

**Seasonal Replenishment of
Nipissar Lake, Rankin Inlet,
Nunavut**

Environmental Screening Report



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Table of Contents

EXECUTIVE SUMMARY	V
1.0 INTRODUCTION	1.1
1.1 BACKGROUND	1.1
1.2 SUMMARY OF PROJECT ACTIVITIES	1.4
2.0 GENERAL PROJECT DESCRIPTION	2.1
2.1 PROJECT LOCATION	2.1
2.2 GENERAL INFORMATION	2.1
2.2.1 Need for Project	2.1
2.2.2 Project Alternatives	2.1
2.2.3 Project Schedule	2.2
2.2.4 Regulatory Framework.....	2.2
2.2.5 Required Permits and Approvals.....	2.3
2.3 TRANSPORTATION	2.4
2.3.1 Culvert Installation	2.5
2.4 CAMP SITE	2.5
2.5 EQUIPMENT	2.5
2.6 WATER.....	2.6
2.6.1 Potable Water.....	2.6
2.7 WASTE WATER AND SOLID WASTE	2.7
2.7.1 Domestic Waste	2.7
2.7.2 Used Oil / Waste Fuel	2.7
2.7.3 Contaminated Soil	2.7
2.7.4 Waste Water.....	2.7
2.7.5 Overburden and Excavation Material	2.8
2.8 FUEL.....	2.8
2.9 CHEMICALS AND HAZARDOUS MATERIALS.....	2.8
2.10 WORKFORCE AND HUMAN RESOURCES.....	2.9
2.11 PUBLIC INVOLVEMENT / COMMUNITY KNOWLEDGE.....	2.9
3.0 PROJECT SPECIFIC INFORMATION	3.1
3.1 DESCRIPTION OF PROJECT.....	3.1
3.1.1 Site Preparation	3.1
3.1.2 Culvert Installation	3.1
3.1.3 Winter Access Trail.....	3.2
3.1.4 Pipeline Installation.....	3.2
3.1.5 Pipeline Granular Cover	3.2
3.1.6 Water Intake System	3.3
3.2 RAW CONSTRUCTION MATERIALS.....	3.3
3.3 SAFETY.....	3.4
3.4 NOISE.....	3.4
3.5 GASEOUS EMISSIONS AND ODORS.....	3.4

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

3.6	RADIATION SOURCES.....	3.4
3.7	BULK STORAGE FACILITY AND QUARRY DEVELOPMENT / PIT DEVELOPMENT.....	3.4
4.0	EXISTING ENVIRONMENT	4.1
4.1	PHYSICAL ENVIRONMENT	4.1
4.1.1	Terrain	4.1
4.1.2	Climate.....	4.1
4.1.3	Hydrology and Water Quality	4.2
4.2	BIOLOGICAL ENVIRONMENT	4.5
4.2.1	Vegetation	4.5
4.2.2	Wildlife	4.6
4.2.3	Avifauna	4.9
4.2.4	Fisheries	4.10
4.3	SOCIOECONOMIC ENVIRONMENT	4.12
4.3.1	Local Economy and Traditional Land Use	4.12
4.3.2	Heritage Resources	4.12
5.0	IDENTIFICATION OF EFFECTS AND PROPOSED MITIGATION.....	5.1
5.1	BOUNDARIES.....	5.1
5.2	VALUED COMPONENTS.....	5.1
5.3	PROJECT INTERACTIONS WITH VALUED COMPONENTS	5.3
5.4	EFFECT ASSESSMENT AND MITIGATION	5.6
5.5	RESIDUAL EFFECTS OF THE PROJECT	5.17
5.5.1	Assessment of Residual Environmental Effects	5.17
5.5.2	Physical VCs	5.18
5.5.3	Biological VCs	5.20
5.5.4	Socio-economic VCs	5.24
6.0	CUMULATIVE EFFECTS	6.1
6.1	CUMULATIVE EFFECTS BOUNDARIES	6.1
6.2	CUMULATIVE EFFECTS INCLUSION LIST	6.2
6.3	SCREENING OF RESIDUAL PROJECT EFFECTS.....	6.2
6.4	SIGNIFICANCE OF CUMULATIVE EFFECTS.....	6.3
7.0	SUPPORTING DOCUMENTATION.....	7.1
8.0	REFERENCES.....	8.1

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

LIST OF TABLES

Table 2-1	Project Schedule	2.2
Table 2-2	Required Permits and Approvals for the Project.....	2.3
Table 4-1	Climate Normal over the Period 1981 to 2010 at Rankin Inlet, NU (EC, 2014).....	4.1
Table 4-2	Water Quality Conditions in Char River – Based on Water Samples Collected in July 2011 (Golder 2011).....	4.3
Table 5-1	Valued Components in the Project Area and Rationale for Selection	5.2
Table 5-2	Project Activity – Valued Component Potential Interaction Matrix.....	5.4
Table 5-3	Potential Effects and Mitigations for Valued Components.....	5.7
Table 5-4	Assessment Criteria for Potential Residual Environmental Effects.....	5.17
Table 6-1	Cumulative Effects Assessment Program Inclusion List.....	6.2

LIST OF FIGURES

Figure 1-1	Nipissar Lake Resupply Line – Site Plan	1.3

LIST OF APPENDICES

APPENDIX A	DRAWINGS.....	A.1
APPENDIX B	ISSUED FOR TENDER SPECIFICATIONS	B.1
APPENDIX C	PHOTOGRAPHS	C.1
APPENDIX D	SPECIES LISTS.....	D.1
APPENDIX E	SPILL CONTINGENCY PLAN	E.1
APPENDIX F	OPERATIONS AND MAINTENANCE PLAN.....	F.1
APPENDIX G	SUPPORTING DOCUMENTATION	G.1

Executive Summary

The Government of Nunavut Department of Community and Government Services (GN-CGS) constructed a 4.05 kilometer pipeline to replenish the community potable water source. The pipeline was constructed in 2012 and extends from the Char River to Nipissak Lake (also known as Nipissar Lake), the potable water source in the hamlet of Rankin Inlet, Nunavut (the Project).

A number of regulatory approvals were required prior to the construction of the pipeline; however, these approvals were not obtained. Stantec was retained to prepare the required regulatory applications to ensure that the Project conforms with regulatory requirements prior to the operation of the pipeline.

This Environmental Screening document contains information regarding the activities at Site, existing environmental conditions, and an assessment of the potential effects of the Project on valued components of the physical, biological and socioeconomic environment. This Environmental Screening document has been developed to fulfill the Part 2 Project-Specific Information Requirements of the Nunavut Impact Review Board, and provide information on the Project to other regulatory agencies.

A number of mitigation measures have been identified for various Project-related activities, and with the implementation of these mitigations, adverse effects of the Project on valued components are expected to be negligible or low in magnitude. Positive residual effects were identified for several valued components.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Introduction
May 2014

1.0 Introduction

In 2014, the Government of Nunavut Department of Community and Government Services (GN-CGS) contracted Stantec Consulting Ltd. (Stantec) to prepare regulatory applications for a 4.05 kilometer (km) pipeline located within the municipal boundary of Rankin Inlet, Nunavut (NU). The pipeline was constructed in 2012 to transport water from the Char River to Nipissak Lake (also known as Nipissar Lake). Nipissar Lake is the potable water source for the community of Rankin Inlet, NU.

A number of regulatory approvals were required prior to the construction of the pipeline; however, these approvals were not obtained. Stantec was retained to prepare the required regulatory applications to ensure that the Project conforms with regulatory requirements prior to the operation of the pipeline.

This Environmental Screening document contains information regarding the construction and operation of the Project, existing environmental conditions and an assessment of the potential effects of the Project on identified valued components (VCs) of the physical, biological, and socio-economic environment. The Environmental Screening document has been developed to fulfill the Part 2 Project Specific Information Requirements (PSIR) of the Nunavut Impact Review Board (NIRB), and provides required Project information to other regulatory agencies with responsibility for issuing necessary permits and approvals.

1.1 BACKGROUND

In 2009, the GN-CGS retained FSC Architects and Engineers (FSC) and Resource Management Strategies Inc. (RMSi) to complete a Water Supply Capacity, Consumption and Conservation Study of the potable water system located in Rankin Inlet, NU (FSC 2010)(the Study). The purpose of the Study was to provide advice on how to optimize water use in the community. The Study concluded that the volume reductions observed in Nipissar Lake were attributed to inefficient water use and increased demand due to increases in the population of the community. FSC determined that Nipissar Lake would cease to be a suitable potable water source by 2019.

Upon completion of the Study, bathymetric surveys were completed at three water bodies (Nipissar Lake, Little Meliadine Lake and First Landing Lake). The purpose of the surveys was to determine the volume of Nipissar Lake and to determine the suitability of Little Madeline Lake and First Landing Lake (also known as Lower Landing Lake) as potential water sources for the replenishment of Nipissar Lake. Based on the findings of these surveys, GN-CGS concluded that Lower Landing Lake would be the most suitable option to replenish Nipissar Lake; and, a pipeline would be required to be constructed between the two lakes.

In 2010, FSC was retained by GN-CGS to complete the design and tender specifications for the proposed pipeline. During the design phase of the Project, the location of the pipeline intake area was revised from the original location in Lower Landing Lake to the Char River due to accessibility, proximity to the intake pump area and quality of pumping. FSC proposed that the

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Introduction
May 2014

pipeline be constructed overland from the Char River to a discharge location at the north edge of Nipissar Lake. The location of the Lower Landing Lake in relation to the Char River, as well as the pipeline alignment, is shown on Figure 1-1.

As part of the design work, FSC and GN-CGS held a community meeting in Rankin Inlet to discuss the Project and community concerns. During this meeting, community members expressed concern regarding the location of the proposed pipeline alignment and its potential to cross a primary snowmobile route. Based on this feedback, FSC modified its design and proposed that two sections of the pipeline, which crossed the snowmobile trail, be covered with granular material to maintain snowmobile access.

Considering these design recommendations, the preliminary design of the pipeline consisted of the following:

- 3.885 km pipeline between the Char River and Nipissar Lake (the Site)
- One culvert under the access road at KM 0.25
- Two high point air releases located at KM 0.27 and KM 3.699
- One low point water release at KM 0.673
- Two areas of cover consisting of 0.5 m of granular material placed atop of the pipeline extending from approximately KM 0.45 to KM 0.56; and, KM 0.615 to KM 0.754
- One culvert under the access road at KM 0.571
- One culvert under the access road at KM 3.535

In August 2011, tender specifications and issued for construction drawings were developed for the GN-CGS based on FSCs' preliminary design. Shortly after the completion of the documents, FSC amended the pipeline alignment to allow for more gradual inclination of the pipeline. As such, the location of the culverts, high point air releases, low point water release and the covered areas were modified (Figure 1-1). In addition, the total pipeline length was extended to 4.05 km.

In 2012, GN-CGS contracted Oomilik Enterprises Ltd. of Rankin Inlet, NU (the Contractor) to complete the construction activities.



Sources: Imagery - Microsoft BING, Thematic Data - FSC Architects and Engineers

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Nipissar Lake Resupply Line - Site Plan

Figure 1-1



SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Introduction
May 2014

1.2 SUMMARY OF PROJECT ACTIVITIES

A summary of activities completed during the construction phase of the Project include:

- Grading of the existing access road at the intake area on the south side of the Char River
- Construction of a 4.05 km pipeline extending from the intake pump area to Nipissar Lake (including the installation of two high point air releases and one low point drain).
- Construction of a temporary winter access trail to facilitate the installation of the pipeline.
- Installation of granular material directly on the pipeline in two areas to facilitate snowmobile access.
- Installation of one culvert under the existing access road to facilitate surface water drainage.
- Installation of two culverts under the existing access road for the pipeline to pass under.
- Installation of a water intake system (consisting of a water intake pump, sea canister and a 50 m intake pipeline) at the intake area.
- Installation of a concrete pad at the pipeline discharge area located at Nipissar Lake.
- Installation of riprap around the concrete pad.

Upon the receipt of regulatory approvals, the water intake system and pipeline will be operated annually between June and September on an as needed basis. The pipeline has a design life of 20 years; however, it is intended to remain operational as long as it is functional.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

2.0 General Project Description

2.1 PROJECT LOCATION

The Project Footprint incorporates three main areas including the intake pump area, pipeline alignment and the discharge area at Nipissar Lake.

- The intake pump area located approximately 20 m east of the Char River, at the end of an existing municipal access road.
- The pipeline alignment extending from the Char River to Nipissar Lake
- The discharge area located on the north edge of Nipissar Lake.

The Project location is provided in Figure 1-1; detailed drawings for the pipeline alignment are provided in the Issued for Tender drawings in Appendix B.

2.2 GENERAL INFORMATION

2.2.1 Need for Project

The purpose of this Project is to replenish the potable water supply at Nipissar Lake to support municipal projects and community growth.

2.2.2 Project Alternatives

Alternatives to the Project, including both viable technical and economic options for carrying out the Project, have been considered. These include not constructing the pipeline, alternate pipeline routes, and alternate water intake locations. The option to not construct the pipeline is considered not feasible as the community requires additional water supply to meet the current and future water demand.

A routing study was completed to identify a preliminary pipeline alignment with potential alternatives in FSCs' Schematic Design Report (FSC 2010). This study identified two potential routes for the pipeline. The first route placed the pipeline alongside the existing access roads between Lower Landing Lake and Nipissar Lake. This option had the advantage of being easily accessible via the existing access roads; however, it had the disadvantage of having significant elevation changes, which would significantly increase the pumping and maintenance requirements. The second route consisted of an overland route between Lower Landing Lake and Nipissar Lake through a primarily undeveloped corridor. The advantage of this option was the decreased elevation changes throughout the route, which would allow for lower pumping and maintenance requirements. Upon consideration, the second route was determined to be the most viable option.

In addition to the routing, FSC also evaluated potential water intake locations for the pipeline. The first water intake option was situated in Lower Landing Lake. However, to use this location,

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

the construction of a short access road extending from the current access road north of the Char River to the proposed intake location on Lower Landing Lake would have been required. Due to the depth and flood potential in that area, the intake pump would be required to be set back approximately 100 m from the shoreline; causing significant reduction in the pumping capacity. The second water intake option was located at the Char River, approximately 185 m downstream of its discharge from Lower Landing Lake. With this option, the water intake pump would be located in a previously disturbed area (at the location of the old bridge abutments), with the intake line situated in an existing pool approximately 25 m upstream of the disturbed area. This option would utilize the existing access road and would have a shortened intake line. Upon consideration of these intake location options, FSC recommended the second option (i.e. the Char River).

During the schematic design, FSC also evaluated alternatives for pipeline diameter, pumping rates etc., (FSC 2010). The selected specifications presented in this document represent the preferred methods given the flow and volume requirements for the Project.

2.2.3 Project Schedule

Construction activities for the Project were completed as outlined in Table 2-1. The proposed operation period is also provided

Table 2-1 Project Schedule

Timeline	Activity
Fall 2012	• Mobilization and preparation tasks
September 2012	• Hauling, placing and compacting granular materials for the covered portion of the pipeline • Installation of three culverts under the existing access road • Installation of the low-point water release • Grading of the intake area
November to December 2012	• Construction of a temporary winter access trail to facilitate the installation of the pipeline. • Placement and welding of the overland portion of the pipeline • Installation of the two highpoint air releases • Installation of the water intake pump infrastructure
Winter 2013	• Inspection and repairs of the pipeline
June 2014 – onward	• Seasonal operation of the water intake pump and pipeline (June to September)

2.2.4 Regulatory Framework

Several federal and territorial acts, regulations and guidelines apply to the Project. Throughout all Project phases, Project personnel will work in cooperation with regulatory authorities to ensure compliance with applicable acts/regulations/guidelines outlined below.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

Federal

- *Arctic Waters Pollution Prevention Act* and Regulations
- *Canadian Environmental Protection Act*
- Canada Labor Code
- Canadian Occupational Health and Safety Regulations
- *Fisheries Act*
- Guidelines for Spill Contingency Planning (INAC 2007)
- *Migratory Birds Convention Act*
- *Navigable Waters Protection Act*
- Nunavut Land Claims Agreement
- *Nunavut Waters and Surface Rights and Tribunal Act*
- *Species at Risk Act*
- Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (CEPA SOR/2008-197)
- *Territorial Lands Act* and Regulations
- *Transportation of Dangerous Goods Act* and Regulations

Territorial

- *Commissioners Lands Act*
- Nunavut Archaeological and Paleontological Site Regulations
- *Nunavut Environmental Protection Act*
- Nunavut Environmental Protection Guidelines
 - Guidelines for Used Oil and Waste Fuel (GN 2012)
- *Public Health Act* and Regulations
- Spill Planning and Reporting Regulations.

2.2.5 Required Permits and Approvals

The Project is situated on municipal land within the hamlet of Rankin Inlet in Nunavut's Kivalliq region, within the Keewatin Planning Region. The Project has been screened by the Nunavut Planning Commission and has received a positive conformity determination. A copy of the determination is provided with the Supporting Documentation in Appendix G.

The GN-CGS is required to obtain the following permits and approvals (Table 2-2) to ensure compliance with the regulatory requirements.

Table 2-2 Required Permits and Approvals for the Project

Permit / Approval	Issuing Agency	Trigger
Type A Water License (amendment to Water License 3AM-GRA1015)	Nunavut Water Board (NWB)	Under the Nunavut Water Regulations: • Use of more than 300 m³ per day
Screening Decision	Nunavut Impact Review	Application for a Type A Water

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

Table 2-2 Required Permits and Approvals for the Project

Permit / Approval	Issuing Agency	Trigger
	Board	License are automatically referred to the NIRB for screening

Based on the self-assessment process for Projects Near Water, a federal Department of Fisheries and Oceans (DFO) review of the Project is not required as long as the activities are restricted to surface water extraction for drinking and sanitary purposes, and there is no reduction in the width of nearby water bodies. However, the Project will need to comply with the pollution provisions in the *Fisheries Act* and the *Species at Risk Act*. In addition, the DFO has identified mitigation measures to avoid causing serious harm to fish. These measures have been incorporated into the Project design.

The DFO have identified mitigation measures to avoid causing serious harm to fish, which replace the former Operational Statements. Currently, DFOs' mitigation measures do not address all of the Project activities, specifically the construction of the winter access trail. Therefore, the Project will follow mitigation measures contained within the former Operational Statement for *Ice Bridges and Snow Fills* (DFO 2007).

2.3 TRANSPORTATION

During construction of the pipeline, the Site was accessed using an existing municipal access road and a temporary winter access trail. Activities completed in September 2012 utilized the existing municipal access road; however, the winter construction activities (completed in November to December 2012) were accessed using the temporary winter access trail. Use of the temporary winter access trail was restricted to Project-related traffic transporting heavy equipment, materials and personnel. No restrictions were placed on the existing municipal access road.

The alignment of the temporary winter access trail followed the selected pipeline alignment; no water crossings were required.

Although the heavy equipment required for the Project was contracted locally, Project materials (e.g. High Density Polyethylene (HDPE) piping, culvert materials, etc.) were transported to the hamlet via sealift, to the barge landing area located in Rankin Inlet. Once in the community, the Project materials were transported to the Site via the existing municipal roads and/or the temporary winter access trail.

Maintenance activities of the existing access road will be limited to the intake area at the Char River and the culvert locations. At the intake area, maintenance activities will include the re-grading of the pump area. The culvert locations will be monitored regularly during freshet; and, if required, cleared of any flow impediments.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

2.3.1 Culvert Installation

Three culverts were installed as part of the Project. These include:

- One culvert was installed at approximately KM 0.245 of the pipeline (Drawing C2 in Appendix B) to facilitate drainage under the existing access road.
- Two culverts at KM 0.575 and KM 3.750 of the pipeline were installed at locations where the existing municipal access road intersected with the pipeline; allowing for the pipeline to pass under the road.

Further information regarding culvert installation is provided in Section 3.1.2.

2.4 CAMP SITE

A camp was not required during the construction phase of the Project. All Project personnel were local residents or were accommodated in the hamlet. Other phases of the Project (operation and decommissioning) will not require camp facilities.

2.5 EQUIPMENT

Equipment required during all Project phases are listed below:

- Pickup truck and/or all-terrain vehicles (ATVs') – used for crew transportation
- Excavator and/or loader - used to install pipeline
- Crane – 8.5 tonne – used to install pipeline
- Tractor with trailers – used to transport pipeline to the Site
- Dump truck – used to transport granular material to the Site
- Butt fusion machine and mobile welder– used during the installation of the pipeline
- Generators – used to power equipment during the installation of the pipeline
- One 4.05 km pipeline – used to pump water from the water intake system to Nipissar Lake.
- One water intake system including:
 - One intake pump – used to pump water from the Char River into the pipeline. The intake pump consists of a trailer mounted four cylinder 75 horsepower diesel powered generator.
 - One intake pipeline (extending from the Char River to the intake pump area)
 - End-of-pipe screened water intake, connected to the intake pipeline.
 - One sea canister – used to store the intake pipeline and the screened intake when not in use. The intake pump and sea canister is surrounded by a chain link fence with a vehicle gate for security and vandalism protection.
- Three 600 mm corrugated steel pipes – used as culvert material
- One prefabricated concrete splash pad (approximately 1.5 m by 3.0 m) – used as a splash pad at the pipeline outlet location at Nipissar Lake.

Project specific information pertaining to the pipeline, water intake system, culvert installation and the concrete splash pad are provided in Section 3.1.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

2.6 WATER

2.6.1 Potable Water

Water will be withdrawn from the Char River during the months of June to September. The intake is located approximately 25 m upstream of the water intake pump. The intake consists of a floating structure, anchored in place during the months of June to September. Upon completion of the water extraction, the intake will be removed from the water, dismantled and stored in the sea canister housing the water intake pump.

Water withdrawal for the operations phase of the Project will be undertaken in accordance with the recommendations in the *Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada* (DFO 2013), which state that the withdrawal of less than 10 % of the instantaneous flow has a low probability of detectable impacts to aquatic ecosystems. In addition, the withdrawal operations phase will also adhere to the *Freshwater Intake End-of-pipe Fish Screen Guideline* (DFO 1995).

The total volumes of water to be pumped from the Char River to Nipissar Lake during the Project will likely increase as the community increases in size over time. For the purposes of the pipeline design, Stantec evaluated the water requirements based on the population of the community in 2030 (FSC 2010). As such, the volume to be withdrawn during the 2014 season is considerably less than what would be withdrawn later in the Projects' lifespan. Assuming a consumption rate of 344 L per person per day and a population of 2,859, Stantec has estimated that the maximum water volume required to meet community needs and prevent water decreases in the lake is 47,187 m³ in 2014. By 2030, the maximum water volume required is estimated to be 271,924 m³. As noted, these volumes will prevent water level decreases in Nipissar Lake; however, they will not provide for full replenishment of the lake.

The instantaneous stream flow rate of the river is highly variable throughout the summer months. Due to the absence of detailed hydrological field data and fisheries information, the maximum withdrawal rate for the 2014 pumping season will not exceed the maximum withdrawal criteria of 10 % of the instantaneous flow rate (DFO 2013). The instantaneous flow rate will be calculated by obtaining measurements of the water velocity, width and depth of the river. Upon calculation, the daily pumping rate will be modified as necessary to ensure the 10 % withdrawal rate is not exceeded.

The data collected during the 2014 pumping season would be used to develop a Withdrawal Plan for pumping activities conducted during subsequent years. The Withdrawal Plan will allow for the withdrawal activities to occur whilst ensuring the protection of fish and fish habitat in the river.

The procedures for operating the pump during the 2014 pumping season are outlined in the Operations and Maintenance (O&M) Plan provided in Appendix F.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

To reduce the potential for the entrainment and impingement of fish, the end-of-pipe intake screen consists of a screened perforated cylinder; with a screen mesh size of 2.54 mm as per DFO criteria (DFO 1995).

The outfall of the pipeline is located on the shoreline of Nipissar Lake. A prefabricated concrete splash pad, armored with riprap material, has been installed at the pipeline outfall location to prevent any erosion and/or sedimentation along the shoreline of Nipissar Lake during discharge.

2.7 WASTE WATER AND SOLID WASTE

Waste generated during the Project includes, but is not limited to:

- Domestic waste from workers general activities;
- Waste oil;
- Potential contaminated soil / snow;
- Waste water; and,
- Overburden and excavated material from culvert installation.

The wastes generated are described in further detail in the following sections.

2.7.1 Domestic Waste

Domestic wastes generated during the Project have been restricted to wastes generated by workers general activities (i.e. food waste). During the construction phase of the Project, all domestic waste was transported to Rankin Inlet daily and disposed of at the communities Solid Waste Facility. During the operation phase of the Project, personnel will be familiar with the required waste management procedures, outlined in the O&M Plan in Appendix F.

2.7.2 Used Oil / Waste Fuel

Used oil and waste fuel generated during the construction of the Project have been transported and disposed of at an approved disposal facility in Rankin Inlet (See Appendix E for the Spill Contingency Plan). During the operation phase of the Project, used oil and waste fuel will be disposed of in a similar manner.

2.7.3 Contaminated Soil

Contaminated soil was not generated during the construction phase of the Project; however, if encountered during the operation phase (i.e. during the fueling of the pump), contaminated soil will be disposed of at a suitable disposal facility in Rankin Inlet.

2.7.4 Waste Water

Waste water generated during construction included excavation intrusion water encountered during the installation of the culverts. The amount of water intrusion will vary based on the excavation location.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

During operations, waste water will include water discharged from the pipeline at the end of each pumping season (i.e., September); this will be released from a low point drain located at pipeline KM 1.020 (see Drawing C1 in Appendix A). The estimated volume of discharge water from the pipeline is approximately 127 m³ (127,000 L). The discharge will be limited by the discharge rate of the low point drain (which consists of a 0.075 m diameter HDPE pipe extending east of the pipeline towards Hudson Bay).

2.7.5 Overburden and Excavation Material

Upon completion of the culvert installation, any remaining granular material was removed from the Project Area. The disposal location of this material could not be confirmed.

2.8 FUEL

Diesel fuel was used during the construction phase of the Project for heavy equipment. No information on the handling practices during the construction phase was available.

Diesel fuel will also be used during the operations phase of the Project for the operation of the water intake system. Fuel will be transported to the pump area via the existing access road. The designated re-fueling location at the pump area will be determined by Project personnel. Due to the logistical constraints, the re-fueling location will be required to be within approximately 25 m of the ordinary high water mark of the Char River; however, fuelling will only be performed via hand pump or electrical pump over drip trays. During the operation of the pump, a drip tray will be used under the pump to catch any fuel drips. Due to the close proximity of the Char River, the drip tray will have a minimum volume of 110 % of the volume of the fuel tank on the water intake pump.

Spill response equipment, including sorbent pads and booms, will be located inside of the sea canister located at the intake area. Prior to the commencement of pumping each year, a pre-operation inspection of the water intake pump will be completed by a qualified mechanic. During the operation of the pump, personnel will monitor equipment to ensure that the equipment is properly maintained and is in good working condition to reduce the potential for leaks.

A Spill Contingency Plan for the operations phase of the Project has been developed for the Project and is included in Appendix E.

2.9 CHEMICALS AND HAZARDOUS MATERIALS

Chemicals and hazardous materials may have been used during the construction phase of the Project for heavy equipment. No information on the handling practices during the construction phase was available.

Chemicals and hazardous materials used during the operations phase of the Project will primarily include oils and lubricants for the water intake pump; it is estimated approximately 10 L per year

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

General Project Description
May 2014

will be required over the life of the Project. All oils and lubricants for the Project will be transported to the pump by Project personnel on an as needed basis; therefore, no chemicals and hazardous materials will be stored at the water intake pump location.

Oils and lubricants will be transferred via hand into the equipment during regular equipment maintenance. This will occur over spill pads or drip trays.

2.10 WORKFORCE AND HUMAN RESOURCES

In 2012, Oomilik Enterprise Ltd, a qualified contractor with expertise in the installation of the pipeline, was contracted by the GN-CGS to execute the Project. The pipeline was constructed using local labour and equipment mobilized to Site via the existing access road. Operation of the pipeline will be completed using personnel from Rankin Inlet.

2.11 PUBLIC INVOLVEMENT / COMMUNITY KNOWLEDGE

To date, parties consulted for this Project include the Hamlet of Rankin Inlet, and community members in Rankin Inlet. The following is a summary of the formal and informal consultation that has occurred in relation to the Project.

One community meeting was completed on September 29, 2010 with representatives from the GN-CGS. The purpose of this meeting was to discuss the proposed pipeline alignment and review potential water intake locations. Community members expressed concern regarding the location of the pipeline, as it crossed a primary snowmobile route. No concerns were expressed regarding the proposed water intake location at the Char River.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Project Specific Information
May 2014

3.0 Project Specific Information

As discussed in Section 1, the Project includes the construction and operation of a 4.05 km water intake pipeline extending from the Char River to Nipissar Lake. The Project consists of a municipal activity and is therefore considered as a public business type.

3.1 DESCRIPTION OF PROJECT

3.1.1 Site Preparation

Site preparation activities prior to the start of the construction activities were restricted to the clearing of debris along the pipeline alignment. During the operations phase of the Project, grading of the water pump area will be completed. The grading activities on the existing municipal access road are part of the GN-CGS' Water License (3AM-GRA1015).

3.1.2 Culvert Installation

As discussed in Section 2.5, the two culverts installed at the access road locations consisted of 600 mm diameter corrugated steel pipes approximately 20 m and 50 m in length. The culverts were installed where the municipal access road intersected the pipeline alignment, at approximately KM 0.57 and KM 3.75 of the pipeline. To install the culverts, the access road was excavated to its base. Approximately 0.15 m of gravel was then placed in the excavation, graded to have a 1 % minimum grade, and then compacted to a 95 % Standard Proctor Density (SPD; see Drawing C8 in Appendix B). One 600 mm culvert was then placed atop of the compacted material, with the culvert outlet approximately 0.05 m above the base of the excavation. The excavation was then backfilled by hand with a 0.3 m lift of granular material and compacted. The succeeding layers consisted of 0.2 m lifts of granular material backfilled and compacted using heavy equipment. The top 0.25 m was compacted to 100 % SPD using Type 1 granular material.

Surface and ground water intrusion into the excavations were reduced as much as possible during the excavation activities. (i.e. completing the Project activities during the fall when water levels were low). Intrusion water was not reported to have been encountered during the construction activities.

A third culvert was installed under the access road located at KM 2.475 to promote surface water drainage under the access road and pipeline to an area of ponded water located west of the access road. Construction activities occurred during September 2012, a dry time of year, therefore it is unlikely that any surface water was encountered during the culvert installation. The installation of the culvert and the backfilling/compaction activities were the same as the previous culverts.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Project Specific Information
May 2014

3.1.3 Winter Access Trail

As discussed in Section 2.3, a temporary winter access trail was required to mobilize equipment, materials and personnel to the Site during the winter construction activities (November 2012 to December 2012). The winter access trail connected to the existing municipal roads near the Site.

Construction of the winter road occurred once the ground was frozen and there was sufficient snow cover to protect the ground from the tracks of vehicles. A minimum of 0.1 m of compacted snow was in place prior to the use of heavy equipment on the winter access trail. The snow was pre-packed to reduce the disturbance on the ground surface. As the winter access trail followed the pipeline alignment, no water bodies were crossed by the winter access trail.

3.1.4 Pipeline Installation

The 4.05 km pipeline was constructed of 200 mm HDPE piping; each pipe having a length of approximately 15 m. The pipeline was secured to the ground surface every 50 m using galvanized steel rods, installed a minimum of 0.5 m into the ground. Two high point releases were constructed at KM 0.275 and KM 3.825. To facilitate draining of the pipeline at the end of the season, one low point drain was installed at approximately KM 1.025. The low point drain consisted of a 75 mm HDPE drain line leading from the pipeline; protected by a circular galvanized steel case.

The pipeline installed in September 2012 included the sections from:

- Two sections of pipeline installed inside of the culverts located under the access road at KM 0.575 and KM 3.750
- Granular material cover area #1 – extending from approximately KM 0.450 and KM 0.555
- Granular material cover area #2 - extending from approximately KM 0.615 and KM 0.755

All other sections of the pipeline were installed in November 2012.

3.1.5 Pipeline Granular Cover

As discussed in Section 1.1, portions of the pipeline in vicinity of the snowmobile trail were covered with granular material consisting of well graded natural sand. Approximately 0.5 m of granular material was placed in two locations along the pipeline including between approximately KM 0.450 and KM 0.555, and between approximately KM 0.615 and KM 0.755 in September 2012. The level of compaction completed was to 90 % SPD. The granular material was sloped to a minimum 2:1 horizontal to vertical ratio to prevent wind and water erosion.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Project Specific Information
May 2014

3.1.6 Water Intake System

As discussed in Section 2.5, a water intake system was installed approximately 25 m east of the Char River. The system was installed in 2012 in a previously disturbed area at the old bridge abutments at the end of an existing municipal access road (Drawing C1 in Appendix A).

The water intake system includes the intake pump, intake pipeline and the screened water intake and is located within a sea canister. A chain link fence with a vehicle gate surrounds the sea canister providing security and vandalism protection.

The intake pump consists of a trailer mounted four cylinder 75 horsepower diesel powered generator, with a maximum pumping capacity of 0.04 m³/s. During the pumping season (June to September), the pump will be connected to a 50 m HDPE reinforced intake line with a diameter of 0.15 m. The intake line has an end-of-pipe screened water intake which is inserted into the Char River during pumping to comply with DFO intake screen guidelines. The water intake is supported in the river by a floating structure, which is removed from the water upon the completion of the seasonal pumping activities.

The duration of the pumping activity will be dependent on the total volume of water required for that year. As noted in Section 2.6.1, Stantec has estimated that 47,187 m³ of water will be required to be pumped during the summer of 2014 to meet the community needs and prevent decreases in the water level of Nipissar Lake. Based on the pumping rate of 0.04 m³/s, the duration of pumping will span over approximately 14 days, with the pump operating 24 hours a day. Later in the project life, in 2030, the pump will need to operate for approximately 79 days if current water use projections remain valid and the 10 % maximum volume extraction from the Char River is maintained. Modifications in water useage and/or the water withdrawal rate would influence the duration of the pumping season.

Upon completion of the seasonal pumping activities, the intake pump, intake pipeline and the screened intake will be stored within the sea canister. An Operations and Maintenance (O&M) Plan detailing the procedures associated with the operation and maintenance of the water intake system is provided in Appendix F.

3.2 RAW CONSTRUCTION MATERIALS

Raw materials used during construction include granular material sourced from the community borrow pit located in Rankin Inlet. The granular materials were transported by dump truck and or excavator.

The pipeline materials (including the HDPE piping material, connectors, pump, etc.,) were sourced from a supplier in southern Canada. The materials were shipped to Rankin Inlet via barge during the summer of 2012.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Project Specific Information
May 2014

3.3 SAFETY

Employee Safety Training

All Project personnel on-site during the construction phase of the Project were required to wear the appropriate personal protective equipment (PPE) (i.e., hard hats, steel-toe boots, reflective vests and appropriate clothing), and work with a buddy system (not alone). Safety meetings were held during the Project. The purpose of these meetings were to inform the staff of the Project tasks, potential hazards, mitigation measures, required PPE and emergency procedures.

As the operation of the pipeline will be completed by GN-CGS, the health and safety training will follow their requirements.

Fire Extinguishers

During the construction of the pipeline, fire extinguishers were located inside of the work vehicles at the Site. Prior to the commencement of each pumping season, a fire extinguisher will be installed inside of the sea canister. Upon completion of the seasonal pumping activities, the fire extinguisher will be removed (as it may freeze). No other firefighting equipment will be installed during the Project.

3.4 NOISE

Noise sources associated with the Project are limited to the use of heavy equipment and the water intake pump. Mitigative measures are discussed in Section 5.4.

3.5 GASEOUS EMISSIONS AND ODORS

The gaseous emissions and odors associated with the Project are confined to emissions from heavy equipment and the operation of the water pump. Mitigative measures are discussed in Section 5.4.

3.6 RADIATION SOURCES

No radiation sources are associated with the Project.

3.7 BULK STORAGE FACILITY AND QUARRY DEVELOPMENT / PIT DEVELOPMENT

The construction of a Bulk Storage Facility is not included in the Project. In addition, no quarry or pit development was associated with this Project

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

4.0 Existing Environment

4.1 PHYSICAL ENVIRONMENT

4.1.1 Terrain

The Project Area (including the Project Footprint plus a 1 km buffer) is located within the Maguse River Upland ecoregion of the Southern Arctic Ecozone. The terrain in this area consists predominantly of broadly rolling uplands and lowlands, with interspersed long flowing eskers, lakes, ponds, and wetlands (ESWG 1995).

Bedrock geology in the Project Area is principally of Precambrian granitic origin, which is exposed in many parts of the region. On the surface, hummocky outcrops are dominant, with discontinuous coverings of acidic, sandy, and granitic tills (ESWG 1995). Soils in this area are mainly turbic crysol type soils, with underlying continuous permafrost and medium ice content (ESWG 1995). Permafrost lies within 2 m of the ground surface, and soils of this nature show marked evidence of cryoturbation within the active layer, as indicated by disrupted or mixed horizons, or displaced material (SCWG 1998). These soils are well to moderately well drained (SCWG 1998).

The Project Area consists of undulating terrain with elevations ranging between approximately 8.5 m above sea level (masl) to approximately 29 masl.

4.1.2 Climate

Within the Maguse River Upland ecoregion, climate is classified as a low-arctic ecoclimate, with long cold winters and short cool summers (ESWG 1995).

The weather station nearest the Site is located at the Rankin Inlet airport, approximately 1.7km southeast of the Site. Climate normal data for Rankin Inlet, over the period from 1981 to 2010 are provided in Table 4-1.

Table 4-1 Climate Normal over the Period 1981 to 2010 at Rankin Inlet, NU (EC, 2014)

Month	Mean Daily Temperature (°C)	Minimum Daily Temperature (°C)	Maximum Daily Temperature (°C)	Total Precipitation (mm)	Total Rainfall (mm)	Total Snowfall (mm)
January	-30.8	-34.4	-27.3	8.7	0	8.9
February	-29.9	-33.6	-26.1	8.2	0	8.5
March	-25	-29.2	-20.6	12.3	0	12.5
April	-15.6	-20.1	-11.1	19.9	1.1	19.2
May	-5.8	-9	-2.4	19.5	7	13
June	4.2	0.5	7.9	26.6	22.1	4.6

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Table 4-1 Climate Normal over the Period 1981 to 2010 at Rankin Inlet, NU (EC, 2014)

Month	Mean Daily Temperature (°C)	Minimum Daily Temperature (°C)	Maximum Daily Temperature (°C)	Total Precipitation (mm)	Total Rainfall (mm)	Total Snowfall (mm)
July	10.5	6.1	14.9	42	41.9	0.1
August	9.7	6.2	13.1	57.4	57.2	0.2
September	3.8	1.3	6.3	42.9	39.1	3.8
October	-4.6	-7.3	-1.9	38	12.9	25.5
November	-17	-20.9	-13	21.7	0.3	22.4
December	-25.7	-29.4	-21.9	12.8	0.1	13.3
Annual	-10.5	-14.2	-6.9	310.1	181.8	131.9

4.1.3 Hydrology and Water Quality

The Project Area lies within the Western Hudson Bay Freshwater Ecoregion within the greater Hudson Bay watershed (Burridge and Mandrak 2013). Lakes in this region are characteristic Canadian Shield lakes with irregular shorelines and clear and deep waters that are frozen in the winter and thaw in the summer. The water bodies associated with the Project, the Nipissar Lake and the Char River, are discussed in greater detail below.

4.1.3.1 Nipissar Lake

A bathymetry and topographical survey of Nipissar Lake was completed in 1995 by Vista Engineering; the results indicated that the volume of the lake was 3,469,780 m³ (FSC 2010). In 2011, the Geological Survey of Canada completed a bathymetric survey of Nipissar Lake. the GSC study concluded that Nipissar Lake covers an area of 0.966 km², a depth of 6.9 m, and an approximate volume of 2,860,000 m³ (Budkewitsch et al. 2011), a difference of approximately 609,780 m³. FSC and RMSi attributed to the decrease in lake volume to an increase in population and, consequently, water usage in Rankin Inlet (FSC 2010).

No information regarding the water quality of Nipissar Lake is available at this time. During the summer of 2014, water samples will be obtained from the lake to characterize water chemistry.

4.1.3.2 Char River

The Char River, originating at Char Lake, has a drainage area of 69.0 km² and deposits into Hudson Bay, located approximately 1.5 km southeast of Char Lake (Golder 2011). The river consists of a moderately meandering channel with river bed materials consisting of mainly gravels and cobbles (Golder 2011).

Previous hydrometric monitoring events have been limited but identified fluctuating flow measurements throughout the summer months (June to September); with peak flows occurring

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

at the height of the freshet followed by low flows during the remainder of the summer (Golder 2011). In 2000, AMEC identified that the river had an instantaneous flow rate of 12.5 m³/s at the peak of freshet in early June (AMEC 2000). However, the discharge of the Char River into Hudson Bay was determined to be variable, ranging from 9.45 m³/s at the height of the freshet to negligible flows in the fall (Golder 2011). The average flow at the peak of the freshet was 7.37 m³/s; with the peak flow of 9.45 m³/s recorded over a four day period. Upon completion of the freshet, flow rates dropped significantly to 0.131 m³/s. As discussed in Section 2.6.1, hydrological field data will be collected to characterize the flow, depth and width of the river over the summer. The data will be used to develop a Withdrawal Plan for water withdrawal during subsequent pumping events.

As part of the environmental impact assessment of the Agnico-Eagle Mines (AEM) Meliadine Gold Project, the water quality of the Char River was assessed in 2011 (Golder 2011). The analytical results adhered to the Canadian Council of Ministers of the Environment's (CCME) Canadian Water Quality Guidelines (CWQG), Health Canada's Guidelines for Canadian Drinking Water Quality, and Environment Canada's Freshwater Quality Indicators.

Table 4-2 Water Quality Conditions in Char River – Based on Water Samples Collected in July 2011 (Golder 2011)

Parameters ^a	Units	Results
Parameter	Units	Concentration
Conventional Parameters (Laboratory-Measured)		
Total Alkalinity	mg/L	27
Specific Conductivity	µS/cm	120
Total Hardness	mg/L	34.8
pH	pH	7.83
Total Dissolved Solids	mg/L	64
Total Suspended Solids	mg/L	<5.0
Turbidity	NTU	0.51
Major Ions		
Bicarbonate	mg CaCO ₃ /L	33
Calcium	mg/L	10.5
Carbonate	mg CaCO ₃ /L	<0.60
Chloride	mg/L	18.2
Fluoride	mg/L	<0.10
Hydroxide	mg/L	<0.40
Magnesium	mg/L	2.09
Potassium	mg/L	1.51
Sodium	mg/L	10.5
Sulphate	mg/L	4.99

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Table 4-2 Water Quality Conditions in Char River – Based on Water Samples Collected in July 2011 (Golder 2011)

Parameters ^a	Units	Results
Parameter	Units	Concentration
Nutrients		
Total Ammonia as Nitrogen	mg/L	<0.050
Nitrate+Nitrite as Nitrogen	mg/L	<0.071
Nitrate as Nitrogen	mg/L	<0.050
Nitrite as Nitrogen	mg/L	<0.050
Phosphorus, Total	mg/L	0.012
Others		
Biological Oxygen Demand (BOD)	mg/L	<1.0
Total Metals		
Aluminum (Al)	µg/L	11.4
Antimony (Sb)	µg/L	<0.2
Arsenic (As)	µg/L	0.32
Barium (Ba)	µg/L	14.5
Beryllium (Be)	µg/L	<0.2
Bismuth (Bi)	µg/L	<0.2
Boron (B)	µg/L	14
Cadmium (Cd)	µg/L	<0.01
Cesium (Cs)	µg/L	<0.1
Chromium (Cr)	µg/L	<1
Cobalt (Co)	µg/L	<0.2
Copper (Cu)	µg/L	1.19
Iron (Fe)	µg/L	<100
Lead (Pb)	µg/L	<0.09
Lithium (Li)	µg/L	<2
Manganese (Mn)	µg/L	3.2
Mercury (Hg)	µg/L	<0.05
Molybdenum (Mo)	µg/L	0.33
Nickel (Ni)	µg/L	<2
Rubidium (Rb)	µg/L	1.99
Selenium (Se)	µg/L	<1
Silicon (Si)	µg/L	231
Silver (Ag) µg/L <0.1	µg/L	<0.1
Strontium (Sr)	µg/L	55
Tellurium (Te)	µg/L	<0.2

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Table 4-2 Water Quality Conditions in Char River – Based on Water Samples Collected in July 2011 (Golder 2011)

Parameters ^a	Units	Results
Parameter	Units	Concentration
Thallium (Tl)	µg/L	<0.1
Thorium (Th)	µg/L	<0.1
Tin (Sn)	µg/L	<0.2
Titanium (Ti)	µg/L	0.55
Tungsten (W)	µg/L	<1
Uranium (U)	µg/L	<0.1
Vanadium (V)	µg/L	<0.2
Zinc (Zn)	µg/L	<5
Zirconium (Zr)	µg/L	<0.4
NOTES: a Data from samples collected by AEM, July 2011 µS/cm = micro seimens per centimetre; mg/L = milligrams per litre; µg/L = micrograms per litre; NTU = nephelometric turbidity units		

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Vegetation

The Southern Arctic Ecozone represents a major transition zone between the taiga forest to the south and the arctic tundra to the north. Specifically within the Maguse River Upland ecoregion, vegetation is characterized by a cover of shrub tundra vegetation (ESWG 1995). On warm and dry sites, dwarf birch (*Betula glandulosa*), willow (*Salix* spp.), and alder (*Alnus* spp.) tend to occur, whereas willow, sphagnum moss (*Sphagnum* spp.), and sedge dominate in poorly drained sites (ESWG 1995).

A field survey of the Project area has not been completed; however, it is assumed that it contains vegetation and landscape features that are typical of the regional conditions. Field surveys within proximity to the Project area (25 km northwest of Rankin Inlet) in 2011 for the Meliadine Gold Project, reported typical tundra-type vegetation, with a dominance of heaths, sporadic wetlands and riparian areas, as well as bare ground and rock outcrops (Golder 2011). A list of all vegetation species that might be present within the Project Area and their territorial status ranking is provided in Table D-1 in Appendix D.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

4.2.1.1 Rare Plant Species

A rare plant survey of the Project area has not been conducted. Results from a vegetation assessment completed in proximity to the Project Area, does not identify any territorially- or federally-listed rare plant species (Golder, 2011).

4.2.2 Wildlife

The following sections identify wildlife species (terrestrial and marine mammals) that are known or expected to occur in or near the Project Area (see Table D-2 in Appendix D for a complete list).

4.2.2.1 Terrestrial Mammals

There are approximately 36 terrestrial mammalian species that are known or expected to occur in Nunavut (CESCC 2011), and 21 species are known or expected to occur within the Regional Area (including the Project Footprint plus a 5 km buffer distance) area (Table D-2 in Appendix D). Of these 21 species, the barren-ground caribou (*Rangifer tarandus groenlandicus*), grizzly bear (*Ursus arctos horribilis*), and wolverine (*Gulo gulo*) are listed as of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and are discussed in further detail below.

4.2.2.1.1 Barren-ground Caribou

In Nunavut, 12 distinct herds are recognized (Nunami 2012). Annual home ranges mapped by the GN Department of Environment show that the Project Area lies within, or in close proximity to, the annual home ranges of the Qamanirjuaq and the Lorillard herds (Golder 2011). Barren-ground caribou are currently ranked as Secure in the territory (CESCC 2011) and the Qamanirjuaq and Lorillard herds are not listed by COSEWIC or the federal Species at Risk Act (SARA).

The annual range of the Qamanirjuaq herd occurs in Nunavut, southeastern Northwest Territories, northern Manitoba and northeastern Saskatchewan (Campbell et al. 2010). The Maguse River Upland Ecoregion, in which Rankin Inlet lies, is the dominant ecoregion making up much of the northern extent of the herds' range through May to August. Traditional calving grounds of the herd are entirely within this ecoregion (extending from Chesterfield Inlet south to Churchill, Manitoba) including much of the post-calving range and spring migration corridor (Campbell et al. 2010).

The Lorillard herd typically winter in the area north of Chesterfield and west of Baker Lake and the Back River (GN 2007). In April, they begin their spring migration by moving north, primarily spending their summer (including calving and post-calving) between Chesterfield Inlet and Wager Bay, around the Lorillard River, which lies approximately 180 km north of Rankin Inlet (GN 2007).

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

The most recent population estimates of the Qamanirjuaq and Lorillard herds were conducted in 2008 and 2003, respectively, and showed significant declines for both populations (Nunami 2012). Key limiting factors that may be particularly important in barren-ground caribou population declines are habitat loss (through displacement and/or habitat alteration), habitat degradation and fragmentation, increased hunting through increased access to sensitive ranges, and predation.

Barren-ground caribou are an important food source for residents of Rankin Inlet, and the Nunavut Wildlife Harvest Study (NWHS) reported an average harvest of 989 animals per year (Priest and Usher 2004).

4.2.2.1.2 Grizzly Bear

The western population of the grizzly bear has a range that extends throughout much of mainland Nunavut (COSEWIC 2012). The grizzly bear is currently ranked as Secure in the territory (CESCC 2011); however, the Western population is listed as Special Concern by COSEWIC, but is not listed under the SARA (SARAPR 2014). Population densities in the Kivalliq region are low (COSEWIC 2012) however the grizzly bear population in Nunavut, as a whole, was noted as increasing in 1999 at an annual rate of 3% (McLoughlin et al. 2003). The range of grizzly bear in Nunavut also appears to be expanding, though without further research it is unknown if this expansion is due to an increase in abundance or due to changes in movements or disturbances (COSEWIC 2012).

Grizzly bears are habitat generalists and occupy a diverse range of habitats throughout Canada. In Nunavut, grizzly bears can be found through the low Arctic tundra area (COSEWIC 2012), utilizing bedrock habitats, wetland areas with good cover, eskers, and mesic and mat tundra sites (Gau 1998). Habitat associations are strongly seasonal and generally reflect changes in the grizzly bear's environment and food source (i.e. regional plant phenology, and timing of spring ungulate calving) (Schwartz et al. 2003).

In Nunavut, grizzly bears typically den from October/November to April/May (COSEWIC 2012). Grizzly bears have been shown to prefer esker habitat in the Slave Geologic Province of the Northwest Territories and Nunavut, with dens typically occurring on well-drained slopes under cover of tall shrubs (greater than 0.5 m) (McLoughlin et al. 1999). However, the same study also showed the use of typical heath tundra habitat for denning, as well as birch seeps, tall shrub riparian areas, and spruce forest (McLoughlin et al. 1999).

4.2.2.1.3 Wolverine

In Nunavut, the wolverine is territorially ranked as Secure (CESCC 2011). However, the Western population is listed as Special Concern by COSEWIC, but is not listed under the SARA (SARAPR 2014). Population densities in Nunavut range from 'moderate' in the western portion to 'low' throughout the rest of the territory, which includes the Regional Area (including the Project Footprint and a 5 km buffer area) (COSEWIC 2003). The wolverine population in Nunavut is expected to be stable, though it is likely sensitive due to harvest pressures (COSEWIC 2003).

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Wolverine fur is valued in the Kivalliq Region, and residents of Rankin Inlet do harvest wolverine in small numbers annually (up to 15 animals per year) (Priest and Usher 2004). The majority of harvested Wolverine appears to be kept for domestic purposes rather than sent to auction however fur trade statistics appear to largely underestimate the total harvest in Nunavut (COSEWIC 2003). Wolverines utilize a variety of habitats, but specific denning habitats include boulders, under deadfall, rock outcrops, and wind-hardened snowdrifts (Magoun and Copeland 1998). Wolverine dens are generally built under 1 to 5 m of snow and consist of complex snow tunnels that lead to boulder fields, rock overhangs, or large cracks in rocks; these provide additional protection from predators and allow the kits to move around (Magoun and Copeland 1998). Denning females typically enter dens for the birthing season, which occurs in late winter (February to mid-March) and emerge in early spring (May) (Magoun and Copeland 1998). Females may re-occupy den sites or denning habitats for several consecutive years (Magoun 1985, Lee and Niptantiak 1996). Denning females are particularly sensitive to disturbance (Magoun and Copeland 1998) and disturbance can lead to den relocation or litter abandonment (COSEWIC 2003).

4.2.2.2 Marine Mammals

There are an estimated 13 marine mammalian species that are known or expected to occur within the marine waters of Nunavut (CESCC 2011). However, only polar bears (*Ursus maritimus*) are expected to occur within or near the Project Area. Polar bear are currently ranked as Sensitive in Nunavut (CESCC 2011), listed as Special Concern by COSEWIC, and are listed as Special Concern under the SARA on Schedule 1 (SARAPR 2014). The polar bear is discussed in further detail below.

Polar bears occur throughout coastal Nunavut, including all marine areas and Arctic islands. The Project area is situated within the range of the Western Hudson Bay sub-population (York 2012). In 2004, this sub-population was estimated at 935 bears and is considered to be decreasing due to changes in sea ice conditions, which impact body condition, survival, recruitment, and over hunting (Regehr et al. 2007, cited in COSEWIC 2008).

Currently, perspectives differ greatly between traditional ecological knowledge and scientific methods of population estimates, as there have been increased sightings of polar bears by Inuit along the western coast of Hudson Bay. An aerial survey covering the entire Western Hudson Bay summer retreat area was conducted in 2011, and preliminary results have confirmed Inuit knowledge that the population has not declined, and may have even increased (York 2012). These observations of increased abundance may be due to higher levels of bear activity in response to increased time spent on-shore in response to climate warming in the region. Regardless, it does appear that body condition, survival rate, and recruitment rates have declined, and the main population stressors of climate change and over harvesting will continue to affect the future of this subpopulation (York 2012).

In the Arctic, polar bear habitat is closely linked with that of the ringed seal (*Pusa hispida*), their main prey species. Typical habitat includes consolidated pack ice, areas adjacent to pressure

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

ridges, areas between first-year and multi-year ice floes, and at the floe edge between marginal and land-fast sea ice (Stirling et al. 1982, Kingsley et al. 1985, Stirling and Derocher 1993, Stirling et al. 1993, Ferguson et al. 2000). The distribution of bears in most areas changes with the seasonal cover of sea-ice; throughout the summer, polar bears tend to concentrate long the edge of persistent pack ice, unless they are pushed onto land due to lack of sea ice (COSEWIC 2008). If forced onto land, their habitat utilization is often dependent upon age group and sex; for example, males tend to displace females and cubs further inland, away from the coast (Stirling et al. 2004). While on land, some bears may rely entirely on their fat reserves and not consume any food over the summer period (Derocher and Stirling 1990). However, some may eat and bears have been observed to feed on berries, depredate waterfowl nests, and even take down caribou; whale carcasses can also attract large numbers of bears (COSEWIC 2008). In autumn, as the sea ice begins to form again, bears that were forced on land re-distribute themselves throughout their sub-population range (COSEWIC 2008). One major concern for polar bear management and human safety is the attraction of bears to garbage while they are on land (Lunn and Stirling 1985); therefore, acceptable waste management practices need to be implemented.

