum.

20 min floc time: pH = 7.2. Small, distinct floc visible. Add 0.2 mg/L Praestol 2515 - immediate agglomeration to give large, easily settlable particles. Visually, supernatant has negligible colour.

Conclusions: Raw water could be fairly easily flocculated with 10 to 20 mg/L alum, which was sufficient to reduce colour to very low levels. Floc size could be increased by using anionic polymer, although this will probably not be necessary for direct filtration.

Run No. 4 - Alum coagulation, Run 2

Objective: Determine coagulation performance (particularly colour removal) with and without pH adjustment.

Normal jar test procedure, room temperature (21°C) with:

Sample 1: 3 mg/L caustic, 20 mg/L alum.

Sample 2: no caustic, 10 mg/L alum,

After 10 minutes flocculation:

Sample 1: pH = 7.09. Small but distinct floc visible.

Sample 2: pH = 6.87. Similar floc to Sample 1.

Stop flocculation after 20 minutes; settle; filter through 0.45µ membrane filter. See below for results.

Conclusions: 10 to 20 mg/L of alum resulted in apparently acceptable flocculation at room temperature (~20°C). Addition of caustic soda before coagulation was not necessary.

Run No. 5 - Alum coagulation, Run 3

Objective: Determine coagulation performance (particularly floc formation time) at low temperatures.

Cool samples to approx. 0°C. Normal jar test procedure. No pH adjustment by caustic soda.

Sample 3: 10 mg/L alum.

Sample 4: 20 mg/L alum.

5 minutes flocculation (sample temp = 3.9°C);

Sample 3: No floc visible.

Sample 4: Some very small floc visible, pH = 6.9.

15 minutes flocculation time (sample temp = 4.8°C);

Sample 3: Some floc now visible.

Sample 4: More floc visible than in Sample 3, but still very small, pH = 6.5.

20 minutes flocculation time (sample temp = 5.6°C);

No visible change from 15 minutes. All floc is small, Sample 4 (pH = 6.4) visually somewhat better than Sample 3 (pH = 6.6).

40 minutes flocculation time (sample temp = 7.6°C):

No visible changes. Floc is small but distinct and should be OK for direct filtration. Sample 4 pH = 6.5; Sample 3 pH = 6.6. Stop flocculation, settle, and filter. See below for results.

Conclusions: At lower temperatures (~5°C) about 20 minutes flocculation time was necessary. The floc formed fairly easily and would probably be suitable for direct filtration.

Summary of results:

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Sample	Chemical treatment	рН	Turbidity NTU	Colour TCU
Raw water (unfiltered)	None	6.4	0.45	14
Raw water (filtered)	None	-	0.09	13
Sample 1	3 mg/L caustic, 20 mg/L alum, 21°C	7.1	0.04	5
Sample 2	10 mg/L alum, 21°C	6.9	0.06	4
Sample 3	10 mg/L alum, ~5°C	6.6	0.07	4
Sample 4	20 mg/L alum, ~5°C	6.5	0.03	3
Distilled water	None	_	0.02	0

Conclusions: The raw water could be readily coagulated with 10 to 20 mg/L of alum, to give almost complete colour removal. pH adjustment before coagulation was unnecessary. Note somewhat erratic pH readings (normal for very low alkalinity waters such as this).

Run No. 5 - pH readjustment after alum coagulation

Objective: Determine caustic soda dosages needed to adjust pH of coagulated water (for corrosion control).

Coagulate 1 L sample of raw water with 20 mg/L alum; settle; decant supernatant; add caustic soda to supernatant.

Caustic soda dosage, mg/L	рH
0.0	6.30
2.5	6.61
5.0	8.69
7.5	9.46
10.0	9.88
15.0	10.28

Above results shown graphically in Figure A2.2.

Conclusions: pH of raw water coagulated with 20 mg/L alum could be readjusted to desired levels (pH - 8 to 9) with about 5 mg/L of caustic soda.

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IQALUIT RAW WATER PH ADJUSTMENT