4.2.3 Avifauna

Of the over 250 avian species which are known or expected to occur in Nunavut, an estimated 44 avian species are known or expected to occur within or near the Project area; these species are listed in Table D-3 in Appendix D.

Six of the 44 species are recognized as non-migratory or resident in Nunavut; these include hoary redpoll (*Acanthis hornemanni*), snowy owl (*Bubo scandiacus*), common raven (*Corvus corax*), gyrfalcon (*Falco rusticolus*), willow ptarmigan (*Lagopus lagopus*) and rock ptarmigan (*Lagopus muta*). The remaining 38 species are migratory and may breed in or near the Project area, depending on habitat requirements (Cornell, 2008).

Of the 44 avian species which may be found within or near the Project area, eight (8) are listed as Sensitive in Nunavut. Peregrine falcon *anatum/tundrius* (*Falco peregrinus anatum/tundrius*) is listed as Special Concern by COSEWIC and is also on Schedule 1 of the SARA (SARAPR 2014), though it is considered Secure in the territory (CESCC 2011). The Peregrine falcon is discussed in further detail below.

4.2.3.1 Peregrine Falcon

This species was originally evaluated by COSEWIC as three separate subspecies: *anatum*, *tundrius*, and *pealei*, however genetic evidence now shows that the *anatum* and *tundrius* subspecies are the same (COSEWIC 2007).

Between the 1950's and 1970's, the Peregrine Falcon population underwent a significant decline primarily due to the rising use of pesticides (e.g., DDT), which is known to cause eggshell thinning and subsequently egg mortality in birds (COSEWIC 2007). Since the mid-1970's however, when organochlorine pesticides were banned in Canada and the United States, there has been a

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

decrease in the levels of these pesticides in bird tissues and consequently the number of nesting pairs has increased (COSEWIC 2007). In early 2007, COSEWIC down listed the Peregrine falcon from Threatened to Special Concern, and it was also removed from the SARA registry. In April of 2012 however, an order was submitted to have the Peregrine Falcon added to Schedule 1 after multiple consultations by the Nunavut Wildlife Management Board were conducted within communities in Nunavut. This resulted in the peregrine falcon being placed on Schedule 1 of the SARA registry, and being given a species of Special Concern designation (SARA 2012).

The Peregrine falcon, much like many other species of raptors, is considered a valuable indicator of the environment. Rankin Inlet has been a site of long-term research concerning peregrine falcons, initiated in 1980. The falcons in this area have been monitored by government biologists and universities since 1980, resulting in a long-term database describing peregrine diet, organochlorine levels, turnover, recruitment, behavior, and population dynamics (Golder 2011).

Peregrines in this area have been observed to nest on both cliffs and boulders, but generally near substantial water bodies, both freshwater and saltwater, with the nests ranging in height from 4 m to 26 m from the ground (Court et al. 1988a). 22 nests were reported to exist within the Rankin Inlet area in 2000, and over 400 nest sites have been reported in Nunavut as a whole (COSEWIC 2007). In 1998, one raptor nest was observed on an unnamed lake approximately 950 m west of the intake area (Golder, 2011).

Small mammals, including lemmings and juvenile Arctic ground squirrels, can make up an important portion of a Peregrine Falcon's diet though they have also been shown to consume ptarmigans, shorebirds, and small songbirds in tundra areas (COSEWIC 2007).

4.2.4 Fisheries

4.2.4.1 Fish and Fish Habitat

Fish habitat use found within or potentially affected by the Project is largely dependent on the presence of permanent flow.

Richardson et al. (2001) reported on 46 freshwater fish species utilizing Canadian Arctic riverine systems, and Evans et al. (2002) reported on 45 species of freshwater fish utilizing lacustrine environments. As the Project area lies inland and is predominantly terrestrial, only freshwater anadromous fish species are evaluated.

Limited fisheries inventory or fish habitat information is available for the Project area specifically, but there are an estimated 24 freshwater fish known or expected to occur within Nunavut (CESCC 2011). A list of freshwater fish species known or expected to occur in Nunavut is provided in Table D-5 in Appendix D.

Three species are listed as Sensitive within Nunavut, including Arctic char (*Salvelinus alpinus*), Arctic grayling (*Thymallus arcticus*), and Arctic cisco (*Coregonus autumnalis*). Currently, no species are listed by COSEWIC or given status under SARA occur in the Project Area.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Rankin Inlet lies within the Western Hudson Bay freshwater ecoregion, which spans from northeast Saskatchewan, northern Manitoba, southeastern Northwest Territories, and much of the mainland of Nunavut and is typically of a boreal assemblage (Burrudge and Mandrak 2013).

The fish fauna of this ecoregion include more primary species such as northern pike (*Esox lucius*), walleye (*Sander vitreus*), and Arctic char (*Salvelinus alpinus*) than it does of secondary species such as cisco (*Coregonus artedii*) and lake trout (*Salvelinus namaycush*) (Burrudge and Mandrak 2013).

Electrofishing of the Char River was conducted in 1998 and 2000 as part of the Meliadine *All-weather Access Road Project Description and Environmental Assessment* (Golder, 2011). During these fishing events, five species were identified including Arctic grayling, round whitefish (*Prosopium cylindraceum*), ninespine stickleback (*Pungitius pungitius*), threespine stickleback (*Gasterosteus aculeatus*), and slimy sculpin (*Cottus cognatus*). Members of the Rankin Inlet HTO confirmed that Arctic char have not been caught in the Char River for several decades. Although Arctic char were not observed, the connection to potentially fish-bearing lakes upstream and the proximity to the Hudson Bay, the Char River may provide a migration route and may also have suitable fish habitat for spawning, rearing, and food supply. Fish assessments of Lower Landing Lake and Nipissar Lake were not completed as part of the Meliadine project.

For the purposes of this environmental screening, only the three species listed as Sensitive within the Nunavut Arctic char and Arctic grayling will be discussed below.

4.2.4.1.1 Arctic Char

Within the Rankin Inlet area, Arctic char are an extremely valuable commercial and cultural species, while also being sought out by anglers and for subsistence purposes (Nunami 2012). These fish exhibit anadromous¹ and lacustrine² life history types, although between Hudson Bay and its tributaries, and at most northern latitudes, these fish are predominantly anadromous (Richardson et al. 2001). Unlike some other salmonids, Arctic char undergo a yearly migration, returning repeatedly to spawn and overwinter in fresh water. However, individuals rarely venture far from the mouth of their home rivers when they are in the ocean (Hebert 2002). This species can occur in rivers, lakes, estuaries, and marine environments, and are known to spawn during September or October choosing shallow waters (less than 2.0 m in depth) of rivers and lakes, on substrates such as cobble and gravel (Richardson et al. 2001).

Arctic char populations in Nunavut are considered to be healthy and very abundant (Nunami 2012), however population stressors do exist, and should be mitigated properly to ensure these fish populations remain intact. In particular, special consideration for their critical spawning, rearing, and overwintering habitat is essential (Nunami 2012).

4.2.4.1.2 Arctic Grayling

1 migrating from salt water to spawn in fresh water (Random House Kernerman Webster's College Dictionary, © 2010)

2 living in, or growing in lakes (Random House Kernerman Webster's College Dictionary, © 2010). Also named landlocked

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

Commonly found in the clear waters of large cold rivers, streams and lakes throughout the north the Arctic grayling populations exhibit a wide variety of life history types, including fluvial³, adfluvial⁴, and lacustrine (Hebert 2002).

Arctic grayling spawn in the spring when ice first breaks up, usually from April to June, in both rivers and lakes and use streams as migration corridors from one lake to another (Stewart et al. 2007). Adult Arctic grayling from the fluvial populations migrate from lakes and larger rivers into smaller streams to spawn over gravel or rocky bottoms. Juveniles remain in their natal stream for up to 15 months, then begin yearly migrations between their natal stream and overwintering habitat. Not all juveniles remain in their natal stream feeding however as Arctic grayling can also move to other areas of the river system. Adfluvial populations use the same habitat for spawning as do fluvial populations.

4.3 SOCIOECONOMIC ENVIRONMENT

4.3.1 Local Economy and Traditional Land Use

The population of Rankin Inlet was last estimated in 2011 at 2,717, an 8.30 % change in population from the last estimate in 2006, at 2,358 (StatsCan 2012). The unemployment rate is 10.2 %, with the sales and service sector being the dominant type of employment of the total experienced labor force in Rankin Inlet, providing approximately 26 % of the current employment (StatsCan 2012). Occupations in business services and trades are the second and third greatest occupation types in Rankin Inlet, retaining approximately 19 % and 16 % of the total experienced work force, respectively (StatsCan 2012).

Rankin Inlet is the second largest community in Nunavut, and is the capital of the Kivalliq region, serving as an important government and transportation regional centre. Tourism opportunities in Rankin Inlet and the surrounding area include outfitter hunting for caribou, wildlife watching, and access to Ukkusiksalik National Park, which is located south of the community.

Species typically harvested within the Rankin Inlet area include caribou, arctic fox, wolf, seals (with the majority being ringed seals), and ptarmigan (NWMB, 2004). Arctic char are also an important species harvested by residents in the area, as well as within Nunavut as a whole. Approximately 80 % of Nunavut's char fishery is utilized in the domestic economy, with only 20 % of the harvest going to the commercial industry (Brubacher 2004).

4.3.2 Heritage Resources

To prepare a review of the archaeological sites in relation to the Project, a site file search was requested from the Government of Nunavut's Department of Culture and Heritage.

3 relating to, or occurring in a river (Collins Discovery Encyclopedia, 1st edition © HarperCollins Publishers 2005)

4 Migrating between lakes and rivers or streams (McGraw-Hill Dictionary of Scientific & Technical Terms, 6E, Copyright © 2003)

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Existing Environment
May 2014

The file search confirmed that there are no known archaeological sites present at the intake area, along the pipeline alignment or at the discharge location. The five closest archaeological sites to these areas include the following sites:

1. KfJm-46, a site of unknown cultural affiliation that contains a house ring and is over 250 m from the pipeline;
2. KfJm-47, a site of unknown cultural affiliation that contains two tent rings and is over 400 m from the pipeline;
3. KfJm-7, a site of unknown cultural affiliation that contains two tent rings and a possible fox trap and is approximately 600 m from the pipeline;
4. KfJm-194, an indigenous historic Inuit site that contains a fox trap, a stone marker and a tent ring, and is approximately 600 m from the pipeline; and,
5. KfJm-45, a site of unknown cultural affiliation that contains multiple stone features and is over 700 m from the pipeline.

Based on the desktop review, no known archaeological sites will be impacted by the Project.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

5.0 Identification of Effects and Proposed Mitigation

This section describes the potential effects of Project activities on Valued Components (VCs), identifies mitigation measures to reduce, control or eliminate the effects, and presents the residual effects following application of mitigation measures. The assessment of potential effects has been completed using the standard methodological framework developed by Stantec to meet the requirements of the *Nunavut Land Claims Act* and other environmental legislation, as well as the NIRB's *Proponent's Guide* (Draft 2; NIRB 2013a).

Potential environmental effects were identified through the community consultation and a review of literature. The Project activities are confined to the intake area, the pipeline alignment and the discharge area.

5.1 BOUNDARIES

Spatial boundaries consider the geographic extent over which the Project activities and their effects are likely to occur. The spatial scope of the Project was evaluated at three scales: the Project Footprint, the Project Area, and the Regional Area. The Project Footprint represents the areas of physical disturbance associated with Project activities at the water intake area, pipeline alignment and the discharge area at Nipissar Lake. The Project Area includes a 1 km buffer around the Project Footprint while the Regional Area includes a 5 km buffer around the Project Footprint.

The temporal boundaries are defined based on the timing and duration of the Project environmental effects in relation to each VC. The temporal boundaries of the Project include the construction, operation, and decommissioning activities. Although, the construction activities have already occurred (during 2012), the operations and decommissioning phases of the Project have yet to begin. The operations phase will consist of seasonal operation (June to September) for an indeterminate duration. Therefore, the timing of the decommissioning phase is uncertain.

5.2 VALUED COMPONENTS

A VC is defined as an environmental, social, economic or cultural component that is considered important by the proponent, local communities, technical specialists and/or government. The assessment of Project effects on VCs provides an indication of Project effects on broader environmental and social conditions. Similarly, mitigation measures for Project effects on VCs provide protection for the broader environmental and social systems that they represent. The VCs in relation to the Project were selected based on:

- Sensitivity to Project effects
- Importance to local communities and resource users
- Territorial, national or international importance (include status under the SARA)
- Value as an indicator of effects on related resources and broader systems.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Candidate VCs were identified for the Project based on the environmental overview and community consultation, with the final VCs selected based on their potential to be affected by Project activities. In this study, candidate VCs were excluded if they did not overlap temporally or spatially with the Project, or if there was no, or negligible, potential for the Project to affect them.

Selected VCs and the rationale for selection are provided in Table 5-1, while their potential Project interactions are described in Table 5-2. Potential effects and selected mitigation measures for each VC are discussed in Section 5.4 via Table 5-3.

Table 5-1 Valued Components in the Project Area and Rationale for Selection

Valued Component	Rationale for Selection
Physical	
Terrain, Soils and Permafrost	- Links to other ecosystem components, e.g. soil quality, surface water, vegetation and infrastructure - Construction and operation activities have the potential to affect terrain characteristics, soil capabilities and permafrost
Soil Quality	- Soils are components of vegetation and wildlife habitat - May be affected by Project activities
Atmospheric Environment	- Project activities will result in emissions that could affect ambient air quality in the surrounding area - Potential changes in ambient sound levels
Water Quality and Quantity	- Project activities may cause changes to surface water drainage in the Project Footprint - Project activities will require water withdrawal reducing water quantity - Project activities may produce water of degraded water quality - Project activities may cause erosion and sedimentation, and/or introduction of a deleterious substance (as a result of accidental spill or discharge)
Biological	
Vegetation	Project activities may result in localized impacts to species distribution and abundance of vegetation.
Mammals, including: - Barren-ground caribou - Grizzly bear - Wolverine - Polar bear	- Potential sensory disturbance during all Project phases - Potential for bears to interact with personnel during operation phase of the Project. - Potential mortality risk from vehicle and equipment collisions
Avifauna, including: Peregrine falcon	- Potential habitat loss for nesting or migrating birds from the construction of Project facilities (e.g. pipeline, pump area, discharge location, etc.,) - Potential sensory disturbance of nesting or hunting areas during all Project phases - Potential mortality risk from vehicle and equipment collisions
Fish and Fish Habitat for species including: - Arctic char - Arctic grayling	- Potential for increased erosion, sedimentation, and the introduction of a deleterious or toxic substance resulting in reduced fish habitat quality or fish health - Potential for changes in mortality risk caused by the screened intake in

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-1 Valued Components in the Project Area and Rationale for Selection

Valued Component	Rationale for Selection
	- the Char River - Potential for loss of habitat and impedance of fish movement associated with the water withdrawal activities
Socioeconomic	
Local Economy	- Potential employment during all Project phases - Potential business opportunities during all Project phases
Public Health	- Potential effect to drinking water quality - Positive effect due to the increase in potable water supply for community growth and development
Traditional Land Use	- Noise and vehicle movements from Project activities may temporarily change distribution of harvested species through avoidance and may affect personal enjoyment of the land - Potential effect on fishing activities within the Char River
Archaeological and Heritage Resources	Potential effect to unknown heritage resources of cultural, archaeological, and/or historical significance

5.3 PROJECT INTERACTIONS WITH VALUED COMPONENTS

A summary of potential Project interactions with VCs is presented in Table 5-2. This table identifies which Project component may affect the VC, and sets the context for further discussion regarding the potential effects and mitigation measures used to reduce these effects (Section 5.4).

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-2 Project Activity – Valued Component Potential Interaction Matrix

Project Activity	VC												
	Terrain Stability and Permafrost	Soil Quality	Atmospheric Environment	Water Quantity	Water Quality	Vegetation	Mammals	Avifauna	Fish Populations and Fish Habitat	Local Economy	Public Health	Traditional Land Use	Archaeological and Heritage Resources
Construction													
Mobilizing Equipment to the Project Area			M				M	M		P			M
Site preparation including grading of the Intake Pump Area	M	M	M		M		M	M	M	P			M
Construction of temporary winter access trail	M		M			M	M	M		P			M
Construction of pipeline	N/M	M	M			N	M	M		P		P	M
Installation of granular cover material	N/M		M			N	M	M		P		P	M
Culvert installation	M		M	M	M		M	M	M	P			M
Installation of water intake system			M	M	M		M	M	M	P		U	M
Concrete pad installation at Nipissar Lake			M		M	N	M/U	M/U		P		U	M
Equipment re-fueling		M			M	M	M/U	M/U					
Operation													
Seasonal water withdrawal activities			M	M	M		M	M	M	P	P		
Equipment re-fuelling		M			M	M			M				M

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-2 Project Activity – Valued Component Potential Interaction Matrix

Project Activity	VC												
	Terrain Stability and Permafrost	Soil Quality	Atmospheric Environment	Water Quantity	Water Quality	Vegetation	Mammals	Avifauna	Fish Populations and Fish Habitat	Local Economy	Public Health	Traditional Land Use	Archaeological and Heritage Resources
Closure													
Culvert removal (only culverts under the access road)	M		M	M	M		M	M	M	P			M
Contouring of disturbed areas to match natural grades	M		M			P	M	M		P			M
Construction of the temporary winter access trail to remove pipeline	M		M			M	M	M		P			M
Excavation of granular cover from atop pipeline	M		M			M/P	M	M		P			
Removal of pipeline	M		M			M/P	P	P		P			
Equipment re-fuelling		M			M	M			M	P			
NOTES: As per the NIRB's PSIR tables, the above lettering denotes the following: P = positive effect N = negative and non-mitigable M = negative and mitigable U = unknown If cell is left blank, no impact is expected													

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

5.4 EFFECT ASSESSMENT AND MITIGATION

The following section describes the potential effects on VCs and the proposed mitigation measures to reduce, control, or eliminate the effects. The mitigation measures provided in Table 5-3 will be implemented for the protection of the VCs identified in Section 5.2.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation

May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
Terrain Stability and Permafrost			
Disturbance of vegetation and surficial materials may increase the active layer depth and causes melting of ground ice within the near surface materials resulting in ponding of water, erosion, thaw settlement and mass movement on slopes.	• Avoidance of steep slopes, areas of thaw sensitive terrain (e.g., polygons, ice-rich ground, wetlands). • Restricting activities completed in undisturbed areas prior to freeze up to sections of the pipeline requiring the placement of cover material (in the vicinity of the snowmobile access route) and in the vicinity of the two access roads (where excavation was required to facilitate pipeline installation). • Completed remaining construction activities in undisturbed areas when the ground was frozen. • Granular materials used were not frozen to reduce the potential for excessive settlement, slope failures and surface water ponding. • Build-up and pre-packing of snow on the winter access trail to a minimum of 0.10 m thickness to protect the underlying ground and vegetation. • Project activities were restricted to designated work areas and existing access roads, where practical.	• Annual monitoring of the Project facilities will be undertaken to determine the presence of potential issues including surface water ponding, slumping, etc., of granular material.	• Decommissioning activities to be completed when the ground is frozen to reduce rutting • Repair any areas of disturbance attributed to the construction or operation phases of the Project.
The ponding of water in low-lying areas may lead to permafrost degradation	• The low-point drain has been constructed in an area that is slightly sloped east, towards Hudson Bay allowing for gradual drainage; to reduce water ponding.	• Discharge rates from the pipeline will be monitored daily by GN-CGS staff; with alterations made to the flow rate depending on the presence of ponding and/or erosion.	• Not Applicable
Admixing and compaction of surface soil, and overburden may	• The culvert excavations were backfilled with the excavated material.	• Not Applicable	• Not Applicable

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
result in reduced quality soils, and hence issues with natural site re-vegetation	Where surface soils were present, they were salvaged and returned to the surface of the affected area.		
Soil voids formation after backfilling of the culverts resulting in water and ice becoming trapped into the soils, affecting the local thermal regime and resulting in subsidence	Not Applicable	If determined necessary during the annual monitoring events, additional fill may be used where the excavations are required in ice- or water- rich soils.	Not Applicable
Soil Quality			
Accidental release of fuel during Project resulting in degraded soil quality	Storage of fuel was not reported to have been present at the Project Area.	- Storage of fuel will not be located at the Site during the operations phase - All refueling and servicing of equipment will be restricted to designated areas. - Regular inspections of all machinery used will be completed to reduce the risk of a spill by identifying and correcting potential equipment failures. - Emergency spill kits will be kept inside of the sea canister at the intake area. - Development and implementation of Project-specific Spill Contingency Plan (SCP) (Appendix E).	Storage of fuel or other hazardous materials will not be located at the Site during the decommissioning phase
Air Quality			
Release of air contaminants	All equipment complied with Nunavut (i.e., GN 2011d) and Canadian emissions regulations.	Follow best practices to reduce vehicle/equipment exhaust emissions, including ensuring equipment are	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
		maintained regularly, properly muffled, and turned off when not in use unless required for effective operation.	
Release of fugitive dust during use of access roads at the intake area	• Not Applicable	• Implement dust suppression techniques in the intake area, including following best practices for dust suppression such as the GN's <i>Environmental Guideline for Dust Suppression</i> (GN 2002).	• Not Applicable
Water Quantity			
Reduction of surface water quantities	• Not Applicable	• Complete width, depth and flow rate measurements during the summer of 2014 for the purposes of developing a Withdrawal Plan for pumping activities in subsequent years. • Adhere to a maximum withdrawal rate of 10 % of the flow rate of the river. Cease pumping if this cannot be achieved. • Comply with water license conditions	• Not Applicable
Alteration of flow resulting from culvert installations or a change in natural surface drainage patterns along the pipeline alignment	• The culverts were designed using standard practices to provide adequate flow.	• Complete annual monitoring to ensure natural drainage is not obstructed, or that flooding or channel diversion does not occur along the pipeline alignment.	• Not Applicable

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation

May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
Water Quality			
Introduction of deleterious substances (sediments, hydrocarbon spills, etc.) into water bodies	• Implemented spill prevention and response protocols • Used pre-existing roads, where available • Limited activities near water bodies or sensitive aquatic habitat • Conducted post construction monitoring	• Maintain working areas and equipment clean and free of potential deleterious substances • Implement sediment and erosion prevention and control measures • Implement spill prevention and response protocols • Limit surface disturbance, especially near water bodies and riparian areas • Conduct routine equipment inspections • Comply with fuel handling best practices, including personnel training, setbacks and secondary containment	• Re-vegetate exposed soils, if required.
Alteration of existing water chemistry parameters	• Not Applicable	• Comply with Project approvals and discharge release limits.	• Not Applicable
Vegetation			
Loss of vegetation as a result of construction of Project facilities (e.g. pipeline and water pump area) Damage to vegetation from ground disturbance or accidental spills	• Restricted equipment operation during the construction phase to previously disturbed and built-up areas. • Avoided sensitive land areas and features, where possible. • The winter access trail was constructed when the ground was frozen. Build-up and pre-packing of snow on winter access trail was a minimum thickness of 0.10 m thickness to protect the underlying ground and vegetation.	• Where off-road travel is required (i.e. during annual monitoring, or seasonal discharging of the pipeline), activities will be completed with low ground pressure vehicles (e.g., rubber-tired ATVs).	• Where surface layer disturbances are present (e.g., rutted areas generated during the construction phase), the area will be backfilled with clean granular material to prevent

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
			possible melting of permafrost.
Wildlife			
Typical Measures Used for All Wildlife Valued Components	- No wildlife sightings during the construction phase were reported. - Construction methodologies used during this phase could not be confirmed by Stantec.	- Project personnel will not feed, harass, approach wildlife - No firearms or hunting and fishing by Project personnel will be allowed - Only the minimum area required for work to proceed safely was cleared - Comply with the Nunavut <i>Wildlife Act</i> - Project equipment and vehicles will not travel at speeds greater than 30 km/h - All sightings of caribou, wolverine, grizzly bear or polar bear will be reported to the wildlife monitors and their location recorded; the information will be submitted to the GN Department of Environment (GN-DOE) upon completion of the Project. - Reduce Project Footprint. - All domestic wastes, food, and petroleum-based chemicals will be kept in secure locations, and/or disposed off-site	
Sensory disturbance from general Project activities – Barren-ground caribou		Project activities will be suspended when caribou are within 500 m of operations.	
Sensory disturbance from general Project activities – grizzly bear, wolverine, polar bear		- If active bear or wolverine dens are encountered within the Project Footprint, the GN-DOE will be contacted immediately to determine appropriate mitigation. Activities may be temporarily suspended pending consultation with GN-DOE. - Workers will not work off-site, unless there is a specific requirement (i.e., waste recovery); workers required to	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
		work off-site will be accompanied by a wildlife monitor.	
Increased mortality risk – barren-ground caribou		• All human/caribou conflicts and incidents will be reported to the GN-DOE immediately.	
Increased mortality risk – grizzly bear, wolverine, polar bear		• All site personnel will receive appropriate bear awareness training. • Waste management practices that reduce attractants to wildlife, including removing wastes off-site for disposal • Work crews will inspect the Project Footprint to collect and properly dispose of any waste material that has blown off site. • Trained staff will have access to bear deterrent materials including bear spray, cracker shells, and firearms with plastic slugs and bullets. The use of any wildlife deterrent will be reported to the GN-DOE.	
Avifauna			
Sensory disturbance – Avifauna (general)	• No avifauna sightings during the construction phase were reported. • Construction methodologies used during this phase could not be confirmed by Stantec.	• If identified, nests or eggs of migratory birds will not be disturbed or destroyed. • Hunting or egg collection by Project personnel will not be allowed; only wildlife monitors will be allowed to carry firearms.	
Sensory disturbance – Peregrine Falcon		• If a raptor nest is established and identified within close proximity to the Project during operations, it will be reported to the GN-DOE.	
Direct habitat loss – Avifauna (general)		• Where possible, avoid Project activities along the edges of wetlands or in riparian areas. • Reduce Project Footprint in undisturbed, natural areas. • Restrict equipment operation to previously disturbed areas. • Where off-road travel is required for remedial work, activities will be completed with low ground pressure vehicles (e.g., rubber-tired ATVs) and sensitive land	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
		areas and features will be avoided.	
Increased risk of indirect mortality – Avifauna (general)		• Waste management practices that reduce attractants to wildlife, including removing wastes off-site for disposal • Work crews will inspect areas in the Project Area to collect and properly dispose of any waste material that has blown off-site.	
Increased risk of direct mortality – Avifauna (general)		• If nests are found in the area where the intake pipe will be deployed annually, the local Wildlife Officer and/or Environment Canada (if species are migratory) will be contacted to provide advice. • Throughout the Project Area, Project equipment and vehicles will not travel at speeds greater than 30 km/h. • Restriction of all Project activities to designated, previously-disturbed work areas and existing roads, or areas that have been built-up with gravel pad(s), where practical. • Where off-road travel is required for remedial work, activities will be completed with low ground pressure vehicles (e.g., rubber-tired ATVs) and sensitive land areas and features will be avoided.	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
Fish and Fish Habitat			
Introduction of a deleterious substance (e.g., sediments, impacted water [turbidity, hydrocarbons from spills, etc.]) into water bodies in the Project Area (including the Char River and Nipissar Lake).	Restriction of all Project activities to designated, previously-disturbed work areas and existing roads, or areas that have been built-up with gravel pad(s), where practical.	- Implement sediment and erosion prevention and control measures, where necessary. - Implement spill prevention and response protocols. - Reduce disturbance near water bodies and riparian areas. - Complete any required in-water work by hand, and with clean equipment. - Maintain clean work sites. - Comply with appropriate regulations, guidelines and Project approvals, including withdrawal flow rates - Comply with fuel handling guidelines and best practices, including personnel training, storage setbacks, secondary containment, and regular storage inspection. - Restriction of all fueling, servicing and staging of machines to designated areas. - Regular inspections to reduce the risk of a spill by identifying and correcting potential equipment failures. - Emergency spill kits will be kept in the sea canister at the intake area. - Development and implementation of Project-specific SCP (see Appendix E for draft SCP).	
Effects to potential spawning habitat in Nipissar Lake from the discharge area of the pipeline	- The concrete splash pad has been constructed at the HWM of Nipissar Lake at the discharge area of the pipeline to dissipate the kinetic energy of flow of water entering the lake. - Placement of riprap around the perimeter of the concrete splash pad to provide additional erosion protection.	Limit activity to timing windows.	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
Fish and Fish Habitat (cont'd)			
Loss of fish habitat from reduced water levels	• Not applicable	• Complete daily calculations of river width, depth and flow rate. • Adhere to a maximum withdrawal rate of 10 % of the flow rate of the river. Cease pumping if this cannot be achieved. • Comply with Water License conditions.	
Loss of fish habitat due to excessive water withdrawal	• Not applicable	• Complete daily flow measurements to confirm the flow rate of the river. • Modify the pumping operations to correspond to a maximum 10 % withdrawal rate.	
Entrainment or impingement of fish during water withdrawal	• Not applicable	• Screens used for water withdrawal will be designed and operated according to the DFO <i>Freshwater Intake End-of-pipe Fish Screen Guidelines</i> (DFO 1995).	
Local Economy			
Employment opportunities Business opportunities	Construction activities provided employment and business opportunities within Rankin Inlet.	• Employment opportunities for these phases will be completed by GN-CGS personnel. • Limited additional business opportunities during these phases of the Project.	
Traditional Land Use			
Change in access to harvesting areas	• The construction phase of the Project included the installation of cover materials atop of sections of the pipeline to prevent any access issues to the primary snowmobile trail.	• No changes in access associated with these phases of the Project.	
Human Health			
Project personnel health and safety	• Construction personnel were required to wear personnel protective equipment (PPE)	• All Project personnel will receive appropriate health and safety training, applicable to the tasks they will be performing. • All Project personnel will attend an orientation, which will discuss site-specific health and safety protocols.	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

Table 5-3 Potential Effects and Mitigations for Valued Components

Potential Effects on Valued Components	Mitigation Measures for each Project Phase		
	Construction	Operation	Decommissioning
Archaeological and Heritage Resources			
Loss of site contents and contexts if potential effects not mitigated	No archaeological and/or heritage resource sites were reported to have been disturbed during the construction phase.	- If sites are encountered during the operations or decommissioning phase personnel will avoid conducting Project activities within 30 of the identified archaeological site. - Project activities will be restricted previously-disturbed work areas and existing roads, or areas that have been built-up with gravel pad(s), where practical. - Where off-road travel is required, activities will be completed with low ground pressure vehicles (e.g., rubber-tired ATVs) and sensitive land areas and features will be avoided.	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

5.5 RESIDUAL EFFECTS OF THE PROJECT

The NIRB is required to consider whether the Project might have a significant adverse effect on the physical, biological or socioeconomic environment, or might cause public concern. The significance of potential residual effects (if any) of Project activities on selected VCs are presented and discussed in the following section. The determination whether the Project residual effects are significant has been based on applicable guidelines or thresholds, professional judgment and knowledge of the Project Area. Generally, potentially significant effects would be those that threaten the long-term sustainability of the VC, so those that are long-term, moderate to high in magnitude and may occur in the Regional Area.

5.5.1 Assessment of Residual Environmental Effects

Residual environmental effects are those effects to VCs that remain after the application of the mitigation measures identified in Table 5-3. The assessment criteria of residual effects are presented in Table 5-4.

Table 5-4 Assessment Criteria for Potential Residual Environmental Effects

Criteria	Potential Outcomes			
Duration	Short-Term: Effect lasts for duration of construction phase of the Project	Medium-Term: Effect lasts for the duration of the Project	Long-Term: Effect lasts greater than five years after Project ceases	
Frequency	Once: Effect occurs once	Intermittent: Effect occurs intermittently	Continuous: Effect occurs continuously	
Seasonal Timing	Season-Specific: Effect is restricted to a particular season or seasons		Non Season-Specific: Effect could occur year round	
Geographic Extent	Project Footprint: Water intake area, pipeline alignment and Nipissar Lake discharge area	Project Area: Project Footprint, plus a 1 km buffer	Regional Area: Project Footprint plus a 5 km buffer, and/or seasonal range of VC	
Reversibility ¹	Reversible or Irreversible			
Magnitude of effect	None/Negligible	Low: Class 3 Effect ²	Moderate: Class 2 Effect ³	High: Class 1 Effect ⁴
NOTES:				
1. Reversibility— The likelihood that the VC will recover from an environmental effect.				
2. Class 3 Effect—The predicted trend in the measurable parameter under projected levels of development may result in a decline in the VC in the Project Area during the life of the Project, but VC levels should recover to baseline after Project closure.				
3. Class 2 Effect—The predicted trend in the measurable parameter under projected levels of development will likely result in a decline in the VC to lower than baseline, but stable levels in the Project Area after closure and into the foreseeable future.				
4. Class 1 Effect—The predicted trend in the measurable parameter under projected levels of development could threaten the sustainability of the VC in the Project Area, after Project closure, and into the foreseeable future.				

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

5.5.2 Physical VCs

5.5.2.1 Terrain Stability and Permafrost

Existing ATV trails at the Site appear to have had an effect on the Site as rutting is present at several locations. In addition, the use of heavy equipment during the construction activities completed in September 2012 may have exacerbated this effect and caused a larger area to be affected as equipment had to work around rutted terrain.

The excavation of native soils may cause some warming and melt back of the permafrost due to the removal of the active layer/overburden. Where excavations within sensitive land areas could not be avoided (i.e., the low point drain location), excavations were backfilled as soon as possible once the low point drain was installed.

Water discharge will be managed during the seasonal purging of the pipeline to limit ponding and permafrost degradation in the area of the low point drain. Given the short-term nature of the construction phase and the short duration of the seasonal pipeline purging activities, any increased warming or melt back of the permafrost in these areas is expected to recover upon completion of the construction activities.

Through the application of the mitigation measures outlined in Table 5-3, the potential residual effects to the terrain stability and permafrost VC are predicted to be short to medium-term, will occur continuously, be season-specific and confined to the Project Footprint. The potential residual effects are predicted to be low in magnitude, reversible, and not significant.

5.5.2.2 Soil Quality

Improper fuel handling and storage is a concern through all Project phases, as it could cause an adverse effect on soil quality in the Project Footprint. No releases or spills were reported during the construction phase of the Project. Mitigation measures for potential adverse effects during the operations phase of the Project to soil quality are presented in Table 5-3. The application of these mitigation measures, including the use appropriate fuel handling and storage techniques, will limit adverse effects of Project activities on the soil quality in the Project Footprint. The potential adverse residual effects to the soil quality VC are therefore predicted to be short-term, occur once, be season-specific, confined within the Project Footprint, be negligible in magnitude, reversible, and are not significant.

5.5.2.3 Air Quality

The use of heavy equipment and diesel and/or gasoline fueled vehicles during construction, and vehicles and the water pump during operations will produce atmospheric emissions, contributing to local air quality.

Mitigation measures for potential Project effects to air quality are presented in Table 5-3. The application of these mitigation measures, including the use of equipment which meets emissions

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

standards and regular equipment maintenance will limit the effects of the Project on air quality. With these mitigation measures, residual effects on air quality are expected to be short-term, season-specific and occur continuously during the pump operation season (June to September). The effects are also predicted to be largely restricted to the Project Footprint, be reversible, negligible in magnitude, and not significant.

5.5.2.4 Water Quantity

The construction phase of the Project included the installation of snow fills along the winter access trail. These fills may have resulted in a delayed melt due to increased accumulation and density; however, the snow water equivalent (the amount of water on the ground once the snow has melted) is inconsequential at the basin scale. The Contractor complied with the mitigation measures identified within this document for construction and operation of the winter access trail and the installation of culverts.

The operations phase of the Project will involve the withdrawal of water from the Char River. As noted in Section 2.6.1, the water pumping requirements will fluctuate over time. Based on the water flows recorded during the Meliadine Project (outlined in Section 4.1.3.2), sufficient flow is present to fulfill the current water withdrawal requirements. However, as the required volume of water increases, modifications to the pumping methods (i.e. lowering the pumping rate during low flow periods) may be necessary to ensure that the maximum water withdrawal does not impact fisheries resources. As such, the withdrawal rate is not anticipated to affect the hydrologic function of the river.

The decommissioning phase of the Project will involve the installation of snow fills along the winter access trail similar those constructed during the construction phase of the Project. In addition, the decommissioning phase will include the decommissioning of culverts. The GN-CGS will comply with the mitigation measures for the culvert decommissioning.

With the implementation of the identified mitigation measures, residual effects of Project activities on water quantity will be reduced. The residual effects on water quantity are considered to be of medium-term duration, intermittent in frequency (throughout all Project Phases, seasonally during the operations phase), and contained within the Regional Area. Any residual effects are considered reversible, provided all mitigations and suitable water withdrawal practices are in place. The magnitude of potential residual impacts is classified as low, and the effect is not significant.

5.5.2.5 Water Quality

During the construction phase of the Project, proper sizing of culverts reduced the potential impact to water quantity, water quality, and subsequently any downstream fish and fish habitat.

As refueling activities during the Project will be completed in away from sensitive areas, the risk of deleterious substances entering the watercourses will be reduced. The proper siting of low point drain location (i.e., at least 30 m away from the high water mark of any water body) will

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

prevent degradation of the water quality in those water bodies, by reducing the potential for erosion in the Project Area.

The concrete splash pad has been constructed at the high water mark of Nipissar Lake at the discharge area of the pipeline to dissipate the kinetic energy of the water entering the lake. Furthermore, riprap was installed around the perimeter of the concrete splash pad to provide additional erosion protection. Residual effects of the Project on water quality are expected to be medium-term, intermittent, season-specific, confined to the Project Area, reversible, negligible or none in magnitude, and not significant.

5.5.3 Biological VCs

5.5.3.1 Vegetation

Mitigation measures for potential Project effects to vegetation are presented in Table 5-3. Vegetation within the pipeline alignment has been covered by the pipeline and/or the cover materials (in vicinity of the snowmobile route). Along the winter access trail, the vegetation cover was protected with the build-up of snow along the route (minimum of 0.1 m).

Installation of the pipeline will remove a limited area of vegetation. The primary method of mitigation against loss of native vegetation communities was to reduce the area of disturbance and therefore the potential loss of vegetation.

With the application of the mitigation measures, residual effects of the Project on vegetation are expected to be medium-term, occur once, be non-season-specific, confined to the Project Footprint, reversible, moderate in magnitude, and not significant.

5.5.3.2 Mammals

Potential residual effects of the Project on wildlife include wildlife habitat avoidance or displacement due to sensory disturbance and mortality risk (i.e., due to interactions with vehicles and/or equipment, and attraction to the Site). Project effects were assessed on selected VCs with the potential to interact with Project activities, including barren-ground caribou, grizzly bear, wolverine and polar bear, and are discussed below.

Mitigation measures to reduce potential Project effects on wildlife are presented in Table 5-3. The mitigation measures identified will reduce potential Project effects by reducing the Project Footprint, maintaining setbacks from active den sites, implementing site-specific waste and wildlife management procedures, and restricting Project activities to disturbed areas.

5.5.3.2.1 Barren-ground Caribou

Potential effects to barren-ground caribou during all Project phases, include direct habitat loss and fragmentation along the pipeline alignment, sensory disturbance and increased mortality risk (i.e., due to collisions with Project vehicles or equipment). The mitigation measures identified

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

in Table 5-3 will reduce potential effects; however, it is anticipated that some potential residual effects will persist as a result of sensory disturbance.

Noise from Project equipment may cause caribou to alter their behavior and/or avoid habitat within the Project Area during all Project phases. Though a different sub-species, island caribou have been shown to behave in the following ways in response to nearby land-based seismic operations (F.F. Slaney and Co. 1975a, b):

- Caribou remained for a day or more within 4 km of sight or sound of a seismic operation.
- Caribou continued to forage following the detonation of seismic shots 3.5 km away, and remained in the area for at least several hours.
- Caribou by-passed a seismic camp within 800 m without altering their direction of movement.
- Caribou ceased foraging when approached by seismic vehicles that were closer than 800 m away.

F.F. Slaney and Co. (1975 a, b) noted that there was some displacement from foraging areas and some increased energy expenditure as a result of the nearby land-based seismic operations, these were within the range of normal activities (e.g., predator avoidance). Explosive shots are typically used for land-based seismic activities, and given that explosives will not be used for the Project, Project activities are not expected to be as loud as land-based seismic operations.

Project activities will occur annually with no anticipated decommissioning date. The majority of activities will be concentrated to the summer months (June to September) using 12-hour work shifts. As a result, sensory disturbance to barren-ground caribou is expected to be intermittent, medium-term, reversible, and will be limited to the Project Area. Based on the mitigation measures in Table 5-3, sensory disturbance is expected to be limited and residual effects are expected to be low in magnitude and not significant.

5.5.3.2.2 Grizzly Bear

Potential effects to grizzly bear during all Project phases include sensory disturbance and increased mortality risk. The mitigation measures identified in Table 5-3 will reduce potential effects; however, some potential residual effects may persist. These are related to potential disruption of denning during winter access trail construction and operation, sensory disturbance during operation of the water intake pipeline, and increased mortality risk from attraction of grizzly bear to the Project Area.

Project activities that occurred in the winter include construction and operation of the winter access trail. These activities had the potential to disrupt denning bears during their winter dormancy period. During the construction phase of the Project, no active bear dens were reported. Potential residual effects to grizzly bear from den disturbance are therefore considered low in magnitude, reversible, and not significant.

During the operations phase in the summer, grizzly bear may avoid the Project Area due to sensory disturbance (increased noise) from Project activities, potentially resulting in a decline in local abundance for the duration of the Project. However, grizzly bears may also be attracted to

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

the Project Area as a result of aromatic wastes (e.g., oils, gas). This attraction increases the potential for human/bear interactions and potential subsequent grizzly bear mortality if they become a nuisance. With the implementation of mitigation measures in Table 5-3, including fuel and waste management procedures, staff training, site inspections, and off-site disposal of all wastes, potential residual effects to grizzly bear from operations phase of the Project will be reduced. If a grizzly bear does become a nuisance, the GN-DOE will be contacted for advice on dealing with the bear. Potential residual effects from sensory disturbance and attraction will be medium-term in duration, season-specific, be restricted to the Project Area, reversible, low in magnitude and not significant.

5.5.3.2.3 Wolverine

Potential effects to wolverine during Project phases include sensory disturbance and increased mortality risk. The mitigation measures identified in Table 5-3 will reduce potential effects; however, some potential residual effects may persist; these are related to potential disruption of denning during winter access trail construction and operation, sensory disturbance during operation of the water intake pipeline, and increased mortality risk from attraction of wolverine to the Project Area.

Wolverines have been reported to be sensitive to human activity, particularly in the winter, and disturbance at den sites may cause den relocation, den abandonment, or litter abandonment (COSEWIC 2003). As with grizzly bear, no wolverine dens were reported during the construction phase of the Project. Potential residual effects to wolverine from den disturbance are therefore low in magnitude, reversible, and not significant.

Similar to grizzly bear, wolverine may avoid the Project Area as a result of increased noise from Project activities. Due to wolverine's keen sense of smell, they may also be attracted to the Project Area due to the presence of aromatic wastes (e.g., oils, gas); this attraction could occur through each of the Project phases as wolverine are active throughout the year. This increases the potential for human/wolverine interactions and, if they become a problem, potential subsequent wolverine mortality.

With the implementation of mitigation measures in Table 5-3, including fuel and waste management procedures, potential residual effects will be reduced, but may occur continuously over the duration of the Project. Potential residual effects are expected to be medium-term in duration, restricted to the Project Area, reversible, low in magnitude and not significant.

5.5.3.2.4 Polar Bear

Potential effects to polar bear may occur during all Project phases and include sensory disturbance and increased mortality risk. During winter, Project effects are expected to be negligible as polar bears will be out on the sea ice away from the Project Area. Polar bear – Project interactions only have the greatest potential to occur during the summer portion of the Project, if the bears are pushed on land due to lack of sea ice.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

The mitigation measures identified in Table 5-3, including implementation of waste management procedures, will reduce potential effects of the Project on Polar Bear. However, a potential residual effect may persist due to increased mortality risk as a result of the potential attraction of land-based polar bears to the Project Area.

Again, similar to grizzly bear and wolverine, polar bear may be attracted to domestic wastes while they are on land (Lunn and Stirling 1985). Given the potential requirement to destroy a bear should an interaction occur, and that polar bear are a SARA-listed species, the consequence of human/bear interactions is potentially high with a long-term effect. However, the probability of this occurring is expected to be low. With the implementation of the mitigation measures in Table 5-3, including fuel and waste management procedures, potential residual effects of the Project on polar bear are predicted to be medium-term in duration and limited to the summer season within the Project Area. Potential residual effects to polar bear are therefore expected to be reversible, low in magnitude, and not significant.

5.5.3.3 Avifauna

Potential residual effects of the Project on avifauna include habitat loss and habitat avoidance or displacement due to sensory disturbance. Project effects were assessed on avifauna with the potential to interact with Project activities; the assessment focused on general avifauna species, as well as the species at risk, peregrine falcon.

Mitigation measures to reduce potential Project effects on avifauna are presented in Table 5-3. The mitigation measures identified will reduce potential Project effects by reducing the Project footprint; implementing waste management procedures; and, restriction of Project activities to previously disturbed areas.

Therefore potential residual effects on avifauna, including the peregrine falcon, are predicted to be short- to medium-term, occur intermittently, season-specific, restricted to the Project Area, reversible, low in magnitude and not significant.

5.5.3.3.1 Peregrine Falcon

Potential effects to the peregrine falcon may occur during all Project phases and include direct habitat loss, sensory disturbance and increased direct and indirect mortality risk. The mitigation measures identified in Table 5-3 will reduce potential effects however some potential residual effects on sensory disturbance may persist if peregrine falcons are in the area during Project activities. Any habitat avoidance due to sensory disturbance is expected to be negligible in magnitude and not significant, as the Project footprint is relatively small compared to peregrine falcon hunting territory.

5.5.3.4 Fish and Fish Habitat

Potential residual effects of the Project on fish and fish habitat include the potential for habitat loss and the impediment of movement due to the water withdrawal activities. Mitigation measures for potential Project effects to fish and fish habitat are presented in Table 5-3. When

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

complete, the Project is expected to have little to no residual effect on fish or fish habitat, as long as the mitigative measures related to water quantity, water quality and fish and fish habitat are followed.

Therefore, with the application of the identified mitigation measures, any residual effects of Project activities on potential fish and fish habitat at the Site are expected to be medium-term, intermittent, season-specific (summer), be confined to the Project Footprint, reversible, of a negligible magnitude, and not significant.

5.5.4 Socio-economic VCs

5.5.4.1 Local Economy

Mitigation measures for potential Project effects to local economy are presented in Table 5-3. Completion of the Project is expected to generate some direct employment, develop employee skills and business opportunities for Rankin Inlet; this includes the short term opportunities associated with the construction phase of the Project, as well as the longer term opportunities associated with the operation of the pipeline. The effect of the Project on local economy is expected to be positive, medium-term, season-specific, regional, and negligible in magnitude.

5.5.4.2 Traditional Land Use

Mitigation measures for potential Project effects to traditional land use are presented in Table 5-3. Information collected at community consultations completed for the Project did not identify any concerns related to traditional land use of this Site; with the exception of a primary snowmobile route located in the vicinity of the pipeline. To ensure access to this important route, granular material was placed atop of the pipeline in vicinity of the route during the construction phase. Therefore, the activities at the Site are unlikely to interfere with subsistence harvesting activities and long-term use of traditional/local trails. The effect of the Project on traditional land use is expected to be positive, medium-term, season-specific, regional, and negligible in magnitude.

5.5.4.3 Human Health

Mitigation measures for potential Project effects to human health are presented in Table 5-3. With the application of mitigation measures, including provision of appropriate health and safety training and PPE, Project effects on human health as a result of standard operations are not anticipated. Should a residual effect occur, it would be considered short-term, intermittent, season-specific, reversible, restricted to the Project Footprint, negligible in magnitude, and not significant.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Identification of Effects and Proposed Mitigation
May 2014

5.5.4.4 Archaeological and Heritage Resources

Mitigation measures for potential Project effects to archaeological and heritage resources are presented in Table 5-3. The desktop search completed identified a number of features within the Project Area; however, these were located outside the Project Footprint. In addition, no resources were reported to have been disturbed during the construction phase of the Project. The operation and decommissioning activities will be restricted to the Project Footprint and/or within previously disturbed areas (i.e. access roads). If resources are identified in these areas, the establishment of a 30 m buffer around identified features, as well as the completion of work manually, and with low ground pressure vehicles, will protect the identified features. Residual effects are therefore not expected.

6.0 Cumulative Effects

From the NIRB's Technical Guide Series Terminology and Definitions (Draft 2) (NIRB 2013b), a cumulative effect is described as "... *an impact on the biophysical and socio-economic environment that results from the incremental effects of a development when added to other past, present and reasonably foreseeable future developments, regardless of what agency or person undertakes such other developments. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*" From this definition, the assessment of cumulative effects predicts the significance of potential residual Project effects in combination with past, present and reasonably foreseeable activities that have the potential to interact with Project effects. The assessment of the significance of cumulative effects is based on technical information and professional judgment, and considers the following:

- Are there adverse residual effects from Project activities?
- Do identified residual effects overlap with (i.e., act in combination with) those of other existing projects and activities?
- What is the contribution of the Project to those overlapping cumulative effects of present projects, if any?
- Do the combined Project and environmental effects of present projects or activities overlap with those of any approved or proposed projects that will be carried out?

6.1 CUMULATIVE EFFECTS BOUNDARIES

The purpose of the cumulative effects assessment is to determine if the effects of other programs might interact cumulatively, both spatially and temporally, with the Project.

The spatial boundary for the cumulative effects assessment is defined as encompassing the Regional Area, which includes the Project Footprint and a 5 km buffer area.

The temporal boundary for the cumulative effects assessment is based on the potential of residual effects to environmental resources or harvesting from past, present and reasonably foreseeable programs to combine with effects to environmental resources or harvesting of the Project. Programs included within the temporal scope of the cumulative effects assessment include:

- Programs that have occurred one year prior to the construction phase of the Project within the spatial boundary defined above
- Programs occurring at the same time as the Project (2012 to 2032) , within the spatial boundary defined above
- Programs that are known to have a reasonable chance of occurring in the year following the decommissioning phase of the Project, within the spatial boundary defined above.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Cumulative Effects
May 2014

6.2 CUMULATIVE EFFECTS INCLUSION LIST

The Project inclusion list is provided in Table 6-1. This table only lists programs with the spatial boundary of the cumulative effects assessment that could have the potential to interact with any residual effects of the Project. There may be a number of other programs planned, but not disclosed at the time of completion of this assessment.

Table 6-1 Cumulative Effects Assessment Program Inclusion List

Proponent	Location	Type of Activity	Overlap	Residual Program Effects
Past Activities (Completed)				
Agnico-Eagle Mines	Rankin to Meliadine All Weather Access Road extending from the Char River to the Meliadine Gold Project located approximately 30 km northwest of Rankin Inlet	Road construction and operation	Spatial overlap	Wildlife and avifauna
Hamlet of Rankin Inlet	Within municipal boundary of Rankin Inlet	Community Development	Spatial and temporal overlap	Wildlife and avifauna
Present Activities (Completed during the Project lifespan)				
Hamlet of Rankin Inlet	Within municipal boundary of Rankin Inlet	Community Development	Spatial and temporal overlap	Wildlife and avifauna
Agnico-Eagle Mines	Rankin to Meliadine All Weather Access Road extending from the Char River to the Meliadine Gold Project located approximately 30 km northwest of Rankin Inlet	Road operation	Spatial and temporal overlap	Wildlife and avifauna
Reasonably Foreseeable Activities				
Hamlet of Rankin Inlet	Within municipal boundary of Rankin Inlet	Community Development	Spatial and temporal overlap	Wildlife and avifauna

6.3 SCREENING OF RESIDUAL PROJECT EFFECTS

Residual Project effects, once mitigations are applied, are predicted to be none to negligible in magnitude for the following VCs:

- Terrain stability and permafrost
- Soil quality
- Air quality

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Cumulative Effects
May 2014

- Water quantity
- Water quality
- Vegetation
- Fish and fish habitat
- Local economy
- Traditional land use
- Human Health
- Archaeology and Historical Resources

Residual Project effects, once mitigations are applied, are predicted to be low to moderate for the following VCs:

- Avifauna – sensory disturbance
- Barren-ground Caribou – sensory disturbance
- Grizzly Bear – den disturbance
- Wolverine – den disturbance
- Polar Bear – increased mortality risk

Residual effects that are predicted to be low to moderate are discussed below.

6.4 SIGNIFICANCE OF CUMULATIVE EFFECTS

The assessment of the significance of cumulative effects follows from the interaction of Project residual effects with the anticipated residual effects of past, present and foreseeable programs. Such interactions can be anticipated if residual effects to Project VCs overlap spatially and temporally with VCs impacted by other programs.

The residual effects from the Project to wildlife VCs within the Regional Area and/or the seasonal ranges of the VCs include residual effects to grizzly bears and wolverines due to den disturbance; barren-ground caribou from sensory disturbance; and, polar bears due to mortality.

The potential effects generated during the programs identified in Table 6-1 that have the potential to interact with the residual effects of the Project include;

1. Denning grizzly bears and/or wolverines could have been disturbed during the construction phase of the Project, resulting in the abandonment of dens,
2. Sensory disturbance of barren-ground caribou and avifauna
3. Increased mortality rates of polar bears due to increased use of the Regional Area

Given that Project residual effects are predicted to be low to moderate in magnitude, generally seasonal and occur intermittently, their potential to contribute cumulatively to the effect of other limited past and present projects in the Regional Area is considered to be low.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Supporting Documentation
May 2014

7.0 Supporting Documentation

Project-specific mitigation plans have been submitted with this Environmental Screening document as an indication of a proposed approach, and are included in appendices. The mitigation plans describe the practices and techniques that will be employed and adhered to in order to meet the commitments stated in this document and to meet the conditions of approvals and permits. The mitigation plans include:

- Spill Contingency Plan:
 - The Spill Contingency Plan describes the steps that will be taken in the event of a fuel, oil, or chemicals spill. This includes a description of clean up materials and tools, waste handling, and large spills. In addition, this document describes how to report a spill and includes Project-specific contact names and phone numbers.
 - The SCP is provided in Appendix E of this document.
- Operations and Maintenance Plan
 - The Operations and Maintenance (O&M) Plan describes the procedures that will be completed during the operation of the Project facilities.
 - The O&M Plan is provided in Appendix F of this document.

In addition, the following documents are included to support Project permitting, and provide further background information on the Site and Project:

- Water Supply Capacity, Consumption and Conservation Study, FSC, 2010
- Design of Pipeline System to Augment Natural Replenishment of Nipissar Lake, FSC, 2010
- Nunavut Planning Commission Conformance Review

These supporting documents are included in Appendix G.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

References

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8.0 References

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SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

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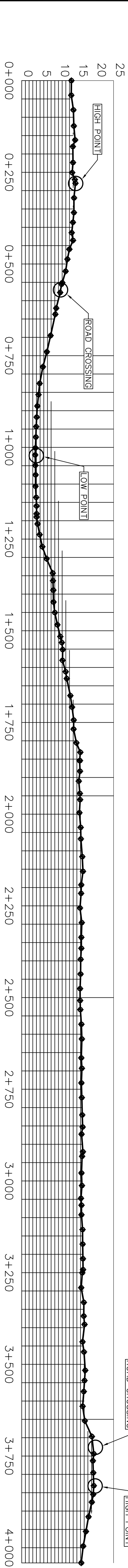
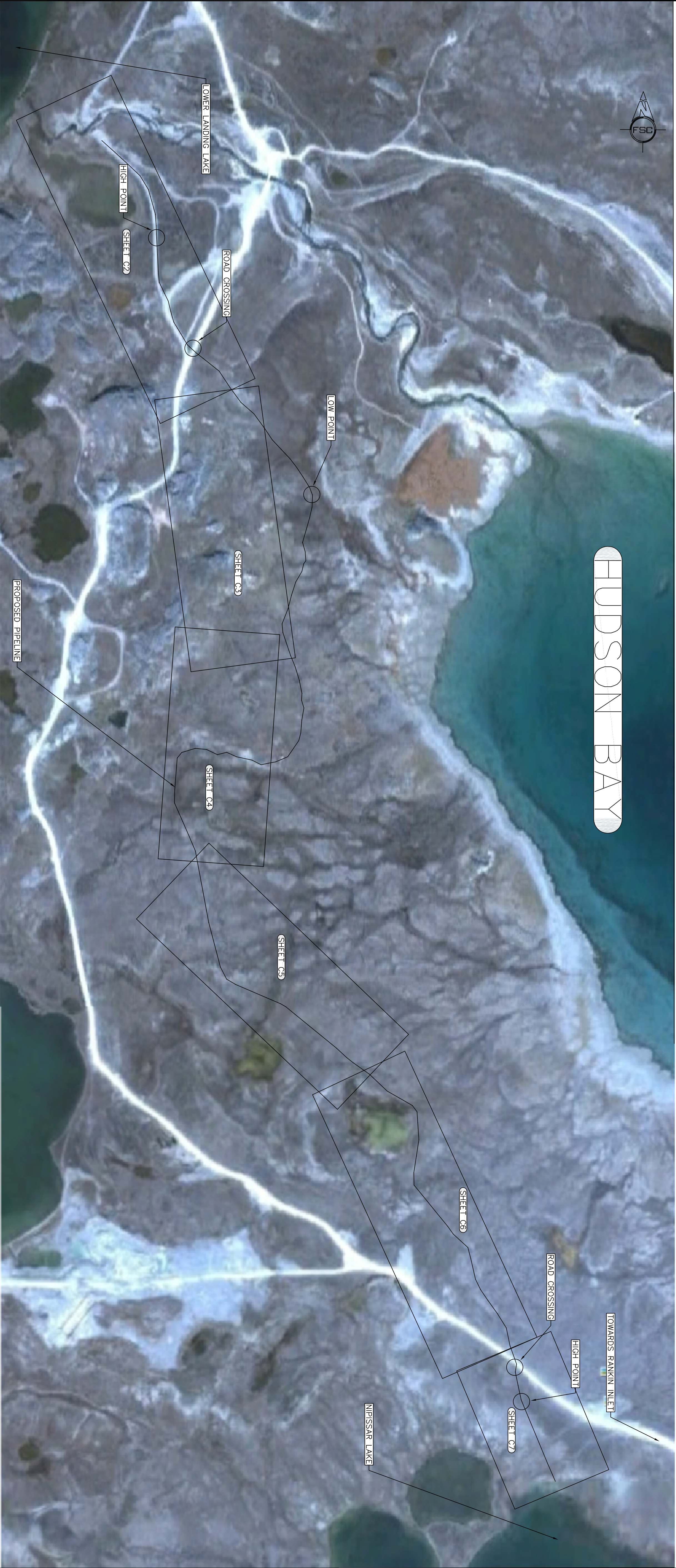
SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix A Drawings
May 2014

Appendix A Drawings



HUDSON BAY



Alignment – Actual Pipeline CL PROFILE

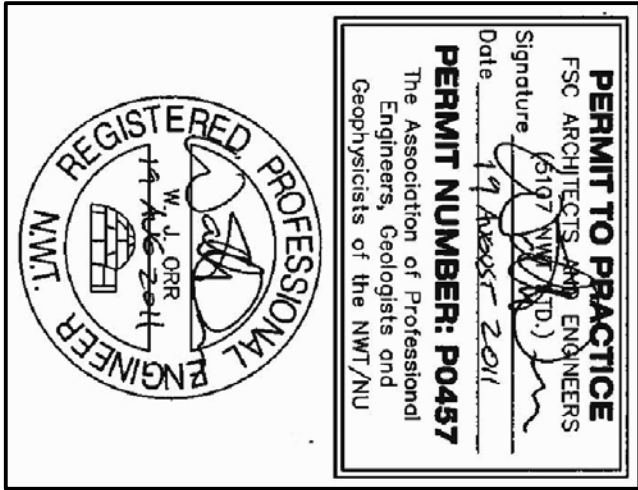


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NOTE:
MANTON CONSTRUCTION, TOWARDS RANKIN INLET AND LOW POINTS TO RANKIN INLET, TOWARDS RANKIN INLET.

F	ISSUED FOR CONSTRUCTION	2011/11/04
E	ISSUED FOR TENDER - REVISED	2011/09/12
D	ISSUED FOR TENDER	2011/08/19
C	ISSUED FOR REVIEW	2010/12/15
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NIPISSAR LAKE RESUPPLY LINE

LOCATION
RANKIN INLET, NU

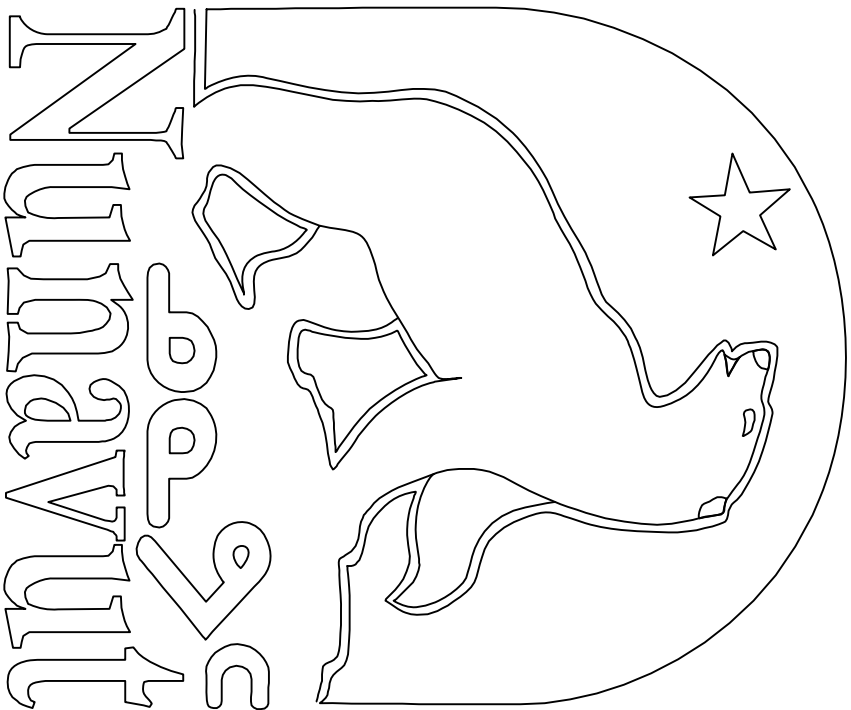
PIPELINE SITE PLAN

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DRAWING NO. C1	

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix B Issued for Tender Specifications
May 2014

Appendix B Issued for Tender Specifications



RANKIN INLET, NUNAVUT NIPISSAR LAKE RESUPPLY LINE

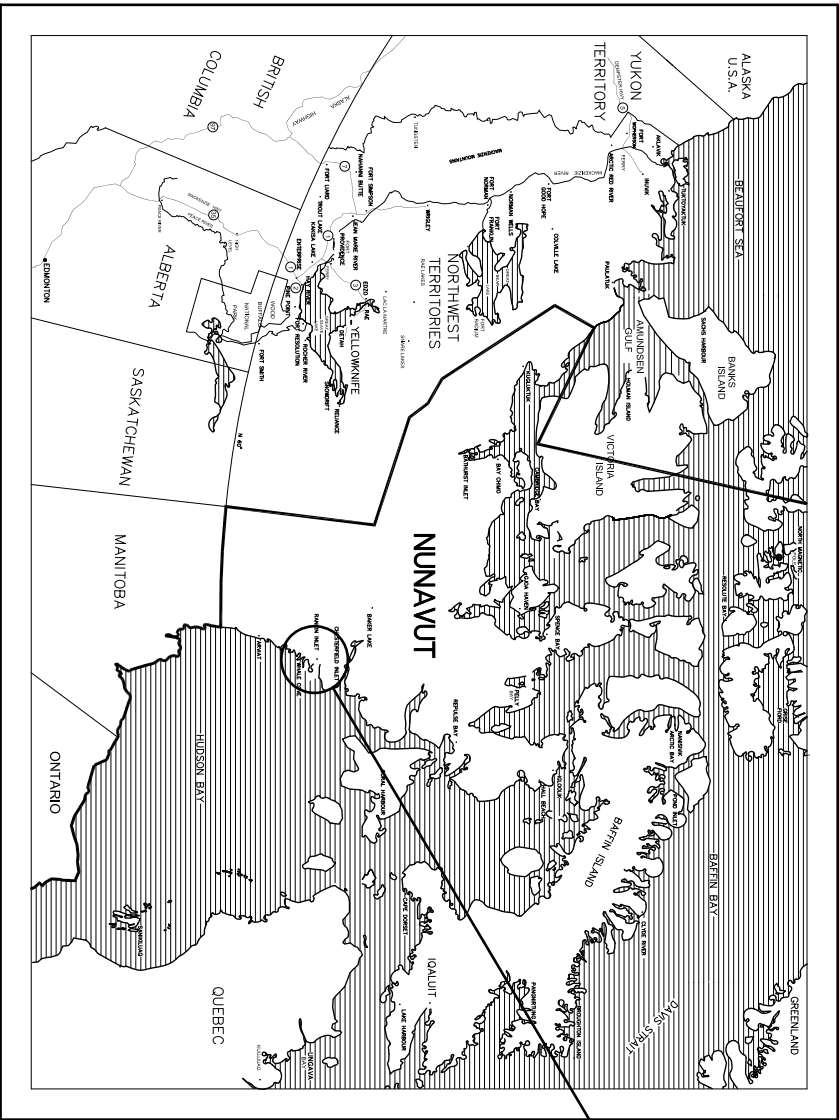
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RANKIN INLET

LIST OF DRAWINGS

1. PIPELINE SITE PLAN	
2. PIPELINE PLAN & PROFILE 0+000 – 0+700	C1
3. PIPELINE PLAN & PROFILE 0+700 – 1+350	C2
4. PIPELINE PLAN & PROFILE 1+350 – 2+050	C3
5. PIPELINE PLAN & PROFILE 2+050 – 2+750	C4
6. PIPELINE PLAN & PROFILE 2+750 – 3+450	C5
7. PIPELINE PLAN & PROFILE 3+450 – 3+890	C6
8. PIPELINE & SCREEN DETAILS	C7
9. INTAKE PUMP DETAILS (NIC)	C8
10. INTAKE SITE PLAN	C9
11. GENERAL SPECIFICATIONS	C10
	C11



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PROJECT TITLE

**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION RANKIN INLET, NU

DRAWING TITLE
PIPELINE SITE PLAN

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of 11



NIPISSAR LAKE

TOWARDS RANKIN INLET

SHEET C1

SHEET C5

SHEET C9

SHEET C4

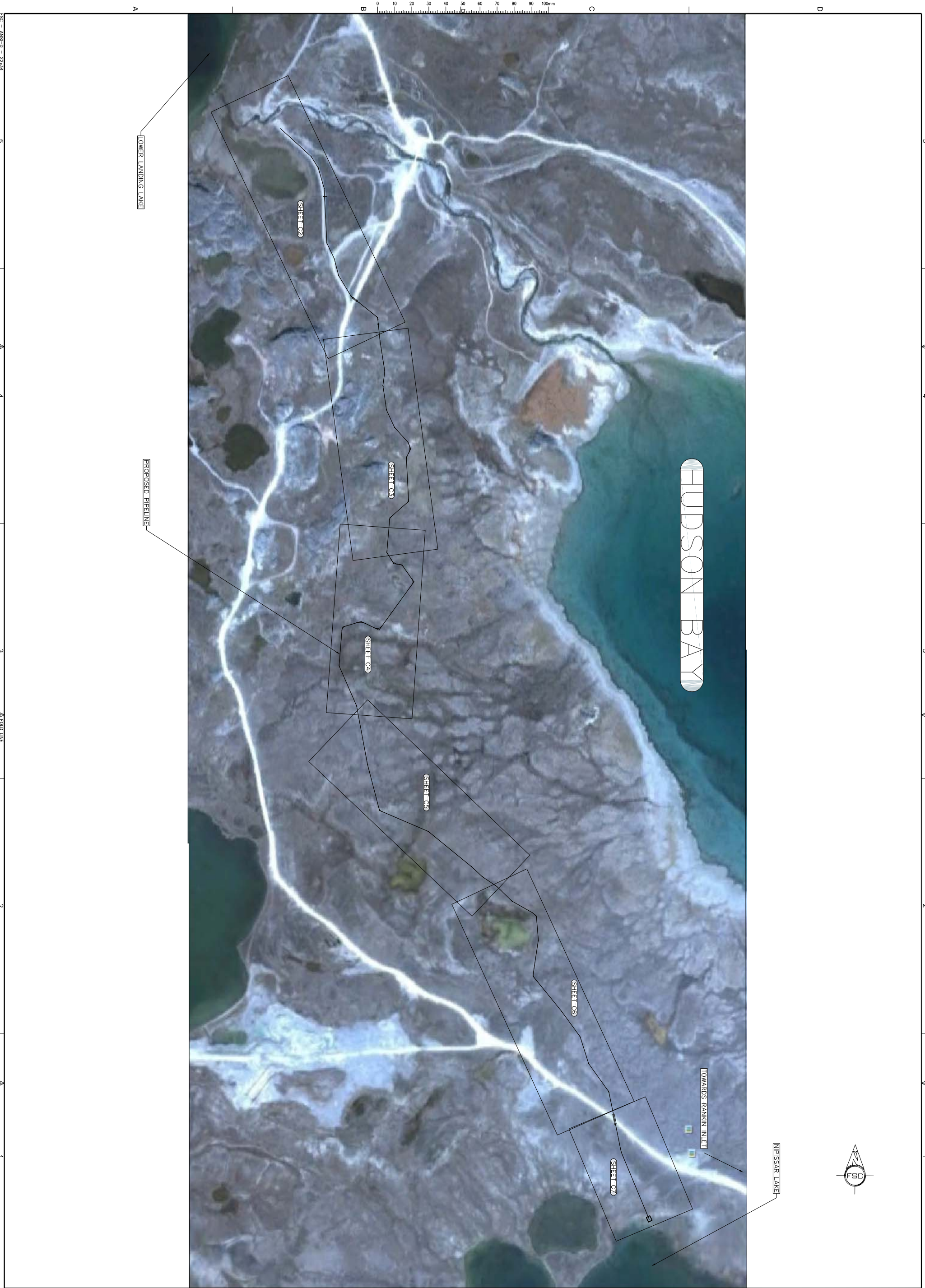
SHEET C3

SHEET C2

PROPOSED PIPELINE

LOWER LANDING LAKE

HUDSON BAY



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NIPISSAR LAKE
RESUPPLY LINE

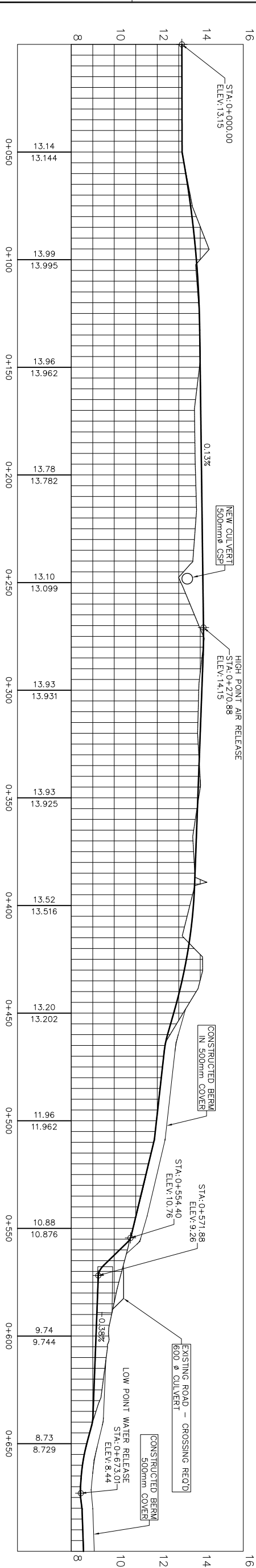
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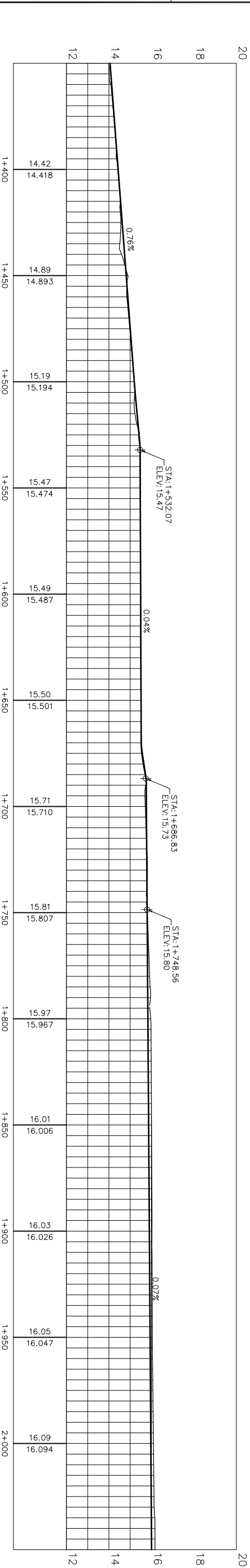
PIPELINE PLAN & PROFILE
0+000 - 0+700

DESIGNED BY	SCALE
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FSC PROJECT NO.	CLIENT PROJECT NO.
2010 0570	-
DRAWING NO.	
C2	



Alignment – Proposed Pipeline CL PROFILE





Alignment – Proposed Pipeline CL PROFILE



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**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION RANKIN INLET, NU

DRAWING TITLE
PIPELINE PLAN & PROFILE
1+350 - 2+050

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NOTE:
MAINTAIN CONSISTENT SLOPE TOWARDS HIGH POINTS AND LOW POINTS TO FACILITATE SEASONAL PIPELINE DRAINAGE

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NIPISSAR LAKE RESUPPLY LINE

RANKIN INLET, NU

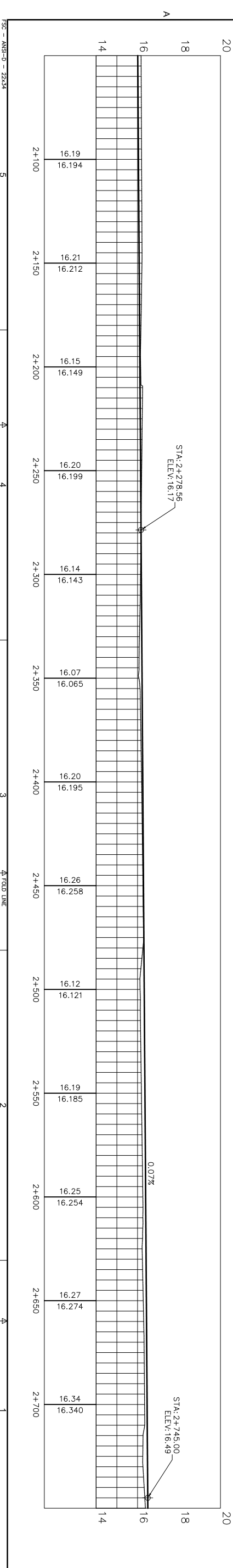
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2+050 - 2+750

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FSC PROJECT NO.	
2010 0570	

C5



Alignment – Proposed Pipeline CL PROFILE



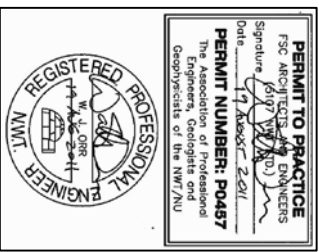


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NOTE: MAINTAIN CONSISTENT SLOPE TOWARDS HIGH POINTS AND LOW POINTS TO FACILITATE SEASONAL PIPELINE DRAINAGE

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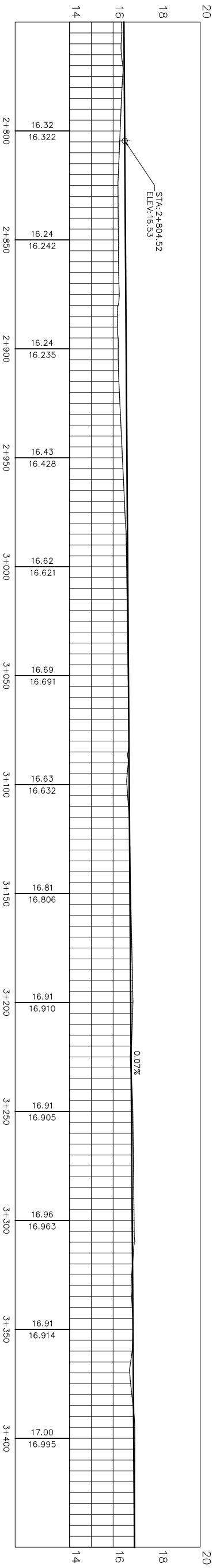
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DRAWING TITLE
PIPELINE PLAN & PROFILE
2+750 - 3+450

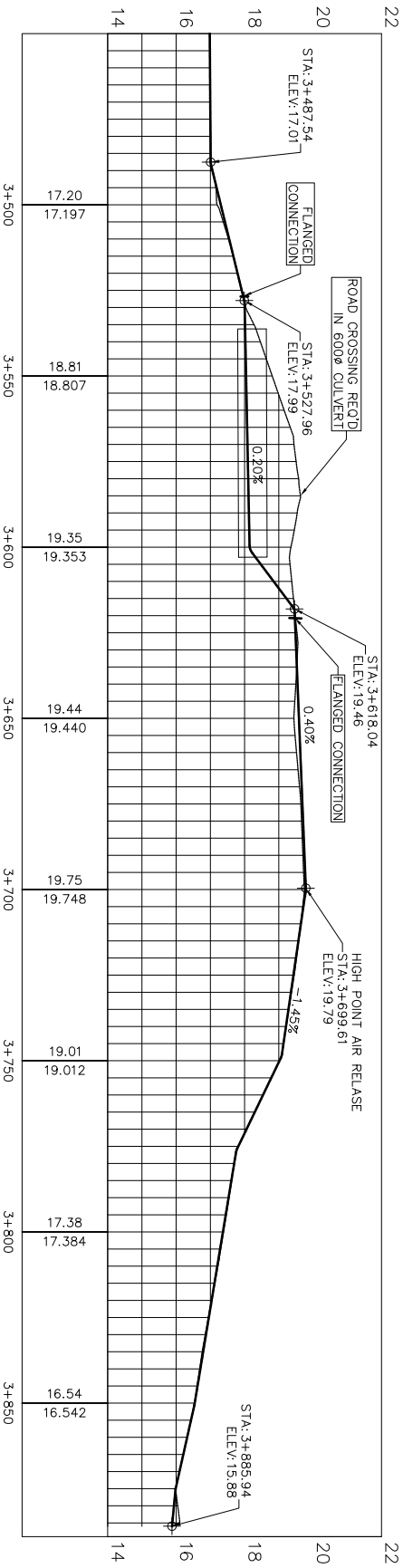
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OF 11



Alignment – Proposed Pipeline CL PROFILE



Alignment – Proposed Pipeline CL PROFILE

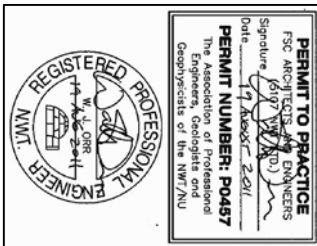


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**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION: RANIKIN INLET, NU

PIPELINE PLAN & PROFILE
3+450 - 3+890

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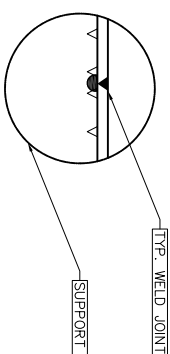
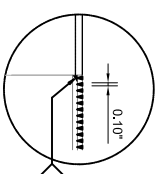
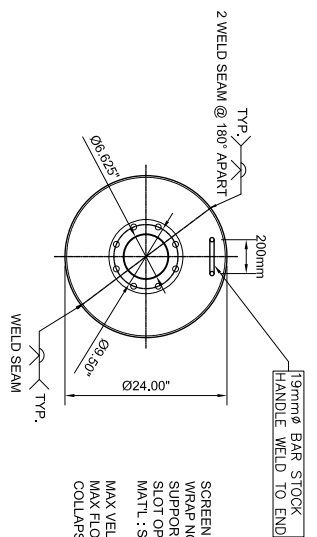
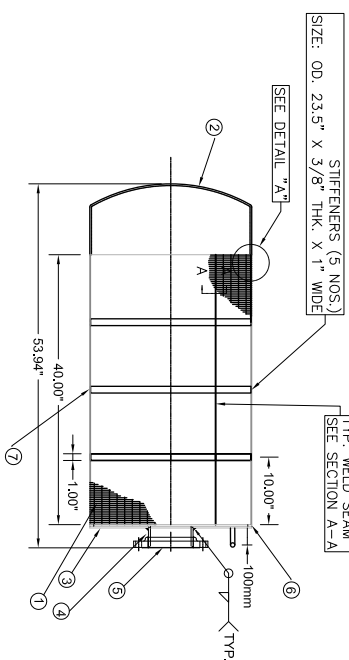
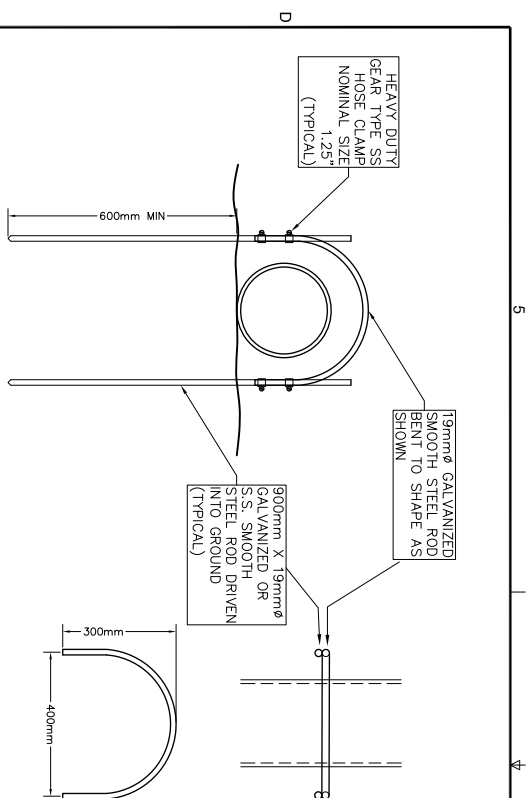
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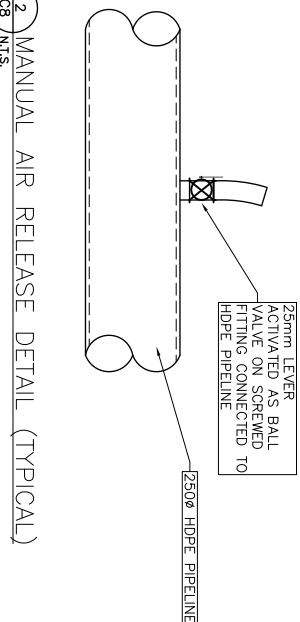
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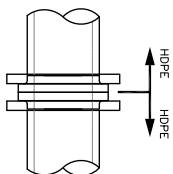
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C8 N.T.S.

BILL OF MATERIAL				
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6	1		WELD RING	304 SIS
5	1		Ø 6" x #150 RFSSO	304 SIS
4	1		PIPE	304 SIS
3	1		END PLATE	304 SIS
2	1		CAP	304 SIS
1	1		SCREEN	304 SIS

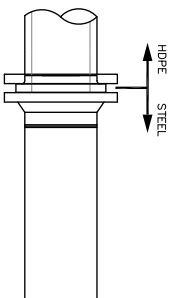
7
C8 INTAKE SCREEN
N.T.S.



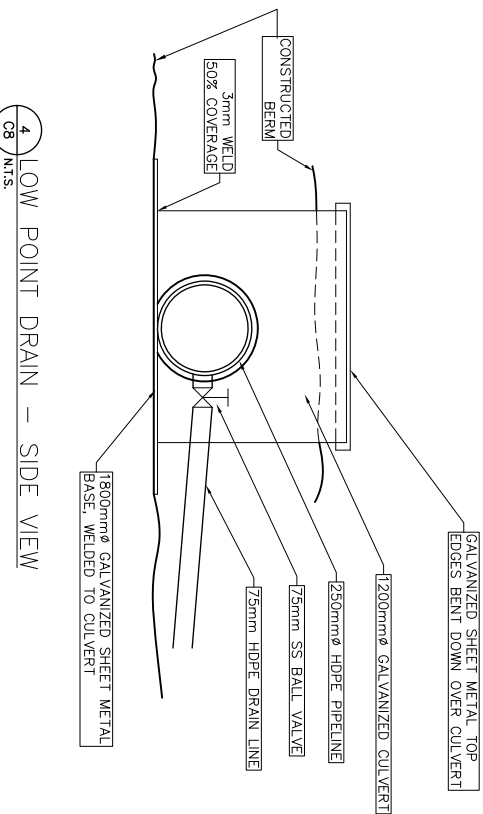
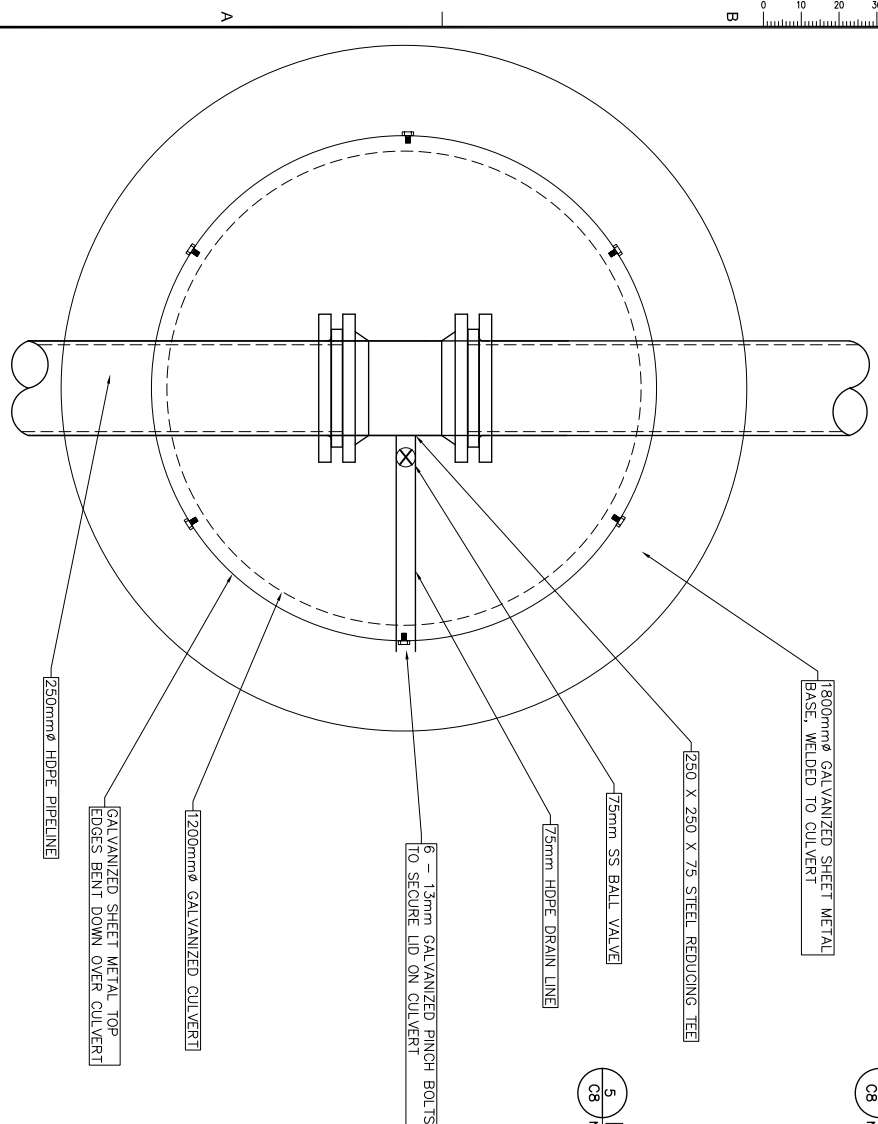
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C8 N.T.S.



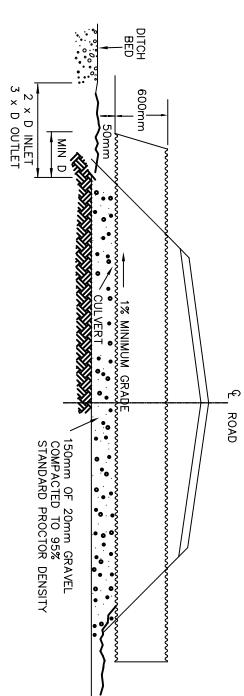
6 HDPE TO HDPE FLANGED CONNECTION
C8 N.T.S.



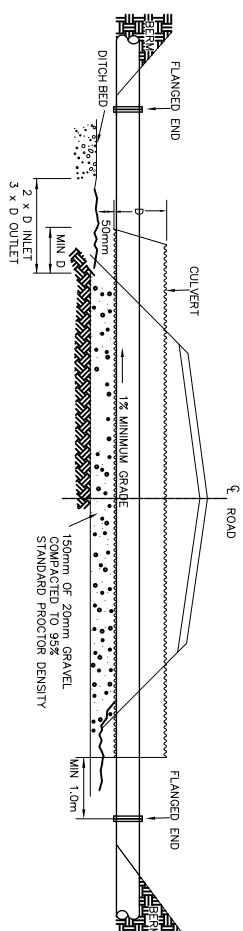
5	HDPE TO STEEL FLANGED CONNECTION
C8	N.T.S.



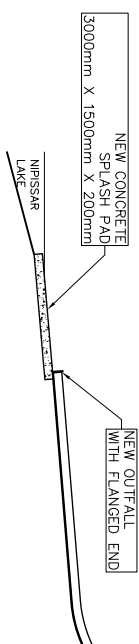
4 LOW POINT DRAIN – SIDE VIEW
C8 N.T.S.



12 CULVERT INLET AND OUTLET
C8 N.T.S.



10 OUTFALL SPLASH PAD
C8 N.T.S.



9 INTAKE SCREEN SECTION A-A
C8 N.T.S.

8 INTAKE SCREEN DETAIL "A"
C8 N.T.S.

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**PIPELINE & SCREEN
DETAILS**

NIPISSAR LAKE RESUPPLY LINE

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CHECKED BY	CLIENT P
WO	
FSC PROJECT NO.	
2010 0570	
DRAWING NO.	



NOTE:
MAINTAIN CONSISTENT SLOPE TOWARDS HIGH POINTS AND LOW
POINTS TO FACILITATE SEASONAL PIPELINE DRAINAGE

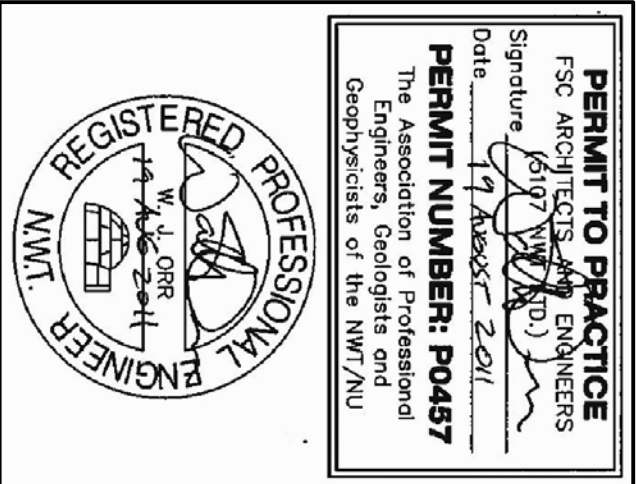


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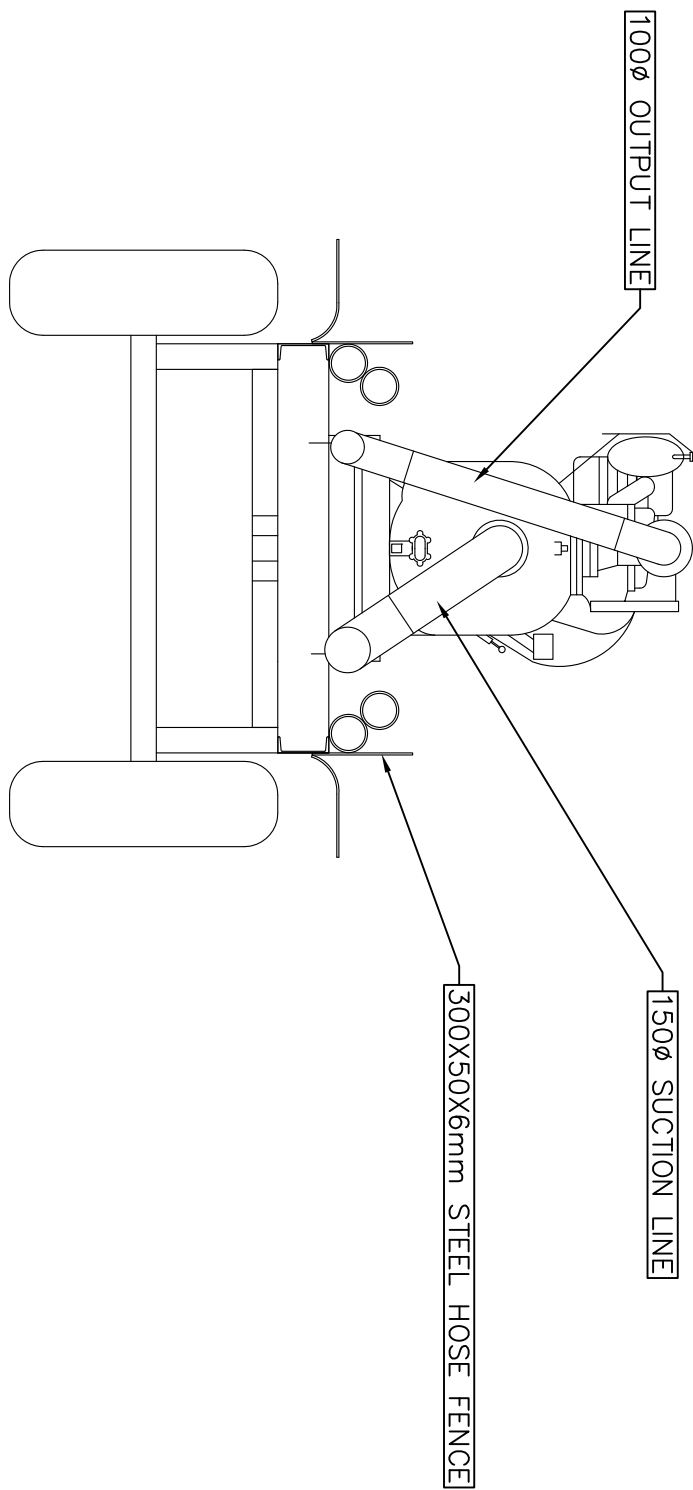
PROJECT TITLE
**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION
RANKIN INLET, NU

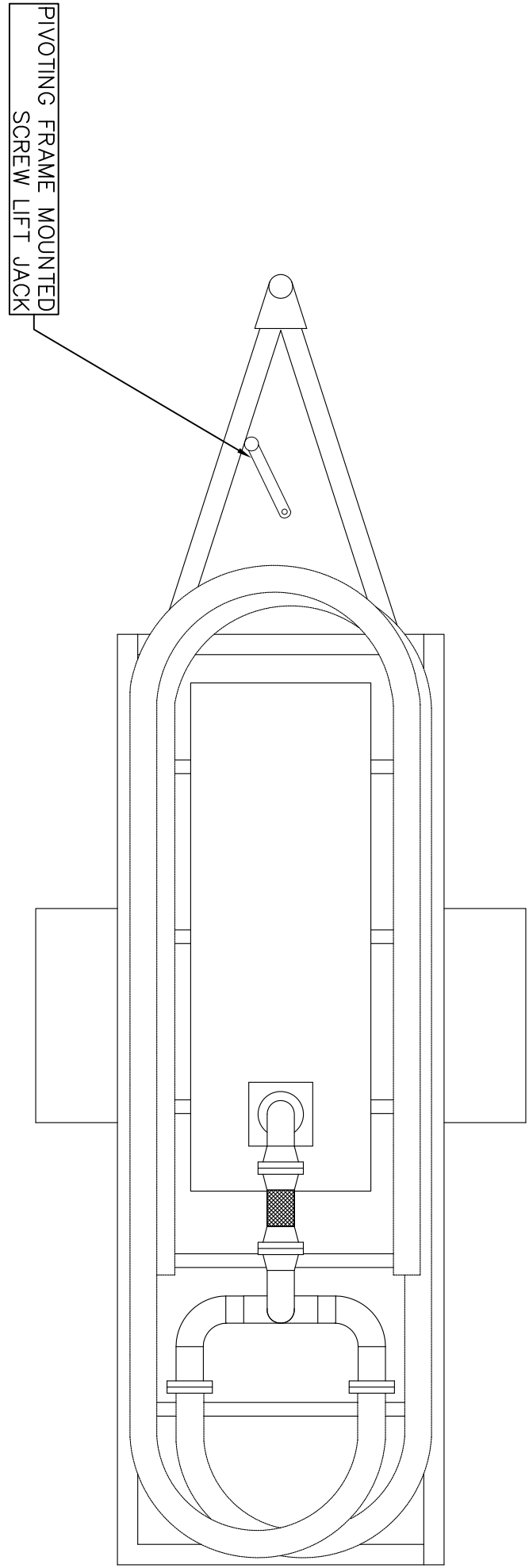
DRAWING TITLE
INTAKE PUMP DETAILS

REVISED

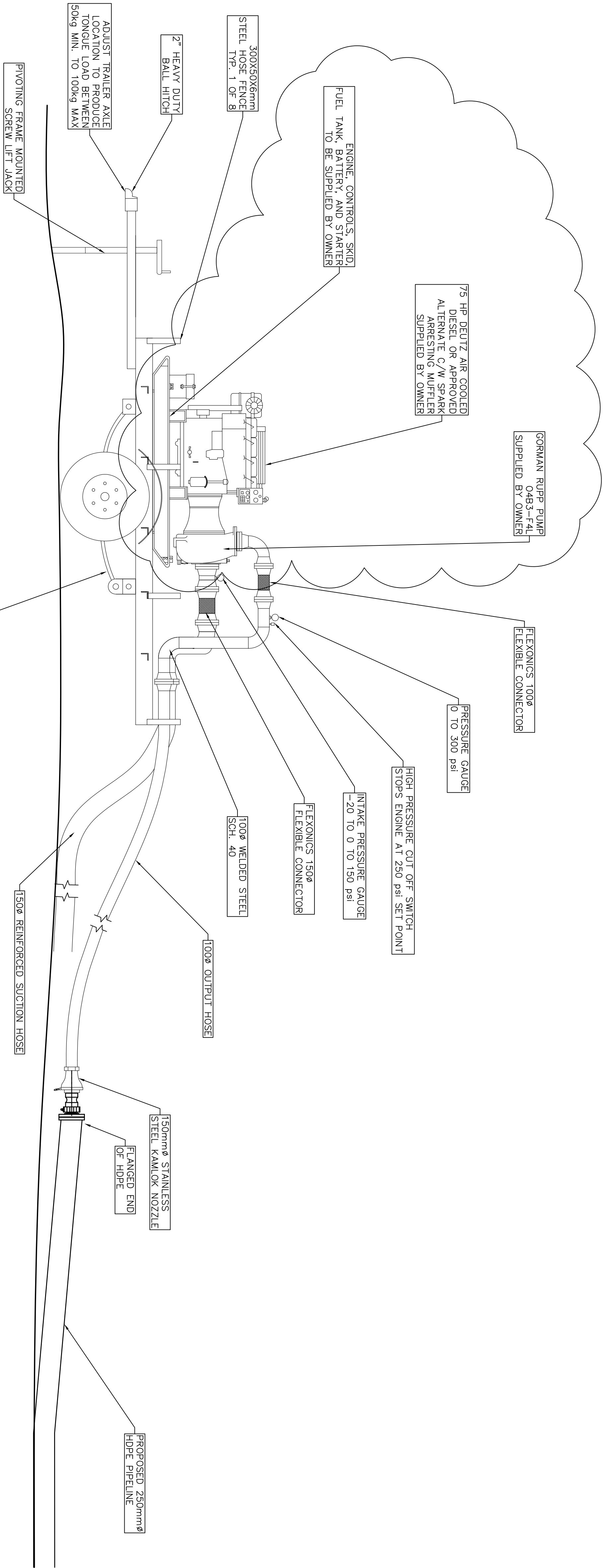
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OS/FC/AF	NTS
CHECKED BY	CLIENT PROJECT NO.
WO	-
FSC PROJECT NO.	2010 0570
DRAWING NO.	C9



1 INTAKE PUMP – REAR VIEW
C9 N.T.S.



2 INTAKE PUMP – PLAN VIEW
C9 N.T.S.



3 INTAKE PUMP – PROFILE VIEW
C9 N.T.S.



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PROJECT TITLE

**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION

RAVINKIN INLET, NU

DRAWING TITLE

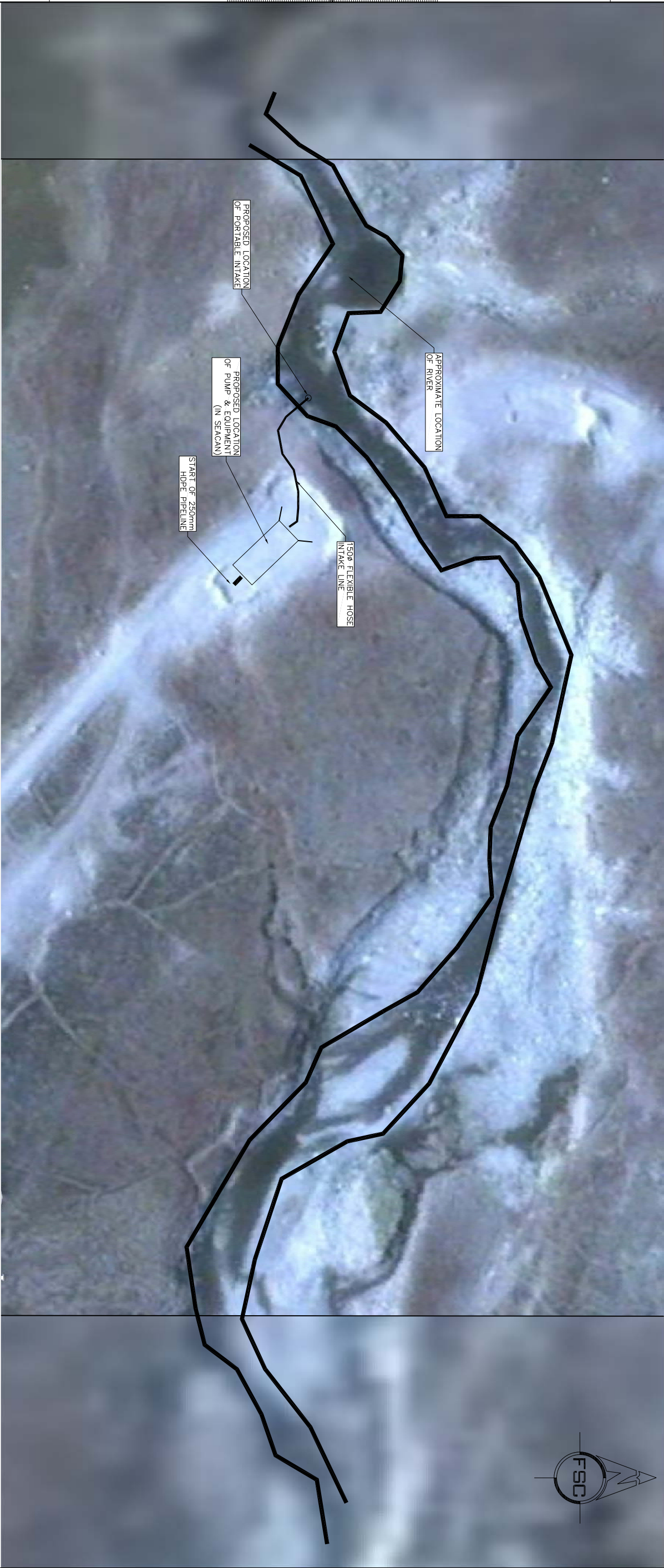
INTAKE SITE PLAN

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PROJECT TITLE

**NIPISSAR LAKE
RESUPPLY LINE**

LOCATION
RANKIN INLET, NU

DRAWING TITLE
**PROJECT
SPECIFICATIONS**

DRAWN BY CS/FG/AF	SCALE NTS
CHECKED BY WO	CLIENT PROJECT NO. -

FSC PROJECT NO.
2010 0570

DRAWING NO.

C11

INSTALLATION OF HDPE PIPE SPECIFICATIONS.

A) PREPARATION

1. CLEAN PIPES, FITTINGS, AND APPURTENANCE OF ACCUMULATED DEBRIS AND WATER BEFORE INSTALLATION. CAREFULLY INSPECT MATERIALS FOR DEFECTS. REMOVE DEFECTIVE MATERIALS FROM SITE.

B) PIPE PLACEMENT

1. HDPE PIPE SHALL BE PLACED DIRECTLY ON THE GROUND, MATCHING AS CLOSELY AS IS PRACTICAL THE ENGINEERS LAYOUT STAKES AND HUBS. PLACE PIPE TO AVOID LARGE ROCKS WHERE POSSIBLE, HOWEVER.
2. THE INTENT OF THE DESIGN OF THIS SYSTEM, IS TO HAVE A SINGLE LOW POINT AND DRAIN ALONG THE PIPELINE ROUTE, WITH THE ONLY OTHER LOW POINTS BEING AT EITHER END OF THE PIPELINE ROUTE. PLACE THE PIPE SUCH THAT NO LOCATION IN THE PIPELINE HAS MORE THAN 100 MM MAXIMUM DEPRESSION IN THE PIPELINE DESIGN GRADE, WHICH WOULD HOLD WATER WHEN THE PIPE IS DRAINED.
3. THE INTENT OF THE DESIGN OF THIS SYSTEM, IS TO HAVE A ONLY TWO HIGH POINTS ALONG THE PIPELINE ROUTE. CONNECT THE TWO HIGH POINT AIR RELEASES AT THE HIGH POINTS IN THE PIPELINE, ONE NEAR NIPISSAR LAKE, AND ONE NEAR THE PUMP CONNECTION POINT. PLACE THE PIPE SUCH THAT NO LOCATION IN THE PIPELINE HAS MORE THAN 100 MM MAXIMUM ELEVATION ABOVE THE PIPELINE DESIGN GRADE, WHICH WOULD TRAP AIR WHEN THE PIPE IS FILLED.
4. SECURE THE PIPE EVERY 50 M WITH 'U' SHAPED GALVANIZED OR STAINLESS STEEL CONSTRAINTS, TO MINIMIZE THE SHIFTING OF THE PIPE WITH THERMAL EXPANSION AND CONTRACTION.
5. PIPE ALIGNMENT AND ELEVATION REQUIRE ENGINEER'S APPROVAL PRIOR TO PLACING PIPE.

C) PIPE INSTALLATION

1. LAY PIPE TRUE TO LINE AND GRADE, EITHER ON PREPARED BEDDING OR DIRECTLY ON THE GROUND WHERE APPROPRIATE.
2. HANDLE PIPE BY APPROVED METHODS. DO NOT USE CHAINS OR CABLES PASSED THROUGH PIPE BORE SO THAT WEIGHT OF PIPE BEARS ON PIPE ENDS.
3. KEEP JOINING MATERIALS AND INSTALLED PIPE FREE TO DIRT, WATER AND OTHER FOREIGN MATERIALS. WHENEVER WORK IS STOPPED, INSTALL A REMOVAL WATERTIGHT BULB-HEAD AT OPEN END OF LAST PIPE LAID TO PREVENT ENTRY OF FOREIGN MATERIALS.
4. DO NOT TRAVEL ON THE EXPOSED TUNDRA TO LAY AND FUSE PIPE WHILE THE TUNDRA IS NOT FROZEN. ALL WORK ON THE TUNDRA IS TO BE SCHEDULED AND COORDINATED TO MINIMIZE DAMAGE TO THE TUNDRA AND ITS ASSOCIATED VEGETATION.
5. THERMAL BUTT-FUSION AND THERMAL SOCKET FUSION OF POLYETHYLENE PIPE SHALL BE CARRIED OUT AS DESCRIBED IN BULLETIN "CONSTRUCTION 3" BY DUPONT OF CANADA LTD. BY A CERTIFIED FUSION TECHNICIAN. THE TECHNICIAN SHALL HAVE A MINIMUM OF 2 YEARS EXPERIENCE AND A COPY OF HIS RESUME SHALL BE SUBMITTED FOR APPROVAL.
6. FLANGED COLLARS TO BE FUSED TO POLYETHYLENE PIPE SHALL BE MADE FROM THE SAME TYPE AND GRADE OF POLYETHYLENE, FROM THE SAME RAW MATERIAL SUPPLIER, AS THE PIPE. UNDER NO CIRCUMSTANCES WILL SOCKET FUSION JOINTS BE PERMITTED.
7. PIPE SHALL BE JOINED BY THERMAL BUTT-FUSION.
8. MINIMUM BEND RADIUS OF HDPE PIPE TO BE 50 X PIPE DIAMETER

D) HYDROSTATIC AND LEAKAGE TESTING

PROVIDE LABOUR, EQUIPMENT AND MATERIALS REQUIRED TO PERFORM HYDROSTATIC AND LEAKAGE TESTS HEREINAFTER DESCRIBED.

PRESSURE TESTING OF NIPISSAR WATER SUPPLY LINE

1. ONCE THE WATER LINE IS ASSEMBLED AND PRIOR TO THE PIPE BEDDING AND BACKFILL BEING PLACED, THEY SHALL BE PRESSURE TESTED. THE ENDS OF THE MAIN TO BE TESTED SHALL BE SEALED OFF USING BLIND FLANGES AND GASKETS. THE FLANGE ON THE LOWER END OF THE MAIN SHALL BE TAPPED TO RECEIVE THE TEST PUMP DISCHARGE LINE. THE AIR RELEASE VALVE ON THE HIGH END OF THE MAIN SHALL BE OPENED TO DISCHARGE AIR FROM THE LINE DURING THE FILLING PROCESS.
2. THE MAIN SHALL BE LAID TO A CONTINUOUSLY RISING GRADE TO THE VENT COCK. THE MAIN SHALL BE FILLED WITH WATER AT A GAUGE PRESSURE OF AT LEAST 100 PSI. THE PRESSURE SHALL BE MAINTAINED FOR ONE HOUR. NO LEAKAGE SHALL BE PERMITTED.
3. ALL LEAKS OR DEFECTIVE MATERIAL SHALL BE REPAIRED TO THE ENGINEER'S REQUIREMENTS, OR REPLACED. AFTER REPAIR WORK IS COMPLETED REPEAT TESTING SHALL BE REQUIRED.
4. NOTIFY ENGINEER AT LEAST 7 DAYS IN ADVANCE OF ALL PROPOSED TESTS. PERFORM TESTS IN PRESENCE OF ENGINEER.
5. ISOLATE ALL LOW PRESSURE EQUIPMENT DURING TESTING SO AS NOT TO PLACE ANY HYDROSTATIC HEAD IN EXCESS OF DESIGN OPERATING PRESSURE ON THE EQUIPMENT.
6. WHERE LEAKS ARE FOUND, THE LINE SHALL BE RETESTED AFTER MAKING REPAIRS EXCEPT, THAT WHERE LEAKS ARE MINOR, THE ENGINEER MAY AT HIS SOLE DISCRETION WAIVE THE RETEST.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix C Photographs
May 2014

Appendix C Photographs

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix C: Photographs
May 2014



Photo 1: Char River at the intake area with sea canister in the background.



Photo 2: Pipeline traversing land adjacent to access road.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix C: Photographs
May 2014



Photo 3: Future location of the pump. Note sea canister in foreground.



Photo 4: One section of the pipeline crossing under the existing municipal access road.

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix D Species Lists
May 2014

Appendix D Species Lists

Table D-1: Vegetation Species Which May Occur At or Near the Site, Rankin Inlet, Nunavut

English Name	Latin Name	Territorial Ranking ¹	COSEWIC Status ²
Dwarf birch	<i>Betula nana</i>	Secure	Secure
Arctic white heather	<i>Cassiope tetragona</i>	Secure	Secure
Reindeer lichen	<i>Cladina spp.</i>	Secure	Secure
Crowberry	<i>Empetrum nigrum</i>	Secure	Secure
Northern Labrador Tea	<i>Ledum palustre</i>	Secure	Secure
Arctic lichen	<i>Masonhalea richardsonii</i>	Secure	Secure
Grass spp.	<i>Poa spp.</i>	-	-
Arctic willow	<i>Salix arctica</i>	Secure	Secure
Blueberry	<i>Vaccinium uliginosum</i>	Secure	Secure
Lingonberry (Cowberry)	<i>Vaccinium vitis-idaea</i>	Secure	Secure

NOTES:

1. Territorial Ranking from CESSC (2011)
2. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status from SARPR (2013)

Table D-2: Terrestrial and Marine Mammal Species Which May Occur At or Near the Site, Rankin Inlet, Nunavut

English Name	Latin Name	Territorial Ranking ¹	COSEWIC Status ²
Terrestrial Mammals			
Arctic grey wolf	<i>Canis lupus arctos</i>	-	Data Deficient
Northern grey wolf	<i>Canis lupus occidentalis</i>	Sensitive	Not at Risk
Northern collared lemming	<i>Dicrostonyx groenlandicus</i>	Secure	-
Victoria collared lemming	<i>Dicrostonyx kilangmiutak</i>	Secure	-
Richardson's collared lemming	<i>Dicrostonyx richardsoni</i>	Secure	-
Wolverine	<i>Gulo gulo</i>	Sensitive	Special Concern
Brown lemming	<i>Lemmus trimucronatus</i>	Secure	-
Arctic hare	<i>Lepus arcticus</i>	Secure	-
Tundra vole	<i>Microtus oeconomus</i>	Undetermined	-
Meadow vole	<i>Microtus pennsylvanicus</i>	Secure	-
Ermine	<i>Mustela erminea</i>	Secure	-
Least weasel	<i>Mustela nivalis</i>	Secure	-
American mink	<i>Mustela vison</i>	Undetermined	-
Barren-ground caribou	<i>Rangifer tarandus groenlandicus</i>	Sensitive	Special Concern
Barren-ground shrew	<i>Sorex ugyunak</i>	Undetermined	-
Arctic ground squirrel	<i>Spermophilus parvii</i>	Secure	-
Red squirrel	<i>Tamiasciurus hudsonicus</i>	Undetermined	-
Grizzly bear	<i>Ursus arctos</i>	Sensitive	Special Concern
Arctic fox	<i>Vulpes arcticus</i>	Secure	-
Red fox	<i>Vulpes vulpes</i>	Secure	-
Marine Mammals			
Polar Bear	<i>Ursus maritimus</i>	Sensitive	Special Concern

NOTES:

1. Territorial Ranking from CESSC (2011)
2. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status from SARPR (2013)

Table D-3: Avifauna Species Which May Occur At or Near the Site, Rankin Inlet , Nunavut

English Name	Latin Name	Migration Habit	Territorial Ranking ¹	COSEWIC Status ²
Spotted Sandpiper	<i>Actitis macularius</i>	Migratory	Undetermined	-
Greater white-fronted goose	<i>Anser albifrons</i>	Migratory	Secure	-
American pipit	<i>Anthus rubescens</i>	Migratory	Secure	-
Brant	<i>Branta bernicla</i>	Migratory	Secure	-
Canada goose	<i>Branta Canadensis</i>	Migratory	Secure	-
Snowy owl	<i>Bubo scandiacus</i>	Resident	Secure	Not at Risk
Rough-legged hawk	<i>Buteo lagopus</i>	Migratory	Secure	Not at Risk
Lapland longspur	<i>Calcarius lapponicus</i>	Migratory	Secure	-
Sanderling	<i>Calidris alba</i>	Migratory	Sensitive	-
Dunlin	<i>Calidris alpine</i>	Migratory	Secure	-
Baird's sandpiper	<i>Calidris bairdii</i>	Migratory	Secure	-
Red Knot	<i>Calidris canutus rufa</i>	Migratory	At Risk	Endangered
White-rumped sandpiper	<i>Calidris fuscicollis</i>	Migratory	Secure	-
Pectoral sandpiper	<i>Calidris melanotos</i>	Migratory	Secure	-
Semipalmated sandpiper	<i>Calidris pusilla</i>	Migratory	Sensitive	-
Common redpoll	<i>Carduelis flammea</i>	Migratory	Secure	-
Hoary redpoll	<i>Carduelis hornemanni</i>	Resident/Migratory	Secure	-
Semipalmated plover	<i>Charadrius semipalmatus</i>	Migratory	Sensitive	-
Snow goose	<i>Chen caerulescens</i>	Migratory	Secure	-
Ross's goose	<i>Chen rossii</i>	Migratory	Secure	-
Long-tailed duck	<i>Clangula hyemalis</i>	Migratory	Secure	-
Common raven	<i>Corvus corax</i>	Resident	Secure	-
Tundra swan	<i>Cygnus columbianus</i>	Migratory	Secure	-
Horned lark	<i>Eremophila alpestris</i>	Migratory	Secure	-
Peregrine falcon	<i>Falco peregrinus anatum/tundrius</i>	Migratory	Secure	Special Concern
Gyr Falcon	<i>Falco rusticolus</i>	Resident	Secure	Not at Risk
Yellow-billed loon	<i>Gavia adamsii</i>	Migratory	Secure	Not at Risk
Pacific loon	<i>Gavia pacifica</i>	Migratory	Secure	-
Red-throated loon	<i>Gavia stellate</i>	Migratory	Secure	-
Sandhill crane	<i>Grus canadensis</i>	Migratory	Secure	-
Willow ptarmigan	<i>Lagopus lagopus</i>	Resident	Secure	-
Rock ptarmigan	<i>Lagopus mutus</i>	Resident	Secure	-
Herring gull	<i>Larus argentatus</i>	Migratory	Secure	-
Iceland gull	<i>Larus glaucoides</i>	Migratory	Secure	-
Glaucous gull	<i>Larus hyperboreus</i>	Migratory	Secure	-
Red phalarope	<i>Phalaropus fulicarius</i>	Migratory	Sensitive	-
Snow bunting	<i>Plectrophenax nivalis</i>	Migratory	Sensitive	-
American golden plover	<i>Pluvialis dominica</i>	Migratory	Sensitive	-
Common eider	<i>Somateria mollissima</i>	Migratory	Sensitive	-
King eider	<i>Somateria spectabilis</i>	Migratory	Sensitive	-
Long-tailed jaeger	<i>Stercorarius longicaudus</i>	Migratory	Secure	-
Parasitic jaeger	<i>Stercorarius parasiticus</i>	Migratory	Secure	-
Pomarine jaeger	<i>Stercorarius parasiticus</i>	Migratory	Secure	-
Arctic tern	<i>Sterna paradisaea</i>	Migratory	Secure	-
Sabine's gull	<i>Xema sabini</i>	Migratory	Secure	-

NOTES:

1. Territorial Ranking from CESSC (2011)
2. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status from SARPR (2013)

SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix E Spill Contingency Plan
May 2014

Appendix E Spill Contingency Plan

**Spill Contingency Plan for
Water Supply and Sewage
Treatment Facilities
Rankin Inlet, Nunavut**

Final



Prepared for:
Department of Community and
Government Services,
Government of Nunavut

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May 2014

Revision Record							
Revision	Description	Prepared By		Checked By		Approved By	
	Original	05/01/14	KD	05/05/14	PC	05/09/14	PC

**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

Table of Contents

1.0	INTRODUCTION	1
1.1	PURPOSE AND SCOPE	1
2.0	SITE DESCRIPTION	3
2.1	WATER SUPPLY, TREATMENT, DISTRIBUTION AND STORAGE.....	3
2.2	SEWAGE COLLECTION AND TREATMENT.....	3
2.3	POTENTIAL CONTAMINANTS	3
2.4	ADDITIONAL COPIES.....	4
3.0	RESPONSE ORGANIZATION	5
3.1	RESPONSE ORGANIZATION PROCEDURE	5
3.3	EMERGENCY CONTACT INFORMATION	7
4.0	REPORTING PROCEDURE.....	8
5.0	ACTION PLANS.....	9
5.1	SPILL PREVENTION	9
5.2	SPILL RESPONSE	9
5.2.1	Chlorine Gas Release.....	9
5.2.2	Fluosilicic Acid	10
5.2.3	Other Chemicals (Gasoline, diesel, sewage).....	11
5.2.4	Spills on Land	12
5.2.5	Spills in Water.....	13
5.3	ADDITIONAL SPILL DELINEATION OR MONITORING	13
6.0	RESOURCE INVENTORY	14
6.1	ON-SITE RESOURCES.....	14
6.1.1	Personnel	14
6.1.2	Equipment	14
6.1.3	Spill Kits	14
7.0	TRAINING AND EXERCISES.....	16
7.1	OUTLINE	16
7.2	SCHEDULE	16
8.0	REFERENCES.....	17

LIST OF TABLES

Table 2-1:	Overview of Potential Contaminants	4
Table 3-1:	Off-Site Spill Contingency Contact Information.....	7
Table 3-2:	Regulatory agencies' Spill Contingency Contact Information	7
Table 6-1:	Chlorine Gas Initial Isolation and Protective Distances.....	10

**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

LIST OF APPENDICES

APPENDIX A	FIGURES	A.1
APPENDIX B	NORTHWEST TERRITORIES – NUNAVUT SPILL REPORT FORM	B.1
APPENDIX C	2012 EMERGENCY RESPONSE GUIDEBOOK GUIDES.....	C.1
APPENDIX D	MSDS SHEETS	D.1

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Introduction
May 2014

1.0 Introduction

This Spill Contingency Plan (SCP) has been developed for use by the Government of Nunavut Department of Community and Government Services (GN-CGS) for the operation of the Water Supply and the Sewage Treatment Facilities (the facilities) located in Rankin Inlet, Nunavut.

The contact information for the GN-CGS is provided below:

Government of Nunavut
Department of Community and Government Services
Box 490
Rankin Inlet, NU X0E 0G0
(867) 645-2895

This SCP has been developed for the operation of the facilities and the regulatory approvals in accordance with the *Guidelines for Spill Contingency Planning* prepared by Indian and Northern Affairs Canada (INAC 2007) and the Spill Contingency Planning and Reporting Regulations issued under the Nunavut *Environmental Protection Act*.

Upon finalizing this SCP, the document will be in effect. The SCP will be updated and revised annually to reflect site-specific conditions, as needed.

1.1 PURPOSE AND SCOPE

The GN-CGS directs that all personnel working at its facilities are prepared to provide prompt response to any spills. The SCP allows for the prompt and coordinated response of the GN-CGS to any spill located at the Water Supply Facility and the Sewage Treatment Facilities.

The purpose of the SCP is to provide a guide to all site personnel during routine Facility operation and/or the accidental release of sewage, solid waste, hydrocarbons or other hazardous materials related to the operation of the Facilities. Specifically, the SCP ensures:

1. Life and property are protected;
2. Resources are used effectively;
3. Environmental impacts are minimized; and,
4. Essential reporting is completed.

The SCP identifies key response personnel and their roles and responsibilities in the event of a spill, as well as the equipment and other resources available to respond to a spill. To be effective, it is important that all personnel are familiar with their responsibilities and steps to take

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Introduction
May 2014

in the event of a spill. Personnel should not read the SCP for the first time during an emergency. The SCP details spill response procedures that will minimize potential health and safety hazards, environmental impacts and spill response activities.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Site Description
May 2014

2.0 Site Description

The community of Rankin Inlet (or Kangiqliniq, meaning “deep bay/inlet”, in Inuktitut) has a total land area of 20.24 km², with a population of 2,266 people (StatsCan 2012). Rankin Inlet is situated on Kudlulik Peninsula which protrudes into the Rankin Inlet of Hudson Bay, located approximately at 62°52’00” N, 92°00’00” W. The community is approximately 450 km north of Churchill, Manitoba and approximately 1,100 km east of Yellowknife, Northwest Territories.

The community is mostly residential with several commercial establishments including construction contracting businesses, a grocery store, and a variety of other smaller businesses. Community buildings include a high school, elementary school, arena, swimming pool, the Hamlet of Rankin Inlet office, Government of Nunavut offices and a police station. Future developments in the community include the Nunavut Arctic College Trades Training Centre, Rankin Inlet Healing Centre, Area 5 subdivision expansion project (including the construction of public and GN staff housing complexes. In recent years, the community has supported the progress of the Agnico-Eagle Meliadine Gold Project, located 24 km northwest of the community, which is currently in the advanced exploration and environmental assessment stage.

2.1 WATER SUPPLY, TREATMENT, DISTRIBUTION AND STORAGE

Water supply for the community is taken from Nipissar Lake, located approximately 2 km northwest of the community. During the summer months (June to September), Nipissar Lake is replenished with additional water pumped via a 4.05 km pipeline from the Char River (Figure 1 in Appendix A).

Water is withdrawn from Nipissar Lake and pumped to the Williamson Lake Pump house, where it is chlorinated, stored and distributed using a series of buried utilidors and water mains. For buildings that are not connected to the utilidor system, water is delivered using water trucks.

2.2 SEWAGE COLLECTION AND TREATMENT

Underground sanitary sewers are used throughout the community to direct sewage, wastewater, and storm water to the Sewage Treatment Facility (STF). Upon arrival at the STF, the sewage undergoes primary treatment before being discharged into the Hudson Bay. For buildings that are not connected to the sanitary sewage system, sewage is collected by vacuum truck and transported to the STF.

2.3 POTENTIAL CONTAMINANTS

Potential contaminants that may be released during the operation of the Facilities are identified in Table 2-1 below.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Site Description
May 2014

Table 2-1: Overview of Potential Contaminants

Material	Storage Location	Maximum Quantity
Sewage	Lift Stations	N/A – Continuous Flow
	Force Main	N/A – Continuous Flow
Fuel Storage	Water Treatment Plant/ Williams Lake Pump House	10,000 gallons
	Nipissar Lake Lift Station	2,500 gallons
	Con Shed Storage Facility	4 x 250 gallons
Chlorine Gas	Williams Lake Pump House	1,500 lbs (10 x 150 lbs cylinders)
	Con Shed Storage Facility	7,500 lbs (50 x 150 lbs cylinders)
Fluosilicic Acid	Williams Lake Pump House	410 L (two x 205 L drums)
	Con Shed Storage Facility	8,200 L (40 x 205 L drums)
Calcium hypochlorite	Con Shed Storage Facility	100 L (five x 20 L pails)

2.4 ADDITIONAL COPIES

Copies of the SCP are located at each of the pump houses and inside of the sea canister located adjacent to the water intake pump at the Char River. A copy of the SCP can also be located at the GN-CGS Rankin Inlet office and the Nunavut Water Board.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014

3.0 Response Organization

The GN-CGS will be responsible for preparing and implementing a detailed SCP during the entire Project duration. Whenever a spill is identified, the GN-CGS Regional Project Manager will be contacted as soon as possible.

The GN-CGS has limited equipment and personnel in the community to address a large spill. In the case of a large spill, it may require the combined efforts of the GN-CGS and the Hamlet of Rankin Inlet to address the issue.

In the event of a spill, the GN-CGS Regional Project Manager or his/her Designate will serve as the Spill Response Coordinator.

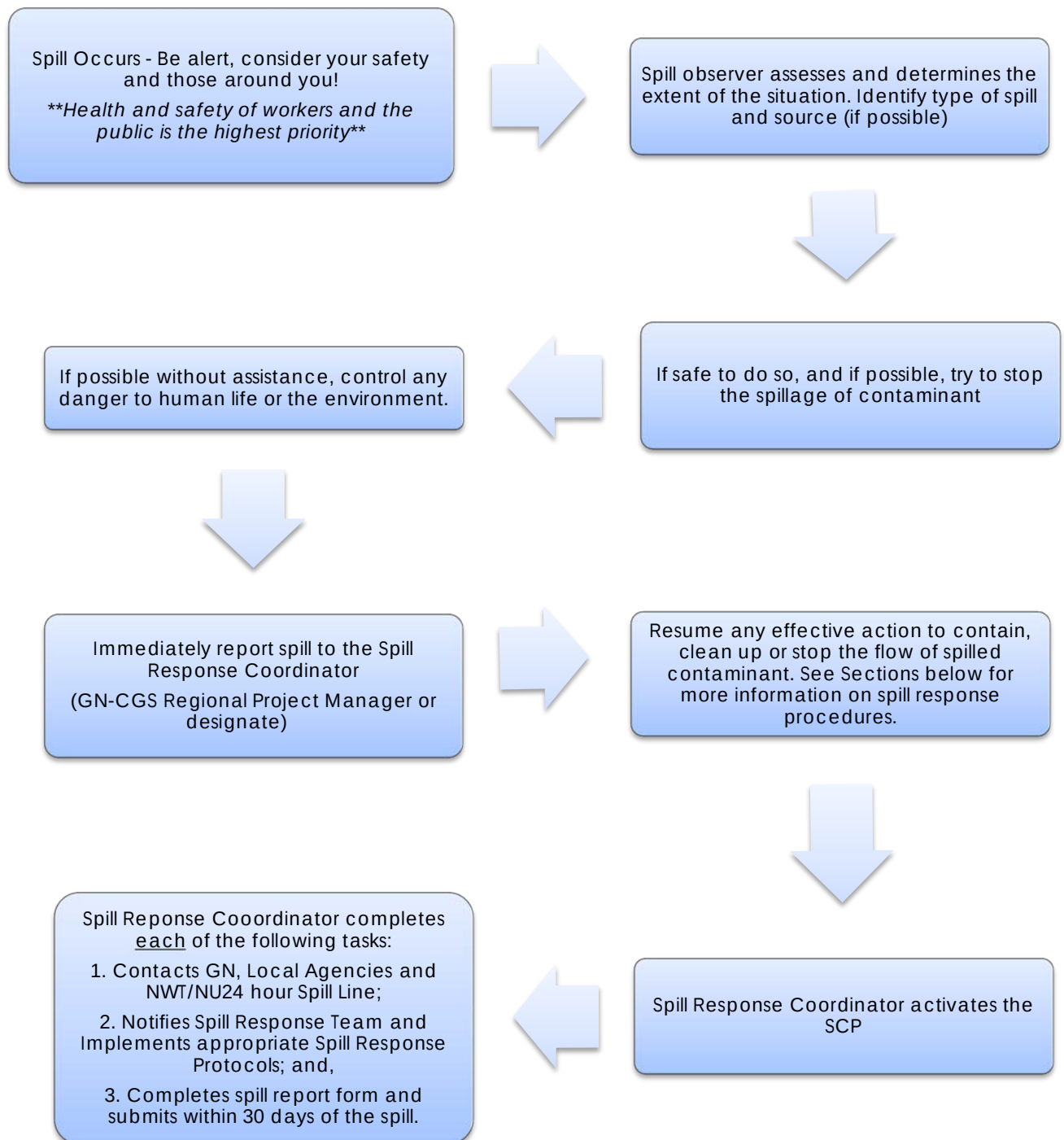
The GN-CGS Regional Project Manager or his/her Designate will appoint Hamlet Public Works personnel to the Spill Response Team and will provide the necessary training.

3.1 RESPONSE ORGANIZATION PROCEDURE

The following illustration outlines the sequence of events that must be followed in the event of a spill at the Facilities:

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014



SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014

3.3 EMERGENCY CONTACT INFORMATION

Table 3-1 provides contact information for personnel who may be contacted to provide advice, expertise, and supply resources in the event of a spill.

Table 3-1: Off-Site Spill Contingency Contact Information

Contact	Location	Telephone number
Fire Department	Rankin Inlet, NU	(867) 645-2598
RCMP Detachment	Rankin Inlet, NU	(867) 645-0123
Community Health Center	Rankin Inlet, NU	(867) 645-8300
GN-CGS – Facilities Manager	Rankin Inlet, NU	(867) 645-8154
24-Hour Emergency Spill Report Line	Yellowknife, NT	(867) 920-8130
Aboriginal Affairs and Northern Development Canada – Inspector	Rankin Inlet, NU	(867) 645-2831
Government of Nunavut – Regional Engineer	Rankin Inlet, NU	(867) 645-4074
Hamlet of Rankin Inlet	Rankin Inlet, NU	(867) 645-2895

The following agencies can be contacted for assistance in spill reporting, response and/or clean-up and remediation.

Table 2-2: Regulatory agencies' Spill Contingency Contact Information

Agency	Legislation	Contact Information
Nunavut Water Board	<i>Nunavut Waters and Surface Right Tribunal Act</i>	Phone: (867) 360-6338 Fax: (867) 360-6369
Nunavut Impact Review Board	<i>Nunavut Land Claims Agreement Act</i>	Phone: (867) 983-2593
Government of Nunavut Department of Environment	<i>Nunavut Environmental Protection Act</i>	Phone: (867) 975-7700 Fax: (867) 975-7740
Environment Canada	<i>Canadian Environmental Protection Act, 1999</i>	Phone: (867) 975-4464 Fax: (867) 975-4645
Fisheries and Oceans Canada (Iqaluit)	<i>Fisheries Act</i>	Phone: (519) 383-1813 Fax: (519) 464-5128
Transport Canada (Coast Guard)	<i>Transportation of Dangerous Goods Act</i>	Phone: (867) 979-5269 Fax: (867) 979-4260

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Reporting Procedure
May 2014

4.0 Reporting Procedure

All spills or potential spills of contaminants must be reported to the 24-hour Northwest Territories – Nunavut Emergency Spill Report Line to ensure that an investigation may be undertaken by the appropriate government authority. Reporting of any spills associated with the Project should be completed by the Spill Response Coordinator or their designate.

To Report a Spill:

1. Fill out the Northwest Territories/Nunavut Spill Report Form (found in Appendix B of this SCP) as completely as possible before calling in the spill report.
2. Contact the Government of the Northwest Territories/Nunavut 24-hour Emergency Spill Report Line:
24-HOUR EMERGENCY SPILL REPORT LINE (867) 920-8130
3. Where fax is available, fax the completed Northwest Territories/Nunavut Spill Report Form to (867) 873-6924. Alternatively, if email is available, email the completed Northwest Territories – Nunavut Spill Report Form to spills@gov.nt.ca.

Any person reporting a spill is required to give as much information as possible. However, reporting of a spill should not be delayed if all of the necessary information is not known. Additional information can be provided later. From the Consolidation of Spill Contingency Planning and Reporting Regulations (1998), as much of the following information should be reported during the initial spill report:

- Date and time of spill
- Location of spill
- Direction if the spill is moving
- Name and phone number of a contact person close to the location of the spill
- Type of contaminant spilled and quantity
- Cause of spill
- Whether spill is continuing or has stopped
- Description of existing contaminant
- Action taken to contain, recover, clean up, and dispose of spilled contaminant
- Name, address and phone number of person reporting the spill
- Name of owner or person in charge, management or control of contaminants at the time of the spill.

In addition to reporting to the 24-hour Emergency Spill Report Line, an Aboriginal Affairs and Northern Development Canada (AANDC) Inspector must be notified of a spill immediately after occurrence. A copy of the completed Spill Report Form should be forwarded to them.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

5.0 Action Plans

5.1 SPILL PREVENTION

The most likely spill possibilities at the Facilities would be spillage from sewage pump-out activities; leakage or failure from sewage lines; spillage or leakage from chlorine containment or injection lines; leakage of diesel from on-site generators; spillage when refueling generators; or, a vehicular accident. Primary spill prevention measures will include:

- All Project personnel will receive spill contingency training prior to beginning work.
- All contaminants will be stored at designated storage areas more than 30 m from the high-water mark of any waterbody.
- All fuel storage vessels will have secondary containment such as containment trays, berms, and/or double-walled tanks designed to hold 110% of total volume of stored fuel.
- All fuel storage and transfer operations will take place at a designated fuel storage area and will be conducted by trained personnel.
- Emergency spill response kits will be kept at the Nipissar Lake Pump house, Williamson Lake Pump house, the Char River sea canister and any designated fuel storage areas, in case of fluid leaks or spills from machinery.
- Spill mats and/or drip pans/trays will be placed under all mobile fueling containers and under equipment when not in use.
- All stationary activities will be conducted at least 30 m from the ordinary high water mark of any waterbody or watercourse, where possible.
- All equipment and vehicles used for operations will be in good working order and free of leaks.
- Identified equipment or vehicle deficiencies will be repaired.
- Regular inspection and maintenance will be conducted for all hoses and lines associated with the Facilities.
- All sewage and solid waste will be contained and sealed in watertight containers.
- Drips will be cleaned up immediately.

5.2 SPILL RESPONSE

The following steps outline the general spill response procedures for initial actions to be taken to contain and clean up a contaminant spill, as well as disposing of contaminated materials.

5.2.1 Chlorine Gas Release

Potential impacts of failure and release of chlorine gas would be to public health and surrounding infrastructure. The chlorine gas is held in ventilated and restricted access rooms. Chlorine gas will disperse to the atmosphere leaving no residue, however in liquid form it is corrosive and therefore should be cleaned up and disposed of using proper procedures and

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

equipment. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 124 – Gases – Toxic and/or Corrosive – Oxidizing.

Any person finding a discharge of chlorine gas or a malfunction of chlorine gas in the facilities should immediately report the incident to the GN-CGS Facilities Manager. Use the Response Organization to notify the proper authorities (Section 3.3). In the event of a spill or leak, enclosed spaces should be ventilated; do not access unventilated areas without proper respiratory and protective clothing/gloves. Eliminate all sources of ignition and where possible elevate the cylinder such that gas and not liquid escapes.

If there is a chlorine gas leak or spill during transportation follow the emergency response plan developed as per the TDG regulations. The TDG plan must be shipped with the dangerous goods and be readily available. If no emergency plan is available follow the Transport Canada Emergency Guidebook (2012) Guide 124 – Gases – Toxic and/or Corrosive – Oxidizing provided in Appendix C.

From the Transport Canada Emergency Guidebook (2012) the initial isolation and protective action distances for chlorine are:

Table 5-1: Chlorine Gas Initial Isolation and Protective Distances

Chemical Name	Small Spills (from a small package or a small leak from a large unit)			Large Spills (from a large package or from many small packages)		
	First Isolate in All directions	Then Protect Persons Downwind during		First Isolate in All directions	Then Protect Persons Downwind during	
		Day	Night		Day	Night
Chlorine	60 m	0.4 km	1.6 km	600 m	3.5 km	8.0 km

5.2.2 Fluosilicic Acid

Fluosilicic acid is a toxic substance that can cause severe burns and destruction to tissue of the mucous membranes and upper respiratory tract when inhaled. Fluosilicic acid is a liquid and should be stored in a tightly closed container in a well-ventilated area. After use, container must be resealed and kept upright to prevent leaks. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 154 – Substance – Toxic and/or Corrosive (Non-combustible) provided in Appendix C.

In the event of an accidental spill, wear respiratory protection and avoid breathing in the vapors. Evacuate personnel from the area. Any person finding a leak of fluosilicic acid in the facilities should immediately report the incident to the GN-CGS Facilities Manager. Notify the

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

proper authorities (Section 3.3). If inhaled, move to fresh air immediately. If the liquid has made contact with skin or eyes, rinse thoroughly with plenty of water. The substance is not combustible; however, over time, the substance may decompose to produce corrosive or toxic fumes. Use water spray, alcohol resistant foam, dry chemical or carbon dioxide to extinguish flames. More detailed information on this substance can be found on the attached MSDS sheet in Appendix D.

For clean-up, soak up with absorbent pads and contain pads in sealed containers. Dispose of pads as hazardous waste at the community landfill.

5.2.3 Other Chemicals (Gasoline, diesel, sewage)

Gasoline, diesel and sewage spills could potentially affect the public and the surrounding environment. When fuel spills, vapors may travel to sources of ignition and flash back or collect in confined areas. Raw sewage spills can be a concern to public health. If a fuel or sewage leak is observed, stop the flow of contaminant if safe to do so. Immediately report the incident to the GN-CGS Facilities Manager and notify the proper authorities (Section 3.3).

For fuel spills, isolate the spill or leak area for a minimum of 50 m in all directions. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 128 – Flammable Liquids (Non-polar/Water Immiscible), provided in Appendix C. All fuel contaminated soils should be treated in the local landfarm in accordance with normal operating procedures. Small quantities of material can be stored in labelled drums at the hazardous waste storage area in the landfill.

A small sewage spill can occur from a truck lead or household tank. If the spill is small, cleanup may be accomplished with a vacuum truck. Any residual sewage can be diluted with water. For larger spills, the area must be contained with berms. Vacuum trucks and/or excavators can be used to remove contaminated material. All sewage contaminated materials will be transported to the sewage treatment facility (liquids) or landfill facility for disposal.

5.2.3.1 Spills on Snow/Ice

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative to report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES

RANKIN INLET, NUNAVUT

Action Plans
May 2014

6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent materials or a snow/soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g., gasoline, diesel).
7. Once the spill has been controlled and further spreading prevented, contact the GN-CGS facilities representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with the spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for disposal. Impacted snow should be stored in drums for proper disposal.

5.2.4 Spills on Land

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage, etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container), or contain the spill (e.g., place a container or tarp with built up edges under the spill source to contain the spill).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative and report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.
6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent (oil-absorbing) materials or a soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g., gasoline, diesel).
7. If some contaminant has entered a waterway, follow procedures in Section 5.2.5 to contain and clean-up the contaminant in the water.
8. Once the spill has been controlled and further spreading prevented, contact the GN-CGS site representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
9. If possible with spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for proper disposal. Do not flush the affected area with water.
10. If possible, remove any contained liquid by pumping into secure drums.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

5.2.5 Spills in Water

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative and report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.
6. If the spill is small enough to be controlled with the spill response materials at hand, use sorbent booms to contain the spill for recovery. Place sorbent sheets on the water within the boomed area to help contain the contaminant. For narrow waterways such as streams, place one or more sorbent booms across the waterway, downstream of the spill location, and anchor the booms on each bank.
7. Once the spill has been controlled and further spreading prevented, contact the GN-CGS facilities representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with spill response materials at hand, clean up the remaining spilled contaminant within the boom area. Store contaminated materials in a secure container for proper disposal.

5.3 ADDITIONAL SPILL DELINEATION OR MONITORING

In the event of a large spill or a spill in which not all of the spilled contaminant can be readily cleaned up with materials at hand (as described in Section 5.2), delineation of the affected area may be required. This would include subsurface investigation of the area (i.e., digging of test pits, soil sampling, installation of monitoring wells) to determine how large and how deep the contaminant affected the subsurface soil and/or groundwater (horizontal and vertical extent of the spill). The delineation would result in the development of an appropriate remediation plan for the affected area. In this case, a qualified environmental consultant should be retained to provide advice on how to proceed with delineation and remediation of a large spill.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Resource Inventory
May 2014

6.0 Resource Inventory

6.1 ON-SITE RESOURCES

6.1.1 Personnel

All personnel hired to work on the sites will be trained on-site in spill prevention, response and clean-up measures (see Section 7.0).

6.1.2 Equipment

The following is a list of equipment available to respond to possible spills.

- Loader
- Dozers
- Haul/dump trucks
- Excavator
- Personnel pick-up trucks, ATVs and snowmobiles.

6.1.3 Spill Kits

6.1.3.1 Spill Kit Locations

At least one spill kit will be clearly marked and present at the Williamson Lake Pump house, the Nipissar Lake Pump house and the Char River sea canister. Additional spill kits will be placed with working equipment and crews.

6.1.3.2 Spill Kit Contents

The following outlines the recommended minimum requirements for contents of spill kits to be used; the GN-CGS facilities representative is responsible to supply the spill kits. Each spill kit will be regularly inspected to ensure it always contains the following, at a minimum:

- 1 – 205 L open top steel drum with lid, bolting ring and gasket (spill kit container)
- 10 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm) with ties
- 4 – 12.5 cm x 3 m (5 in. x 10 ft.) sorbent booms
- 10 kg bag of sorbent particulate
- 100 sheets (1 bale) of 50 cm x 50 cm sorbent sheets
- 2 large (5 m x 5 m) plastic tarps
- 1 roll duct tape
- 1 utility knife
- 1 field notebook and pencil
- 1 rake

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Resource Inventory
May 2014

- 1 pick-axe
- 3 spark-proof shovels
- 4 Tyvex® splash suits
- 4 pairs chemical resistant gloves
- 4 pairs of splash protective goggles
- Instruction binder, including the SCP.

The entire spill kit contents, with the exception of the spark-proof shovels, can be stored within the 205 L steel drum. The drum should be sealed securely to protect the spill kit contents though should always be accessible without the use of tools (i.e., finger tight bolt ring). The drum's bolt ring should be inspected regularly during facility inspections to ensure it turns freely and is lubricated.

Extra spill response materials should also be available for use, in addition to the spill kit contents. These include:

- 10 – 205 L open top steel drum with lid, bolting ring and gasket
- 2 spark-proof shovels
- 50 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm)
- 10 – 12.5 cm x 3 m (5 in. x 10 ft.) sorbent booms
- 5 – 10 kg bags of sorbent particulate
- 500 sheets (5 bales) of 50 cm x 50 cm sorbent sheets
- 2 Tyvex® splash suits
- 2 pairs of chemical resistant gloves
- 2 pairs of splash protective goggles

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Training and Exercises
May 2014

7.0 Training and Exercises

7.1 OUTLINE

The GN-CGS facilities representative will be responsible for providing a qualified supervisor and training personnel in spill response. All individuals hired to work at the facilities should have their basic first aid and Workplace Hazardous Materials and Information System (WHMIS) training before working at any of the Facilities.

A training session on spill prevention and response will be held for all facility employees on an annual basis, or when initially hired. Training exercises, including proper use of spill kits, will provide hands-on training for individuals on spill response procedures and equipment. Training exercises can be held during the training session for all individuals or at another time for individuals directly involved with handling of hazardous materials.

The training session should review this SCP and include information on:

- Individuals roles and responsibilities in regards to spill prevention, detection, response and clean-up
- Location(s) of hard copies of the SCP, maps and spill kits
- Equipment available for spill response
- Content of spill kits
- Initial actions and spill reporting procedures and,
- Spill response and clean-up actions.

7.2 SCHEDULE

The training session and exercises will be provided as part of the Worker Orientation and held annually thereafter.

The GN-CGS facilities representative will keep records of all individuals who attend the training session and exercises, as well as copies of their training certificates (e.g., first aid, WHMIS).

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

References
May 2014

8.0 References

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SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix A Figures
May 2014

Appendix A Figures



Sources: Imagery - Microsoft BING, Thematic Data - FSC Architects and Engineers

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Nipissar Lake Resupply Line - Site Plan

Figure 1-1



**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

Appendix B Northwest Territories – Nunavut Spill Report Form
May 2014

Appendix B Northwest Territories – Nunavut Spill Report Form



Canada

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE

TEL: (867) 920-8130

FAX: (867) 873-6924

EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR		REPORT TIME	☐ ORIGINAL SPILL REPORT, OR ☐ UPDATE # TO THE ORIGINAL SPILL REPORT	REPORT NUMBER -
	OCCURRENCE DATE: MONTH – DAY – YEAR		OCCURRENCE TIME		
C	LAND USE PERMIT NUMBER (IF APPLICABLE)		WATER LICENCE NUMBER (IF APPLICABLE)		
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM THE NAMED LOCATION			REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR	
E	LATITUDE DEGREES MINUTES SECONDS		LONGITUDE DEGREES MINUTES SECONDS		
F	RESPONSIBLE PARTY OR VESSEL NAME		RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION		
G	ANY CONTRACTOR INVOLVED		CONTRACTOR ADDRESS OR OFFICE LOCATION		
H	PRODUCT SPILLED		QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
	SECOND PRODUCT SPILLED (IF APPLICABLE)		QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
I	SPILL SOURCE		SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES	
J	FACTORS AFFECTING SPILL OR RECOVERY		DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR EQUIPMENT	
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS				
L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION Station operator	EMPLOYER	LOCATION CALLED Yellowknife, NT	REPORT LINE NUMBER (867) 920-8130
LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ AANDC ☐ NEB ☐ TC			SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN		FILE STATUS ☐ OPEN ☐ CLOSED
AGENCY		CONTACT NAME	CONTACT TIME	REMARKS	
LEAD AGENCY					
FIRST SUPPORT AGENCY					
SECOND SUPPORT AGENCY					
THIRD SUPPORT AGENCY					

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix C 2012 Emergency Response Guidebook Guides
May 2014

Appendix C 2012 Emergency Response Guidebook Guides

POTENTIAL HAZARDS

HEALTH

- **TOXIC; may be fatal if inhaled or absorbed through skin.**
- Fire will produce irritating, corrosive and/or toxic gases.
- Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite.
- Runoff from fire control may cause pollution.

FIRE OR EXPLOSION

- Substance does not burn but will support combustion.
- Vapors from liquefied gas are initially heavier than air and spread along ground.
- These are strong oxidizers and will react vigorously or explosively with many materials including fuels.
- May ignite combustibles (wood, paper, oil, clothing, etc.).
- Some will react violently with air, moist air and/or water.
- Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.
- Containers may explode when heated.
- Ruptured cylinders may rocket.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION

Spill

- See Table 1 - Initial Isolation and Protective Action Distances.

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE

Small Fire

CAUTION: These materials do not burn but will support combustion. Some will react violently with water.

- Contain fire and let burn. If fire must be fought, water spray or fog is recommended.
- **Water only; no dry chemical, CO₂ or Halon®.**
- Do not get water inside containers.
- Move containers from fire area if you can do it without risk.
- Damaged cylinders should be handled only by specialists.

Fire involving Tanks

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not direct water at source of leak or safety devices; icing may occur.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Keep combustibles (wood, paper, oil, etc.) away from spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material.
- Do not direct water at spill or source of leak.
- If possible, turn leaking containers so that gas escapes rather than liquid.
- Prevent entry into waterways, sewers, basements or confined areas.
- Isolate area until gas has dispersed.
- Ventilate the area.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- **Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Clothing frozen to the skin should be thawed before being removed.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Keep victim warm and quiet.
- Keep victim under observation.
- Effects of contact or inhalation may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

POTENTIAL HAZARDS

HEALTH

- **TOXIC**; inhalation, ingestion or skin contact with material may cause severe injury or death.
- Contact with molten substance may cause severe burns to skin and eyes.
- Avoid any skin contact.
- Effects of contact or inhalation may be delayed.
- Fire may produce irritating, corrosive and/or toxic gases.
- Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

FIRE OR EXPLOSION

- Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.
- Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.).
- Contact with metals may evolve flammable hydrogen gas.
- Containers may explode when heated.
- For UN3171, if Lithium ion batteries are involved, also consult GUIDE 147.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters (150 feet) for liquids and at least 25 meters (75 feet) for solids.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate enclosed areas.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION

Spill

- See Table 1 - Initial Isolation and Protective Action Distances for highlighted materials. For non-highlighted materials, increase, in the downwind direction, as necessary, the isolation distance shown under "PUBLIC SAFETY".

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE**Small Fire**

- Dry chemical, CO₂ or water spray.

Large Fire

- Dry chemical, CO₂, alcohol-resistant foam or water spray.
- Move containers from fire area if you can do it without risk.
- Dike fire-control water for later disposal; do not scatter the material.

Fire Involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Do not get water inside containers.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- DO NOT GET WATER INSIDE CONTAINERS.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- **Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- For minor skin contact, avoid spreading material on unaffected skin.
- Keep victim warm and quiet.
- Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

POTENTIAL HAZARDS

FIRE OR EXPLOSION

- **HIGHLY FLAMMABLE:** Will be easily ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.
- For UN3166, if Lithium ion batteries are involved, also consult GUIDE 147.
- **If molten aluminum is involved, refer to GUIDE 169.**

HEALTH

- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO₂, water spray or regular foam.

Large Fire

- Water spray, fog or regular foam.
- **Do not use straight streams.**
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim warm and quiet.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix D MSDS Sheets
May 2014

Appendix D MSDS Sheets

MATERIAL SAFETY DATA SHEET

CHLORINE, LIQUEFIED GAS

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Brenntag Canada Inc.
43 Jutland Rd.
Toronto, ON
M8Z 2G6
(416) 259-8231

WHMIS#: 00010002
Index: GCD0016/10C
Effective Date: 2008 January 15
Date of Revision: 2010 August 03

Website: <http://www.brenntag.ca>

EMERGENCY TELEPHONE NUMBERS (FOR EMERGENCIES INVOLVING CHEMICAL SPILLS OR RELEASE)

Toronto, ON (416) 226-6117
Edmonton, AB (780) 424-1754

Montreal, QC (514) 861-1211
Calgary, AB (403) 263-8660

Winnipeg, MB (204) 943-8827
Vancouver, BC (604) 685-5036

PRODUCT IDENTIFICATION

Product Name: Chlorine, Liquefied Gas.
Chemical Name: Chlorine.
Synonyms: Not available.
Chemical Family: Halogen.
Molecular Formula: Cl₂.
Product Use: Bactericide in water treatment. Chemical intermediate.

DO NOT RE-USE EMPTY CONTAINERS. RETURN ALL CONTAINERS TO BRENNTAG CANADA.

WHMIS Classification / Symbol:

A: Compressed Gas
C: Oxidizer
D-1A: Very Toxic (acute effects)
D-2A: Very Toxic (chronic effects)
E: Corrosive



READ THE ENTIRE MSDS FOR THE COMPLETE HAZARD EVALUATION OF THIS PRODUCT.

2. COMPOSITION, INFORMATION ON INGREDIENTS (Not Intended As Specifications)

<i>Ingredient</i>	<i>CAS#</i>	<i>ACGIH TLV</i>	<i>% Concentration</i>
Chlorine	7782-50-5	0.5 ppm *A4	95 - 100

A4 = Not classifiable as a human carcinogen. (ACGIH-A4).

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Corrosive! Toxic! May be fatal if inhaled. Causes severe skin and eye burns. Gas is extremely irritating to eyes and respiratory tract. See "Other Health Effects" Section. Strong, offensive odor. Strong oxidizer. Contact with other combustible material can cause fire. Liquefied compressed gas. Contents under pressure. Ruptured containers may rocket.

POTENTIAL HEALTH EFFECTS

Inhalation:	Corrosive! Toxic! Product may cause severe irritation of the nose, throat and respiratory tract. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary oedema (fluid build-up in lungs), and reduction of pulmonary function. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4) Toxic effects may be delayed. See "Other Health Effects" Section.
Skin Contact:	Corrosive! Chlorine vapours may cause burning and prickling sensations, reddening and blisters. Direct contact with liquid causes severe local irritation, blistering and burns. Avoid handling when the skin is moist, wet or abraded. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4) Burns (chemical) can occur if not promptly removed.
Skin Absorption:	May be absorbed through intact skin. Skin absorption is a secondary concern to the continual destruction of tissue while the product is in contact with the skin.
Eye Contact:	Extremely corrosive! This product causes corneal scarring and clouding. Glaucoma, cataracts and permanent blindness may occur. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4)
Ingestion:	Corrosive! Product is a gas. Ingestion is not a likely route of exposure.
Other Health Effects:	Corrosive effects on the skin and eyes may be delayed, and damage may occur without the sensation or onset of pain. Strict adherence to first aid measures following any exposure is essential. May cause frostbite, olfactory fatigue, tooth erosion, cardiovascular effects, shock, central nervous system (CNS) depression, asphyxia and cyanosis. Olfactory fatigue is a term used to describe a condition characterized by the temporary loss of odour perception. CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure. Cyanosis is characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia. Asphyxia is characterized by increased breathing volume, accelerated pulse rate, muscular incoordination, faulty judgement, emotional instability, fatigue, nausea, vomiting, bewilderment, gasping respiration and unconsciousness. Chlorine: Inhalation exposure can result in primary irritation of the respiratory tract, gradual loss of pulmonary function and asthma-like attacks in susceptible individuals. Acute exposure is characterized by the irritation of the respiratory tract causing runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function. Overexposure may lead to bronchitis, bronchial spasm and pulmonary oedema. Chronic exposure may lead to asthmatic attack in certain individuals, with the following symptoms: chest tightness, wheezing, cough and shortness of breath. (3)

4. FIRST AID MEASURES

FIRST AID PROCEDURES

Inhalation:	Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Oxygen administration may be beneficial in this situation but should only be administered by personnel trained in its use. Obtain medical attention IMMEDIATELY.
Skin Contact:	Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. See "Note to Physicians" below. When treating frost bite, flush affected areas with water no warmer than 44 Deg. Celsius. Do not use heated water or dry heat and frozen parts should not be rubbed before or after thawing.
Eye Contact:	Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim until the recommended flushing period is completed unless flushing can be continued during transport. When treating frost bite, flush affected areas with water no warmer than 44 Deg. Celsius. Do not use heated water or dry heat and frozen parts should not be rubbed before or after thawing.
Ingestion:	Do not attempt to give anything by mouth to an unconscious person. If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. IMMEDIATELY contact local Poison Control Centre. Vomiting should only be induced under the direction of a physician or a poison control centre. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. IMMEDIATELY transport victim to an emergency facility.

Note to Physicians:	Treatment for corrosive chemical contact with skin after initial flushing procedures: 1. Immerse the exposed part immediately in ice water to relieve pain and to prevent swelling and blistering. Place cold packs, ice or wet cloths on the burned area if immersion is not possible. 2. Remove anything that is constrictive, such as rings, bracelets or footwear, before swelling begins. 3. Cover the exposed part with a clean, preferably sterile, lint-free dressing. 4. For severe exposure, immediately seek medical attention and monitor breathing and treat for shock. Medical conditions that may be aggravated by exposure to this product include neurological, cardiovascular and skin disorders, diseases of the skin, eyes or respiratory tract.

5. FIRE-FIGHTING MEASURES

<i>Flashpoint (°C)</i>	<i>Autolgnition Temperature (°C)</i>	<i>Flammability Limits in Air (%):</i>	
		<i>LEL</i>	<i>UEL</i>
Not Flammable.	Not applicable.	Not applicable.	Not applicable.
Flammability Class (WHMIS):	Not regulated.		
Hazardous Combustion Products:	Thermal decomposition products are toxic and may include oxides of chlorine and irritating gases. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)		
Unusual Fire or Explosion Hazards:	Although non-combustible in air, chlorine supports the combustion of other materials. Flammable gases and vapours will form explosive mixtures with chlorine. Chlorine cylinders and tonne containers are equipped with fusible plugs. The fusible plugs are designed to melt at temperatures above 70 Deg. Celsius to reduce the internal pressure of the cylinder by releasing Chlorine gas. Expansion of liquid and change of state from liquid to vapour will allow mixture to encompass a large area. If tank is involved in a fire situation, a BLEVE (Boiling Liquid Expanding Vapour Explosion) may result. Ruptured containers may rocket. Where possible, elevate the leak to the highest position such that gas and not liquid escapes.		
	This product is a strong oxidizer. Strong oxidizers can cause ignition of combustible or oxidizable materials. May decompose violently on contact with metals, or their salts, dusts or other contaminants.		
Sensitivity to Mechanical Impact:	Not expected to be sensitive to mechanical impact.		
Rate of Burning:	Not available.		
Explosive Power:	Not available.		
Sensitivity to Static Discharge:	Not expected to be sensitive to static discharge.		
EXTINGUISHING MEDIA			
Fire Extinguishing Media:	Use media appropriate for surrounding fire and/or materials.		
FIRE FIGHTING INSTRUCTIONS			
Instructions to the Fire Fighters:	Fire-exposed containers should be kept cool by spraying with water to reduce pressure. Isolate materials that are not involved in the fire and protect personnel. Cool containers with flooding quantities of water until well after the fire is out. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Remove containers from fire zone whenever possible. Ventilate low lying areas such as sumps or pits where dense vapours may collect.		
Fire Fighting Protective Equipment:	Use self-contained breathing apparatus and special protective clothing.		

6. ACCIDENTAL RELEASE MEASURES

Information in this section is for responding to spills, leaks or releases in order to prevent or minimize the adverse effects on persons, property and the environment. There may be specific reporting requirements associated with spills, leaks or releases, which change from region to region.

Containment and Clean-Up Procedures: In all cases of leak or spill contact vendor at Emergency Number shown on the front page of this MSDS. See Section 13, "Deactivating Chemicals".

Wear respirator, protective clothing and gloves. Ruptured containers may rocket. Ventilate enclosed spaces. Where possible, elevate the leak to the highest position of the cylinder, such that gas and not liquid escapes. Apply emergency device. Eliminate all sources of ignition. Move unprotected personnel upwind of leaking container. Call emergency response naming the chemical and the type of container that is leaking. Consider the use of fog-nozzles to control vapours. Do not immerse in water. Notify applicable government authority if release is reportable or could adversely affect the environment. Vapour knock down water is corrosive and toxic, thus it should be diked for containment. Ensure compatible materials are used. For a leaking container: dispose of contents to a safe out-of-doors area or a hood with forced ventilation. Attach appropriate control valve provided with a trap or check valve and a long piece of flexible hose connected to the valve outlet. Discharge the gas at a moderate rate into an adequate amount of approximately 15% aqueous Sodium Hydroxide or other alkali or reducing solution in suitable container. When all the gas is discharged, close the cylinder valve and tag the cylinder as defective. (3)

7. HANDLING AND STORAGE

HANDLING

Handling Practices: 9 Vapours are heavier than air. Use self-contained breathing apparatus. Secure containers at all times. Fix leaks promptly. Immerse contaminated clothing in water immediately and KEEP WET until discarded or laundered. Avoid moisture contamination. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Do not store or transport with food or feed. Keep away from combustibles and incompatible materials.

Ventilation Requirements: See Section 8, "Engineering Controls".

Other Precautions: Use only with adequate ventilation and avoid breathing vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

STORAGE

Storage Temperature (°C): Ideal storage temperature is 10-27 Deg. Celsius. Do not expose sealed containers to temperatures above 51 °C or Below -29 °C. (3)

Ventilation Requirements: Do not use in poorly ventilated or confined areas without proper respiratory protection. Ventilation should be corrosion proof.

Storage Requirements: Store in a cool, well-ventilated area. Keep away from heat, sparks and flames. Keep containers closed. Do not expose sealed containers to temperatures above 51 °C. Use of a Chlorine gas monitor with local and remote alarms and monitoring is strongly recommended. Secure containers at all times. Fix leaks promptly. Regularly inspect process equipment, piping and detection equipment. Chlorine cylinders and tonne containers are equipped with fusible plugs. The fusible plugs are designed to melt at temperatures above 70 Deg. Celsius to reduce the internal pressure of the cylinder by releasing Chlorine gas. Avoid storage of cylinders for more than 6 months. (3)

Special Materials to be Used for Packaging or Containers: Chlorine is stable in steel containers at room temperatures when stored dry. Intense local heat above 200 C on steel walls can cause steel to ignite chlorine. (3) Equipment for storage, handling or transportation should NOT be made of: stainless steel. Confirm suitability of any material before using.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Recommendations listed in this section indicate the type of equipment, which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

ENGINEERING CONTROLS

Engineering Controls: Local exhaust ventilation required. Ventilation should be corrosion proof. Make up air should be supplied to balance air that is removed by local or general exhaust ventilation. Ventilate low lying areas such as sumps or pits where dense vapours may collect. Restrict access to storage area. Post warning signs. Consider leak detection and alarm systems.

For personnel entry into confined spaces (i.e. bulk storage tanks) a proper procedure must be followed. It must include consideration of, among other things, ventilation, testing of tank atmosphere, provision and maintenance of SCBA, and emergency rescue. Use the "buddy" system. The second person should be in view and trained and equipped to execute a rescue. (4)

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye Protection:	Use full face-shield and gas-tight goggles when there is potential for contact. Contact lenses should not be worn when working with this material.
Skin Protection:	Gloves and protective clothing made from neoprene, viton, butyl rubber or nitrile rubber should be impervious under conditions of use. Prior to use, user should confirm impermeability. Skin protection should be insulated against cold temperatures. Do not use gloves or protective clothing made from leather, polyethylene, PVC, rubber or plastic. Discard contaminated gloves.
Respiratory Protection:	DO NOT USE chemical cartridge respirators with oxidizable sorbents (charcoal). Chlorine: Up to 5 ppm, wear a chemical cartridge respirator with Chlorine or acid gas cartridges; up to 10 ppm self-contained breathing apparatus (SCBA). (3,4) Use an air-supplied respirator if concentrations are high or unknown. If while wearing a respiratory protection, you can smell, taste or otherwise detect anything unusual, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator to face seal is still good. If it is, replace the filter, cartridge or canister. If the seal is no longer good, you may need a new respirator. (4) Immediately Dangerous to Life and Health (IDLH) value: 10 ppm. (4) The purpose of establishing an IDLH value is to ensure that the worker can escape from a given contaminated environment in the event of failure of the most protective respiratory equipment. In the event of failure of respiratory protective equipment, every effort should be made to exit immediately. (4)
Other Personal Protective Equipment:	Wear an impermeable apron and boots. Locate safety shower and eyewash station close to chemical handling area. Take all precautions to avoid personal contact. Use of a Chlorine gas monitor with local and remote alarms and monitoring is strongly recommended.

EXPOSURE GUIDELINES

SUBSTANCE	ACGIH TLV (STEL)	OSHA PEL (TWA) (STEL)	NIOSH REL (TWA) (STEL)
Chlorine	1 ppm	---	1 ppm (Ceiling) --- 0.5 ppm (Ceiling)

9. PHYSICAL AND CHEMICAL PROPERTIES (Not intended as Specifications)

Physical State:	Gas.
Appearance:	Greenish yellow liquified gas.
Odour:	A sharp, pungent, irritating odour.
Odour Threshold (ppm):	0.2 - 0.4 ppm. (3)
Boiling Range (°C):	-35. (3)
Melting/Freezing Point (°C):	-101. (3)
Vapour Pressure (mm Hg at 20° C):	4 788 - 5 120. (3)
Vapour Density (Air = 1.0):	2.47 - 2.67. (3)
Relative Density (g/cc):	1.33 - 1.47. (3)
Bulk Density:	88.76 lb/ft³ @ 15.6 C.
Viscosity:	0.346 mPa @ 20 C. (3)
Evaporation Rate (Butyl Acetate = 1.0):	Not available.
Solubility:	Slightly soluble in water.
% Volatile by Volume:	100. (3)
pH:	1.5 - 2.0 (0.8 % solution). (3)
Coefficient of Water/Oil Distribution:	Not applicable.
Volatile Organic Compounds (VOC):	0 %.
Flashpoint (°C):	Not Flammable.

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY

Under Normal Conditions:	Stable.
Under Fire Conditions:	Although non-combustible in air, chlorine supports the combustion of other materials.
Hazardous Polymerization:	Will not occur.

Conditions to Avoid:	High temperatures, sparks, open flames and all other sources of ignition. Avoid contact with water. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)
Materials to Avoid:	This product is a strong oxidizer. Strong oxidizers can cause ignition of combustible or oxidizable materials. May decompose violently on contact with metals, or their salts, dusts or other contaminants. Reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Chlorine reacts with combustible, organic or nitrogen compounds (hydrocarbons, cleaning solvents, paints or thinners, oil, grease gasoline, petroleum products, turpentine, alcohols, carbon disulphide, hydrogen acetylene, hydrogen, ether and ammonia). (3,4) Strong oxidizers. Lewis or mineral acids. Metal halides. Carbon. Lead. Sulphides. Reducing agents. Fluorine. Metal Acetylides. Halogenated compounds. Diethyl Zinc. Metal hydrides. Sulfamic Acid. Diethyl Ether. At ordinary temperatures: Dry Chlorine (gas or liquid) is not corrosive to most common metals, including steel, stainless steel, silver, iron, cast iron, nickel and its alloys, copper, brass, bronze, lead platinum and tantalum. Dry Chlorine (gas or liquid) reacts with aluminum, zinc, arsenic, gold, mercury, class 300 stainless steel, titanium, selenium, tellurium and tin. (3,4) At high temperatures: Dry Chlorine is corrosive to most metals. The reaction rate of dry Chlorine increases rapidly above a temperature which is characteristic for the metal. (3,4)
Decomposition or Combustion Products:	Thermal decomposition products are toxic and may include oxides of chlorine and irritating gases. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL DATA:

SUBSTANCE	LD50 (Oral, Rat)	LD50 (Dermal, Rabbit)	LC50 (Inhalation, Rat, 4h)
Chlorine	---	---	147 ppm (1)
Carcinogenicity Data:	The ingredient(s) of this product is (are) not classed as carcinogenic by ACGIH, IARC, OSHA or NTP. See "Other Studies Relevant to Material".		
Reproductive Data:	No adverse reproductive effects are anticipated.		
Mutagenicity Data:	No adverse mutagenic effects are anticipated.		
Teratogenicity Data:	No adverse teratogenic effects are anticipated.		
Respiratory / Skin Sensitization Data:	None known.		
Synergistic Materials:	Mortality in Chlorine-Nickel test groups for rainbow trout was found to be higher than that of either nickel or chlorine alone. The relevance to humans is not known. Incidences of respiratory sensitization in platinum refinery workers increased following a spill of chlorine. (3)		
Other Studies Relevant to Material:	Effects in rats during acute inhalation exposure to Chlorine were primarily attributed to its severe irritant effects. Repeated inhalation of Chlorine (1, 3 or 9 ppm for 6 weeks) by rats resulted in respiratory irritation, reduced body weight gain, organ weight changes, increased white blood cells, some animal deaths and changes in liver, kidney, spleen, thymus and gastric mucosa. Longer term (1 year) inhalation of Chlorine (0.1, 0.5 or 2.3 ppm) by monkeys resulted in eye and upper respiratory tract irritation. Effects observed in rabbits following repeated inhalation (up to 9 months) were weight loss, nasal irritation, sneezing and laboured respiration. Life-time inhalation of Chlorine (up to 2.5 ppm) produced nasal cell injury in rats and mice. No effects were observed in guinea pigs after repeated inhalation (87 days) or in mice after drinking chlorinated water (33 or 55 days). Repeated exposure of rats to 30 ppm Chlorine in their drinking water resulted in reduced spleen weights and immunological effects. Long term (2 years) administration of Chlorine in drinking water (70, 140 or 275 ppm) resulted in an increase in leukemia in female rats at 140 ppm only. No adverse effects on fertility, life span, growth pattern, hematology or histology were seen in rats given chlorinated water (100 mg Chlorine / Litre daily) throughout the entire lifespan for 7 consecutive generations. No birth defects were observed in mice after drinking chlorinated drinking water during pregnancy. Chlorine produced no genetic changes in standard tests using animals. A positive response was observed in a test using human cells, while mixed responses have been reported in a variety of tests using bacterial cells or animal cells. (3)		

12. ECOLOGICAL INFORMATION

Ecotoxicity:	Highly toxic to aquatic life. Fish toxicity: critical concentration = 0.3 mg/L Aesthetic: critical concentration = 0.5 mg/L Plant: critical concentration = 100 mg/L 72-HR LC50 = 0.5 mg/L, Daphnia Magna 96-HR LC50 = 0.02 mg/L, Daphnia Magna 96-HR LC50 = 0.08 to 0.18 mg/L, Brook Trout 96-HR LC50 = 0.07 mg/L, Channel Catfish Fingerlings 96-HR LC50 = 0.44 to 2.32 mg/L, Bluegill Sunfish 96-HR LC50 = 1.6 mg/L, Redsid Shiner 96-HR LC50 = 0.70 mg/L, Blackside Dance Exposure of Sand-dollar sperm to 0.002 mg/L for 5 minutes resulted in a 50 percent reduction in egg fertilization. Depressed shoot and total plant dry weight and shoot length were reported when the aquatic plant myriophyllum spicatum was continuously exposed to chlorine (as low as 0.05 mg total residual chlorine/L) for 96 hours. Chlorine is considered to be phytotoxic and has bactericidal, algicidal and fungicidal properties. Chlorine does not appear to retard seed germination. (3) This product does not bioaccumulate in aquatic or terrestrial food chains.
Environmental Fate:	In an uncontrolled spill scenario where the concentration of Chlorine is well above those used for drinking water, it can be dangerous if allowed to contaminate irrigation water supplies, lakes, streams, ponds or rivers.

13. DISPOSAL CONSIDERATIONS

Deactivating Chemicals:	Chlorine gas will disperse to the atmosphere leaving no residue. Gaseous material can be absorbed in alkaline solutions of Caustic Soda, Soda Ash or Hydrated Lime. When absorbing Chlorine in alkaline solutions, the reaction is exothermic. Ensure the absorption is controlled as to heat and reaction. (3) Since hypochlorites are formed, solutions must be treated with reducing agents such as sodium sulphite before disposal. Do not immerse container in caustic solution. Liquid and/or solid residues from neutralization must be disposed of in a permitted waste management facility. (3) Hypochlorites: Carefully neutralize by adding hydrogen peroxide: one US pint of 35 % hydrogen peroxide solution per pound of hypochlorite to be neutralized. Dilute the neutralized residue with water. (3)
Waste Disposal Methods:	This information applies to the material as manufactured. Reevaluation of the product may be required by the user at the time of disposal since the product uses, transformations, mixtures and processes may influence waste classification. Dispose of waste material at an approved (hazardous) waste treatment/disposal facility in accordance with applicable local, provincial and federal regulations. Do not dispose of waste with normal garbage, or to sewer systems.
Safe Handling of Residues:	See "Waste Disposal Methods".
Disposal of Packaging:	Empty containers retain product residue (liquid and/or vapour) and can be dangerous. See Section 13, "Deactivating Chemicals". Do not expose such containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death. Return empty containers. DO NOT REFILL COMPRESSED GAS CONTAINERS. RETURN TO BRENNTAG CANADA FOR CARE AND MANAGEMENT.

14. TRANSPORTATION INFORMATION

CANADIAN TDG ACT SHIPPING DESCRIPTION:

CHLORINE, Class 2.3(8), UN1017.

Label(s): Toxic Gases, Corrosives. Placard: Toxic Gases.

ERAP Index: 500. Exemptions: None known.

Marine: P (Marine Pollutant).

Please consult the North American Emergency Response Guidebook, via the UN#, for guidance in addressing spills.

US DOT CLASSIFICATION (49CFR 172.101, 172.102):

CHLORINE, Class 2.3(8), UN1017.

Label(s): Poison Gas, Corrosive. Placard: Poison Gas.

CERCLA-RQ: 10 lb / 4.54 kg Exemptions: Not applicable.

Special Documentation Addition: Chlorine, Poison - Inhalation Hazard, Zone B.
Marine: P (Marine Pollutant).

IMO: Marine Pollutant: Chlorine.

Please consult the North American Emergency Response Guidebook, via the UN#, for guidance in addressing spills.

15. REGULATORY INFORMATION

CANADA

CEPA - NSNR: This material is included on the DSL under the CEPA.

CEPA - NPRI: This material is on the NPRI list of substances.

Controlled Products Regulations Classification (WHMIS):

A: Compressed Gas

C: Oxidizer

D-1A: Very Toxic (acute effects)

D-2A: Very Toxic (chronic effects)

E: Corrosive

USA

Environmental Protection Act: This material is included on the TSCA Inventory.

OSHA HCS (29CFR 1910.1200): Compressed Gas. Oxidizer. Highly Toxic. Chronic Effects. Corrosive.

NFPA: 4 Health, 0 Fire, 0 Reactivity (3)

HMIS: 4 Health, 0 Fire, 0 Reactivity (3)

INTERNATIONAL

The following component or components of this product appear on the European Inventory of Existing Commercial Chemical Substances: Chlorine.

16. OTHER INFORMATION

REFERENCES

1. RTECS-Registry of Toxic Effects of Chemical Substances, Canadian Centre for Occupational Health and Safety RTECS database.
2. Clayton, G.D. and Clayton, F.E., Eds., Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. IIA,B,C, John Wiley and Sons, New York, 1981.
3. Supplier's Material Safety Data Sheet(s).
4. CHEMINFO chemical profile, Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada.
5. Guide to Occupational Exposure Values, 2008, American Conference of Governmental Industrial Hygienists, Cincinnati, 2008.
6. Regulatory Affairs Group, Brenntag Canada Inc.
7. The British Columbia Drug and Poison Information Centre, Poison Managements Manual, Canadian Pharmaceutical Association, Ottawa, 1981.

The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Brenntag Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

To obtain revised copies of this or other Material Safety Data Sheets, contact your nearest Brenntag Canada Regional office.

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Prepared By: Regulatory Affairs Group, Brenntag Canada Inc., (416) 259-8231.

Material Safety Data Sheet

Version 3.6

Revision Date 11/22/2012

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1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Fluosilicic acid

Product Number : 01301

Brand : Sigma-Aldrich

Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832

Fax : +1 800-325-5052

Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555

Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards

Toxic by ingestion, Corrosive

GHS Classification

Acute toxicity, Oral (Category 4)

Acute toxicity, Dermal (Category 3)

Skin corrosion (Category 1B)

Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram



Signal word

Danger

Hazard statement(s)

H302

Harmful if swallowed.

H311

Toxic in contact with skin.

H314

Causes severe skin burns and eye damage.

Precautionary statement(s)

P280

Wear protective gloves/ protective clothing/ eye protection/ face protection.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P310

Immediately call a POISON CENTER or doctor/ physician.

HMIS Classification

Health hazard: 3

Chronic Health Hazard: *

Flammability: 0

Physical hazards: 0

NFPA Rating

Health hazard: 3

Fire: 0
Reactivity Hazard: 0

Potential Health Effects

Inhalation May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin May be harmful if absorbed through skin. Causes skin burns.
Eyes Causes eye burns.
Ingestion Toxic if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Fluorosilicic acid
Hexafluorosilicic acid
Hydrogen hexafluorosilicate

Formula : $\text{H}_2\text{F}_6\text{Si}$
Molecular Weight : 144.09 g/mol

Component		Classification	Concentration
Hexafluorosilicic acid			
CAS-No.	16961-83-4	Skin Corr. 1B; H314	30 - 50 %
EC-No.	241-034-8		
Index-No.	009-011-00-5		

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

If swallowed

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability

Not flammable or combustible.

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products

Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride, silicon oxides

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up

Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE**Precautions for safe handling**

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Conditions for safe storage

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION**Components with workplace control parameters**

Components	CAS-No.	Value	Control parameters	Basis
Hexafluorosilicic acid	16961-83-4	TWA	2.5 mg/m ³	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
Remarks	Varies with compound			
		TWA	2.5 mg/m ³	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.28-1969			
		TWA	2.5 mg/m ³	USA. ACGIH Threshold Limit Values (TLV)
	Bone damage Fluorosis Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen varies			
		TWA	2.5 mg/m ³	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000

Personal protective equipment**Respiratory protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection

Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection

Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures

Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	clear, liquid
Colour	light yellow

Safety data

pH	1.0 - 1.2 at 10 g/l
Melting point/freezing point	no data available
Boiling point	no data available
Flash point	no data available
Ignition temperature	no data available
Autoignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	no data available
Density	no data available
Water solubility	no data available
Partition coefficient: n-octanol/water	no data available
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability

Stable under recommended storage conditions.

Possibility of hazardous reactions

no data available

Conditions to avoid

no data available

Materials to avoid

Strong oxidizing agents, Metals, Alkalis, Strong acids, Stoneware, glass

Hazardous decomposition products

Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride, silicon oxides

Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50

no data available

Inhalation LC50

no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
Eyes: no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: 3 - Group 3: Not classifiable as to its carcinogenicity to humans (Hydrofluoric acid)

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Ingestion	Toxic if swallowed.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.

Signs and Symptoms of Exposure

Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity

no data available

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

Product

Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)

UN number: 1778 Class: 8 Packing group: II

Proper shipping name: Fluorosilicic acid

Reportable Quantity (RQ): 10001 lbs

Marine pollutant: No

Poison Inhalation Hazard: No

IMDG

UN number: 1778 Class: 8 Packing group: II EMS-No: F-A, S-B

Proper shipping name: FLUOROSILICIC ACID

Marine pollutant: No

IATA

UN number: 1778 Class: 8 Packing group: II

Proper shipping name: Fluorosilicic acid

15. REGULATORY INFORMATION

OSHA Hazards

Toxic by ingestion, Corrosive

SARA 302 Components

The following components are subject to reporting levels established by SARA Title III, Section 302:

	CAS-No.	Revision Date
Hydrofluoric acid	7664-39-3	1993-04-24

SARA 313 Components

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards

Acute Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Hexafluorosilicic acid	16961-83-4	1993-04-24
Hydrofluoric acid	7664-39-3	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hexafluorosilicic acid	16961-83-4	1993-04-24
Hydrofluoric acid	7664-39-3	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hexafluorosilicic acid	16961-83-4	1993-04-24

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Text of H-code(s) and R-phrase(s) mentioned in Section 3

H314	Causes severe skin burns and eye damage.
Skin Corr.	Skin corrosion

Further information

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SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix F Operations and Maintenance Plan
May 2014

Appendix F Operations and Maintenance Plan

**Addendum to Operations and
Maintenance Plan for the
Water Supply Facility, Char
River, Rankin Inlet, Nunavut**

Final



Prepared for:
Department of Community and
Government Services,
Government of Nunavut

Prepared by:
Stantec Consulting Ltd.
5021 – 49 Street
Yellowknife, NT X1A 2N4

May 2014

Revision Record							
Revision	Description	Prepared By		Checked By		Approved By	
	Version 1	KD	05/01/14	PC	05/05/14	PC	05/09/14

**ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY,
CHAR RIVER, RANKIN INLET, NUNAVUT**

Table of Contents

ABBREVIATIONS	I
1.0 INTRODUCTION	1.1
2.0 SYSTEM OVERVIEW	2.1
2.1 WATER INTAKE PIPELINE	2.1
2.2 INTAKE AREA	2.1
2.3 PIPELINE ALIGNMENT	2.1
2.4 DISCHARGE AREA	2.1
3.0 PERSONNEL TRAINING	3.1
4.0 HEALTH AND SAFETY	4.2
5.0 OPERATIONAL PROCEDURES	5.2
5.1 PLACEMENT OF INTAKE LINE	5.2
5.2 OPERATION OF THE PUMP	5.2
5.3 ANNUAL PIPELINE SHUT DOWN	5.3
6.0 MONITORING	6.3
6.1.1 Pre-operation Annual Monitoring	6.3
6.1.2 Culvert Monitoring	6.3
6.1.3 Flow Monitoring	6.3
6.1.4 End of Season Discharge Monitoring	6.4
7.0 EMERGENCY RESPONSE AND CONTINGENCIES	7.4
8.0 REPORTING	8.5
9.0 REFERENCES	9.6

LIST OF TABLES

Table 7-1	Emergency Contacts	7.4

LIST OF FIGURES

Figure 1-1	Nipissar Lake Resupply Line – Site Plan	2.1

LIST OF APPENDICES

APPENDIX A	CURRENT OPERATIONS AND MAINTENANCE PLAN – WATER LICENSE 3AM-GRA1015	A.1
APPENDIX B	SPILL CONTINGENCY PLAN	B.2

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Abbreviations

GN-CGS	Government of Nunavut Community and Government Services
HDPE	High Density Polyethylene
km	kilometre
m	metre
mm	millimetre
O&M	Operations and Maintenance
PPE	Personal Protective Equipment
USGPM	US Gallons per Minute
WHMIS	Workplace Hazardous Materials and Information System
%	percent

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Introduction
May 9, 2014

1.0 Introduction

On behalf of the Government of Nunavut Department of Community and Government Services (GN-CGS), Stantec Consulting Ltd. (Stantec) has prepared the following addendum to the Operations and Maintenance (O&M) Plan for the Water Treatment Facilities located in the community of Rankin Inlet. The original O&M Plan for the Water Treatment Facilities was submitted in response to a condition of its Water License 3AM-GRA1015 and was approved by the Nunavut Water Board (NWB). The Water Treatment Facilities included in the original O&M Plan comprise of:

1. A water intake plant (including the collection of water from Nipissar Lake); and,
2. A waste water treatment plant.

This addendum was prepared in response to additional infrastructure constructed, namely a 4.05 kilometre (km) water intake pipeline extending from the Char River to Nipissar Lake. The following sections provide an overview of the O&M amendments associated with the installation of the 4.05 km water intake pipeline.

2.0 System Overview

The water supply for the community is collected from Nipissar Lake, located approximately 2 km northwest of Rankin Inlet. Water is withdrawn using two submersible pumps and pumped year-round through an insulated watermain extending from Nipissar Lake pump house to the Williamson Lake pump house. Further information on the O&M requirements for the existing water treatment facilities are provided in the main O&M Plan in Appendix A.

2.1 WATER INTAKE PIPELINE

Due to water level decreases in Nipissar Lake, the GN-CGS retained Stantec in 2010 to design a 4.05 km water intake pipeline extending from the Char River approximately to Nipissar Lake (Figure 1-1). The purpose of this pipeline is to transport water during the summer months (June to September) to replenish Nipissar Lake. In 2012, the pipeline was constructed. The pipeline will begin operation in June 2014.

The water intake pipeline has three distinct areas:

1. Intake Area (including the pump, intake hose, floating base, intake screen and sea canister)
2. Pipeline (the 4.05 km pipeline, one low point drain, two high point air releases)
3. Discharge Area (including a concrete slab and riprap area at the end of the pipeline)



Sources: Imagery - Microsoft BING, Thematic Data - FSC Architects and Engineers

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Nipissar Lake Resupply Line - Site Plan

Figure 1-1



ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Personnel Training
May 9, 2014

A brief summary of each of the areas are provided in the sections below.

2.2 INTAKE AREA

The intake area includes a pump, sea canister, 50 m intake hose, and a floating base which anchors the intake hose in place during seasonal operation (June to September). The intake line extends from the Char River to the pump and consists of a 150 mm reinforced suction hose connected to an end-of-pipe screen (mesh size 2.54 mm) to prevent fish entrapment. During operation, the screen and a portion of the intake hose are inserted into the river, immediately down gradient from the intake pump. The pump consists of a trailer mounted four cylinder 75 horsepower diesel powered generator.

The sea canister provides equipment storage for the intake line, floating base and intake screen when not in use. The sea canister will not house any hazardous materials, such as antifreeze, fuel, etc. or materials that have the potential to freeze over the winter months. As per the Spill Contingency Plan, fire extinguishers will be located in the sea canister during pumping activities; however, they will be removed from the sea canister at the end of the pumping season.

2.3 PIPELINE ALIGNMENT

The pipeline is constructed of 250 mm high density polyethylene (HDPE) piping. The pipeline is secured to the ground using galvanized steel rods. To facilitate pipeline drainage at the end of the season, two high point releases and one low point drain were installed. The low point drain consists of a 75 mm HDPE drain line leading from the pipeline, protected by a circular galvanized steel case.

2.4 DISCHARGE AREA

The discharge area is located at Nipissar Lake. A prefabricated concrete pad (approximately 3.0 m by 1.5 m in size) is used as a splash pad at the pipeline outlet location at Nipissar Lake. The pad should be periodically inspected for any deficiencies. Nipissar Lake will be replenished until the water level returns to the ordinary high water mark. When this water level is reached, the pump at the Char River will be turned off.

3.0 Personnel Training

All personnel working at the water intake pipeline will require training to follow this O&M Plan. In addition, personnel should have site-specific instruction including, but not limited to, operating procedures, basic first aid and Workplace Hazardous Materials and Information System (WHMIS) training.

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Health and Safety
May 9, 2014

4.0 Health and Safety

Health and safety must be taken into consideration when working at the water intake pipeline. All staff will be required to wear appropriate personal protective equipment (PPE) including hard hats, steel-toe boots, reflective vests and appropriate clothing.

5.0 Operational Procedures

The following sections provide an overview of the procedures required for the operation of the water intake pipeline.

5.1 PLACEMENT OF INTAKE LINE

The floating base with the screened intake line will be placed in the Char River, immediately down gradient from the pump. The floating base will be anchored in place.

5.2 OPERATION OF THE PUMP

During the summer of 2014, daily flow measurements will be collected to develop a Withdrawal Plan for the river; this Plan will be used during subsequent years to direct pumping activities. Once the measurements have been collected, the pump start-up and/or operation will be in accordance with the manufacturer's operational procedures. The pumping rate will not exceed 10% of the flow rate of the river. If insufficient flow to operate the pump is present, pumping activities will cease until sufficient water is present.

The diesel generator for the pump will be refueled with a hand pump or electric pump (e.g. tidy tanks). Because the pump is located within 30 m of the high water mark of the Char River, extra precautions are necessary. The pump will be placed in a drip pan when operational and during fueling. The drip pan will be large enough to contain 110% of the total volume of fuel in the generator. The spill kit dedicated to the sea canister will be readily available when refueling the generator. No refueling will take place in water or on ice. There will be no fuel stored at the sea canister at any time and all fuel will be transported via the existing access road.

In the event of a spill, the Spill Contingency Plan will be implemented. As per the Spill Contingency Plan, any spills of waste are to be reported to the 24-hour Spill Report Line. A copy of the Spill Contingency Plan is provided in Appendix B.

The site representative will record the time that the pumping began to the time the pumping was completed and the rate at which the water was pumped on a daily basis. These recordings will then be used to determine the water usage volumes.

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Monitoring
May 9, 2014

5.3 ANNUAL PIPELINE SHUT DOWN

Upon completion of the water extraction (i.e. September), the intake will be removed from the water, dismantled and stored in the sea canister along with the intake pump. Other maintenance activities will include re-grading of the pump area as necessary. Also, the bank of the River where the intake line comes back out of the water will be monitored for erosion. If erosion is suspected, then erosion control measures will be implemented.

6.0 Monitoring

The following sections outline the monitoring requirements for the water intake pipeline.

6.1.1 Pre-operation Annual Monitoring

Prior to the commencement of pumping each year, a pre-operation inspection of the water intake pump will be completed by a qualified mechanic. During the operation of the pump, personnel will monitor equipment to ensure that the equipment is properly maintained and is in good working condition to reduce the potential for leaks.

In addition to checking the pump, an annual monitoring of the pipeline alignment will be undertaken to determine the presence of potential issues including surface water ponding, slumping, etc., of granular material. If issues are identified, corrective measures are to be completed as soon as possible.

6.1.2 Culvert Monitoring

Three culverts located along the alignment of the pipeline will be monitored daily during freshet; and, if required, cleared of any flow impediments. Cleared debris will be placed adjacent to the culvert location and/or removed from the area if required. Debris will not be placed into adjacent water bodies.

6.1.3 Flow Monitoring

Prior to the operation of the pump each day, measurements of the river will be collected by personnel. These measurements include:

1. River width (from bank to bank at the intake location)
2. A profile of river depth across the width of the river (from water level to river bottom at the intake location, every 0.25 m)
3. Flow measurement (at the intake location)

Once these measurements have been collected, the pumping rate will be adjusted on the pump to ensure that the 10% maximum withdrawal rate is not exceeded at any time.



ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Emergency Response and Contingencies

May 9, 2014

The monitoring equipment (i.e. flow meter) will be maintained and operated by the GN-CGS facility representative. Any equipment malfunctions will be remedied as soon as possible, prior to commencement of pumping activities.

6.1.4 End of Season Discharge Monitoring

To prevent freezing of the line, any residual water remaining in the pipeline at the end of the season will be discharged from the low point drain. Discharge rates from the drain will be monitored daily by personnel, with alterations made to the flow rate depending on the presence of ponding and/or erosion.

7.0 Emergency Response and Contingencies

An overview of the emergency contacts is provided in Table 7-1 below.

Table 7-1 Emergency Contacts

Contact	Location	Telephone number
24-Hour Emergency Spill Report Line	Yellowknife, Northwest Territories	867-920-8130
Aboriginal Affairs and Northern Development Canada – Manager of Field Operations	Rankin Inlet, Nunavut	867-645-2831
Hamlet of Rankin Inlet – Senior Administrative Officer	Rankin Inlet, Nunavut	867-645-2895
Government of Nunavut – Regional Engineer	Rankin Inlet, Nunavut	867-645-4074
Environment Canada – Inspector	Edmonton, Alberta	780-951-8600
Fire Department	Rankin Inlet, Nunavut	867-645-2598
Royal Canadian Mounted Police Detachment	Rankin Inlet, Nunavut	867-645-0123
Community Health Center	Rankin Inlet, Nunavut	867-645-4532

In the event of fuel or contaminant spill, the Spill Contingency Plan will be activated. A copy of the Spill Contingency Plan is provided in Appendix B.

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Reporting
May 9, 2014

8.0 Reporting

As part of the Nunavut Water Board License General Conditions (Part B of the License), an annual report must be completed. In relation to this Site, the report will include:

- The monthly and annual quantities in cubic meters of freshwater obtained from the Char River.
- A summary of alterations and/or major maintenance work carried out at the Char River Station and associated pump and pipeline components.
- A summary of any abandonment and restoration work carried out during the year and any scheduled maintenance or restoration to be completed the following year.
- A summary of any studies, reports and plans requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned; and
- Any other details on water use or waste disposal requested by the board by November 1st of the year being reported.

In addition to the annual report, a quarterly report will also be submitted to the board for review which will include monthly quantities of fresh water obtained from the Char River.

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

References
May 9, 2014

9.0 References

Statistics Canada (StatsCan). 2012. Rankin Inlet, Nunavut (Code 1320) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. Released October 24, 2012. <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E> (accessed April 27, 2014).

Nuna Burnside Engineering and Environmental Ltd. 2010. Water Supply Facility Operation and Maintenance (O&M) Plan, Hamlet of Rankin Inlet. Department of Community and Government Services.

ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Appendix A Current Operations and Maintenance Plan –
Water License 3AM-GRA1015
May 9, 2014

Appendix A Current Operations and Maintenance Plan – Water License 3AM-GRA1015



**Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet
Department of Community and
Government Services,
Government of Nunavut**

Prepared by

Nuna Burnside Engineering and Environmental Ltd.
Box 175 Rankin Inlet NU X0C 0G0 Canada
15 Townline Orangeville ON L9W 3R4 Canada

*December 2008
Revised April 2010*

File No: N-O 14850

The material in this report reflects best judgement in light of the information available at the time of preparation.

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Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

Executive Summary

Community and Government Services (CGS) of the Government of Nunavut (GN), provides water supply services for the Hamlet of Rankin Inlet.

Nunavut Water Board (NWB) license Number NWB3GRA0207 expired November 30, 2008 and a new water license application is in progress.

A Water Supply Facility Operation and Maintenance (O&M) Plan dated December 2008, was prepared by Nuna Burnside Engineering and Environmental Ltd. (Nuna Burnside), as required by the original license and in support of the application for a new license.

As noted in the December 2008 O&M Plan as per the NWB license, the Plan is to be reviewed and updated annually. This April 2010 update of the Plan also addresses comment provide by review agencies during the license renewal application process.

During the new license application review, various agencies provided comments and concerns regarding:

- The impact of water withdrawals from Nipissar Lake
- Sustainability of the Lake as a long term supply
- Compliance with the DFO end of pipe fish screen guidelines.

This O&M Plan includes the current studies and effects underway to address these issues.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

Table of Contents

Executive Summary	i
1.0 Introduction.....	1
1.1 Hamlet Description.....	1
1.2 Nunavut Water Board License	1
1.3 Climate	2
1.4 Water Supply	2
1.5 Health and Safety	2
1.6 Training	3
1.7 Waste Disposal.....	3
2.0 Operation and Maintenance of the Water Supply Facility	4
2.1 Overview	4
2.2 Water Supply Facility Design	4
2.3 Water Intake System Operational Procedures	4
2.4 Periodic and Seasonal Maintenance Procedures	4
2.5 Water Intake System Monitoring Program	5
3.0 Operation and Maintenance of Water Storage and Distribution System (Utilidor)	7
3.1 Water Storage Design	7
3.2 Water Distribution System	7
3.3 Periodic and Seasonal Maintenance Procedures	10
4.0 Emergency Response and Contingencies.....	11
5.0 Reporting	12
6.0 Summary	14
6.1 Overview	14
6.2 Outstanding Issues	14
7.0 References	17

Figures

- 1 Site Location
- 2 Community Plan
- 3 Water Supply Facility

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

Appendices

- A Nunavut Water Licence NWB3GRA0207
- B Climate Data
- C Projected Water Requirements
- D Site Photographs
- E Site Forms
- F Annual Monitoring Report Format
- G March 25, 2010 Letter to DFO Regarding Freshwater Intake from Nippisar Lake

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

1.0 Introduction

1.1 Hamlet Description

The Hamlet of Rankin Inlet is located on Rankin Inlet, on the west coast of Hudson Bay. It is 96-air km southwest of Chesterfield Inlet and 1088 air km east of Yellowknife, at 62° 49'N latitude and 92° 05' W longitude, as shown on Figure 1. The Hamlet has been growing substantially in the past 10 years. Economic activities now include government, commercial fishing, transportation/communications, carvings/handicrafts, trapping, hunting, and tourism. The community has a population of approximately 2,358 residents.

Community and Government Services (CGS) of the Government of Nunavut (GN), provides water supply and sewage disposal services for the Hamlet of Rankin Inlet.

The Hamlet provides solid waste collection for the residents, businesses and institutions. The water, wastewater, and solid waste systems include the following facilities and services:

- A water intake plant, which draws water from Nipissar Lake and provides treatment by chlorination
- A waste water treatment plant that provides primary treatment of sewage with use of a mechanical screen
- A current (old) solid waste disposal facility, which includes a bulky metals disposal area and a waste oil and liquid waste storage area
- A new solid waste management facility that has not been commissioned yet.

Key features of the community are shown on Figure 2.

1.2 Nunavut Water Board License

The Water Supply Facility currently operates under Nunavut Water Board License Number NWB3GRA0207 issued December 01, 2002 to the Government of Nunavut. The license expired November 30, 2008 (Appendix A). An application for a renewal/amendment of the licence was submitted in December 2008.

This O&M Plan includes items outlined in the requirements of the current license such as:

- Operation and Maintenance Plans
- Environmental Emergency Contingency Plan (Spill Contingency Plans) – separate document

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

- Monitoring Program and Quality Assurance/Quality Control Plan – separate document.

The O&M Plan is focussed on environmental impacts and compliance, which are the mandate of the NWB. It does not address the treatment and supply of drinking water for human consumption. It does not address human health and safety, these are the mandate of other agencies.

This O&M Plan should be updated annually, as required by the license and when the new NWB license is issued.

1.3 Climate

Rankin Inlet is affected by arctic air masses, and experiences a maritime Arctic climate characterized by short cool summers, and long cold winters. The Rankin Inlet area receives an average of 18.1 cm of rainfall and 107 cm of snowfall per annum. Mean annual precipitation totals 29.7 cm per annum. July mean high and low temperatures are 14.9°C and 5.9°C, respectively. January mean high and low temperatures are -28.3°C and -35.5°C, respectively. Winds are generally north-west, and average 23 km/h (Rankin Inlet Weather Station, Climate Normals 1991-2000, Environment Canada, 2008). A summary of climate conditions in Rankin Inlet is included in Appendix B.

1.4 Water Supply

The community of Rankin Inlet obtains its potable water from Nipissar Lake, located approximately two kilometres northwest of the community (Figure 2). Nipissar Lake covers an area of 1,090,565 m². Using an average depth of 4 metres the estimated volume is 4,362,260 m³. The total drainage area of Nipissar Lake is 323 hectares. Using an annual precipitation rate of 297.2 mm and an annual evapotranspiration rate of 200 mm, the total recharge to the lake is approximately 314 000 m³ per year. Hydrology calculations are included in Appendix C.

1.5 Health and Safety

Health and safety of workers and the public is the first priority while operating the Water Supply Facility. The requirements of the Nunavut Safety Act must be followed at all times. All actions and operations must be undertaken with safety as the first priority.

It should be noted, that this document was prepared to meet the requirements of the NWB and is not to be considered a Health and Safety Plan.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

1.6 Training

Staff training is an important aspect of the operation of a Water Supply Facility. Staff must be adequately trained to follow this O&M Plan and operate the facility. This O&M Plan is dependent on sufficient site specific training to ensure staff are appropriately trained to operate the facility.

1.7 Waste Disposal

The facility does not generate wastes other than small amounts of municipal type wastes, that are collected and disposed of through an agreement with the Hamlet of Rankin Inlet.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

2.0 Operation and Maintenance of the Water Supply Facility

2.1 Overview

The community draws its water from the Nipissar Lake, located 2 km northwest of the Hamlet. The Water Supply Facility consists of a pump house and water intake located on the south-east side of the lake. A fuel storage tank is located in a fenced off area on the north side of the pumphouse. Photographs of the facility taken by Nuna Burnside in September 2008 are included in Appendix D.

2.2 Water Supply Facility Design

The Nipissar Lake pump house contains vertical turbine submersible pumps installed inside the twin intake lines. Each of the 10 Hp pumps has a 1020 L/min. capacity. Only one pump operates at a time. Operation of the pump is controlled by the water level in the water storage tank adjacent to the Williamson Lake pump house. An air compressor aerates water around the intake to prevent taste and odour problems.

2.3 Water Intake System Operational Procedures

The following operational procedures shall be carried out by the Government of Nunavut on behalf Hamlet of Rankin Inlet:

- Monitoring and inspections will occur as outlined in the NWB license and described in this O&M Plan
- In the event of an accident, a spill of petroleum products or a fire during water distribution operations, *the Hamlet of Rankin Inlet Environmental Emergency Contingency Plan* (separate document) shall be implemented
- No motorized vehicles should be operated in the lake or on the ice of the lake due to risk of fuel spills
- If the lake is used for fishing, no motorized augers shall be used and there should be no materials that could contaminate the water brought onto the ice of the lake.

2.4 Periodic and Seasonal Maintenance Procedures

The following procedures shall be undertaken by the staff of the Government of Nunavut on behalf of Hamlet of Rankin Inlet during periodic and seasonal maintenance operations at the Water Supply Facility:

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

- The roadway and truck pad shall be maintained by snow clearing in the winter and surface grading in the summer, with any defects repaired as necessary
- Site warning signage, which identifies the boundaries of the Water Supply Facility shall be inspected weekly, and repaired or replaced as necessary
- The berms at the Water Supply Facility reservoir shall be inspected during the summer for erosion and settlement weekly, and repaired as necessary
- Any airborne litter shall be removed from the area of the pump house and taken to the Hamlet landfill in the spring and fall, or as required.

Forms to assist site staff in conducting the inspections and data recording are included in Appendix E.

The activities described above shall be completed by the staff of the Government of Nunavut on behalf of the Hamlet and details of any repairs shall be reported in the Annual Report submitted to the Nunavut Water Board, in compliance with the Water License.

2.5 Water Intake System Monitoring Program

All water sampling completed by the Government of Nunavut on behalf of the Hamlet of Rankin Inlet shall be in accordance with the *Hamlet of Rankin Inlet Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan* (separate document).

The sampling program is focussed on meeting the requirements of the Water License, which is environmental protection not water quality for drinking.

Daily monitoring of residual chlorine levels shall be undertaken, to facilitate and confirm the maintenance of free chlorine residual in treated water in accordance with the *Public Health Act* (1992) and associated *Regulations*. Drinking water quality control is not the mandate of the NWB. Refer to other documents and agencies with jurisdiction for operational procedures and requirements regarding drinking water quality.

2.5.1 Water License Requirements

As outlined in the NWB water license, regular monitoring of the quantities of water obtained from the natural environment and processed through the Water Treatment Facility is required.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

As part of the General Conditions, the licence requires that monthly and annual quantities in cubic metres of fresh water obtained be recorded and reported in the Annual Reports. It also requires that metres, recorders, or other such methods to record the volume of water used be installed, operated and maintained by the Licensee. The Licensee must maintain the Water Supply Facilities to the satisfaction of the Inspector.

A Surveillance Station will be established at the intake of the raw water supply before treatment (GRA-1). Monthly and annual quantities of raw water pumped will be measured and recorded in the official operations logbook on a form similar to that presented in Appendix E.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

3.0 Operation and Maintenance of Water Storage and Distribution System (Utilidor)

3.1 Water Storage Design

The Hamlet has a storage tank that is used to provide water during emergencies such as fires. The tank has a useable storage capacity of 3,364,000 L and can provide water for up to two days. In case of an emergency lasting longer than two days, Williamson Lake can be accessed by means of a portable pump, flexible hose, and ice auger.

Water Storage Tank Data	
Height	12.8 m
Diameter	18.3 m
Useable Storage	
2 hour fire demand	545,000 L
2 day emergency storage	2,030,000 L
Peak balance	473,000 L
Total	3,364,000 L

3.2 Water Distribution System

3.2.1 Overview

There are two systems of water distribution in Rankin Inlet. Approximately 99% of the population receives piped water while the remainder is on trucked service. The Hamlet of Rankin Inlet delivers water to the community utilizing an 8172 L capacity water truck. The truck is filled from the truck fill arm, located on the northwest side of the Williamson Lake pump house and delivers three to five days per week. All water deliveries are metered.

3.2.2 Water Distribution System Design

Water from the Nipissar Lake pump house is pumped to the community through a shallow buried insulated main, which operates year-round.

Piping System Data	
Length	2000 m
Supply Line	200 mm diameter insulated HDPE
Return Line	150 mm diameter insulated HDPE
Access Vaults	7 vaults, each 1600 mm diam HDPE. Inside the vaults, each line is fitted with a butterfly valve and two 75 mm diam thaw ports.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

The lines slope continuously upward from Nipissar Lake to Williamson Lake; there are no intermediate drain points.

The supply line passes through the Williamson Lake pumphouse where most of the water is chlorinated in the bottom of the water storage tank adjacent to the pumphouse. A small portion of the water is heated in the Nipissar Lake heat exchanger in the Williamson Lake pumphouse and then pumped back through the return line. Most of the heated water arriving in the Nipissar Lake pumphouse is injected back in to the supply line. Some of the heated water is bled into the Nipissar Lake intake casings to prevent freezing of the intake lines.

The Williamson Lake pumphouse is located on the north berm of the Williamson Lake, in the centre of the community. The pumphouse contains two wet-wells; four distribution pumps, two hot water boilers, three heat exchangers (one for the Nipissar Lake supply line, one for the Hamlet and one spare), chlorination equipment, a diesel standby generator, valves, alarms, and controls.

Water flows by gravity from the water storage tank through a valve into the two wet-wells; the valve is regulated by the water level in the wet-wells. The four 22.4 kW distribution pumps, each rated at 25 L/s, pump water from the wet-wells into the distribution system through a common header. The pump system is sized for maximum daily demand and the fire flow needs. One pump operates continuously, circulating heated water through the distribution loops with a portion returning to the pump house. As demand in the distribution system increases, additional pumps activate according to pressure drop in the system.

The heat for the distribution water is produced by two fuel oil fired boilers. The heated water circulates through the Hamlet heat exchanger, which in turn heats water for injection into the distribution header. Modulating valves, located on each loop where the loop returns to the pumphouse, control water temperatures in the loops by varying their flow rates. If a loop's return temperature falls below a set point, the modulating valve for that loop opens to increase the return flow rate. If the temperature rises above the set point, the valve closes to reduce the loop's return flow rate.

The boilers also provide heat for the building heating system through the Hamlet heat exchanger and for the Nipissar Lake supply line through the Nipissar heat exchanger.

The piped water distribution system consists of shallow-buried and insulated mains, usually installed in the same trenches as the sewer mains to save installation costs. Since the mains both originate and terminate at the Williamson Lake pumphouse, they are known as loops. As part of the freeze protection system, the water is constantly circulating in the loops. Water not consumed is returned to the wet-wells at the pumphouse.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

Access vaults are placed throughout the distribution system at about 100 m intervals, or at bends or intersections. Vault type depends on the year of construction. Vaults constructed prior to 1976 are insulated corrugated metal pipe. Vaults constructed from 1977 to 1979 are rectangular concrete structures. Vaults from 1979 onward are prefabricated insulated double-walled steel structures.

In current designs, the water main passing through the vault is constructed of steel and is typically fitted with a butterfly valve, two 50 mm thaw access ports and two 25 mm drain ports. Many vaults are fitted with electrical outlets but the present design is limited to an access conduit to allow electrical cables and hoses into the vault without keeping the hatch open. The vaults also house cleanouts on the sewer mains to allow access to the sanitary sewer system in the event of a frozen or plugged sewer line.

Water service connections to single-family residential buildings consist of un-insulated 25 mm HDPE supply and return lines taped together, wrapped in a self-limiting heat tape and inserted into a 100 mm diameter insulated HDPE carrier pipe. Water flows from the main through the supply line to circulation pump and flow switch, located inside the building. Water required for consumption then flows through a water meter into the building's water fixtures. Water required for consumption flows into the return line and then back into the main.

By maintaining a constant flow, the circulation pump keeps the water in the service lines from freezing. The heat trace cable, controlled by the floor switch on the supply line, keeps the water from freezing when flow is reduced or stops due to circulation pump failure or other causes. This dual-line circulating system has been found to be the most economical and reliable method of providing water service to the buildings.

Installed service connections are valve at the main and can be shut off by means of valve extensions that extend to above ground level. Older service connections cannot be shut off from above the ground. For multi-family residential, commercial or industrial buildings, the water service connections are individually designated but use basically the same system as described above.

3.2.3 Water Storage and Distribution System Operational Procedures

The following operational procedures shall be carried out by the Government of Nunavut on behalf of the Hamlet of Rankin Inlet:

- Monthly water usage volumes obtained from the Hamlet Water Storage and Treatment Facility shall be recorded on the recording form attached in Appendix E
- Monitoring and inspections will occur as outlined in the NWB license and described in this O&M Plan

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

- Sampling will be conducted as per the Environmental Monitoring Program and Quality Assurance/Quality Control Plan, Hamlet of Rankin Inlet (separate document).

3.3 Periodic and Seasonal Maintenance Procedures

- Facility generators and associated fuel storage shall be monitored daily
- Chlorine residuals shall be monitored daily, or as directed by a Public Health Inspector (as defined by the Public Health Act (1992), not part of the NWB mandate
- The chlorine feed system shall be inspected daily (to prevent spills and environmental impacts).

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

4.0 Emergency Response and Contingencies

In the event of an emergency, guidance regarding containment and site emergency response can be obtained from the following sources (Table 1):

Table 1: Emergency Contacts

Contact	Location	Telephone Number	Fax Number
INAC – Water/Wastewater Resources Manager	Iqaluit	(867) 975-4550	(867) 979-6445
Hamlet of Rankin Inlet – SAO	Rankin Inlet	(867) 645-2895	(867) 645-2146
Government of Nunavut (Regional Engineer)	Rankin Inlet	(867) 645-8159	(867) 645-8196
Environment Canada – Inspector	Iqaluit	(867) 975-4644	(867) 975-4594
Fire Department	Rankin Inlet	(867) 645-2525	-
RCMP Detachment	Rankin Inlet	(867) 645-1111	(867) 645-2568
Community Health Center	Rankin Inlet	(867) 645-8300	(867) 645-8324

Contingency plans are designed to provide site staff with direction and options when there is an unexpected event or accident.

The Environmental Emergency Contingency Plan, Hamlet of Rankin Inlet (prepared as a separate document) provides procedures and direction in the case of a spill or accident.

As outlined in the Contingency Plan, the health and safety of workers and the public are the first priority.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

5.0 Reporting

The Nunavut Water Board License on Part B: General Conditions include the requirement to file an Annual Report with the NWB no later than March 31st of the next calendar year. The report shall include:

- Tabular summaries of all data generated under the "Monitoring Program"
- The monthly and annual quantities in cubic metres of freshwater obtained from all sources
- The monthly and annual quantities in cubic metres of each and all waste discharged
- A summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures
- A list of unauthorized discharges and summary of follow-up action taken
- A summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year
- A summary of any studies, reports and plans (i.e. Operation and Maintenance, Abandonment and Restoration, QA/QC) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned
- Any other details on water use or waste disposal requested by the Board by November 1st of the reporting year.

The format of the NWB Annual Report is included in Appendix F.

The creation of the report can be greatly simplified by staff regularly filling in and filing the Site Forms included in Appendix E. The forms include:

- Form 1 – Annual Water Intake Log – a monthly record of flow measurements
- Form 2 – Monthly Water Supply Facility Inspection Form – a monthly record of conditions and issues at the water supply facility
- Form 3 – Water Supply Facility Planning Form – which provides a list of items to be discussed by the site foreman, Hamlet, and GN Project Manager related to short term and long term water supply and treatment decision making.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

In addition to these forms, there would be sampling information and analytical data collected. The Monitoring Plan and QA/QC Plan (prepared as a separate document) outlines sample collection and analytical data handling protocols. Using the forms and following the procedures provided herein should make submitting the annual monitoring report relatively straight forward.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

6.0 Summary

6.1 Overview

This Operation and Maintenance Plan (O&M) has been prepared for the Hamlet of Rankin Inlet Water Supply Facility. The facility is operated by the Government of Nunavut on behalf of the Hamlet.

Appropriate training for site staff is necessary as part of the implementation of this O&M Plan. This document should be reviewed and updated annually, and whenever the NWB Water License is amended or new relevant legislation is issued.

Nipissar Lake drainage basin should be recognized in community land use plans and zoning. The drainage basin should be classified as a sensitive area where land uses must be restricted to prevent impacts to the lake water supply.

This O&M Plan pertains to those aspects of operating the water supply facility within the NWB mandate for environmental protection. This O&M Plan does not address issues of water quality for human consumption, which is the mandate of other agencies.

6.2 Outstanding Issues

6.2.1 DFO Issues

Comments from Fisheries and Oceans Canada (DFO), regarding the impacts of water withdrawals from Nipissar Lake, were addressed in a letter dated March 25, 2010 and included in Appendix G.

6.2.2 Water Usage and Nipissar Lake Drawdown

As outlined in the license application there are some discrepancies in the volumes reported related to water usage and distribution. There is also significant evidence to indicate Nipissar Lake is not large enough to be a sustainable water supply as the Hamlet grows. To address these issues in August 2009 the GN issued a Request for Proposal (RFP) for a Water Supply Capacity, Consumption and Conservation Study. The Scope of Work included:

- a. Is Nipissar Lake an adequate source of water for the community of Rankin Inlet, currently, and in the future?
- b. When will Nipissar Lake fail to be adequate?
- c. What is the water usage on a per capita basis, in Rankin Inlet?
- d. Why is the water usage, per capita, what is it?
 - How much water is lost through bleeders?
 - How much water is lost through distribution system leaks?

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

- e. How can the GN/Municipality of Rankin Inlet undertake to reduce the amount of water usage?
- How does currently metering and billing practises affect water use?
 - How can the number of bleeders be reduced?
 - How can system leaks be managed?

The Scope outlined the following methodology:

1. Assess

- The capacity of the water supply servicing the Hamlet of Rankin Inlet
 - Complete a survey of the existing shore line of Nipissar Lake
 - Determine Nipissar Lake volume loss compared to Bathymetry and Topographical Survey that was completed in 1995
 - An assessment of climate variables affecting the Nipissar Lake watershed capacity
 - A review of historical precipitation and evapo-transpiration rates to establish if the current volume reduction of Nipissar Lake is a result of climatic variables or municipal consumption/wastage
- The consumption of water in Rankin Inlet, taking into consideration the specific demographic dynamic of the community and the unique climate in which Rankin Inlet is situated
 - Compile existing pumphouse metering data and general consumption data, and graphically present trends
 - Identify abnormalities in residential and commercial meter readings
 - Review historical and current consumption data to determine if Nipissar Lake is an adequate water source for the community
 - Current and future development being undertaken in Rankin Inlet and its anticipated effect on consumption
- Recommend means by which water can be conserved.

2. Report

The final deliverable for the assessment criteria in 1, above, shall be a report (submitted at 50% and 100% complete) which outlines the findings of the assessments undertaken by the consultant. Proponents shall give a detailed proposal on the scope of their report as it relates to their proposed methodology in item 1, above.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

3. *Leak Detection Equipment Report and Training*

The Department of Community and Government Services has an interest in purchasing leak detection equipment and training Operations and Maintenance (O&M) Staff in its use. Services of a consultant are required to:

- Review the water distribution system in Rankin Inlet and prepare a report outlining the type of equipment available and recommending suitable equipment for purchase
- Develop specifications (for use in tendering) for supply of equipment presented in report (after approval by GN).

This project was awarded to FSC Architects and Engineers and is in progress.

Until this work is complete the need for a new or supplemental water supply and related engineering cannot be determined.

It has been suggested that the licence be issued with the following conditions:

- By December 31, 2010, provide an assessment of the water supply capacity of Nipissar Lake and a detailed assessment of Hamlet water supply requirements for the future. Outline a detailed plan for the required engineering and development of a new or supplemental water supply. Following the necessary agency consultation and approvals, conduct the necessary engineering improvements by December 31, 2011.

Water Supply Facility
Operation and Maintenance (O&M) Plan
Hamlet of Rankin Inlet

December 2008
Revised April 2010

7.0 References

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Environment Canada, 2008. *Canadian Climate Normals 1971-2000, Rankin Inlet A Weather Station*, Environment Canada.
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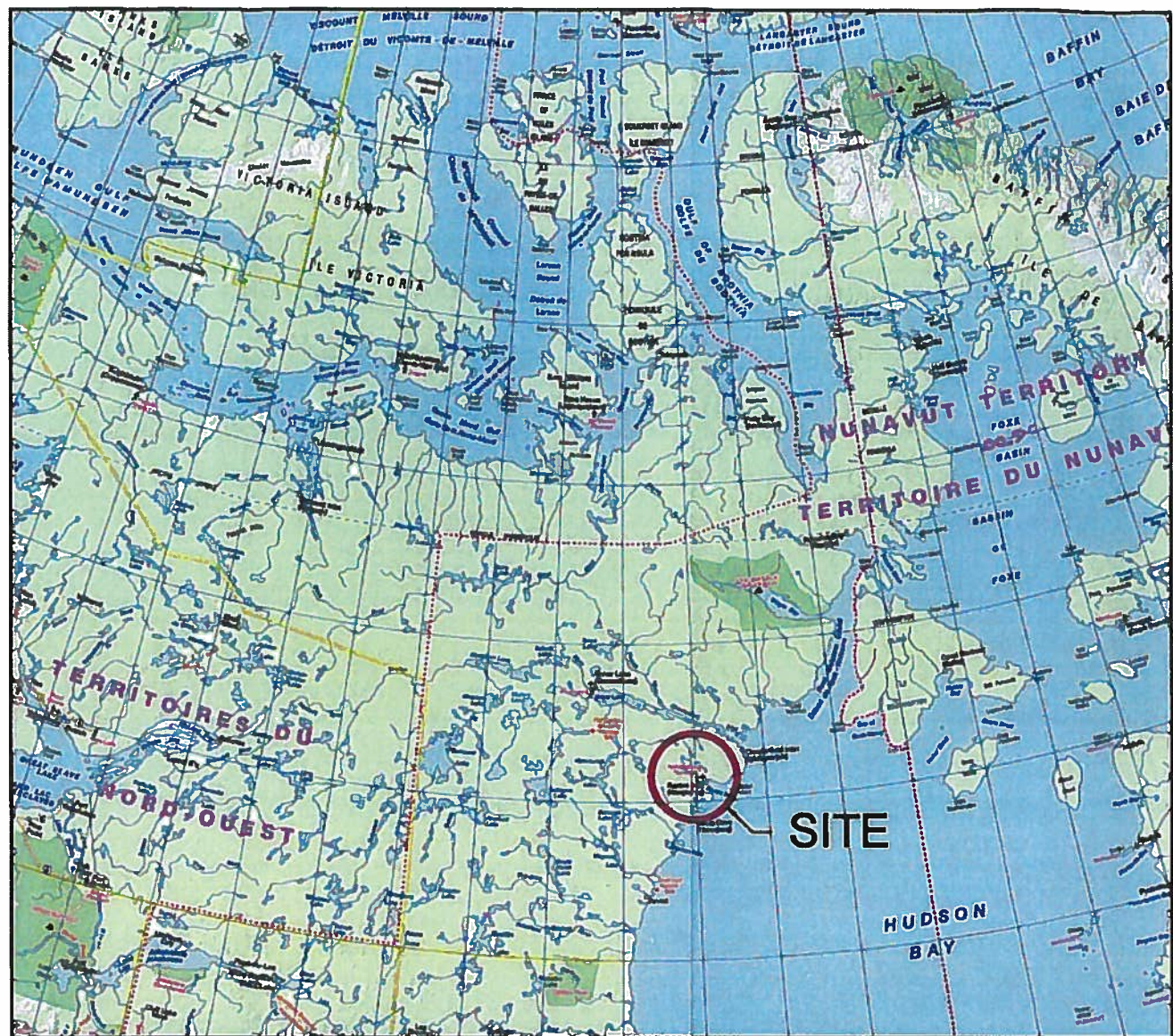
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Figures



Map Reference
Map Art Publishing

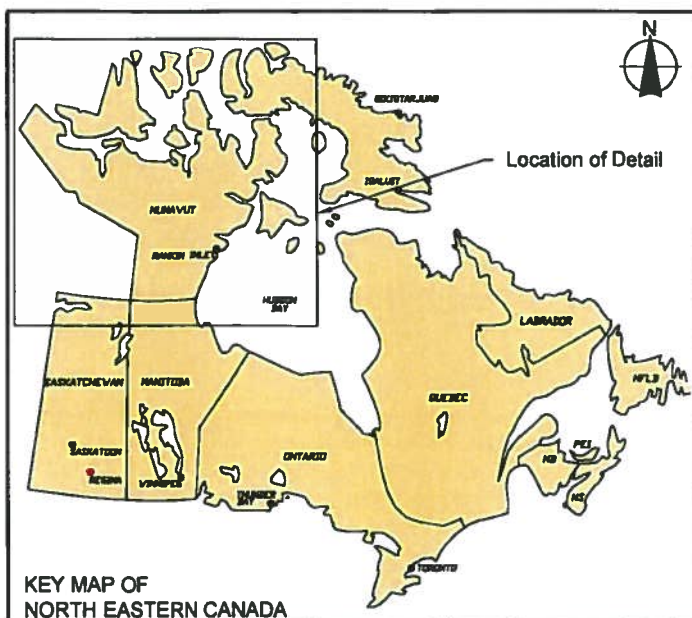


FIGURE 1 - SITE LOCATION MAP

GOVERNMENT OF NUNAVUT
HAMLET OF RANKIN INLET, NUNAVUT

WATER SUPPLY FACILITY
OPERATION & MAINTENANCE PLAN

December 2008

Project Number: N-014850

Prepared by: C. Sheppard

Verified by: J. Walls

burnside BURNSIDE

N-014850 WATER SUPPLY O&M PLAN - GOVERNMENT SL.dwg

FIGURE 2
GOVERNMENT OF NUNAVUT
HAMLET OF RANKIN INLET, NUNAVUT
WATER SUPPLY FACILITY O&M PLAN

COMMUNITY PLAN

Satellite Image Source:
Background 2008 satellite image covering the immediate community area obtained from MDA Geospatial Services.
Background colour satellite image covering the area beyond the immediate community obtained from the Google Earth Pro website.



1:30,000
August 2008
Project Number: N-014850
Prepared by: C. Sheppard
Projection: UTM Zone 15
Datum: NAD83
Verified by: J. Walls





FIGURE 3

GOVERNMENT OF NUNAVUT
HAMLET OF RANKIN INLET, NUNAVUT
WATER SUPPLY FACILITY O&M PLAN

WATER SUPPLY FACILITY

LEGEND

- INTERPRETED NIPISSAR LAKE DRAINAGE
- AREA OUTLINE

Aerial Image Source:
The aerial image covering the immediate community area shown
was obtained from the Canadian Space Agency (CSA) and is
copyrighted by the Government of Canada. The background
image covering the area beyond the immediate community
was obtained from the Google Earth Pro website.



1:12,500
December 2008
Project Number: HQ14850
Projection: UTM Zone 15
Datum: NAD83



Appendix A

Nunavut Water Licence NWB3GRA0207



P.O. Box 119
GJOA HAVEN, NU X0B 1J0
TEL: (867) 360-6338
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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

DECISION

LICENCE NUMBER: NWB3GRA0207

This is the decision of the Nunavut Water Board (NWB) with respect to an application for a Licence originally filed by the Hamlet of Rankin Inlet on 20 November 2002:

Department of Public Works & Services, Government of Nunavut

to allow for the use of water and disposal of waste in the Hamlet at Rankin Inlet, Nunavut.

With respect to this application, the NWB gave notice to the public that the Hamlet had filed an application for a water licence.

DECISION

After having been satisfied that the application, which had originally been filed by the Hamlet of Rankin Inlet on November 20, 2002, was exempt from the requirement for screening by the Nunavut Impact Review Board in accordance with S. 12.3.2 of the *Nunavut Land Claim Agreement* (NLCA), the NWB decided that the application could go through the regulatory process.

Based on the review of the comments and concerns, it was noted that the issue of the operation of Water Treatment and Sewage Treatment Facilities in Rankin Inlet by the Department of Public Works and Services (Government of Nunavut) prevented the issuance of water licence to the Hamlet of Rankin Inlet for the operation of these Facilities. It was determined that the most appropriate action was to issue a water licence to the Hamlet of Rankin Inlet for the operation of the Solid Waste Disposal Facility, while the Department of Public Works and Services would be licensed for the operation of the Water Treatment and Sewage Treatment Facilities, on behalf of the Government of Nunavut.

Applications reflective of this division of activities were received from both the Hamlet of Rankin Inlet and the Department of Public Works and Services. Notice of these applications was posted with local organizations in Rankin Inlet. As the technical information previously reviewed remained unchanged, the Nunavut Water Board accepted written concerns and comments on these applications until December 6, 2002.

After reviewing the submission of the Applicant and written comments expressed by interested parties, the NWB, having given due regard to the facts and circumstances, the merits of the submissions made to it and to the purpose, scope and intent of the *Nunavut Land Claims Agreement* and of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSTRA), decided to waive the requirement to hold a public hearing and furthermore to delegate its authority to approve the application to the Chief Administrative Officer pursuant to S. 49(a) of the NWNSTRA and determined that:

Licence Number NWB3GRA0207 be issued subject to the terms and conditions contained therein. (Motion #: 2002-22)

SIGNED this 1st day of December, 2002 at Gjoa Haven, NU.

Original signed by:

Philippe di Pizzo
Chief Administrative Officer

TABLE OF CONTENTS

DECISION.....	i
TABLE OF CONTENTS.....	iii
I. INTRODUCTION.....	1
II. GENERAL CONSIDERATIONS	1
A. Term of the Licence	1
B. Annual Report.....	1
C. Operation and Maintenance Plan.....	2
D. Abandonment and Restoration Plan	2
E. Monitoring Program	2
F. Quality Assurance/Quality Control Program.....	2
III. LICENCE NWB3GRA0207	3
PART A: SCOPE AND DEFINITIONS.....	4
PART B: GENERAL CONDITIONS	6
PART C: CONDITIONS APPLYING TO WATER USE	8
PART D: CONDITIONS APPLYING TO WASTE DISPOSAL	9
PART E: CONDITIONS APPLYING TO MODIFICATIONS AND CONSTRUCTION.....	9
PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE	10
PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION.....	11
PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM.....	12

I. INTRODUCTION

Following an application filed by Ferguson Simek Clark on behalf of the Hamlet of Rankin Inlet on 6 June 2002 to the Nunavut Water Board, the Board conducted an initial assessment of the Hamlet's request for a municipal water licence for water use and waste disposal activities within the Hamlet. The assessment was conducted so that the Nunavut Water Board could make a fully informed decision on the application. The application was referred for review and comments to Federal, Territorial and local organizations. Based upon the results of this initial assessment and the technical review, including consideration of any potential accidents, malfunctions, or cumulative environmental effects that the overall project might have in the area, the Board concluded that this application was complete and could go through the regulatory process.

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 55.1 and Article 13 of the *Nunavut Land Claims Agreement*, public notice of the application was posted. No public concerns were expressed, and the NWB waived the requirement to hold a public hearing for the application. Authority to approve the application was delegated to the Chief Administrative Officer pursuant to S. 13.7.5 of the *Agreement*. After considering and reviewing the comments submitted by interested parties, the NWB has issued licence NWB3GRA0207.

II. GENERAL CONSIDERATIONS

Term of the Licence

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 45, the NWB may issue a licence for a term not exceeding twenty-five years. The NWB believes that a term of five years is appropriate. Because this is the first licence issued to the Department by the Nunavut Water Board for operations in Rankin Inlet, a 5-year licence will allow enough time for the Department to establish a consistent compliance record. The 5-year licence will allow the Licensee to properly carry out the terms and conditions of the licence and to ensure that sufficient time is given to permit the Licensee to develop, submit, and implement the plans required under the licence to the satisfaction of the NWB.

Annual Report

The requirements imposed on the Licensee in this licence are for the purpose of ensuring that the NWB has an accurate annual update of municipal activities during a calendar year. This information is maintained on the public registry and is available to any interested parties upon request. Refer to attached standard form for completing Annual Report (see Attachment I).

Regulated Parameters

Effluent quality criteria imposed in this Licence are consistent with the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories* (Northwest Territories Water Board; 1992), and follow advice received from both the Department of Indian and Northern Affairs and Environment Canada.

Operation and Maintenance Manual (O&M)

The purpose of an Operation and Maintenance Manual is to assist Department staff in the proper operation and maintenance of their waste disposal facilities. The manual should demonstrate to the Nunavut Water Board that the Department is capable of operating and maintaining all waste disposal sites adequately. The Plan should be completed using the *Guidelines for the Preparation of an Operations and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (Duong and Kent, 1996; see Attachment II).

Abandonment and Restoration (A&R)

To ensure that all future abandoned facilities are reclaimed in an appropriate manner, the NWB has imposed the requirement for the submission of Abandonment and Restoration Plans. These plans should be submitted when the Licensee files preliminary design drawings for the construction of new facilities to replace existing ones.

Monitoring Program

The Monitoring Program is a program established to collect data on water quality to assess the effectiveness of treatment for protection of public health and to assess potential impacts to the environment associated with the municipal facilities. As this is the first Municipal Water Licence issued to the Department by the Board, minimum requirements have been imposed, but additional sampling may be required by an Inspector.

Quality Assurance/Quality Control (QA/QC) Plan

The requirements to develop a QA/QC Plan imposed on the Licensee in this licence are for the purpose of ensuring the NWB that samples taken in the field as part of the Monitoring Program will maintain a high quality, so as to accurately represent the physical and chemical nature of the samples being taken.

LICENCE NWB3GRA0207

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

DEPARTMENT OF PUBLIC WORKS & SERVICES, GOVERNMENT OF NUNAVUT
(Licensee)

of **RANKIN INLET, NUNAVUT, X0A 0S0**
(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water for a period subject to restrictions and conditions contained within this licence:

Licence Number **NWB3GRA0207**

Water Management Area **NUNAVUT 05**

Location **RANKIN INLET, NUNAVUT**

Purpose **WATER USE AND WASTE DISPOSAL**

Description **MUNICIPAL UNDERTAKINGS**

Quantity of Water Not to be Exceeded **400,000 CUBIC METRES ANNUALLY**

Date of Licence **DECEMBER 1, 2002**

Expiry Date of Licence **NOVEMBER 30, 2007**

Dated this 1st of December 2002 at Gjoa Haven, NU.

Original signed by:

Philippe di Pizzo
Chief Administrative Officer

PART A: SCOPE AND DEFINITIONS

1. Scope

- a. This Licence allows for the use of water and the disposal of waste by the Department of Public Works and Services, Government of Nunavut for municipal undertakings at the Hamlet of Rankin Inlet, Nunavut (64°49'N, 92°05'W);
- b. This Licence is issued subject to the conditions contained herein with respect to the taking of water and the depositing of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposits of such waste may enter any waters. Whenever new Regulations are made or existing Regulations are amended by the Governor in Council under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, or other statutes imposing more stringent conditions relating to the quantity or type of waste that may be so deposited or under which any such waste may be so deposited, this Licence shall be deemed, upon promulgation of such Regulations, to be subject to such requirements; and
- c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with the requirements of all applicable Federal, Territorial and Municipal legislation.

2. Definitions

In this Licence: NWB3GRA0207

“**Act**” means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*

“**Amendment**” means a change to original terms and conditions of this licence requiring correction, addition or deletion of specific terms and conditions of the licence; modifications inconsistent with the terms of the set terms and conditions of the Licence;

“**Analyst**” means an Analyst designated by the Minister under Section 85 (1) of the *Act*;

“**Appurtenant undertaking**” means an undertaking in relation to which a use of waters or a deposit of waste is permitted by a licence issued by the Board;

“**Average Concentration**” means the arithmetic mean of the last four consecutive analytical results for contained in composite or grab samples collected from the Waste Facility’s final discharge point;

“Average Concentration For Faecal Coliforms” means the geometric mean of the last four consecutive analytical results for faecal coliforms contained in composite or grab samples collected from the Waste Facility’s final discharge point;

“Board” means the Nunavut Water Board established under the *Nunavut Land Claims Agreement*;

“Chief Administrative Officer” means the Executive Director of the Nunavut Water Board;

“Commercial Waste Water” means water and associated waste generated by the operation of a commercial enterprise, but does not include toilet wastes or greywater;

“Effluent” means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant;

“Freeboard” means the vertical distance between water line and crest on a dam or dyke’s upstream slope;

“Grab Sample” means a single water or wastewater sample taken at a time and place representative of the total discharge;

“Inspector” means an Inspector designated by the Minister under Section 85 (1) of the *Act*;

“Licensee” means the holder of this Licence;

“Modification” means an alteration to a physical work that introduces new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion, and changes to the operating system that are consistent with the terms of this Licence and do not require amendment;

“Monitoring Program” means a program established to collect data on surface water and groundwater quality to assess impacts to the environment of an appurtenant undertaking.

“Nunavut Land Claims Agreement” (NLCA) means the “Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada,” including its preamble and schedules, and any amendments to that agreement made pursuant to it;

“Sewage” means all toilet wastes and greywater;

“Sewage Treatment Facility” comprises the area and engineered lagoon and decant structures designed to contain sewage as described in the Application for Water Licence;

“Toilet Wastes” means all human excreta and associated products, but does not include greywater;

“Waste” means, as defined in S.4 of the *Act*, any substance that, by itself or in combination with other substances found in water, would have the effect of altering the quality of any water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

“Water Supply Facility” means the area and associated intake infrastructure at Nipissar Lake, as described in the Application for Water Licence.

PART B: GENERAL CONDITIONS

1. The Licensee shall file an Annual Report with the Board not later than March 31st of the year following the calendar year reported which shall contain the following information:
 - i. tabular summaries of all data generated under the “Monitoring Program”;
 - ii. the monthly and annual quantities in cubic metres of each and all waste discharged;
 - iii. a summary of modifications and/or major maintenance work carried out on the Solid Waste Disposal Facility, including all associated structures and facilities;
 - iv. a list of unauthorized discharges and summary of follow-up action taken
 - v. a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;
 - vi. a summary of any studies, reports and plans (e.g., Operation and Maintenance, Abandonment and Restoration, QA/QC) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned; and
 - vii. any other details on water use or waste disposal requested by the Board by November 1st of the year being reported.

2. The Licensee shall comply with the "Monitoring Program" described in this Licence, and any amendments to the "Monitoring Program" as may be made from time to time, pursuant to the conditions of this Licence.
3. The "Monitoring Program" and compliance dates specified in the Licence may be modified at the discretion of the Board.
4. Meters, devices or other such methods used for measuring the volumes of waste discharged shall be installed, operated and maintained by the Licensee to the satisfaction of an Inspector.
5. The Licensee shall, within ninety (90) days after the first visit of the Inspector, post the necessary signs, where possible, to identify the stations of the "Monitoring Program." All signage postings shall be in the Official Languages of Nunavut, and shall be located and maintained to the satisfaction of an Inspector.
6. The Licensee shall immediately report to the 24-Hour Spill Report Line (867-920-8130) any spills of Waste, which are reported to or observed by the Licensee, within the municipal boundaries or in the areas of the Solid Waste Disposal Facility.
7. The Licensee shall ensure a copy of this Licence is maintained at the municipal office and at the site of operation at all times. Any communication with respect to this Licence shall be made in writing to the attention of:

(i) Chief Administrative Officer:

Executive Director
Nunavut Water Board
P. O. Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369

(ii) Inspector Contact:

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4298
Fax: (867) 979-6445

(iii) Analyst Contact

Taiga Laboratories
Department of Indian and Northern Affairs
4601 - 52 Avenue, P.O. Box 1500
Yellowknife, NT X1A 2R3
Telephone: (867) 669-2781
Fax: (867) 669-2718

8. The Licensee shall submit one paper copy and one electronic copy of all reports, studies, and plans to the Board. **Reports or studies submitted to the Board by the Licensee shall include a detailed executive summary in Inuktitut.**

PART C: CONDITIONS APPLYING TO WATER USE

1. The Licensee shall obtain all fresh water from Nipissar Lake using the Water Supply Facilities or as otherwise approved by the Board.
2. The annual quantity of water used for all purposes shall not exceed 400,000 cubic metres.
3. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.
4. The water intake hose used on the water pumps shall be equipped with a screen with a mesh size sufficient to ensure no entrainment of fish.

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

1. The Licensee shall direct all Sewage to the Sewage Treatment Facility or as otherwise approved by the Board.
2. All Effluent discharged from the Sewage Treatment Facility at "Monitoring Program" Station Number GRA-3 shall meet the following effluent quality standards:

Parameter	Maximum Average Concentration
Faecal Coliforms	1 x 10 ⁶ CFU/dl
BOD ₅	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	between 6 and 9

3. A Freeboard limit of 1.0 metre, or as recommended by a qualified geotechnical engineer and as approved by the Board, shall be maintained at all dykes and earthfill structures associated with a Sewage Treatment Facility.
4. The Sewage Treatment Facility shall be maintained and operated in such a manner as to prevent structural failure.
5. The Licensee shall maintain the Sewage Treatment Facility to the satisfaction of an Inspector.

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

1. The Licensee shall submit to the Board for approval design drawings stamped by a qualified engineer registered in the Nunavut prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain water or wastes.
2. The Licensee may, without written approval from the Board, carry out modifications to the Water Supply and Sewage Treatment Facility provided that such modifications are consistent with the terms of this Licence and the following requirements are met:
 - a. the Licensee has notified the Board in writing of such proposed modifications at least sixty (60) days prior to beginning the modifications;
 - ii. said modifications do not place the Licensee in contravention of the Licence or the *Act*;
 - iii. the Board has not, during the sixty (60) days following notification of the proposed modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and
 - iv. the Board has not rejected the proposed modifications.
3. Modifications for which all of the conditions referred to in Part E, Item 1, have not been met may be carried out only with written approval from the Board.
4. The Licensee shall provide as built plans/drawings of the modifications referred to in this Licence within ninety (90) days of completion of the modifications.

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

1. The Licensee shall, before December 1, 2003 submit to the Board for approval, a Plan for the Operation and Maintenance of the Water Treatment Facility and the Sewage Treatment Facility in accordance with "*Guidelines for Preparing an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities*" (October 1996).
2. The Licensee shall implement the Plan specified in Part F, Item 1 as and when approved by the Board.
3. The Licensee shall revise the Plan referred to in Part F, Item 1, if not acceptable to the Board. The revised Plan shall be submitted to the Board for approval within thirty (30) days of notification of the Board decision.
4. If, during the period of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:
 - i. employ the appropriate contingency plan as provided for in the Operation and Maintenance Plan;
 - ii. report the incident immediately *via* the 24-Hour Spill Reporting Line at (867) 920-8130 and to an Inspector; and
 - iii. submit to an Inspector a detailed report on each occurrence not later than thirty (30) days after initially reporting the event.

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

1. The Licensee shall submit to the Board for approval an Abandonment and Restoration Plan at least six (6) months prior to abandoning any facilities and the construction of new facilities to replace existing ones. The Plan shall include, but not be limited to where applicable:
 - i. water intake facilities;
 - ii. the water treatment and sewage treatment sites and facilities;
 - iii. petroleum and chemical storage areas;
 - iv. any site affected by waste spills;

- v. leachate prevention;
 - vi. an implementation schedule;
 - vii. maps delineating all disturbed areas, and site facilities;
 - viii. consideration of altered drainage patterns;
 - ix. type and source of cover materials;
 - x. future area use;
 - xi. hazardous wastes; and
 - xii. a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.
2. The Licensee shall implement the plan specified in Part G, Item 1 as and when approved by the Board.
 3. The Licensee shall revise the Plan referred to in Part G, Item 1 if not approved. The revised Plan shall be submitted to the Board for approval within thirty (30) days of receiving notification of the Board's decision.
 4. The Licensee shall complete the restoration work within the time schedule specified in the Plan, or as subsequently revised and approved by the Board.

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

1. The Licensee shall maintain Surveillance Stations at the following locations:

<u>Station Number</u>	<u>Description</u>
GRA-1	Raw Water supply prior to treatment
GRA-3	Effluent discharge from the Sewage Treatment Facility

2. The Licensee shall sample monthly at Monitoring Station GRA-3 during the months of May to August, inclusive.

3. The Licensee shall analyze samples collected at Station Number GRA-3 for the following parameters:

BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Ammonia Nitrogen
Nitrate-Nitrite	Oil and Grease (visual)
Total Phenols	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Arsenic	Total Cadmium
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	

4. Additional sampling and analysis may be requested by an Inspector;
5. The Licensee shall conform to the Quality Assurance/Quality Control (QA/QC) Plan which shall be provided to the Licensee by the NWB within 60 days of the issuance of this licence;
6. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board;
7. All analyses shall be performed in a Canadian Association of Environmental Analytical Laboratories (CAEAL) Certified Laboratory, or as otherwise approved by an Analyst;
8. The Licensee shall measure and record in cubic metres the monthly and annual quantities of water pumped from Monitoring Program Station Number GRA-1 for all purposes;
9. The Licensee shall measure and record the annual quantities of sewage solids removed from the sewage disposal facility ~~shall be measured and recorded~~;
10. The Licensee shall, unless otherwise requested by an Inspector, include all of the data and information required by the "Monitoring Program" in the Licensee's Annual Report, as required *per* Part B, Item 1; and
11. Modifications to the Monitoring Program may be made only upon written approval of the Chief Administrative Officer.



Appendix B
Climate Data

Rankin Inlet Climate Data

Table 1: Rankin Inlet Climate Normals Data Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Total Precipitation (mm)	6.6	8.9	12.6	14.3	18.4	29.8	39.5	57.6	43.8	34.6	19.8	11.3	297.2
Rain (mm)	0.0	0.1	0.0	1.0	7.4	25.0	39.5	57.3	39.2	11.9	0.1	0.0	181.5
Snow (cm)	6.7	9.3	12.9	13.6	11.5	4.9	0.0	0.3	4.6	23.1	20.9	11.9	107.8
Wind Speeds (km/hour)	23.9	23.9	23.4	22.4	22.1	19.8	19.2	21.1	24.2	26.5	25.3	24.0	
Average Temperatures (°C)	-31.9	-30.1	-25.2	-16.3	-5.9	4.2	10.4	9.5	3.4	-5.3	-17.8	-26.7	

*Canadian Climate Normals 1971-2000, Environment Canada, Rankin Inlet Airport Weather Station

Water Use Projections for the Hamlet of Rankin Inlet, Nunavut

Water Use Projections Table

Key Assumptions

Starting Year: 2006
Population Growth Rate: 1.4%

Starting Population: 2358
Residential Water Usage Rate [L/cd]: 220.0

Planning Year	Calendar Year	Projected Population ¹	Projected Water Consumption ²	Projected Total Consumption Volume				Based on Recorded Usage Rate in 2008	
			[Lpcd]	[Litres/day]	[Litres/year]	[m3/day]	[m3/year]	[m3/day]	[m3/year]
	2006	2358	331.8	782435	285,588,672	782	285,589		
	2007	2392	332.8	796150	290,594,757	796	290,595		
0	2008	2426	333.8	809900	295,613,377	810	295,613	2108	769420
	2009	2460	334.8	823683	300,644,356	824	300,644		
	2010	2495	335.8	837907	305,836,035	838	305,836		
	2011	2530	336.8	852166	311,040,449	852	311,040		
5	2012	2566	337.8	866868	316,406,662	867	316,407		
	2013	2602	338.8	881605	321,785,974	882	321,786		
	2014	2639	339.8	896790	327,328,173	897	327,328		
	2015	2676	340.8	912010	332,883,827	912	332,884		
	2016	2714	341.8	927681	338,603,444	928	338,603		
	2017	2752	342.8	943389	344,336,861	943	344,337		
10	2018	2791	343.8	959549	350,235,308	960	350,235		
	2019	2831	344.8	976164	356,299,679	976	356,300		
	2020	2871	345.8	992818	362,378,709	993	362,379		
	2021	2912	346.8	1009931	368,624,715	1010	368,625		
	2022	2953	347.8	1027084	374,885,693	1027	374,886		
	2023	2995	348.8	1044698	381,314,687	1045	381,315		
	2024	3037	349.8	1062353	387,758,957	1062	387,759		
	2025	3080	350.8	1080472	394,372,269	1080	394,372		
	2026	3124	351.8	1099056	401,155,495	1099	401,155		
	2027	3168	352.8	1117684	407,954,795	1118	407,955		
20	2028	3213	353.8	1136781	414,925,019	1137	414,925	2466	900000
	2029	3258	354.8	1155922	421,911,589	1156	421,912		
	2030	3304	355.8	1175534	429,070,078	1176	429,070		
	2031	3351	356.8	1195620	436,401,342	1196	436,401		
	2032	3398	357.8	1215753	443,749,704	1216	443,750		
	2033	3446	358.8	1236361	451,271,817	1236	451,272		
	2034	3495	359.8	1257448	458,968,526	1257	458,969		
	2035	3544	360.8	1278584	466,683,053	1279	466,683		
	2036	3594	361.8	1300200	474,573,133	1300	474,573		
	2037	3645	362.8	1322300	482,639,599	1322	482,640		
30	2038	3697	363.8	1344886	490,883,286	1345	490,883		

- Note:
- 1) Population in 2006 taken from Statistics Canada 2006 Census of Population. A population growth of 1.5% was applied to the subsequent years.
 - 2) The projected water consumption is based on the Nunavut water usage formula $[RWU \text{ L/c/d} \times (-1 + (0.323 \times \ln(\text{population}))]$.
 - 3) The Residential Water Usage Rate is estimated to be 220 L/c/d for populations greater than 2000 and assumes that the water is distributed by a piping system.

Hydrology Calculations, Hamlet of Rankin Inlet

Annual Rainfall (m/year)	0.2972	*Canadian Climate Normals 1971-2000, Environment Canada, Rankin Inlet Airport Weather Station
Evapotranspiration (m ³ /year)	0.200	* Specific values for Rankin Inlet were not available, estimated using several references, see below.

Nippissar Lake Drainage Basin

Lake Drainage Area (m ²)	3,230,000
Rain and Runoff (m ³ /year)	959,956
Evapotranspiration (m ³ /year)	646,000
Net Recharge of Lake (m ³ /year)	313,956

Nippissar Lake Volume

Lake Area (m ²)	1,090,565
Estimated Average Depth (m)	4
Estimated Lake Volume (m ³)	4,362,260

Evapotranspiration Rates

Location	Value (mm)	Reference
Arviat, Nunavut	203	FSC Architects & Engineers, 2003
Mackenzie Basin, Yukon	241	Serrereze et al, 2003
Lena Basin, Russai	182	Serrereze et al, 2003
Knob Lake, Quebec	280	Church, 1974
Boot Creek, Inuvik, NWT	75	Church, 1974
Mackenzie River Basin, Yukon	216	Yi Yip, 2008
Average	200	

References:

FSC Architects & Engineers, 2003. Design Concept for Arviat Sewage Lagoon prepared for Department of Community Government and Transportation, Government of Nunavut.

Church, M. 1974. Hydrology and Permafrost with Reference to Northern North America. In Proceedings: Workshop Seminar on Permafrost Hydrology, 7-20. Ottawa: Canadian National Committee, International Hydrological Decade (IHD).

Yi Yip, Q.M. 2008. Climate Impacts on Hydrometric Variables In Mackenzie River Basin. University of Waterloo, Waterloo, 2008.

Serrereze, M.C., D.H. Bromwich, M.P. Clark, A.J. Etringer, T. Zhang and R. Lammers, 2003. Large-scale hydro-climatology of the terrestrial Arctic drainage system. Journal Geophysical Research, 108(D2). Doi:10. 1029/2002JD000919



Appendix C

Projected Water Requirements

Form 1
Annual Water Intake Log
Hamlet of Rankin Inlet

Year: _____

Date	Date of Record	Total Town Supply (Current Month) (m ³)	Total Town Supply (Since Start) (m ³)	Recorded By	Comments
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Annual Totals					

Form 2
Monthly Water Supply Facility Inspection Form
Hamlet of Rankin Inlet

Inspected By: _____ Date: _____

Wind Direction: _____ Temperature: _____

Precipitation: _____ Ground Cover: _____

Issues and Conditions	Description/Condition/Problems	Action/Maintenance Required
Health and Safety (dangers and concerns)		
Signs		
Access Road and Truck Pad (condition, drainage, snow, surface, etc.)		
Pumps		
Water Intake Screen		
Berm		
Fuel Storage Tanks		

Issues and Conditions	Description/Condition/Problems	Action/Maintenance Required
Wildlife		
Ice		
Litter		
Other Issues and Concerns		

Form 3
Water Supply Facility Planning
Hamlet of Rankin Inlet

Prepared By: _____

Date: _____

Water Supply Facility Planning Issue	Current Operations	To Do Items and Schedule
Health and Safety		
Site Inspection Results/Concerns		
Current Volumes		
Water Treatment Process		
Annual Reporting		
Nunavut Water Board License Requirements		

Water Supply Facility Planning Issue	Current Operations	To Do Items and Schedule
Flow Monitoring		
Staffing		
Equipment		
Costs		
Other Issues/Concerns		



Appendix D
Site Photographs



Photo 1: Nipissar Lake Pump house

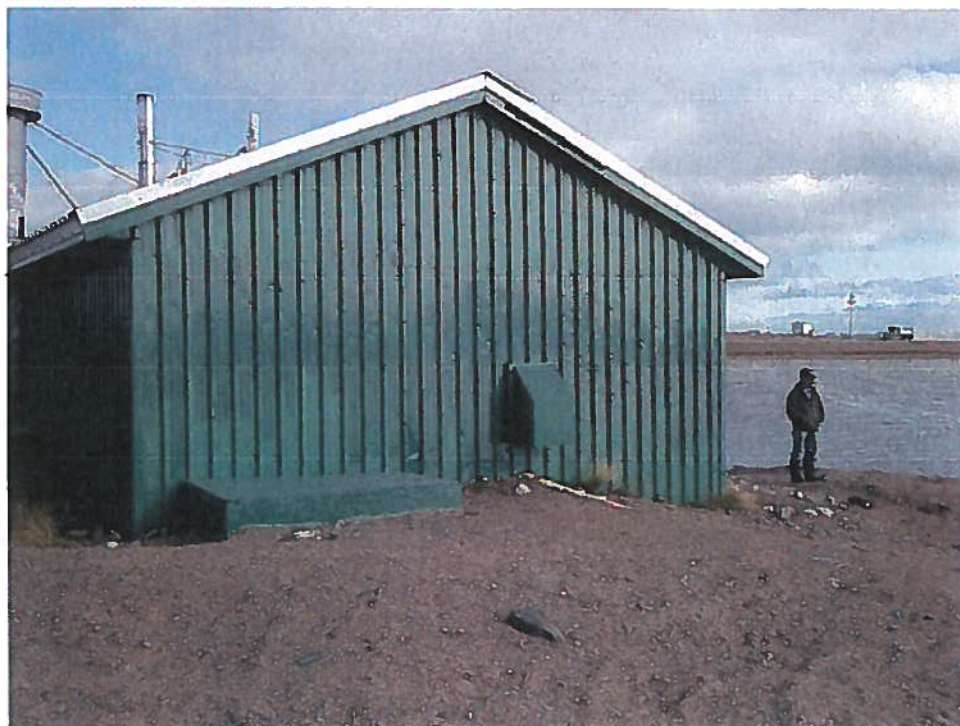


Photo 2: Back of Nipissar Lake pumphouse

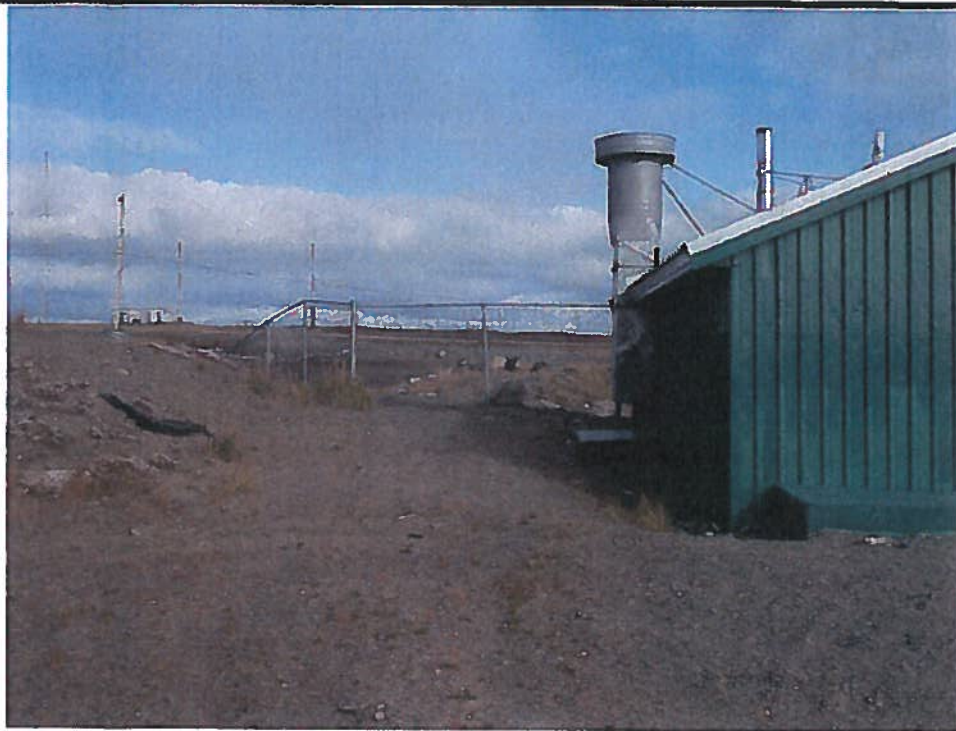


Photo 5: Northwest corner of pump house



Photo 6: Access driveway to pump house



Photo 9: Fuel intake pipe into pumphouse



Photo 10: Fuel storage tank inside of pump house



Appendix E
Site Forms

NWB Annual Report

Year being reported: Select ▼

License No: Issued Date:
 Expiry Date:

Project Name: Licensee: Mailing Address:

Name of Company filing Annual Report (If different from Name of Licensee please clarify relationship between the two entities, if applicable):

General Background Information on the Project (*optional):

Licence Requirements: the licensee must provide the following information in accordance with

Select ▼ Select ▼

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s):	
Water Quantity:	Quantity Allowable Domestic (cu.m)
	Actual Quantity Used Domestic (cu.m)
	Quantity Allowable Drilling (cu.m)
	Total Quantity Used Drilling (cu.m)

Waste Management and/or Disposal

- ☐ Solid Waste Disposal
☐ Sewage
☐ Drill Waste
☐ Greywater
☐ Hazardous
☐ Other:

Additional Details:

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)
 Date of Spill:
 Date of Notification to an Inspector:
 Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc)

Revisions to the Spill Contingency Plan

Select

Additional Details:

Revisions to the Abandonment and Restoration Plan

Select

Additional Details:

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Select

Additional Details:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Select

Additional Details:

Results of any additional sampling and/or analysis that was requested by an Inspector

Select 

Additional Details: (date of request, analysis of results, data attached, etc)

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Select 

Additional Details: (Attached or provided below)

Any responses or follow-up actions on inspection/compliance reports

Select 

Additional Details: (Dates of Report, Follow-up by the Licensee)

Any additional comments or information for the Board to consider

Date Submitted:

Submitted/Prepared by:

Contact Information:

Tel:

Fax:

email:



Appendix F

Annual Monitoring Report Format

NWB Annual ReportYear being reported: Select ▼

License No: Issued Date:
 Expiry Date:

Project Name: Licensee: Mailing Address:

Name of Company filing Annual Report (if different from Name of Licensee please clarify relationship between the two entities, if applicable):

General Background Information on the Project (*optional):

Licence Requirements: the licensee must provide the following information in accordance with

Select ▼ Select ▼

A summary report of water use and waste disposal activities, including, but not limited to: methods of obtaining water; sewage and greywater management; drill waste management; solid and hazardous waste management.

Water Source(s):	
Water Quantity:	Quantity Allowable Domestic (cu.m)
	Actual Quantity Used Domestic (cu.m)
	Quantity Allowable Drilling (cu.m)
	Total Quantity Used Drilling (cu.m)

Waste Management and/or Disposal

- ☐ Solid Waste Disposal
☐ Sewage
☐ Drill Waste
☐ Greywater
☐ Hazardous
☐ Other:

Additional Details:

A list of unauthorized discharges and a summary of follow-up actions taken.

Spill No.: (as reported to the Spill Hot-line)
 Date of Spill:
 Date of Notification to an Inspector:
 Additional Details: (impacts to water, mitigation measures, short/long term monitoring, etc)

Revisions to the Spill Contingency Plan

Select

Additional Details:

Revisions to the Abandonment and Restoration Plan

Select

Additional Details:

Progressive Reclamation Work Undertaken

Additional Details (i.e., work completed and future works proposed)

Results of the Monitoring Program including:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where sources of water are utilized;

Select

Additional Details:

The GPS Co-ordinates (in degrees, minutes and seconds of latitude and longitude) of each location where wastes associated with the licence are deposited;

Select

Additional Details:

Results of any additional sampling and/or analysis that was requested by an Inspector

Select ▼

Additional Details: (date of request, analysis of results, data attached, etc)

Any other details on water use or waste disposal requested by the Board by November 1 of the year being reported.

Select ▼

Additional Details: (Attached or provided below)

Any responses or follow-up actions on inspection/compliance reports

Select ▼

Additional Details: (Dates of Report, Follow-up by the Licensee)

Any additional comments or information for the Board to consider

Date Submitted:

Submitted/Prepared by:

Contact Information:

Tel:	
Fax:	
email:	



Appendix G

**March 25, 2010 Letter to
DFO Regarding Freshwater Intake from
Nippisar Lake**



An Aboriginal Owned Company

March 25, 2010

Ms. Loriena Melnick
Habitat Management Biologist
Fisheries and Oceans Canada – Eastern Arctic Area
PO Box 358
Iqaluit, Nunavut X0A 0H0

Dear Ms. Melnick:

**Re: Fresh Water Intake From Nipissar Lake
Type 'A' Water License Application – 3 AM GRA
Rankin Inlet, Nunavut
DFO Habitat File No. N4-09-0037
File No. N-O 14850**

1.0 Introduction

As per the letter from Fisheries and Oceans Canada (DFO) to the Nunavut Water Boards (NWB), dated December 16, 2009, and the discussions held during the Technical Meeting teleconference on March 3, 2010, we have obtained additional information to address concerns regarding potential impacts to fish habitat. As outlined herein, we were able to make an assessment of the potential for the intake to impact fish. At this time, we are not able to assess the potential impacts of lake drawdown, due to water taking exceeding the capacity of the Nipissar Lake watershed. As discussed, the GN has undertaken lake studies in 2009 and will continue through 2010, to determine the current and future impacts to lake levels resulting from Hamlet with drawls and the potential impacts on the aquatic environment.

2.0 Water Supply

The community draws its water from the Nipissar Lake, located 2 km northwest of the Hamlet. Nipissar Lake covers an area of 1,090,565 m². Using an average depth of 4 metres the estimated volume of the lake is 4,362,260 m³. The total drainage area of Nipissar Lake is 323 hectares. Using an annual precipitation rate of 297.2 mm and an annual evapotranspiration rate of 200 mm, the calculated total recharge to the lake is approximately 314,000 m³ per year (Nuna Burnside 2009). This is lower than the numbers given in the Nipissar Lake Watershed Model, which calculates the useable storage of the lake to be about 1,400,000 m³ and the estimated annual recharge as 600,000 m³ per year (Stanley Assoc., 1996).

The Nipissar Lake pump house has vertical turbine submersible pumps installed inside twin intake lines. Each of the 10 up pumps has a 1020 L/min (17L/sec) capacity. Only one pump operates at a time. Operation of the pump is controlled by the water level in the water storage tank adjacent to the Williamson Lake pump house. An air compressor aerates water around the intake to prevent taste and odour problems.

According to the water use estimates, the Hamlet is using more water per year than the estimated annual recharge of the lake. The Government of Nunavut is conducting studies to identify an alternative water supply that they can pump into the reservoir during the summer months to maintain the water levels in the lake in the future.

3.0 General and Site Information

The name of the water source at the intake location is Nipissar Lake.

The location of Nipissar Lake is 2km northwest of the Hamlet and the pump station located on the east side of the lake 15V 545131.99 m E, 6966238.89 m N.

The type of waterbody is an in-land lake that has no direct connection to any watercourse or estuary associated with Hudson Bay.

The water intake has been elevated above the lake bed by approximately 2.0m. The intake has an air compressor aerates water around the intake to prevent taste and odour problems, this can also prevent fish from entering the intake due to air bubbles surrounding it similar to a bubble curtain used in construction projects to isolate the work area from fish bearing waters. The air bubbles could create a barrier around the intake therefore not allowing fish to enter the intake.

Initial construction of the intake was 30 years ago with modifications to the intake in 2009 based on a previous as built drawing. The intake construction consists of a barrel or cylindrical screen (Stainless Steel) that is aligned vertically and elevated approximately 2.0m from the lake bed.

4.0 Biophysical Information

Potential for fish presence in this waterbody would normally be limited due to the type of waterbody not having direct connection to watercourses or the estuary. Local knowledge states that fish have been released to the lake in the past although fishing is not permitted due to protection of the water supply and its water quality. Native species known to exist in the lake are Arctic grayling (*Thymallus arcticus*) and lake trout (*Salvelinus namaycush*) based on local knowledge (pers. comm. Joe Strickland). Based on the species noted above the potential for reproduction and possibility of smaller sizes and year class of fish may exist if the stock is naturally producing. The potential for forage species such as cyprinids may be possible unless the fish feed primarily on aquatic insects. The fish species known to exist would be classified as subcarangiform.

Physical description of the intake location is on the lake bed elevated 2.0m above the substrate in approximately 5.3m of water. The max depth of the lake is approximately 6.7m. Substrate at depth is reportedly sand and gravel, however there is no confirming documentation. The position of the intake is vertical based on the lake bed.

5.0 Water Use Information

The purpose of water withdrawal is for the consumption and supply for the Hamlet of Rankin Inlet. The inlet consists of 2 intakes with one being a continuous draw depending on consumption uses and reservoir levels. If the reservoir is full then one intake will run continuously but re-circulate the water within the intake system to reduce the potential for freezing during winter conditions. The average intake rate is 17L/sec or 1020L/min for one intake.

Effects on Nipissar Lake from the water taking would primarily be lowering of lake levels during dry periods in the summer. How this is related to the aquatic environment will need to be assessed based on the species known to exist (Arctic grayling and lake trout) and their usage of seasonal depth ranges depending on spawning and forage activities.

Structures associated with the intake include the insulated line, aeration line, pump house and transmission line, reservoir, and distribution system.

The water license application will be for an existing intake and possibly upgrades to the intake screen if required based on DFOs review. Future alternations to the intake are dependent on the findings of the current studies.

6.0 Fish Screen Information

The intake screen open and effective areas will need to be determined based on a rectangular screen opening of 3/16" (4.763mm) and 1" (25.4mm). The intake has been described as cylindrical screen (24"H x 18"Ø) with a sealed top and bottom made of stainless steel. It is unknown at this time what type of screen exists on the intake (i.e. wedge wire, woven wire), and this information must be acquired and verified to determine the "% open area" based on the DFO Fish Screen Guidelines and associated calculations.

Based on a review of the DFO guidelines, protection of fish with a minimum fork length of 25mm must be attained although the largest opening in the existing screen being 1" (25.4mm) therefore allowing for small fish to enter the intake depending on the intake velocity. As mentioned above, the aeration line aerates the water around the intake prior to being drawn into the system to reduce taste and odour issues related to stagnant water. No other cleaning, maintenance, or special requirements are known at this time.

7.0 Calculation Based on Assumptions

If we use a conservative estimate of 50% open area then we can determine what size the intake screen must be to satisfy the guideline requirements based on subcarangiform fish. The result based on a 12"Ø cylinder screen and a flow rate of 17L/sec and the assumed 50% open area the length of the intake screen would need to be 13.2" or longer to ensure that smaller fish can overcome the velocity of the intake.

The dimensions of the intake are 24" long and therefore would equate to an open area of approximately 26% based on the DFO guideline calculations. Due to the required efficiency of intake screens it may be safe to assume that the % open area would be

greater than 26% and that the existing screen complies with the DFO Freshwater Intake End-of-Pipe Intake Guidelines (DFO, 1995) based on length of the screen.

8.0 Summary

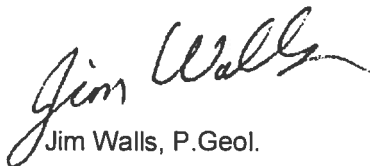
Based on the information currently available and conservative estimates, the current intake complies with DFO requirements, however the impact to aquatic habitat due to fluctuations to lake level due to seasonal drawdowns remains unknown.

We suggest the new license include the Condition to assess the impact of lake level fluctuations, due to Hamlet water taking, on fish habitat in Nipissar Lake by December 31, 2010. The findings should also include recommendations for action with a time line, should it be required.

If you have any questions or comments, or require further information, please contact our Aquatic Resource Specialist, Chris Pfohl, A.Sc.T., or the undersigned.

Yours truly,

Nuna Burnside Engineering and Environmental Ltd.



Jim Walls, P.Geol.

JW:mm

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ADDENDUM TO OPERATIONS AND MAINTENANCE PLAN FOR THE WATER SUPPLY FACILITY, CHAR RIVER, RANKIN INLET, NUNAVUT

Appendix B Spill Contingency Plan
May 9, 2014

Appendix B Spill Contingency Plan

**Spill Contingency Plan for
Water Supply and Sewage
Treatment Facilities
Rankin Inlet, Nunavut**

Final



Prepared for:
Department of Community and
Government Services,
Government of Nunavut

Prepared by:
Stantec Consulting Ltd.
5021 – 49 Street
Yellowknife, NT X1A 2N4

May 2014

Revision Record							
Revision	Description	Prepared By		Checked By		Approved By	
	Original	05/01/14	KD	05/05/14	PC	05/09/14	PC

**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

Table of Contents

1.0	INTRODUCTION	1
1.1	PURPOSE AND SCOPE	1
2.0	SITE DESCRIPTION	3
2.1	WATER SUPPLY, TREATMENT, DISTRIBUTION AND STORAGE.....	3
2.2	SEWAGE COLLECTION AND TREATMENT.....	3
2.3	POTENTIAL CONTAMINANTS	3
2.4	ADDITIONAL COPIES.....	4
3.0	RESPONSE ORGANIZATION	5
3.1	RESPONSE ORGANIZATION PROCEDURE	5
3.3	EMERGENCY CONTACT INFORMATION	7
4.0	REPORTING PROCEDURE.....	8
5.0	ACTION PLANS.....	9
5.1	SPILL PREVENTION	9
5.2	SPILL RESPONSE	9
5.2.1	Chlorine Gas Release.....	9
5.2.2	Fluosilicic Acid	10
5.2.3	Other Chemicals (Gasoline, diesel, sewage).....	11
5.2.4	Spills on Land	12
5.2.5	Spills in Water.....	13
5.3	ADDITIONAL SPILL DELINEATION OR MONITORING	13
6.0	RESOURCE INVENTORY	14
6.1	ON-SITE RESOURCES.....	14
6.1.1	Personnel	14
6.1.2	Equipment	14
6.1.3	Spill Kits	14
7.0	TRAINING AND EXERCISES.....	16
7.1	OUTLINE	16
7.2	SCHEDULE	16
8.0	REFERENCES.....	17

LIST OF TABLES

Table 2-1:	Overview of Potential Contaminants	4
Table 3-1:	Off-Site Spill Contingency Contact Information.....	7
Table 3-2:	Regulatory agencies' Spill Contingency Contact Information	7
Table 6-1:	Chlorine Gas Initial Isolation and Protective Distances.....	10

**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

LIST OF APPENDICES

APPENDIX A	FIGURES	A.1
APPENDIX B	NORTHWEST TERRITORIES – NUNAVUT SPILL REPORT FORM	B.1
APPENDIX C	2012 EMERGENCY RESPONSE GUIDEBOOK GUIDES.....	C.1
APPENDIX D	MSDS SHEETS	D.1

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Introduction
May 2014

1.0 Introduction

This Spill Contingency Plan (SCP) has been developed for use by the Government of Nunavut Department of Community and Government Services (GN-CGS) for the operation of the Water Supply and the Sewage Treatment Facilities (the facilities) located in Rankin Inlet, Nunavut.

The contact information for the GN-CGS is provided below:

Government of Nunavut
Department of Community and Government Services
Box 490
Rankin Inlet, NU X0E 0G0
(867) 645-2895

This SCP has been developed for the operation of the facilities and the regulatory approvals in accordance with the *Guidelines for Spill Contingency Planning* prepared by Indian and Northern Affairs Canada (INAC 2007) and the Spill Contingency Planning and Reporting Regulations issued under the Nunavut *Environmental Protection Act*.

Upon finalizing this SCP, the document will be in effect. The SCP will be updated and revised annually to reflect site-specific conditions, as needed.

1.1 PURPOSE AND SCOPE

The GN-CGS directs that all personnel working at its facilities are prepared to provide prompt response to any spills. The SCP allows for the prompt and coordinated response of the GN-CGS to any spill located at the Water Supply Facility and the Sewage Treatment Facilities.

The purpose of the SCP is to provide a guide to all site personnel during routine Facility operation and/or the accidental release of sewage, solid waste, hydrocarbons or other hazardous materials related to the operation of the Facilities. Specifically, the SCP ensures:

1. Life and property are protected;
2. Resources are used effectively;
3. Environmental impacts are minimized; and,
4. Essential reporting is completed.

The SCP identifies key response personnel and their roles and responsibilities in the event of a spill, as well as the equipment and other resources available to respond to a spill. To be effective, it is important that all personnel are familiar with their responsibilities and steps to take

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Introduction
May 2014

in the event of a spill. Personnel should not read the SCP for the first time during an emergency. The SCP details spill response procedures that will minimize potential health and safety hazards, environmental impacts and spill response activities.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Site Description
May 2014

2.0 Site Description

The community of Rankin Inlet (or Kangiqliniq, meaning “deep bay/inlet”, in Inuktitut) has a total land area of 20.24 km², with a population of 2,266 people (StatsCan 2012). Rankin Inlet is situated on Kudlulik Peninsula which protrudes into the Rankin Inlet of Hudson Bay, located approximately at 62°52’00” N, 92°00’00” W. The community is approximately 450 km north of Churchill, Manitoba and approximately 1,100 km east of Yellowknife, Northwest Territories.

The community is mostly residential with several commercial establishments including construction contracting businesses, a grocery store, and a variety of other smaller businesses. Community buildings include a high school, elementary school, arena, swimming pool, the Hamlet of Rankin Inlet office, Government of Nunavut offices and a police station. Future developments in the community include the Nunavut Arctic College Trades Training Centre, Rankin Inlet Healing Centre, Area 5 subdivision expansion project (including the construction of public and GN staff housing complexes. In recent years, the community has supported the progress of the Agnico-Eagle Meliadine Gold Project, located 24 km northwest of the community, which is currently in the advanced exploration and environmental assessment stage.

2.1 WATER SUPPLY, TREATMENT, DISTRIBUTION AND STORAGE

Water supply for the community is taken from Nipissar Lake, located approximately 2 km northwest of the community. During the summer months (June to September), Nipissar Lake is replenished with additional water pumped via a 4.05 km pipeline from the Char River (Figure 1 in Appendix A).

Water is withdrawn from Nipissar Lake and pumped to the Williamson Lake Pump house, where it is chlorinated, stored and distributed using a series of buried utilidors and water mains. For buildings that are not connected to the utilidor system, water is delivered using water trucks.

2.2 SEWAGE COLLECTION AND TREATMENT

Underground sanitary sewers are used throughout the community to direct sewage, wastewater, and storm water to the Sewage Treatment Facility (STF). Upon arrival at the STF, the sewage undergoes primary treatment before being discharged into the Hudson Bay. For buildings that are not connected to the sanitary sewage system, sewage is collected by vacuum truck and transported to the STF.

2.3 POTENTIAL CONTAMINANTS

Potential contaminants that may be released during the operation of the Facilities are identified in Table 2-1 below.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Site Description
May 2014

Table 2-1: Overview of Potential Contaminants

Material	Storage Location	Maximum Quantity
Sewage	Lift Stations	N/A – Continuous Flow
	Force Main	N/A – Continuous Flow
Fuel Storage	Water Treatment Plant/ Williams Lake Pump House	10,000 gallons
	Nipissar Lake Lift Station	2,500 gallons
	Con Shed Storage Facility	4 x 250 gallons
Chlorine Gas	Williams Lake Pump House	1,500 lbs (10 x 150 lbs cylinders)
	Con Shed Storage Facility	7,500 lbs (50 x 150 lbs cylinders)
Fluosilicic Acid	Williams Lake Pump House	410 L (two x 205 L drums)
	Con Shed Storage Facility	8,200 L (40 x 205 L drums)
Calcium hypochlorite	Con Shed Storage Facility	100 L (five x 20 L pails)

2.4 ADDITIONAL COPIES

Copies of the SCP are located at each of the pump houses and inside of the sea canister located adjacent to the water intake pump at the Char River. A copy of the SCP can also be located at the GN-CGS Rankin Inlet office and the Nunavut Water Board.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014

3.0 Response Organization

The GN-CGS will be responsible for preparing and implementing a detailed SCP during the entire Project duration. Whenever a spill is identified, the GN-CGS Regional Project Manager will be contacted as soon as possible.

The GN-CGS has limited equipment and personnel in the community to address a large spill. In the case of a large spill, it may require the combined efforts of the GN-CGS and the Hamlet of Rankin Inlet to address the issue.

In the event of a spill, the GN-CGS Regional Project Manager or his/her Designate will serve as the Spill Response Coordinator.

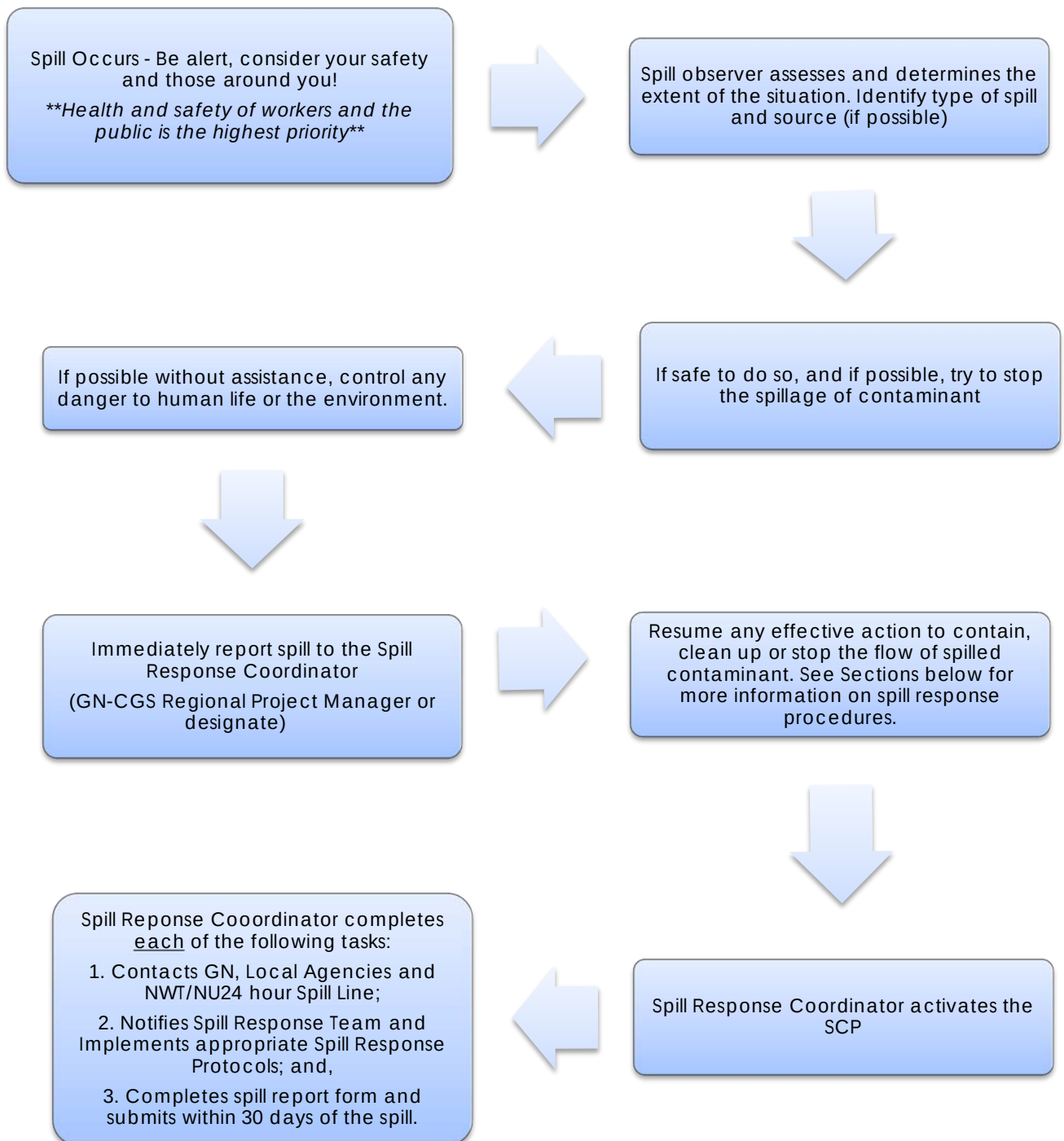
The GN-CGS Regional Project Manager or his/her Designate will appoint Hamlet Public Works personnel to the Spill Response Team and will provide the necessary training.

3.1 RESPONSE ORGANIZATION PROCEDURE

The following illustration outlines the sequence of events that must be followed in the event of a spill at the Facilities:

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014



SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Response Organization
May 2014

3.3 EMERGENCY CONTACT INFORMATION

Table 3-1 provides contact information for personnel who may be contacted to provide advice, expertise, and supply resources in the event of a spill.

Table 3-1: Off-Site Spill Contingency Contact Information

Contact	Location	Telephone number
Fire Department	Rankin Inlet, NU	(867) 645-2598
RCMP Detachment	Rankin Inlet, NU	(867) 645-0123
Community Health Center	Rankin Inlet, NU	(867) 645-8300
GN-CGS – Facilities Manager	Rankin Inlet, NU	(867) 645-8154
24-Hour Emergency Spill Report Line	Yellowknife, NT	(867) 920-8130
Aboriginal Affairs and Northern Development Canada – Inspector	Rankin Inlet, NU	(867) 645-2831
Government of Nunavut – Regional Engineer	Rankin Inlet, NU	(867) 645-4074
Hamlet of Rankin Inlet	Rankin Inlet, NU	(867) 645-2895

The following agencies can be contacted for assistance in spill reporting, response and/or clean-up and remediation.

Table 2-2: Regulatory agencies' Spill Contingency Contact Information

Agency	Legislation	Contact Information
Nunavut Water Board	<i>Nunavut Waters and Surface Right Tribunal Act</i>	Phone: (867) 360-6338 Fax: (867) 360-6369
Nunavut Impact Review Board	<i>Nunavut Land Claims Agreement Act</i>	Phone: (867) 983-2593
Government of Nunavut Department of Environment	<i>Nunavut Environmental Protection Act</i>	Phone: (867) 975-7700 Fax: (867) 975-7740
Environment Canada	<i>Canadian Environmental Protection Act, 1999</i>	Phone: (867) 975-4464 Fax: (867) 975-4645
Fisheries and Oceans Canada (Iqaluit)	<i>Fisheries Act</i>	Phone: (519) 383-1813 Fax: (519) 464-5128
Transport Canada (Coast Guard)	<i>Transportation of Dangerous Goods Act</i>	Phone: (867) 979-5269 Fax: (867) 979-4260

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Reporting Procedure
May 2014

4.0 Reporting Procedure

All spills or potential spills of contaminants must be reported to the 24-hour Northwest Territories – Nunavut Emergency Spill Report Line to ensure that an investigation may be undertaken by the appropriate government authority. Reporting of any spills associated with the Project should be completed by the Spill Response Coordinator or their designate.

To Report a Spill:

1. Fill out the Northwest Territories/Nunavut Spill Report Form (found in Appendix B of this SCP) as completely as possible before calling in the spill report.
2. Contact the Government of the Northwest Territories/Nunavut 24-hour Emergency Spill Report Line:
24-HOUR EMERGENCY SPILL REPORT LINE (867) 920-8130
3. Where fax is available, fax the completed Northwest Territories/Nunavut Spill Report Form to (867) 873-6924. Alternatively, if email is available, email the completed Northwest Territories – Nunavut Spill Report Form to spills@gov.nt.ca.

Any person reporting a spill is required to give as much information as possible. However, reporting of a spill should not be delayed if all of the necessary information is not known. Additional information can be provided later. From the Consolidation of Spill Contingency Planning and Reporting Regulations (1998), as much of the following information should be reported during the initial spill report:

- Date and time of spill
- Location of spill
- Direction if the spill is moving
- Name and phone number of a contact person close to the location of the spill
- Type of contaminant spilled and quantity
- Cause of spill
- Whether spill is continuing or has stopped
- Description of existing contaminant
- Action taken to contain, recover, clean up, and dispose of spilled contaminant
- Name, address and phone number of person reporting the spill
- Name of owner or person in charge, management or control of contaminants at the time of the spill.

In addition to reporting to the 24-hour Emergency Spill Report Line, an Aboriginal Affairs and Northern Development Canada (AANDC) Inspector must be notified of a spill immediately after occurrence. A copy of the completed Spill Report Form should be forwarded to them.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

5.0 Action Plans

5.1 SPILL PREVENTION

The most likely spill possibilities at the Facilities would be spillage from sewage pump-out activities; leakage or failure from sewage lines; spillage or leakage from chlorine containment or injection lines; leakage of diesel from on-site generators; spillage when refueling generators; or, a vehicular accident. Primary spill prevention measures will include:

- All Project personnel will receive spill contingency training prior to beginning work.
- All contaminants will be stored at designated storage areas more than 30 m from the high-water mark of any waterbody.
- All fuel storage vessels will have secondary containment such as containment trays, berms, and/or double-walled tanks designed to hold 110% of total volume of stored fuel.
- All fuel storage and transfer operations will take place at a designated fuel storage area and will be conducted by trained personnel.
- Emergency spill response kits will be kept at the Nipissar Lake Pump house, Williamson Lake Pump house, the Char River sea canister and any designated fuel storage areas, in case of fluid leaks or spills from machinery.
- Spill mats and/or drip pans/trays will be placed under all mobile fueling containers and under equipment when not in use.
- All stationary activities will be conducted at least 30 m from the ordinary high water mark of any waterbody or watercourse, where possible.
- All equipment and vehicles used for operations will be in good working order and free of leaks.
- Identified equipment or vehicle deficiencies will be repaired.
- Regular inspection and maintenance will be conducted for all hoses and lines associated with the Facilities.
- All sewage and solid waste will be contained and sealed in watertight containers.
- Drips will be cleaned up immediately.

5.2 SPILL RESPONSE

The following steps outline the general spill response procedures for initial actions to be taken to contain and clean up a contaminant spill, as well as disposing of contaminated materials.

5.2.1 Chlorine Gas Release

Potential impacts of failure and release of chlorine gas would be to public health and surrounding infrastructure. The chlorine gas is held in ventilated and restricted access rooms. Chlorine gas will disperse to the atmosphere leaving no residue, however in liquid form it is corrosive and therefore should be cleaned up and disposed of using proper procedures and

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

equipment. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 124 – Gases – Toxic and/or Corrosive – Oxidizing.

Any person finding a discharge of chlorine gas or a malfunction of chlorine gas in the facilities should immediately report the incident to the GN-CGS Facilities Manager. Use the Response Organization to notify the proper authorities (Section 3.3). In the event of a spill or leak, enclosed spaces should be ventilated; do not access unventilated areas without proper respiratory and protective clothing/gloves. Eliminate all sources of ignition and where possible elevate the cylinder such that gas and not liquid escapes.

If there is a chlorine gas leak or spill during transportation follow the emergency response plan developed as per the TDG regulations. The TDG plan must be shipped with the dangerous goods and be readily available. If no emergency plan is available follow the Transport Canada Emergency Guidebook (2012) Guide 124 – Gases – Toxic and/or Corrosive – Oxidizing provided in Appendix C.

From the Transport Canada Emergency Guidebook (2012) the initial isolation and protective action distances for chlorine are:

Table 5-1: Chlorine Gas Initial Isolation and Protective Distances

Chemical Name	Small Spills (from a small package or a small leak from a large unit)			Large Spills (from a large package or from many small packages)		
	First Isolate in All directions	Then Protect Persons Downwind during		First Isolate in All directions	Then Protect Persons Downwind during	
		Day	Night		Day	Night
Chlorine	60 m	0.4 km	1.6 km	600 m	3.5 km	8.0 km

5.2.2 Fluosilicic Acid

Fluosilicic acid is a toxic substance that can cause severe burns and destruction to tissue of the mucous membranes and upper respiratory tract when inhaled. Fluosilicic acid is a liquid and should be stored in a tightly closed container in a well-ventilated area. After use, container must be resealed and kept upright to prevent leaks. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 154 – Substance – Toxic and/or Corrosive (Non-combustible) provided in Appendix C.

In the event of an accidental spill, wear respiratory protection and avoid breathing in the vapors. Evacuate personnel from the area. Any person finding a leak of fluosilicic acid in the facilities should immediately report the incident to the GN-CGS Facilities Manager. Notify the

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

proper authorities (Section 3.3). If inhaled, move to fresh air immediately. If the liquid has made contact with skin or eyes, rinse thoroughly with plenty of water. The substance is not combustible; however, over time, the substance may decompose to produce corrosive or toxic fumes. Use water spray, alcohol resistant foam, dry chemical or carbon dioxide to extinguish flames. More detailed information on this substance can be found on the attached MSDS sheet in Appendix D.

For clean-up, soak up with absorbent pads and contain pads in sealed containers. Dispose of pads as hazardous waste at the community landfill.

5.2.3 Other Chemicals (Gasoline, diesel, sewage)

Gasoline, diesel and sewage spills could potentially affect the public and the surrounding environment. When fuel spills, vapors may travel to sources of ignition and flash back or collect in confined areas. Raw sewage spills can be a concern to public health. If a fuel or sewage leak is observed, stop the flow of contaminant if safe to do so. Immediately report the incident to the GN-CGS Facilities Manager and notify the proper authorities (Section 3.3).

For fuel spills, isolate the spill or leak area for a minimum of 50 m in all directions. Refer to the attached Transport Canada Emergency Guidebook (2012) Guide 128 – Flammable Liquids (Non-polar/Water Immiscible), provided in Appendix C. All fuel contaminated soils should be treated in the local landfarm in accordance with normal operating procedures. Small quantities of material can be stored in labelled drums at the hazardous waste storage area in the landfill.

A small sewage spill can occur from a truck lead or household tank. If the spill is small, cleanup may be accomplished with a vacuum truck. Any residual sewage can be diluted with water. For larger spills, the area must be contained with berms. Vacuum trucks and/or excavators can be used to remove contaminated material. All sewage contaminated materials will be transported to the sewage treatment facility (liquids) or landfill facility for disposal.

5.2.3.1 Spills on Snow/Ice

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative to report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent materials or a snow/soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g., gasoline, diesel).
7. Once the spill has been controlled and further spreading prevented, contact the GN-CGS facilities representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with the spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for disposal. Impacted snow should be stored in drums for proper disposal.

5.2.4 Spills on Land

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage, etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container), or contain the spill (e.g., place a container or tarp with built up edges under the spill source to contain the spill).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative and report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.
6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent (oil-absorbing) materials or a soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g., gasoline, diesel).
7. If some contaminant has entered a waterway, follow procedures in Section 5.2.5 to contain and clean-up the contaminant in the water.
8. Once the spill has been controlled and further spreading prevented, contact the GN-CGS site representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
9. If possible with spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for proper disposal. Do not flush the affected area with water.
10. If possible, remove any contained liquid by pumping into secure drums.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Action Plans
May 2014

5.2.5 Spills in Water

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, sewage etc.) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access (if any) of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the GN-CGS facilities representative and report the spill immediately and request assistance (see Section 3.0 for contact information). Use materials on hand to attempt to control the spill.
6. If the spill is small enough to be controlled with the spill response materials at hand, use sorbent booms to contain the spill for recovery. Place sorbent sheets on the water within the boomed area to help contain the contaminant. For narrow waterways such as streams, place one or more sorbent booms across the waterway, downstream of the spill location, and anchor the booms on each bank.
7. Once the spill has been controlled and further spreading prevented, contact the GN-CGS facilities representative and report the spill (see Section 3.0 for contact information). The GN-CGS facilities representative is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with spill response materials at hand, clean up the remaining spilled contaminant within the boom area. Store contaminated materials in a secure container for proper disposal.

5.3 ADDITIONAL SPILL DELINEATION OR MONITORING

In the event of a large spill or a spill in which not all of the spilled contaminant can be readily cleaned up with materials at hand (as described in Section 5.2), delineation of the affected area may be required. This would include subsurface investigation of the area (i.e., digging of test pits, soil sampling, installation of monitoring wells) to determine how large and how deep the contaminant affected the subsurface soil and/or groundwater (horizontal and vertical extent of the spill). The delineation would result in the development of an appropriate remediation plan for the affected area. In this case, a qualified environmental consultant should be retained to provide advice on how to proceed with delineation and remediation of a large spill.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Resource Inventory
May 2014

6.0 Resource Inventory

6.1 ON-SITE RESOURCES

6.1.1 Personnel

All personnel hired to work on the sites will be trained on-site in spill prevention, response and clean-up measures (see Section 7.0).

6.1.2 Equipment

The following is a list of equipment available to respond to possible spills.

- Loader
- Dozers
- Haul/dump trucks
- Excavator
- Personnel pick-up trucks, ATVs and snowmobiles.

6.1.3 Spill Kits

6.1.3.1 Spill Kit Locations

At least one spill kit will be clearly marked and present at the Williamson Lake Pump house, the Nipissar Lake Pump house and the Char River sea canister. Additional spill kits will be placed with working equipment and crews.

6.1.3.2 Spill Kit Contents

The following outlines the recommended minimum requirements for contents of spill kits to be used; the GN-CGS facilities representative is responsible to supply the spill kits. Each spill kit will be regularly inspected to ensure it always contains the following, at a minimum:

- 1 – 205 L open top steel drum with lid, bolting ring and gasket (spill kit container)
- 10 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm) with ties
- 4 – 12.5 cm x 3 m (5 in. x 10 ft.) sorbent booms
- 10 kg bag of sorbent particulate
- 100 sheets (1 bale) of 50 cm x 50 cm sorbent sheets
- 2 large (5 m x 5 m) plastic tarps
- 1 roll duct tape
- 1 utility knife
- 1 field notebook and pencil
- 1 rake

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Resource Inventory
May 2014

- 1 pick-axe
- 3 spark-proof shovels
- 4 Tyvex® splash suits
- 4 pairs chemical resistant gloves
- 4 pairs of splash protective goggles
- Instruction binder, including the SCP.

The entire spill kit contents, with the exception of the spark-proof shovels, can be stored within the 205 L steel drum. The drum should be sealed securely to protect the spill kit contents though should always be accessible without the use of tools (i.e., finger tight bolt ring). The drum's bolt ring should be inspected regularly during facility inspections to ensure it turns freely and is lubricated.

Extra spill response materials should also be available for use, in addition to the spill kit contents. These include:

- 10 – 205 L open top steel drum with lid, bolting ring and gasket
- 2 spark-proof shovels
- 50 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm)
- 10 – 12.5 cm x 3 m (5 in. x 10 ft.) sorbent booms
- 5 – 10 kg bags of sorbent particulate
- 500 sheets (5 bales) of 50 cm x 50 cm sorbent sheets
- 2 Tyvex® splash suits
- 2 pairs of chemical resistant gloves
- 2 pairs of splash protective goggles

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Training and Exercises
May 2014

7.0 Training and Exercises

7.1 OUTLINE

The GN-CGS facilities representative will be responsible for providing a qualified supervisor and training personnel in spill response. All individuals hired to work at the facilities should have their basic first aid and Workplace Hazardous Materials and Information System (WHMIS) training before working at any of the Facilities.

A training session on spill prevention and response will be held for all facility employees on an annual basis, or when initially hired. Training exercises, including proper use of spill kits, will provide hands-on training for individuals on spill response procedures and equipment. Training exercises can be held during the training session for all individuals or at another time for individuals directly involved with handling of hazardous materials.

The training session should review this SCP and include information on:

- Individuals roles and responsibilities in regards to spill prevention, detection, response and clean-up
- Location(s) of hard copies of the SCP, maps and spill kits
- Equipment available for spill response
- Content of spill kits
- Initial actions and spill reporting procedures and,
- Spill response and clean-up actions.

7.2 SCHEDULE

The training session and exercises will be provided as part of the Worker Orientation and held annually thereafter.

The GN-CGS facilities representative will keep records of all individuals who attend the training session and exercises, as well as copies of their training certificates (e.g., first aid, WHMIS).

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

References
May 2014

8.0 References

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Transport Canada, U.S. Department of Transportation, Secretariat of Transport and Communications. 2012. Emergency Response Guidebook – 2012. <http://www.tc.gc.ca/media/documents/canutec-eng/ERG2012.pdf> (accessed May 1, 2014).

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix A Figures
May 2014

Appendix A Figures



Sources: Imagery - Microsoft BING, Thematic Data - FSC Architects and Engineers

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Nipissar Lake Resupply Line - Site Plan

Figure 1-1



**SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES
RANKIN INLET, NUNAVUT**

Appendix B Northwest Territories – Nunavut Spill Report Form
May 2014

Appendix B Northwest Territories – Nunavut Spill Report Form



Canada

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE

TEL: (867) 920-8130

FAX: (867) 873-6924

EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR		REPORT TIME	☐ ORIGINAL SPILL REPORT, OR ☐ UPDATE # TO THE ORIGINAL SPILL REPORT	REPORT NUMBER -
	OCCURRENCE DATE: MONTH – DAY – YEAR		OCCURRENCE TIME		
C	LAND USE PERMIT NUMBER (IF APPLICABLE)		WATER LICENCE NUMBER (IF APPLICABLE)		
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM THE NAMED LOCATION			REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR	
E	LATITUDE DEGREES MINUTES SECONDS		LONGITUDE DEGREES MINUTES SECONDS		
F	RESPONSIBLE PARTY OR VESSEL NAME		RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION		
G	ANY CONTRACTOR INVOLVED		CONTRACTOR ADDRESS OR OFFICE LOCATION		
H	PRODUCT SPILLED		QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
	SECOND PRODUCT SPILLED (IF APPLICABLE)		QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
I	SPILL SOURCE		SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES	
J	FACTORS AFFECTING SPILL OR RECOVERY		DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR EQUIPMENT	
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS				
L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION Station operator	EMPLOYER	LOCATION CALLED Yellowknife, NT	REPORT LINE NUMBER (867) 920-8130
LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ AANDC ☐ NEB ☐ TC			SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN		FILE STATUS ☐ OPEN ☐ CLOSED
AGENCY		CONTACT NAME	CONTACT TIME	REMARKS	
LEAD AGENCY					
FIRST SUPPORT AGENCY					
SECOND SUPPORT AGENCY					
THIRD SUPPORT AGENCY					

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix C 2012 Emergency Response Guidebook Guides
May 2014

Appendix C 2012 Emergency Response Guidebook Guides

POTENTIAL HAZARDS

HEALTH

- **TOXIC; may be fatal if inhaled or absorbed through skin.**
- Fire will produce irritating, corrosive and/or toxic gases.
- Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite.
- Runoff from fire control may cause pollution.

FIRE OR EXPLOSION

- Substance does not burn but will support combustion.
- Vapors from liquefied gas are initially heavier than air and spread along ground.
- These are strong oxidizers and will react vigorously or explosively with many materials including fuels.
- May ignite combustibles (wood, paper, oil, clothing, etc.).
- Some will react violently with air, moist air and/or water.
- Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.
- Containers may explode when heated.
- Ruptured cylinders may rocket.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 100 meters (330 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION

Spill

- See Table 1 - Initial Isolation and Protective Action Distances.

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE

Small Fire

CAUTION: These materials do not burn but will support combustion. Some will react violently with water.

- Contain fire and let burn. If fire must be fought, water spray or fog is recommended.
- **Water only; no dry chemical, CO₂ or Halon®.**
- Do not get water inside containers.
- Move containers from fire area if you can do it without risk.
- Damaged cylinders should be handled only by specialists.

Fire involving Tanks

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not direct water at source of leak or safety devices; icing may occur.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Keep combustibles (wood, paper, oil, etc.) away from spilled material.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material.
- Do not direct water at spill or source of leak.
- If possible, turn leaking containers so that gas escapes rather than liquid.
- Prevent entry into waterways, sewers, basements or confined areas.
- Isolate area until gas has dispersed.
- Ventilate the area.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- **Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Clothing frozen to the skin should be thawed before being removed.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Keep victim warm and quiet.
- Keep victim under observation.
- Effects of contact or inhalation may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

POTENTIAL HAZARDS

HEALTH

- **TOXIC**; inhalation, ingestion or skin contact with material may cause severe injury or death.
- Contact with molten substance may cause severe burns to skin and eyes.
- Avoid any skin contact.
- Effects of contact or inhalation may be delayed.
- Fire may produce irritating, corrosive and/or toxic gases.
- Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

FIRE OR EXPLOSION

- Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.
- Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.).
- Contact with metals may evolve flammable hydrogen gas.
- Containers may explode when heated.
- For UN3171, if Lithium ion batteries are involved, also consult GUIDE 147.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area in all directions for at least 50 meters (150 feet) for liquids and at least 25 meters (75 feet) for solids.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate enclosed areas.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

EVACUATION

Spill

- See Table 1 - Initial Isolation and Protective Action Distances for highlighted materials. For non-highlighted materials, increase, in the downwind direction, as necessary, the isolation distance shown under "PUBLIC SAFETY".

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE**Small Fire**

- Dry chemical, CO₂ or water spray.

Large Fire

- Dry chemical, CO₂, alcohol-resistant foam or water spray.
- Move containers from fire area if you can do it without risk.
- Dike fire-control water for later disposal; do not scatter the material.

Fire Involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Do not get water inside containers.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- DO NOT GET WATER INSIDE CONTAINERS.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- **Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- For minor skin contact, avoid spreading material on unaffected skin.
- Keep victim warm and quiet.
- Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

POTENTIAL HAZARDS

FIRE OR EXPLOSION

- **HIGHLY FLAMMABLE:** Will be easily ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.
- For UN3166, if Lithium ion batteries are involved, also consult GUIDE 147.
- **If molten aluminum is involved, refer to GUIDE 169.**

HEALTH

- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO₂, water spray or regular foam.

Large Fire

- Water spray, fog or regular foam.
- **Do not use straight streams.**
- Move containers from fire area if you can do it without risk.

Fire Involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim warm and quiet.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

SPILL CONTINGENCY PLAN FOR WATER SUPPLY AND SEWAGE TREATMENT FACILITIES RANKIN INLET, NUNAVUT

Appendix D MSDS Sheets
May 2014

Appendix D MSDS Sheets

MATERIAL SAFETY DATA SHEET

CHLORINE, LIQUEFIED GAS

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Brenntag Canada Inc.
43 Jutland Rd.
Toronto, ON
M8Z 2G6
(416) 259-8231

WHMIS#: 00010002
Index: GCD0016/10C
Effective Date: 2008 January 15
Date of Revision: 2010 August 03

Website: <http://www.brenntag.ca>

EMERGENCY TELEPHONE NUMBERS (FOR EMERGENCIES INVOLVING CHEMICAL SPILLS OR RELEASE)

Toronto, ON (416) 226-6117
Edmonton, AB (780) 424-1754

Montreal, QC (514) 861-1211
Calgary, AB (403) 263-8660

Winnipeg, MB (204) 943-8827
Vancouver, BC (604) 685-5036

PRODUCT IDENTIFICATION

Product Name: Chlorine, Liquefied Gas.
Chemical Name: Chlorine.
Synonyms: Not available.
Chemical Family: Halogen.
Molecular Formula: Cl₂.
Product Use: Bactericide in water treatment. Chemical intermediate.

DO NOT RE-USE EMPTY CONTAINERS. RETURN ALL CONTAINERS TO BRENNTAG CANADA.

WHMIS Classification / Symbol:

A: Compressed Gas
C: Oxidizer
D-1A: Very Toxic (acute effects)
D-2A: Very Toxic (chronic effects)
E: Corrosive



READ THE ENTIRE MSDS FOR THE COMPLETE HAZARD EVALUATION OF THIS PRODUCT.

2. COMPOSITION, INFORMATION ON INGREDIENTS (Not Intended As Specifications)

<i>Ingredient</i>	<i>CAS#</i>	<i>ACGIH TLV</i>		<i>% Concentration</i>
Chlorine	7782-50-5	0.5 ppm	*A4	95 - 100

A4 = Not classifiable as a human carcinogen. (ACGIH-A4).

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Corrosive! Toxic! May be fatal if inhaled. Causes severe skin and eye burns. Gas is extremely irritating to eyes and respiratory tract. See "Other Health Effects" Section. Strong, offensive odor. Strong oxidizer. Contact with other combustible material can cause fire. Liquefied compressed gas. Contents under pressure. Ruptured containers may rocket.

POTENTIAL HEALTH EFFECTS

Inhalation:	Corrosive! Toxic! Product may cause severe irritation of the nose, throat and respiratory tract. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary oedema (fluid build-up in lungs), and reduction of pulmonary function. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4) Toxic effects may be delayed. See "Other Health Effects" Section.
Skin Contact:	Corrosive! Chlorine vapours may cause burning and prickling sensations, reddening and blisters. Direct contact with liquid causes severe local irritation, blistering and burns. Avoid handling when the skin is moist, wet or abraded. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4) Burns (chemical) can occur if not promptly removed.
Skin Absorption:	May be absorbed through intact skin. Skin absorption is a secondary concern to the continual destruction of tissue while the product is in contact with the skin.
Eye Contact:	Extremely corrosive! This product causes corneal scarring and clouding. Glaucoma, cataracts and permanent blindness may occur. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. (3,4)
Ingestion:	Corrosive! Product is a gas. Ingestion is not a likely route of exposure.
Other Health Effects:	Corrosive effects on the skin and eyes may be delayed, and damage may occur without the sensation or onset of pain. Strict adherence to first aid measures following any exposure is essential. May cause frostbite, olfactory fatigue, tooth erosion, cardiovascular effects, shock, central nervous system (CNS) depression, asphyxia and cyanosis. Olfactory fatigue is a term used to describe a condition characterized by the temporary loss of odour perception. CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure. Cyanosis is characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia. Asphyxia is characterized by increased breathing volume, accelerated pulse rate, muscular incoordination, faulty judgement, emotional instability, fatigue, nausea, vomiting, bewilderment, gasping respiration and unconsciousness. Chlorine: Inhalation exposure can result in primary irritation of the respiratory tract, gradual loss of pulmonary function and asthma-like attacks in susceptible individuals. Acute exposure is characterized by the irritation of the respiratory tract causing runny nose, sore throat, coughing, chest discomfort, shortness of breath and reduced lung function. Overexposure may lead to bronchitis, bronchial spasm and pulmonary oedema. Chronic exposure may lead to asthmatic attack in certain individuals, with the following symptoms: chest tightness, wheezing, cough and shortness of breath. (3)

4. FIRST AID MEASURES

FIRST AID PROCEDURES

Inhalation:	Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Oxygen administration may be beneficial in this situation but should only be administered by personnel trained in its use. Obtain medical attention IMMEDIATELY.
Skin Contact:	Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. See "Note to Physicians" below. When treating frost bite, flush affected areas with water no warmer than 44 Deg. Celsius. Do not use heated water or dry heat and frozen parts should not be rubbed before or after thawing.
Eye Contact:	Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim until the recommended flushing period is completed unless flushing can be continued during transport. When treating frost bite, flush affected areas with water no warmer than 44 Deg. Celsius. Do not use heated water or dry heat and frozen parts should not be rubbed before or after thawing.
Ingestion:	Do not attempt to give anything by mouth to an unconscious person. If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. IMMEDIATELY contact local Poison Control Centre. Vomiting should only be induced under the direction of a physician or a poison control centre. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. IMMEDIATELY transport victim to an emergency facility.

Note to Physicians:	Treatment for corrosive chemical contact with skin after initial flushing procedures: 1. Immerse the exposed part immediately in ice water to relieve pain and to prevent swelling and blistering. Place cold packs, ice or wet cloths on the burned area if immersion is not possible. 2. Remove anything that is constrictive, such as rings, bracelets or footwear, before swelling begins. 3. Cover the exposed part with a clean, preferably sterile, lint-free dressing. 4. For severe exposure, immediately seek medical attention and monitor breathing and treat for shock. Medical conditions that may be aggravated by exposure to this product include neurological, cardiovascular and skin disorders, diseases of the skin, eyes or respiratory tract.

5. FIRE-FIGHTING MEASURES

<i>Flashpoint (°C)</i>	<i>Autolgnition Temperature (°C)</i>	<i>Flammability Limits in Air (%):</i>	
		<i>LEL</i>	<i>UEL</i>
Not Flammable.	Not applicable.	Not applicable.	Not applicable.
Flammability Class (WHMIS):	Not regulated.		
Hazardous Combustion Products:	Thermal decomposition products are toxic and may include oxides of chlorine and irritating gases. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)		
Unusual Fire or Explosion Hazards:	Although non-combustible in air, chlorine supports the combustion of other materials. Flammable gases and vapours will form explosive mixtures with chlorine. Chlorine cylinders and tonne containers are equipped with fusible plugs. The fusible plugs are designed to melt at temperatures above 70 Deg. Celsius to reduce the internal pressure of the cylinder by releasing Chlorine gas. Expansion of liquid and change of state from liquid to vapour will allow mixture to encompass a large area. If tank is involved in a fire situation, a BLEVE (Boiling Liquid Expanding Vapour Explosion) may result. Ruptured containers may rocket. Where possible, elevate the leak to the highest position such that gas and not liquid escapes.		
	This product is a strong oxidizer. Strong oxidizers can cause ignition of combustible or oxidizable materials. May decompose violently on contact with metals, or their salts, dusts or other contaminants.		
Sensitivity to Mechanical Impact:	Not expected to be sensitive to mechanical impact.		
Rate of Burning:	Not available.		
Explosive Power:	Not available.		
Sensitivity to Static Discharge:	Not expected to be sensitive to static discharge.		
EXTINGUISHING MEDIA			
Fire Extinguishing Media:	Use media appropriate for surrounding fire and/or materials.		
FIRE FIGHTING INSTRUCTIONS			
Instructions to the Fire Fighters:	Fire-exposed containers should be kept cool by spraying with water to reduce pressure. Isolate materials that are not involved in the fire and protect personnel. Cool containers with flooding quantities of water until well after the fire is out. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Remove containers from fire zone whenever possible. Ventilate low lying areas such as sumps or pits where dense vapours may collect.		
Fire Fighting Protective Equipment:	Use self-contained breathing apparatus and special protective clothing.		

6. ACCIDENTAL RELEASE MEASURES

Information in this section is for responding to spills, leaks or releases in order to prevent or minimize the adverse effects on persons, property and the environment. There may be specific reporting requirements associated with spills, leaks or releases, which change from region to region.

Containment and Clean-Up Procedures: In all cases of leak or spill contact vendor at Emergency Number shown on the front page of this MSDS. See Section 13, "Deactivating Chemicals".

Wear respirator, protective clothing and gloves. Ruptured containers may rocket. Ventilate enclosed spaces. Where possible, elevate the leak to the highest position of the cylinder, such that gas and not liquid escapes. Apply emergency device. Eliminate all sources of ignition. Move unprotected personnel upwind of leaking container. Call emergency response naming the chemical and the type of container that is leaking. Consider the use of fog-nozzles to control vapours. Do not immerse in water. Notify applicable government authority if release is reportable or could adversely affect the environment. Vapour knock down water is corrosive and toxic, thus it should be diked for containment. Ensure compatible materials are used. For a leaking container: dispose of contents to a safe out-of-doors area or a hood with forced ventilation. Attach appropriate control valve provided with a trap or check valve and a long piece of flexible hose connected to the valve outlet. Discharge the gas at a moderate rate into an adequate amount of approximately 15% aqueous Sodium Hydroxide or other alkali or reducing solution in suitable container. When all the gas is discharged, close the cylinder valve and tag the cylinder as defective. (3)

7. HANDLING AND STORAGE

HANDLING

Handling Practices: 9 Vapours are heavier than air. Use self-contained breathing apparatus. Secure containers at all times. Fix leaks promptly. Immerse contaminated clothing in water immediately and KEEP WET until discarded or laundered. Avoid moisture contamination. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Do not store or transport with food or feed. Keep away from combustibles and incompatible materials.

Ventilation Requirements: See Section 8, "Engineering Controls".

Other Precautions: Use only with adequate ventilation and avoid breathing vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

STORAGE

Storage Temperature (°C): Ideal storage temperature is 10-27 Deg. Celsius. Do not expose sealed containers to temperatures above 51 °C or Below -29 °C. (3)

Ventilation Requirements: Do not use in poorly ventilated or confined areas without proper respiratory protection. Ventilation should be corrosion proof.

Storage Requirements: Store in a cool, well-ventilated area. Keep away from heat, sparks and flames. Keep containers closed. Do not expose sealed containers to temperatures above 51 °C. Use of a Chlorine gas monitor with local and remote alarms and monitoring is strongly recommended. Secure containers at all times. Fix leaks promptly. Regularly inspect process equipment, piping and detection equipment. Chlorine cylinders and tonne containers are equipped with fusible plugs. The fusible plugs are designed to melt at temperatures above 70 Deg. Celsius to reduce the internal pressure of the cylinder by releasing Chlorine gas. Avoid storage of cylinders for more than 6 months. (3)

Special Materials to be Used for Packaging or Containers: Chlorine is stable in steel containers at room temperatures when stored dry. Intense local heat above 200 C on steel walls can cause steel to ignite chlorine. (3) Equipment for storage, handling or transportation should NOT be made of: stainless steel. Confirm suitability of any material before using.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Recommendations listed in this section indicate the type of equipment, which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

ENGINEERING CONTROLS

Engineering Controls: Local exhaust ventilation required. Ventilation should be corrosion proof. Make up air should be supplied to balance air that is removed by local or general exhaust ventilation. Ventilate low lying areas such as sumps or pits where dense vapours may collect. Restrict access to storage area. Post warning signs. Consider leak detection and alarm systems.

For personnel entry into confined spaces (i.e. bulk storage tanks) a proper procedure must be followed. It must include consideration of, among other things, ventilation, testing of tank atmosphere, provision and maintenance of SCBA, and emergency rescue. Use the "buddy" system. The second person should be in view and trained and equipped to execute a rescue. (4)

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye Protection:	Use full face-shield and gas-tight goggles when there is potential for contact. Contact lenses should not be worn when working with this material.
Skin Protection:	Gloves and protective clothing made from neoprene, viton, butyl rubber or nitrile rubber should be impervious under conditions of use. Prior to use, user should confirm impermeability. Skin protection should be insulated against cold temperatures. Do not use gloves or protective clothing made from leather, polyethylene, PVC, rubber or plastic. Discard contaminated gloves.
Respiratory Protection:	DO NOT USE chemical cartridge respirators with oxidizable sorbents (charcoal). Chlorine: Up to 5 ppm, wear a chemical cartridge respirator with Chlorine or acid gas cartridges; up to 10 ppm self-contained breathing apparatus (SCBA). (3,4) Use an air-supplied respirator if concentrations are high or unknown. If while wearing a respiratory protection, you can smell, taste or otherwise detect anything unusual, or in the case of a full facepiece respirator you experience eye irritation, leave the area immediately. Check to make sure the respirator to face seal is still good. If it is, replace the filter, cartridge or canister. If the seal is no longer good, you may need a new respirator. (4) Immediately Dangerous to Life and Health (IDLH) value: 10 ppm. (4) The purpose of establishing an IDLH value is to ensure that the worker can escape from a given contaminated environment in the event of failure of the most protective respiratory equipment. In the event of failure of respiratory protective equipment, every effort should be made to exit immediately. (4)
Other Personal Protective Equipment:	Wear an impermeable apron and boots. Locate safety shower and eyewash station close to chemical handling area. Take all precautions to avoid personal contact. Use of a Chlorine gas monitor with local and remote alarms and monitoring is strongly recommended.

EXPOSURE GUIDELINES

SUBSTANCE	ACGIH TLV (STEL)	OSHA PEL (TWA)	OSHA PEL (STEL)	NIOSH REL (TWA)	NIOSH REL (STEL)
Chlorine	1 ppm	---	1 ppm (Ceiling)	---	0.5 ppm (Ceiling)

9. PHYSICAL AND CHEMICAL PROPERTIES (Not intended as Specifications)

Physical State:	Gas.
Appearance:	Greenish yellow liquified gas.
Odour:	A sharp, pungent, irritating odour.
Odour Threshold (ppm):	0.2 - 0.4 ppm. (3)
Boiling Range (°C):	-35. (3)
Melting/Freezing Point (°C):	-101. (3)
Vapour Pressure (mm Hg at 20° C):	4 788 - 5 120. (3)
Vapour Density (Air = 1.0):	2.47 - 2.67. (3)
Relative Density (g/cc):	1.33 - 1.47. (3)
Bulk Density:	88.76 lb/ft³ @ 15.6 C.
Viscosity:	0.346 mPa @ 20 C. (3)
Evaporation Rate (Butyl Acetate = 1.0):	Not available.
Solubility:	Slightly soluble in water.
% Volatile by Volume:	100. (3)
pH:	1.5 - 2.0 (0.8 % solution). (3)
Coefficient of Water/Oil Distribution:	Not applicable.
Volatile Organic Compounds (VOC):	0 %.
Flashpoint (°C):	Not Flammable.

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY

Under Normal Conditions:	Stable.
Under Fire Conditions:	Although non-combustible in air, chlorine supports the combustion of other materials.
Hazardous Polymerization:	Will not occur.

Conditions to Avoid:	High temperatures, sparks, open flames and all other sources of ignition. Avoid contact with water. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)
Materials to Avoid:	This product is a strong oxidizer. Strong oxidizers can cause ignition of combustible or oxidizable materials. May decompose violently on contact with metals, or their salts, dusts or other contaminants. Reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4) Chlorine reacts with combustible, organic or nitrogen compounds (hydrocarbons, cleaning solvents, paints or thinners, oil, grease gasoline, petroleum products, turpentine, alcohols, carbon disulphide, hydrogen acetylene, hydrogen, ether and ammonia). (3,4) Strong oxidizers. Lewis or mineral acids. Metal halides. Carbon. Lead. Sulphides. Reducing agents. Fluorine. Metal Acetylides. Halogenated compounds. Diethyl Zinc. Metal hydrides. Sulfamic Acid. Diethyl Ether. At ordinary temperatures: Dry Chlorine (gas or liquid) is not corrosive to most common metals, including steel, stainless steel, silver, iron, cast iron, nickel and its alloys, copper, brass, bronze, lead platinum and tantalum. Dry Chlorine (gas or liquid) reacts with aluminum, zinc, arsenic, gold, mercury, class 300 stainless steel, titanium, selenium, tellurium and tin. (3,4) At high temperatures: Dry Chlorine is corrosive to most metals. The reaction rate of dry Chlorine increases rapidly above a temperature which is characteristic for the metal. (3,4)
Decomposition or Combustion Products:	Thermal decomposition products are toxic and may include oxides of chlorine and irritating gases. Chlorine reacts with water or humidity to produce Hydrochloric Acid and Hypochlorous Acid. These two acids cause metal corrosion. (3,4)

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL DATA:

SUBSTANCE	LD50 (Oral, Rat)	LD50 (Dermal, Rabbit)	LC50 (Inhalation, Rat, 4h)
Chlorine	---	---	147 ppm (1)
Carcinogenicity Data:	The ingredient(s) of this product is (are) not classed as carcinogenic by ACGIH, IARC, OSHA or NTP. See "Other Studies Relevant to Material".		
Reproductive Data:	No adverse reproductive effects are anticipated.		
Mutagenicity Data:	No adverse mutagenic effects are anticipated.		
Teratogenicity Data:	No adverse teratogenic effects are anticipated.		
Respiratory / Skin Sensitization Data:	None known.		
Synergistic Materials:	Mortality in Chlorine-Nickel test groups for rainbow trout was found to be higher than that of either nickel or chlorine alone. The relevance to humans is not known. Incidences of respiratory sensitization in platinum refinery workers increased following a spill of chlorine. (3)		
Other Studies Relevant to Material:	Effects in rats during acute inhalation exposure to Chlorine were primarily attributed to its severe irritant effects. Repeated inhalation of Chlorine (1, 3 or 9 ppm for 6 weeks) by rats resulted in respiratory irritation, reduced body weight gain, organ weight changes, increased white blood cells, some animal deaths and changes in liver, kidney, spleen, thymus and gastric mucosa. Longer term (1 year) inhalation of Chlorine (0.1, 0.5 or 2.3 ppm) by monkeys resulted in eye and upper respiratory tract irritation. Effects observed in rabbits following repeated inhalation (up to 9 months) were weight loss, nasal irritation, sneezing and laboured respiration. Life-time inhalation of Chlorine (up to 2.5 ppm) produced nasal cell injury in rats and mice. No effects were observed in guinea pigs after repeated inhalation (87 days) or in mice after drinking chlorinated water (33 or 55 days). Repeated exposure of rats to 30 ppm Chlorine in their drinking water resulted in reduced spleen weights and immunological effects. Long term (2 years) administration of Chlorine in drinking water (70, 140 or 275 ppm) resulted in an increase in leukemia in female rats at 140 ppm only. No adverse effects on fertility, life span, growth pattern, hematology or histology were seen in rats given chlorinated water (100 mg Chlorine / Litre daily) throughout the entire lifespan for 7 consecutive generations. No birth defects were observed in mice after drinking chlorinated drinking water during pregnancy. Chlorine produced no genetic changes in standard tests using animals. A positive response was observed in a test using human cells, while mixed responses have been reported in a variety of tests using bacterial cells or animal cells. (3)		

12. ECOLOGICAL INFORMATION

Ecotoxicity:	Highly toxic to aquatic life. Fish toxicity: critical concentration = 0.3 mg/L Aesthetic: critical concentration = 0.5 mg/L Plant: critical concentration = 100 mg/L 72-HR LC50 = 0.5 mg/L, Daphnia Magna 96-HR LC50 = 0.02 mg/L, Daphnia Magna 96-HR LC50 = 0.08 to 0.18 mg/L, Brook Trout 96-HR LC50 = 0.07 mg/L, Channel Catfish Fingerlings 96-HR LC50 = 0.44 to 2.32 mg/L, Bluegill Sunfish 96-HR LC50 = 1.6 mg/L, Redsid Shiner 96-HR LC50 = 0.70 mg/L, Blackside Dance Exposure of Sand-dollar sperm to 0.002 mg/L for 5 minutes resulted in a 50 percent reduction in egg fertilization. Depressed shoot and total plant dry weight and shoot length were reported when the aquatic plant myriophyllum spicatum was continuously exposed to chlorine (as low as 0.05 mg total residual chlorine/L) for 96 hours. Chlorine is considered to be phytotoxic and has bactericidal, algicidal and fungicidal properties. Chlorine does not appear to retard seed germination. (3) This product does not bioaccumulate in aquatic or terrestrial food chains.
Environmental Fate:	In an uncontrolled spill scenario where the concentration of Chlorine is well above those used for drinking water, it can be dangerous if allowed to contaminate irrigation water supplies, lakes, streams, ponds or rivers.

13. DISPOSAL CONSIDERATIONS

Deactivating Chemicals:	Chlorine gas will disperse to the atmosphere leaving no residue. Gaseous material can be absorbed in alkaline solutions of Caustic Soda, Soda Ash or Hydrated Lime. When absorbing Chlorine in alkaline solutions, the reaction is exothermic. Ensure the absorption is controlled as to heat and reaction. (3) Since hypochlorites are formed, solutions must be treated with reducing agents such as sodium sulphite before disposal. Do not immerse container in caustic solution. Liquid and/or solid residues from neutralization must be disposed of in a permitted waste management facility. (3) Hypochlorites: Carefully neutralize by adding hydrogen peroxide: one US pint of 35 % hydrogen peroxide solution per pound of hypochlorite to be neutralized. Dilute the neutralized residue with water. (3)
Waste Disposal Methods:	This information applies to the material as manufactured. Reevaluation of the product may be required by the user at the time of disposal since the product uses, transformations, mixtures and processes may influence waste classification. Dispose of waste material at an approved (hazardous) waste treatment/disposal facility in accordance with applicable local, provincial and federal regulations. Do not dispose of waste with normal garbage, or to sewer systems.
Safe Handling of Residues:	See "Waste Disposal Methods".
Disposal of Packaging:	Empty containers retain product residue (liquid and/or vapour) and can be dangerous. See Section 13, "Deactivating Chemicals". Do not expose such containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death. Return empty containers. DO NOT REFILL COMPRESSED GAS CONTAINERS. RETURN TO BRENNTAG CANADA FOR CARE AND MANAGEMENT.

14. TRANSPORTATION INFORMATION

CANADIAN TDG ACT SHIPPING DESCRIPTION:

CHLORINE, Class 2.3(8), UN1017.

Label(s): Toxic Gases, Corrosives. Placard: Toxic Gases.

ERAP Index: 500. Exemptions: None known.

Marine: P (Marine Pollutant).

Please consult the North American Emergency Response Guidebook, via the UN#, for guidance in addressing spills.

US DOT CLASSIFICATION (49CFR 172.101, 172.102):

CHLORINE, Class 2.3(8), UN1017.

Label(s): Poison Gas, Corrosive. Placard: Poison Gas.

CERCLA-RQ: 10 lb / 4.54 kg Exemptions: Not applicable.

Special Documentation Addition: Chlorine, Poison - Inhalation Hazard, Zone B.
Marine: P (Marine Pollutant).

IMO: Marine Pollutant: Chlorine.

Please consult the North American Emergency Response Guidebook, via the UN#, for guidance in addressing spills.

15. REGULATORY INFORMATION

CANADA

CEPA - NSNR: This material is included on the DSL under the CEPA.

CEPA - NPRI: This material is on the NPRI list of substances.

Controlled Products Regulations Classification (WHMIS):

A: Compressed Gas

C: Oxidizer

D-1A: Very Toxic (acute effects)

D-2A: Very Toxic (chronic effects)

E: Corrosive

USA

Environmental Protection Act: This material is included on the TSCA Inventory.

OSHA HCS (29CFR 1910.1200): Compressed Gas. Oxidizer. Highly Toxic. Chronic Effects. Corrosive.

NFPA: 4 Health, 0 Fire, 0 Reactivity (3)

HMIS: 4 Health, 0 Fire, 0 Reactivity (3)

INTERNATIONAL

The following component or components of this product appear on the European Inventory of Existing Commercial Chemical Substances: Chlorine.

16. OTHER INFORMATION

REFERENCES

1. RTECS-Registry of Toxic Effects of Chemical Substances, Canadian Centre for Occupational Health and Safety RTECS database.
2. Clayton, G.D. and Clayton, F.E., Eds., Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. IIA,B,C, John Wiley and Sons, New York, 1981.
3. Supplier's Material Safety Data Sheet(s).
4. CHEMINFO chemical profile, Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada.
5. Guide to Occupational Exposure Values, 2008, American Conference of Governmental Industrial Hygienists, Cincinnati, 2008.
6. Regulatory Affairs Group, Brenntag Canada Inc.
7. The British Columbia Drug and Poison Information Centre, Poison Managements Manual, Canadian Pharmaceutical Association, Ottawa, 1981.

The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Brenntag Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

To obtain revised copies of this or other Material Safety Data Sheets, contact your nearest Brenntag Canada Regional office.

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Prepared By: Regulatory Affairs Group, Brenntag Canada Inc., (416) 259-8231.

Material Safety Data Sheet

Version 3.6

Revision Date 11/22/2012

Print Date 06/05/2013

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Fluosilicic acid

Product Number : 01301

Brand : Sigma-Aldrich

Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832

Fax : +1 800-325-5052

Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555

Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards

Toxic by ingestion, Corrosive

GHS Classification

Acute toxicity, Oral (Category 4)

Acute toxicity, Dermal (Category 3)

Skin corrosion (Category 1B)

Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram



Signal word

Danger

Hazard statement(s)

H302

Harmful if swallowed.

H311

Toxic in contact with skin.

H314

Causes severe skin burns and eye damage.

Precautionary statement(s)

P280

Wear protective gloves/ protective clothing/ eye protection/ face protection.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P310

Immediately call a POISON CENTER or doctor/ physician.

HMIS Classification

Health hazard: 3

Chronic Health Hazard: *

Flammability: 0

Physical hazards: 0

NFPA Rating

Health hazard: 3

Fire: 0
Reactivity Hazard: 0

Potential Health Effects

Inhalation May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin May be harmful if absorbed through skin. Causes skin burns.
Eyes Causes eye burns.
Ingestion Toxic if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Fluorosilicic acid
Hexafluorosilicic acid
Hydrogen hexafluorosilicate

Formula : $\text{H}_2\text{F}_6\text{Si}$
Molecular Weight : 144.09 g/mol

Component		Classification	Concentration
Hexafluorosilicic acid			
CAS-No.	16961-83-4	Skin Corr. 1B; H314	30 - 50 %
EC-No.	241-034-8		
Index-No.	009-011-00-5		

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

If swallowed

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability

Not flammable or combustible.

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products

Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride, silicon oxides

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up

Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE**Precautions for safe handling**

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Conditions for safe storage

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION**Components with workplace control parameters**

Components	CAS-No.	Value	Control parameters	Basis
Hexafluorosilicic acid	16961-83-4	TWA	2.5 mg/m ³	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
Remarks	Varies with compound			
		TWA	2.5 mg/m ³	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.28-1969			
		TWA	2.5 mg/m ³	USA. ACGIH Threshold Limit Values (TLV)
	Bone damage Fluorosis Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen varies			
		TWA	2.5 mg/m ³	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000

Personal protective equipment**Respiratory protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection

Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection

Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures

Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	clear, liquid
Colour	light yellow

Safety data

pH	1.0 - 1.2 at 10 g/l
Melting point/freezing point	no data available
Boiling point	no data available
Flash point	no data available
Ignition temperature	no data available
Autoignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	no data available
Density	no data available
Water solubility	no data available
Partition coefficient: n-octanol/water	no data available
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability

Stable under recommended storage conditions.

Possibility of hazardous reactions

no data available

Conditions to avoid

no data available

Materials to avoid

Strong oxidizing agents, Metals, Alkalis, Strong acids, Stoneware, glass

Hazardous decomposition products

Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride, silicon oxides

Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50

no data available

Inhalation LC50

no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
Eyes: no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: 3 - Group 3: Not classifiable as to its carcinogenicity to humans (Hydrofluoric acid)

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Ingestion	Toxic if swallowed.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.

Signs and Symptoms of Exposure

Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity

no data available

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

Product

Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)

UN number: 1778 Class: 8 Packing group: II

Proper shipping name: Fluorosilicic acid

Reportable Quantity (RQ): 10001 lbs

Marine pollutant: No

Poison Inhalation Hazard: No

IMDG

UN number: 1778 Class: 8 Packing group: II EMS-No: F-A, S-B

Proper shipping name: FLUOROSILICIC ACID

Marine pollutant: No

IATA

UN number: 1778 Class: 8 Packing group: II

Proper shipping name: Fluorosilicic acid

15. REGULATORY INFORMATION

OSHA Hazards

Toxic by ingestion, Corrosive

SARA 302 Components

The following components are subject to reporting levels established by SARA Title III, Section 302:

	CAS-No.	Revision Date
Hydrofluoric acid	7664-39-3	1993-04-24

SARA 313 Components

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards

Acute Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Hexafluorosilicic acid	16961-83-4	1993-04-24
Hydrofluoric acid	7664-39-3	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hexafluorosilicic acid	16961-83-4	1993-04-24
Hydrofluoric acid	7664-39-3	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hexafluorosilicic acid	16961-83-4	1993-04-24

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Text of H-code(s) and R-phrases mentioned in Section 3

H314	Causes severe skin burns and eye damage.
Skin Corr.	Skin corrosion

Further information

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SEASONAL REPLENISHMENT OF NIPISSAR LAKE, RANKIN INLET, NUNAVUT

Appendix G Supporting Documentation
May 2014

Appendix G Supporting Documentation



**Design of Pipeline System to Augment Natural
Replenishment of Nipissar Lake**

Rankin Inlet, Nunavut, Canada

FSC Project # 2010-0570

December 15, 2010

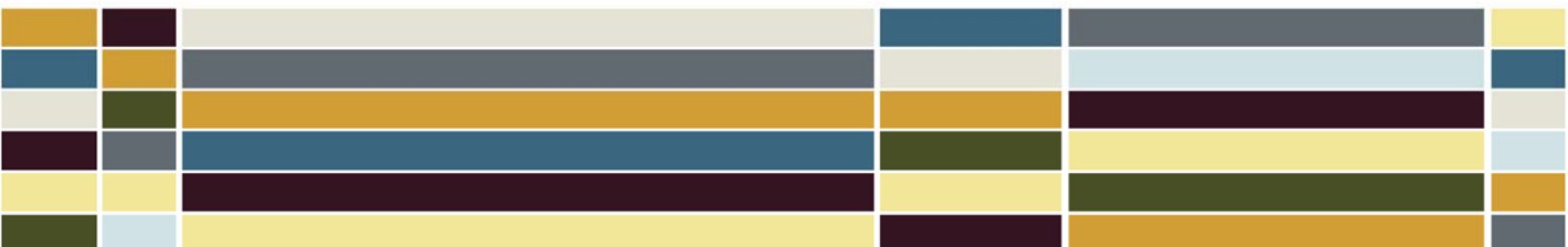
Prepared for:

**The Office of the Regional Director
Kivalliq Region
Department of Community and Government Services
Government of Nunavut**

Prepared by:

FSC Architects & Engineers
Bldg. 1088C, Noble House
Iqaluit, Nunavut
X0A 0H0

LISTEN. DESIGN. MANAGE.



FSC File: 2010-0570
15 December, 2010

Government of Nunavut
Dept. of Community & Government Services
Project Management/O&M Building, PO Bag 002
Rankin Inlet, Nunavut X0C 0G0

Attn: Mr. Jeff Hunter, Project Officer

Re: Design of Pipeline System to Augment Natural Replenishment of Nipissar Lake
Rankin Inlet, Nunavut, Canada

Dear Mr. Hunter,

Following please find our Submission of the Final Design Report for this project.

We consider that this submission, together with the attached Issued for Review drawings is suitable for submission to the Nunavut Water Board for their review and approval.

This submission reflects changes to the Schematic Design Report coming from meetings both on site and in CGS offices in Rankin Inlet.

Please contact Kevin Hodgins or myself should you have any questions.

Sincerely,

FSC ARCHITECTS & ENGINEERS



Walter Orr, P. Eng., Principal
Civil Engineering



Table of Contents

1	Scope of Work	4
1.1	General	4
2	Stage One: Design Services - Requirements.....	5
3	Submission #2: Final Design Report.	7
3.1	Design calculations.....	7
3.2	Consideration of seasonal constraints	8
3.3	Proposed path of pipeline system	8
3.4	Pipeline intake location(s) and intake design	9
3.5	Pipeline discharge location(s) and discharge design	12
3.6	Pump locations, proposed pump operations, pump size and capacity	13
3.7	Proposed capacity of pipeline system	13
3.8	Size of pipeline (length, diameter, etc.)	14
3.9	Design measures for system reliability, and furthermore, system redundancy.	16
3.10	estimates for material supply and construction.	17
4	Appendix A – Pipe Material Quotation	20
5	Appendix B – Issued For Review Design Drawings.....	21



1 Scope of Work

1.1 GENERAL

FSC understands from our earlier work on this project and the GN prepared Terms of Reference that the GN requires Professional Engineering Services for the design and production of tender documents for a pipeline between First Landing Lake and Nipissar Lake intended to augment the natural replenishment of Nipissar Lake which will be suitable to satisfy the community of Rankin Inlet's water demand for a minimum period of 20 years.

It is noted in the Terms of Reference that the Work required to complete this task may include:

1. A study of the volume of water required to augment the natural replenishment of the water supply lake for a 20 year project life.
2. Research and a site visit to develop an understanding of the existing water supply system and the topography of the subject lakes and interlaying land mass.
3. A basic topographical survey of the proposed pipeline route.
4. Sizing of pumps and piping and a development of a possible pumping schedule to determine the composition of the system with respect to weather, topography and other factors.
5. Design of minimalist intake and discharge structures.



2 Stage One: Design Services - Requirements

2.1.1 General

In this first component of the project we have completed the preliminary routing study and topographic survey. Next, we have established a recommended pipe and pump sizing based on the hydraulic analysis of the system.

We have consulted with the community and the GN as the project advanced. This Final Design Report highlights the recommended system elements or additions to the defined conclusions. This report includes two alternative conceptual designs meeting all program requirements, including budgets.

2.1.2 Preliminary Routing Studies

Prior to completing detailed ground surveys, we reviewed the available aerial photography and digital mapping to complete an initial reconnaissance of the possible routing options. This initial research allowed us to complete the ground truthing efficiently and narrow the field surveys to only areas that are pre-selected as practical routes based on accessibility, terrain and soil type.

2.1.3 Topographic Survey

We have completed the topographic survey utilizing state of the art differential GPS survey equipment. We ensured survey accuracy by triangulation and projection of the GPS equipment by referring to locally established geodetic control points.

Mr. Clay Peck completed the survey. He accessed the survey notes by use of a four wheel quad vehicle and worked to choose a routing that will minimize disruption to the natural landscape, and maximize operation requirements

2.1.4 Submission #1: Schematic Design Report.

In this Schematic Design Stage we include:

- ◆ Design calculations, including amount of volume required to be pumped each calendar year for the design life of the system, complete with estimated durations of seasonal pumping.
- ◆ Consideration of seasonal constraints – when pumping will occur, etc.
- ◆ Proposed path of pipeline system
- ◆ Pipeline intake location(s) and intake design
- ◆ Pipeline discharge location(s) and discharge design
- ◆ Pump locations, proposed pump operations, pump size and capacity
- ◆ Proposed capacity of pipeline system
- ◆ Size of pipeline (length, diameter, etc.)
- ◆ Design measures for system reliability, and furthermore, system redundancy
- ◆ Class D estimates for material supply and construction.
- ◆ Community consultation



- ◆ Review and verification of the technical feasibility and practicality of the recommended alternative.
- ◆ Implementation plan and schedule and identify potential construction techniques.
- ◆ Identification of known environmental, construction and other constraints/restrictions.
- ◆ System operations will be identified and explained.
- ◆ We are prepared to attend at teleconference review meetings following this submission.



3 Submission #2: Final Design Report.

The Final Design Report, provides the following information:

3.1 DESIGN CALCULATIONS

In evaluating the requirements of this project, we drew heavily on the 2008/7/8 and 2009 FSC reports examining Rankin Inlets water requirements.

Currently Rankin Inlet is consuming water at approximately 469 LCPD, with a 2009 population of 2499. Utilizing a 2030 population growth rate of 3% gives a population of 4649.

From the FSC 2009 report, the average Water resupply to Nipissar Lake is 311,789 m³/year

We have calculated the expected water consumption at varying per capita rates as per the FSC 2009 report, extended to 2030.

For example if we take the demand rate in year 2030 to be 344 LCPD, this results in a consumption in Year 2030: = 4649 x 344 x 365 / 1000 = 583,713 m³/year

Required Water to be made up into Nipissar Lake from Lower Landing Lake = 583,713 – 311,789 = 271,924 m³/year..

The highest pumping requirement in 2030 is 484,029 m³/year. See Table 2 following.

Table 1 – Rankin Inlet Water Demand

Population Growth Rate		2010 Pop.	2.0% Growth	2.5% Growth	3.0% Growth
2030 Population		2,499	3788	4197	4649
Water Consumption Rate A	301 LCPD	274,553	416,130	461,134	510,749
Water Consumption Rate B	331 LCPD	301,917	457,605	507,094	561,654
Water Consumption Rate MACA	344 LCPD	313,774	475,577	527,010	583,713
Water Consumption Rate C	393 LCPD	358,469	543,319	602,078	666,858
Water Consumption Rate D (current)	469 LCPD	427,791	648,389	718,511	795,818

Table 2 – Rankin Inlet Water Shortfall

Required Recharge Year 2030	2010 Pop.	2.0% Growth	2.5% Growth	3.0% Growth
301 LCPD	-37,236	104,341	149,345	198,960
331 LCPD	-9,872	145,816	195,305	249,865
344 LCPD	1,985	163,788	215,221	271,924
393 LCPD	46,680	231,530	290,289	355,069
469 LCPD	116,002	336,600	406,722	484,029



3.2 CONSIDERATION OF SEASONAL CONSTRAINTS

It is anticipated that the typical pumping season would extend over a maximum of 3 months each year, from Mid June to Mid September. While a longer season could possibly be utilized, starting earlier runs into problems with ice cover on Lower Landing Lake, and access to the site itself.

Starting later could run into problems with freeze up of the pipe.

It would be possible to pump in the winter or the early spring, however freeze up concerns of the pipeline if flow should be interrupted make that a less desirable time. It does, however, make the intake situation a bit easier as the intake would simply drop through a hole in the ice on Lower Landing Lake.

Depending on requirements for total flow, we would recommend that the pumping season be constrained to a three month season in the summer.

3.3 PROPOSED PATH OF PIPELINE SYSTEM

From Lower Landing Lake to Nipissar, we considered basically two options.

Option 1 effectively follows the roadway between the two lakes, with the pipeline following the routing of the of the road passing by, at a minimal offset to the roadway.

Option 2 goes overland from Lower Landing Lake to Nipissar, with the routing selected to minimize elevation changes in the line requiring high point air releases, or low point drains.

Option 1 is slightly shorter than Option 2 and has the additional advantage of easier access for construction and maintenance. However, Option 1 has the disadvantage of going up over a high point of land, some 18 m higher than the lake. This additional 'head' requirement will significantly raise the pumping effort required, and poses issues with possible excessive pipe head loss running downhill resulting in suction on the pipe.

In addition, Option 1 would have a number of high and low points along the line, either requiring an air release valve or a water drain valve. As such, operationally it would be significantly more challenging to operate.

Option 2 would be cheaper to operate, and require a smaller and cheaper pump than Option 1.

In addition, Option 2 is 'graded' so that there is only one low point in the system, and only two high points, for easier filling and draining of the line each year. This greatly simplifies operation of the line.

Community Consultation

On September 29 2010 FSC carried out a site meeting with representatives of the Community of Rankin Inlet, and the Government of Nunavut (GN).



Representing the Community of Rankin Inlet were Councilors Jackson Lindell and Pujutt Kusugak, and the Economic Development Officer, Damian MacInnis.

Representing the GN was Jim Wall, Rankin Inlet Utilidor Systems Manager.

Representing FSC was Walter Orr, P. Eng.

The routing of the line, both Option 1 and 2 locations were reviewed, and discussion took place on the merits of each. Option 1 was recognized as being somewhat easier to construct, but Option 2 was seen to be acceptable.

The proposed intake location (See Section 3.4 following) was examined, and all agreed that it would be appropriate technically to withdraw water at that location.

The only concern mentioned, and one which applied to either Option, was that there was a portion of both routes that crossed a primary snowmobile route, near Lower Landing Lake. It was agreed that a portion of the route (centered on where the line crossed the road to the river) should be buried to prevent interference with the pipe by snowmobiles.

Recommended Routing Option

The recommended pipeline routing is Option 2.

3.4 PIPELINE INTAKE LOCATION(S) AND INTAKE DESIGN

3.4.1 Initial Approach

Initially, our approach to the intake location looked to a spot adjacent to Lower Landing Lake, at a location where deeper water is near shore. This location is also accessible by a short road extension from the existing trail near Lower Landing Lake.

However, upon review of the location, several things stand out that have lead us to reconsider that location. These include the requirement to cross the river with the pipeline to get access to the site, additional length of pipeline to reach that location. Finally the fact that the intake location would be some distance away from the pump location would require a lengthy intake line, possibly more than 100 m in length. Given that one of the mandates for this work is to avoid costly permanent installations, such as a permanent intake line and submersible pumps, this would require a flexible hose intake to be used.

Such a lengthy line would cause problems with excessive head loss on the suction side of the pump, significantly limiting the available flow rate.

In addition, the initially evaluated location is in an area which floods each spring. Access to the area for pump servicing, and refueling could be a problem.



3.4.2 Revised Intake Location

A revised location was examined at the visit in October. The revised location draws water from the river rather than from the lake itself. The pump would be set at the location of the abutments for the old bridge location (the bridge itself is now gone). The intake would be into an existing pool on the south side of the river, adjacent to the pump location.

The revised location would be accessed from the old roadway, which is still intact. The intake line length would be significantly shorter than the other location, a maximum of 30 m in length.

We reviewed the proposed location two times in September, at the time of the year with near the lowest river flows, historically. At both times, there was sufficient depth (over 1 m) at the proposed location, to fully cover the proposed intake structure.

The recommended intake location is at that point.

See Figure 1 following.



Figure 1

3.4.3 Intake Type

The intake type proposed is a screened intake 'can' connected to the flexible intake line. The 'can' is constructed of Stainless Steel, with openings in the wire mesh of 0.1 inch (2.5 cm). It is capable of flowing up to 770 USGPM, the anticipated flow rate of the 250 mm pipeline.



3.4.4 Intake Design

An all weather, year round permanent intake is a significant cost to a project. Such an intake can run in the mid \$100,000s (i.e. \$500,000) to low \$1,000,000s depending on length and details.

Given the seasonal summer only nature of the pipeline, providing an all weather, year round permanent intake would seem to be an unnecessary expense.

We recommend that a seasonal flexible pipe intake be used, with the actual intake itself be a floating structure, anchored in place throughout the summer season.

3.5 PIPELINE DISCHARGE LOCATION(S) AND DISCHARGE DESIGN

We recommend the pipeline end at the closest end of Nipissar Lake to Lower Landing Lake, approximately where shown on the picture following.



Figure 2



The discharge will be on to a concrete pad at the edge of the lake. The pad will be armored with rip rap to prevent soil erosion from the flowing water.

3.6 PUMP LOCATIONS, PROPOSED PUMP OPERATIONS, PUMP SIZE AND CAPACITY

Given the recommendation to utilize a flexible temporary intake line, it is important to have the pump as close to the intake as possible.

We propose to use a trailer mounted, diesel powered pump, set on a pad near the edge of Lower Landing Lake, which connects to both the intake and pipelines with flexible piping.

The pad on which the pump will sit will be surrounded by chain link fence with a vehicle gate, for security and vandalism protection.

The pump size and power ratings depend on the pipeline route, size, material and on the chosen pump rate.

The pump rate depends upon the duration of pumping in any one season, and the amount at which the water consumption demand exceeds the capacity of Nipissar Lake.

3.7 PROPOSED CAPACITY OF PIPELINE SYSTEM

The following Table illustrates the different pump rates required for delivery of water at the year 2030. The rates shown are for different population growth rates, different water consumptions and for different pumping durations.

Table 3

Number of Days Pumping and Required Pump Rate				
301 LCPD		2.0% Growth	2.5% Growth	3.0% Growth
30 Days Pumping	20%	531 USGPM	760 USGPM	1,012 USGPM
45 Days Pumping	20%	354 USGPM	507 USGPM	675 USGPM
60 Days Pumping	20%	265 USGPM	380 USGPM	506 USGPM
75 Days Pumping	20%	212 USGPM	304 USGPM	405 USGPM
90 Days Pumping	20%	177 USGPM	253 USGPM	337 USGPM
105 Days Pumping	20%	152 USGPM	217 USGPM	289 USGPM

Down Time

Number of Days Pumping and Required Pump Rate				
344 LCPD		2.0% Growth	2.5% Growth	3.0% Growth
30 Days Pumping	20%	833 USGPM	1,095 USGPM	1,383 USGPM
45 Days Pumping	20%	556 USGPM	730 USGPM	922 USGPM
60 Days Pumping	20%	417 USGPM	547 USGPM	692 USGPM
75 Days Pumping	20%	333 USGPM	438 USGPM	553 USGPM
90 Days Pumping	20%	278 USGPM	365 USGPM	461 USGPM
105 Days Pumping	20%	238 USGPM	313 USGPM	395 USGPM

Down Time



Number of Days Pumping and Required Pump Rate				
469 LCPD		2.0% Growth	2.5% Growth	3.0% Growth
30 Days Pumping	20%	1,712 USGPM	2,069 USGPM	2,462 USGPM
45 Days Pumping	20%	1,142 USGPM	1,379 USGPM	1,642 USGPM
60 Days Pumping	20%	856 USGPM	1,035 USGPM	1,231 USGPM
75 Days Pumping	20%	685 USGPM	828 USGPM	985 USGPM
90 Days Pumping	20%	571 USGPM	690 USGPM	821 USGPM
105 Days Pumping	20%	489 USGPM	591 USGPM	704 USGPM

The pump rates are shown in US Gallons per minute (USGPM) as that is the standard pump metric for this market.

3.8 SIZE OF PIPELINE (LENGTH, DIAMETER, ETC.)

The pipeline length (for the recommended Option 2) is approximately 4350 m, and the intake line is taken to be 50 m.

The pipe material will be High Density Polyethylene (HDPE) for reasons of flow capacity, durability flexibility and cost.

We will provide estimates for different pipe wall thickness (dimension ratios).

At schematic design we evaluated two possible pump choices for this pipeline. One pump was a 4" pump, powered by a 4 cylinder 75 HP diesel engine. The other was a 6" pump, powered by a 6 cylinder 95 HP diesel engine.

The 6" pump showed little benefit over the 4" pump, and the 4" pumps was and is recommended for use with any of the reviewed pipeline sizes.



Chart 1

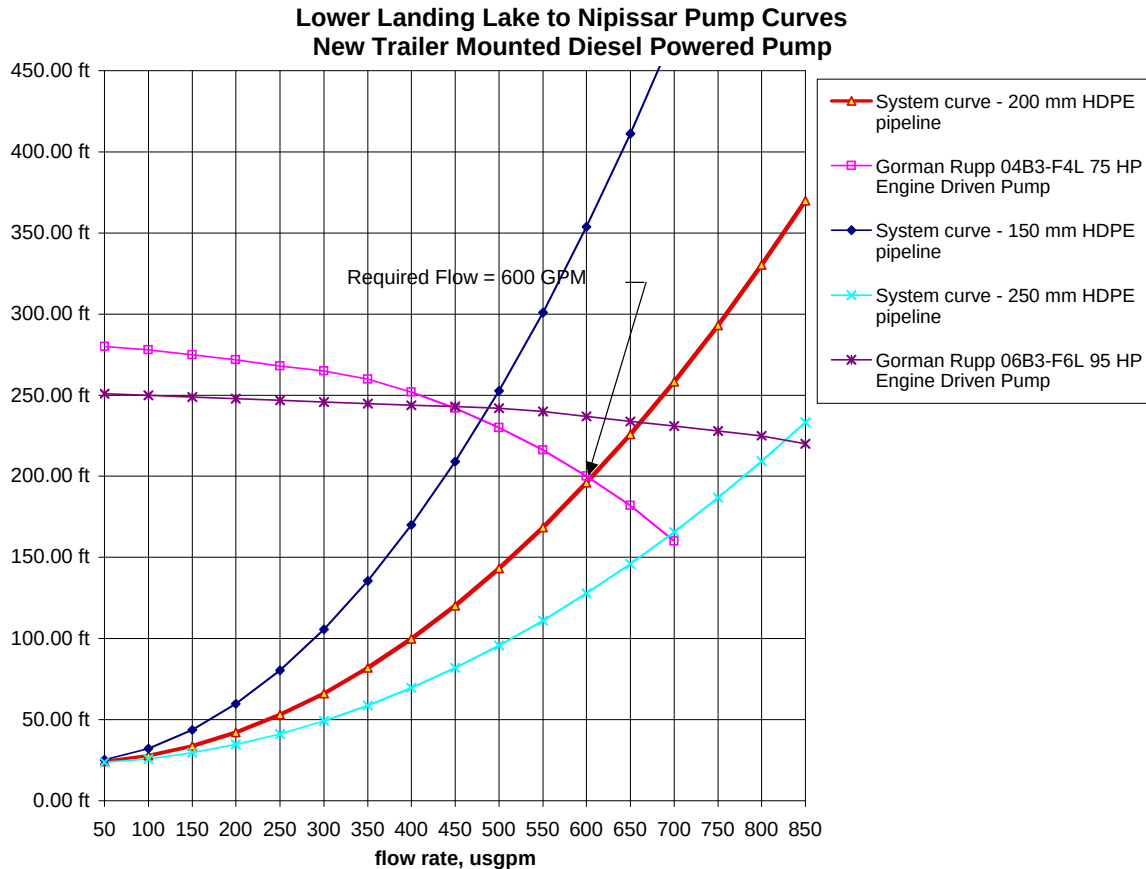


Chart 1 shows that both pumps would produce around 450 to 475 USGPM with a 150 diameter pipeline. The 4" pump gives 600 USGPM and the 6" pump 660 GPM into a 200 mm pipeline. The 4" pump gives 700 USGPM and the 6" pump 825 GPM into a 250 mm pipeline.

Given the above chart, and the previous Table 3 required pump rates, it is apparent that the desired pipeline diameter is linked to the growth of the community, and the success in reducing the water consumption per capita.

We recommend the 4" 75 HP pump. We see little benefit to the 6" pump over the 4", and the pump can be changed in a fairly straightforward way anyway if required in the future.

We recommend either the 200 mm or 250 mm pipelines. With the 75 HP pump, and extended pumping durations, it can supply each of the scenarios in Table 3 up to 2.5% growth and 469 LCPD, and all scenarios with 344 LCPD.

Where the 250 mm diameter pipeline has some merit is future growth. There have been discussions that state that in the future, it could be possible that the water supply source could be moved from Lower Landing Lake to Meliadine Lake in the future.

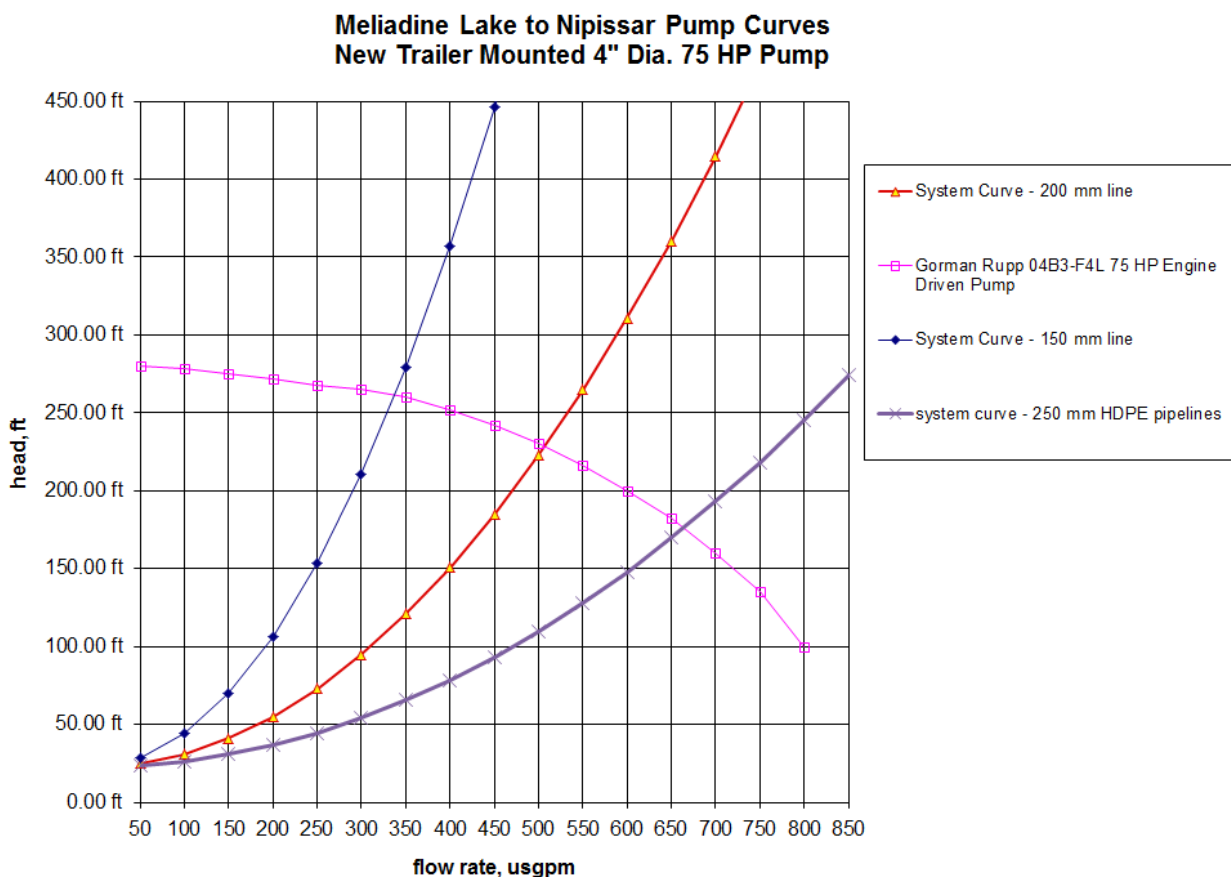


While the merits of such a relocation or move is not a part of this project, providing sufficient pipeline capacity for such a move would be prudent, if it comes at a sufficiently low additional cost.

A 250 mm pipeline, extended to Meliadine Lake, would provide lower head losses than a 200 mm pipeline. These lower head losses would be required to allow reasonable flow rates, without excessive pumping costs.

The following chart shows the pump rate curve for pumping from Meliadine Lake with an extended much longer pipeline.

Chart 2



3.9 DESIGN MEASURES FOR SYSTEM RELIABILITY, AND FURTHERMORE, SYSTEM REDUNDANCY

One issue that is significant in terms of cost, and operations is whether or not to cover the pipeline with an earth berm for protection.



A pipe berm would provide protection to the pipeline, from vandalism or inadvertent damage. It would also minimize the problem of safety concerns due to running into the pipeline on a snowmobile early in the year or when the pipe would be uncovered by drifting.

However, a pipe berm comes at a substantial cost, and presents additional construction difficulties of how to move and place the material for the berm, when constructing away from the road itself.

Given the high volume of snowmobile traffic near the end of the pipeline adjacent to the road crossing near the river, we recommend covering a portion of the pipeline with a gravel berm where it crosses the road near Lower Landing Lake.

3.10 ESTIMATES FOR MATERIAL SUPPLY AND CONSTRUCTION.

We have put together the following estimates for 150 mm, 200 mm and 250 mm pipelines.

150 mm Diameter Pipelines	Length	\$ per m		Cost
150 mm DR 17 HDPE - Supply	4250	\$	10.90	\$ 46,325.00
- Install	4250	\$	20.00	\$ 85,000.00
Access Road Repair and Fenced Pad		\$ per m ³		
25 mm gravel	400 m ³	\$	75.00	\$ 30,000.00
Pipeline Berm (340 m)	340	\$ per m ³		
25 mm gravel	184 m ³	\$	100.00	\$ 18,360.00
Pump	1	\$	50,000.00	\$ 50,000.00
Summer Only Intake	1	\$	20,000.00	\$ 20,000.00
Spill Basin	1	\$	3,500.00	\$ 3,500.00
Pipeline Location Fittings	85	\$	100.00	\$ 8,500.00
High point Air Release	2	\$	500.00	\$ 1,000.00
Shipping	25,245 kg	\$	0.50	\$ 12,622.50
Contractors OH - Div 1			28%	\$ 77,086.10
Contingency			25%	\$ 88,098.40
Total				\$ 440,492.00



200 mm Diameter Pipelines	Length	\$ per m		Cost
200 mm DR 17 HDPE - Supply	4250	\$	18.50	\$ 78,625.00
- Install	4250	\$	25.00	\$ 106,250.00
Access Road Repair and Fenced Pad		\$ per m ³		
25 mm gravel	400 m ³	\$	75.00	\$ 30,000.00
Pipeline Berm (340 m)	340	\$ per m ³		
25 mm gravel	231 m ³	\$	100.00	\$ 23,120.00
Pump	1	\$	50,000.00	\$ 50,000.00
Summer Only Intake	1	\$	20,000.00	\$ 20,000.00
Spill Basin	1	\$	3,500.00	\$ 3,500.00
Pipeline Location Fittings	85	\$	120.00	\$ 10,200.00
High point Air Release	2	\$	500.00	\$ 1,000.00
Shipping	42,543 kg	\$	0.50	\$ 21,271.25
Contractors OH - Div 1			28%	\$ 96,310.55
Contingency			25%	\$ 110,069.20
Total				\$ 550,346.00

250 mm Diameter Pipelines	Length	\$ per m		Cost
250 mm DR 17 HDPE - Supply	4250	\$	28.75	\$ 122,187.50
- Install	4250	\$	30.00	\$ 127,500.00
Access Road Repair and Fenced Pad		\$ per m ³		
25 mm gravel	400 m ³	\$	75.00	\$ 30,000.00
Pipeline Berm (340 m)	340	\$ per m ³		
25 mm gravel	286 m ³	\$	100.00	\$ 28,560.00
Pump	1	\$	50,000.00	\$ 50,000.00
Summer Only Intake	1	\$	20,000.00	\$ 20,000.00
Pipeline Location Fittings	85	\$	140.00	\$ 11,900.00
Spill Basin	1	\$	3,500.00	\$ 3,500.00
High point Air Release	2	\$	500.00	\$ 1,000.00
Shipping	51,893 kg	\$	0.50	\$ 25,946.25
Contractors OH - Div 1			28%	\$ 117,766.25
Contingency			25%	\$ 134,590.00
Total				\$ 672,950.00



3.11 SUMMARY

FSC recommends construction of the following:

250 mm diameter HDPE pipeline, running from the old bridge location on the river between Lower Landing Lake and the bay.

The pipeline is to be covered for a portion of it's length near it's intake, but largely run on the surface with hold down stakes for location.

The pipeline routing is to be such that there is only one low point for drainage, and two high point air releases along the pipeline route, to simplify operations.

The Intake is to be a seasonal, relocatable intake screen, connected to a 150 mm diameter flexible suction line.

The pump is to be a 75 HP diesel engine powered, trailer mounted pump, and is to be stored in a sea can adjacent to the intake location when not in use.

The estimated cost of construction of the pipeline and accessories is \$672,950 not including Project Management or Engineering.



4 Appendix A – Pipe Material Quotation



KWH PIPE (CANADA) LTD.
CORPORATE OFFICE
6507 MISSISSAUGA ROAD
MISSISSAUGA, ON L5N 1A6

Salesman: CURT SMIGEL
Phone: 604-202-7904
Fax: 905-858-0208
Email: curt.smigel@kwhpipe.ca

Sales Quote

Quote Number	2833
Quote Date	6/22/2010
Expires on	6/29/2010
Terms	NET 30
Created By	GKAYE
FOB Point	Saskatoon, SK

To

FSC Architects & Engineers
Yellowknife, NWT
Canada

Customer Contact

Attention: Walter Orr
Email: waltero@fsc.ca
Phone: 867-920-2882 Ext:
Fax: 867-920-4319

Project: HDPE Pipe - Budget Pricing

Line	Estimated Ship Date	Description	Qty	Unit of Measure	Price	Amount
1	7/16/2010	6IPS DR17 SCLAIRPIPE X50' PE3608 F714 C906 NSF	13,150.00	FT	3.33	43,789.50
FROM STOCK.						
2	7/16/2010	8IPS DR17 SCLAIRPIPE X50' PE3608 F714 C906 NSF	13,150.00	FT	5.64	74,166.00
FROM STOCK.						
3	7/16/2010	10IPS DR17 SCLAIRPIPE X50' PE3608 F714 C906 NSF	13,150.00	FT	8.77	115,325.50
FROM STOCK						

All prices shown in Canadian Dollars

Total Price: 233,281.00



KWH PIPE (CANADA) LTD.
CORPORATE OFFICE
6507 MISSISSAUGA ROAD
MISSISSAUGA, ON L5N 1A6

Salesman: CURT SMIGEL
Phone: 604-202-7904
Fax: 905-858-0208
Email: curt.smigel@kwhpipe.ca

Sales Quote

Quote Number	2833
Quote Date	6/22/2010
Expires on	6/29/2010
Terms	NET 30
Created By	GKAYE
FOB Point	Saskatoon, SK

STANDARD QUOTATION NOTES:

1. APPLICABLE TAXES ARE NOT INCLUDED.
2. QUOTATION IS SUBJECT TO THE ATTACHED KWH STANDARD "TERMS AND CONDITIONS OF SALE".
3. SHIP DATE INDICATED IS BASED ON CURRENT PLANT LOADING AND IS SUBJECT TO CONFIRMATION WHEN ORDER IS RECEIVED.
4. QUOTATION IS SUBJECT TO CONFIRMATION WHEN ORDER IS RECEIVED.
5. A 2% MONTHLY STORAGE FEE WILL BE INVOICED FOR SHIPMENTS DELAYED FOURTEEN (14) DAYS PAST THE AGREED UPON SHIP DATE.
6. ALL PIPE DIAMETERS 12" AND SMALLER REQUIRE FULL BUNDLE QUANTITIES TO BE ORDERED.
7. IF BUNDLES ARE REQUIRED TO BE BROKEN, THERE WILL BE A "BREAK BUNDLE" CHARGE OF \$ 250 PER SIZE/DR.
8. ESTIMATED FREIGHT IS BASED ON CURRENT RATES THAT MAY BE SUBJECT TO CHANGE WITHOUT NOTICE.
ACTUAL FREIGHT RATE WILL BE CONFIRMED AT TIME OF PURCHASE
9. ALL SALES ARE FINAL. NO RETURN OF MERCHANDISE WILL BE ACCEPTED



KWH PIPE (CANADA) LTD.
CORPORATE OFFICE
6507 MISSISSAUGA ROAD
MISSISSAUGA, ON L5N 1A6

Salesman: CURT SMIGEL
Phone: 604-202-7904
Fax: 905-858-0208
Email: curt.smigel@kwhpipe.ca

Sales Quote

Quote Number	2833
Quote Date	6/22/2010
Expires on	6/29/2010
Terms	NET 30
Created By	GKAYE
FOB Point	Saskatoon, SK

Terms and Conditions

1. **Acceptance/ Governing Terms:** Unless otherwise specifically agreed in writing, the following terms and conditions of sale ("terms") shall apply to any sale of products and/or services (as defined below) (collectively, "deliverables") by KWH Pipe (Canada) Ltd. ("KWH") specified either on quotation form KWH to Purchase (a "quotation") or an order (whether written or oral) by Purchaser to KWH (an "Order") that was based on a quotation and that has been accepted by KWH. An order may be accepted by KWH only by a written sales memorandum, invoice or other written confirmation from KWH promising to provide Purchaser Deliverables as ordered and such acceptance may be subject to the approval by KWH of the creditworthiness of Purchaser. Unless otherwise stated, Quotations shall be null and void unless accepted by Purchase within 30 days from the date of the Quotation. Purchaser shall be deemed to have full knowledge of the terms and such terms shall be binding if either the Purchaser provides written acceptance to KWH or Deliverables referred to herein as delivered to and accepted by the Purchaser. A Quotation accepted by the Purchaser or an Order accepted by KWH together with these Terms and all Specifications (as defined below) shall constitute the Agreement between KWH and the Purchaser (the "Agreement"). Any additional or different terms and conditions prepared by Purchaser are deemed to be unacceptable to KWH (are expressly objected to and rejected by KWH and shall not become a part to this Agreement). In the event of a conflict or inconsistency between the Terms herein and the terms and conditions contained in any acknowledgement or in any other form issued by Purchaser whether or not any such form has been acknowledged or accepted by KWH the Terms herein shall prevail unless specifically indicated in writing.
2. **INTERPRETATION:** In this Agreement: "Products" means all products, goods, supplies, components, material, articles, systems, processes, and/or equipment to be provided by KWH to Purchaser pursuant to this Agreement: "Services" means all services, labour, work, welding, fusion, joining and/or applications of any kind to be provided by KWH to Purchaser pursuant to this Agreement and "Specifications" means any and all specifications and instructions and plans for the products and/or services whether provided by Purchaser or KWH pursuant to this Agreement including any document providing the scope and/or design of such Products and/or Services, all functional, technical, operational, performance, quality and similar requirements, drawings, schematics, illustrations, Products and/or Service descriptions and any other data relating to the provision of Products and/or Services.
3. **PAYMENTS:** Payment for Deliverables provided within Canada shall be made in full by the Purchaser within thirty continuous days from the invoice date. Payment for Deliverables provided to all other destinations shall be made by confirmed irrevocable letter of credit. All amounts due and not paid when due bear interest until fully paid on such overdue amounts at a rate of 2.5 % per month (30% annum). All references to currency herein are to lawful money of Canada and all amounts payable are payable in Canadian dollars for Canadian customer quotations and to lawful money of the United States of America and all amounts are payable in United States dollars for all other customers. If Purchaser fails to make payments in accordance to this Agreement or Purchaser's financial situation becomes unsatisfactory at the sole discretion of KWH, KWH may in its sole discretion either suspend the provision of Deliverables until such payments are made, terminated this Agreement or if applicable require payment in advance for any Deliverables to be provided hereunder.
4. **SHIPPING/ PRICES:** Unless otherwise stated in the Quotation, quoted prices re subject to change by KWH with or without notice until Purchaser's acceptance unless otherwise specified prices stated or quoted to the Purchaser are Ex Works (Incoterms 2000). KWH is production plant. All costs of shipment and insurance shall, unless agreed otherwise in writing, be for the account of the Purchaser. Unless otherwise agreed, Purchaser shall contract for carriage on usual terms or shall provide shipping instruction to KWH for KWH to arrange for such carriage at Purchaser's risk and expense. Purchaser must obtain at its own risk and expense any export license or other official authorization and carry out where applicable, all customs formalities necessary for the export of the Deliverables. KWH shall provide the Purchaser, at the Purchaser's request, risk and expense assistance in doing so. KWH responsibility for Deliverables ceases upon delivery to the Purchaser at the production plant. In the event of loss or damage during shipment, Purchaser's claim shall be against the carrier only. KWH shall, however, give the Purchaser and reasonable assistance to secure adjustment to the Purchaser's claim against the carrier provided immediate notice of such claim is given to Purchaser by KWH.
5. **SALES TAX AND LOCAL IMPORT DUTIES:** prices stated or quoted do not include Federal, provincial, state or municipal sales taxes, value-added taxes or other taxes or duties. Where appropriate, KWH's invoices shall include taxes to be collected by KWH, including goods and services tax. Any changes in such taxes between the date of this Agreement and the provision of the relevant Deliverables shall be for Purchaser's account.
6. **DELIVERY:** Delivery schedules are approximate and are based on the prevailing market conditions applicable respectively at the time of the Quotation and KWH's acceptance of an Order. KWH may extend delivery schedules or may, at its option, cancel Purchaser's order in full or in part without liability other than to return any deposit or prepayment which is unearned by reason of the cancellation. If the parties, instead of specifying a date for delivery of the Deliverable have specified a period of time on the expiry of which such delivery shall take place, such period shall begin upon the later of (i) the acceptance of the relevant Order by KWH or (ii) the receipt by KWH in satisfactory form off all advanced payments as may be required, an agreed securities, all permits and approvals and upon the completion of all other formalities and the fulfillment of any other preconditions set out therein. If Purchaser fails to accept delivery of any Deliverables within 30 days of the time of agreed, Purchaser shall still pay the purchase price as if such acceptance had taken place unless the parties agree upon a new delivery date. KWH shall be entitled to store and insure any such Deliverables at Purchaser's expense and risk. Unless the Purchaser accepts the Deliverables within a final reasonable period determined by KWH, KWH may terminate this Agreement in whole or in part or sell the Deliverables in the reasonable interest of the Purchaser. Further KWH shall be entitled to compensation for any additional costs for losses suffered by KWH due to such Purchaser's failure.
7. **DELAY IN DELIVERY:** KWH shall forthwith advise Purchaser of any anticipated delays in the provision of the Deliverables. KWH shall not be liable or responsible for any damages, costs, back charges or other expenses incurred by Purchaser due to delay in the provision of Deliverables regardless of the cause of such delay (including equipment failure or malfunction or other commercial delays), whether or not such delay can be attributed to KWH.
8. **PERMITS:** Purchaser undertakes to obtain, at its own expense, all permits, approvals, consents, waivers, licences, certificates, and authorizations, or any item of similar effect, as may be necessary or required for the full performance of this Agreement.
9. **SECURITY AND RETENTION OF TITLE:** If the parties have agreed that security shall be provided by Purchaser under his Agreement, this Agreement shall not become effective and KWH shall not commence any work, production or delivery until such security is provided to the reasonable satisfaction of KWH. KWH and its sole discretion may require Purchaser to place security for the payment of the purchase price if KWH has reason to believe that Purchaser may not be able to pay the purchase price in full when due. KWH has the right to suspend the performance of its obligations under this Agreement if the payment owing by the Purchaser to KWH is overdue (whether pursuant to this Agreement or otherwise) or if Purchaser does not provide security acceptable to KWH when required. Title of the deliverables shall remain with KWH until paid for in full by Purchaser to the extent that such retention of title is valid under applicable law. Risk of loss and/or damage to Deliverables shall pass from KWH to Purchaser upon transfer and receipt (whether to accepted or not) of Deliverables as provided herein.
10. **CANCELLATION:** This Agreement is not subject to changes for cancellation by Purchaser, in whole or in part, without prior written consent of KWH. If KWH consents in writing to any changes or cancellation, or if this Agreement is terminated by KWH as a result of the repudiation or breach of any of the terms of this Agreement by Purchaser, KWH reserves the right to charge Purchaser with reasonable costs based upon expenses already incurred and commitments by KWH.
11. **SHIPPING ERRORS:** Any error in weight, number or other specifications must be noted on the bill of lading and Purchaser shall notify KWH of any claims arising therefrom in writing within 10 days after receipt by Purchaser of Deliverables. Unless so notified, KWH shall have no liability in respect to any of such error.
12. **RETURNED PRODUCTS:** No products may be returned to KWH without KWH's prior written consent. KWH reserves the right to decline or accept all returns subject to a handling/stocking charge. The amount of credit, if any, provided by KWH to Purchaser for returned products, shall be at the sole discretion of KWH. Credit for return Products shall be issued to Purchaser only where such Products are returned by Purchaser and not by any subsequent owner.
13. **ACCEPTANCE TEST:** Acceptance tests may be carried out only if agreed to in writing by the parties and KWH reserves the right to appoint an independent testing authority if such tests are conducted. If for some reasons beyond KWH's control, the acceptance tests cannot be carried out within the specified time by the parties, the qualities to be determined in the test shall be deemed approved and the Deliverables accepted.
14. **JOB SITE AND ACCESS:** Purchaser shall prepare the job site (including entry an access therefrom) in accordance with the Specifications, KWH's Field Service Guide (a copy of which has been provided to Purchaser) and in accordance with any applicable requirements as may be communicated to Purchaser by KWH from time to time. Purchaser grants to KWH and to such persons or entities as KWH may reasonably designate in connection with the provisions of the deliverables hereunder, full right of access to the job site of the Purchaser as may be necessary for the provision of the Deliverables hereunder subject only to reasonable security restrictions as Purchaser may require and that should be notified in advance to KWH.
15. **VEHICLE ACCESS:** Where delivery to the job site is included in the price payable by the Purchaser under this Agreement, such delivery should be construed to mean motor truck delivery as close to job site, designated storage area, or to line of trench as is practical for loaded standard highway motor trucks and trailers operating under their own power. The Purchaser shall provide and maintain a suitable access, including access roads to the job site, for safe and efficient provisions of the Deliverables.
16. **CONFIDENTIALITY:** All specifications and other documents and information provided to the Purchaser by KWH shall be treated in confidence by Purchaser. Such items shall remain the exclusive property of KWH and may not without the prior written consent of KWH, be copy, reproduced or communicated to any third party. All such documents and information shall be returned to KWH upon request.
17. **Force Majeure:** KWH shall not be responsible for any direct or indirect damages whatsoever caused by delays beyond the control of KWH, and without limiting the generality of the foregoing, KWH shall not be responsible for any damages due to delays caused by storms, fires, floods, acts of God, labour difficulties, (including lockouts, strikes and slowdowns) material procurement delays (including inability to obtain power, materials, labour, equipment or transportation) acts of war or terrorism, quarantine restrictions, commercial impossibility, court injunctions or order, or any cause beyond its control.
18. **WARRANTY:** KWH warrants only that the product shall be free from latent defects and shall be made in a workmanlike manner and in conformity with the specifications related thereto. To the extent Services are to be provided hereunder, KWH warrants only that all work rendered shall be provided in a workmanlike manner and in conformity with the Specifications related thereto. For a period of 12 months following the shipping date of any products or the provision of any Service, as applicable, but not thereafter, upon demonstration that any such Products and/or Services include latent defects or do not materially conform to the specifications as applicable, attributable to KWH as manufacturer or Service provider. KWH shall at its sole option, repair or replace such defective Product or re-perform the Service free of charge. Ex Works (Incoterms 2000) or equivalent, or allow credit to the Purchaser in equal amount, provided that the Purchaser gives written notice to KWH of the alleged defect or material nonconformity within 7 days of its discovery and submits to KWH on demand, for examination and testing, all such Products allegedly defective or which allegedly do not materially conform to the Specifications or provides to KWH on demand, access to the purchaser's premise or job site, as applicable, for examination and testing of all services which allegedly do not materially conform with the specifications. In default of such notice and submission, all responsibility on the part of KWH to repair, replace, correct, re-perform or allow credit shall cease. Any products (or parts thereof) returned to KWH pursuant to this provision shall become the property of KWH. Any products not manufactured by KWH or Services not provided by KWH are not warranted, except insofar as the same are warranted to KWH by the manufacturer of such Products or the provider of the Services, but in no event does KWH bind itself to any greater warranty than the ones provided for herein at KWH's sole option. When Products and/or Services are provided in accordance with Purchaser's Specifications, KWH assumes no liability for loss or damage arising from improper or inadequate design or instructions and when provided based on or using materials provided by Purchaser, KWH assumes no liability for loss for damage arising from defects in or inadequacy of such materials. To the extent that any Deliverable is to be repaired, replaced, corrected or performed as provided for herein, KWH shall not be liable for any damage caused its the course of digging up, lifting up, dismounting, transportation, mounting or establishment in connection with such Deliverables.
19. **LIMITED WARRANTIES:** It is understood and Purchaser agrees that the warranties provided in section 0 constitute KWH's sole warranties with respect to the Deliverables and that all other warranties, express or implied, legal or contractual, on the part of KWH with respect to the Deliverables and that all other warranties, are hereby excluded, and in particular, but without limiting the generality of foregoing, no liability is assumed nor is KWH responsible for damage or delays caused by defective materials or workmanship or negligence of KWH, nor shall any allowances for repairs, alterations or re-performance be made unless effected with the prior written consent of KWH. Further, KWH shall not be responsible for any damage or delays caused by defects arising out of faulty maintenance, incorrect installation, incorrect operation, excess of loading from erosion, cavitation, abnormal soil conditions, unsatisfactory foundation, excessive stress during sinking, building or installation work not undertaken by KWH and another reason beyond KWH's control.
20. **LIMITED LIABILITY:** Notwithstanding any other provision of this Agreement, to the maximum extent permitted under applicable law, in no event, and under no circumstances shall the aggregate liability of KWH (including remedies for defective goods, rectification work and damages) exceed the aggregate purchase price Ex Works (Incoterms 2000) for the applicable Products and/or service provided pursuant to this Agreement. KWH shall not be liable under any circumstances for any incidental, consequential, indirect, special or punitive damages arising out of or related to the Performance of this Agreement or the provision of or failure to provide the Deliverables, including without limitation damages or injuries to any person (including death), loss of profits, loss of business revenue, loss of production, loss of use, loss of contracts, interruption of operation, failure to realize expected savings or other commercial or economic loss of any kind, whether or not foreseeable, whether such liability is based in contract or tort, negligence, strict liability or otherwise, or whether or not KWH has been the advised of the possibility of any such liability.
21. **INDEPENDENT CONTRACTOR:** KWH is an independent contractor of Purchaser and nothing in this Agreement can be read to imply or construe KWH as a partner, agent or employee of Purchaser. Neither party shall have authority to commit or create any liability on the part of the other or to bind the other party in any way.
22. **DISPUTES:** Unless otherwise agreed to in writing, any controversy, questions or claim or other dispute arising out of relating to this Agreement must be conclusively settled by submission to arbitration in accordance with the rules of arbitration of the Arbitration Act (Ontario) for domestic sales and to the International Commercial Arbitration Act (Ontario) for International Sales. The arbitration shall be held in Toronto, Canada. The number of arbitrators shall be one and the arbitration shall be conducted in English. Notwithstanding the foregoing, KWH reserves the right to initiate legal proceedings against the Purchaser in any, competent court of law for the purpose of collecting unpaid invoices.
23. **WAIVER'S:** No failure or delayed by KWH in enforcing any of the terms and conditions of this Agreement shall prejudice, or restrict its rights and powers under this Agreement nor shall any waiver of any breach operate as a waiver of any subsequent breach.
24. **GENERAL:** This Agreement: (a) shall be governed by and enforced in accordance with the laws of the Province of Ontario and the federal laws of Canada applicable therein and the parties consent to venue in Ontario and the parties agree that the International Sale of Goods Act (Ontario) does not apply to this Agreement; (b) may not be assigned by Purchaser without the prior written consent of KWH; (c) shall insure to the benefit of and be binding upon the respective heirs, executors, administrators, other legal representatives, successors and permitted assigns of the parties; and (d) constitutes the entire Agreement between the parties with respect to the subject matter hereof and cancels and supersedes any prior understandings, Agreements, representations or warranties, express or implied, between the parties with respect thereto. Any provision of this Agreement that contemplates performance or observance subsequent to any termination or expiration of this Agreement (in whole or in part) shall survive any such termination or expiration and continue in full force and effect. No modifications or amendment to this Agreement is valid or binding unless set forth in writing and executed by the parties. Any provision of this Agreement that declared unenforceable or invalid shall be severed from the balance hereof with out affecting the remaining provisions hereof.



5 Appendix B – Issued For Review Design Drawings



WATER SUPPLY CAPACITY, CONSUMPTION & CONSERVATION STUDY

Rankin Inlet, NU

GN Project # 09-3009

FSC Project # 2009-1310

April 20, 2010

Prepared for:

The Office of the Regional Director
Kivalliq Region
Dept. of Community and Government Services
Government of Nunavut
Delivered to Project Management/O&M Building
P.O. Bag #002, Rankin Inlet, Nunavut X0C 0G0
Attn: Dawn Brigham, Project Officer

LISTEN. DESIGN. MANAGE.

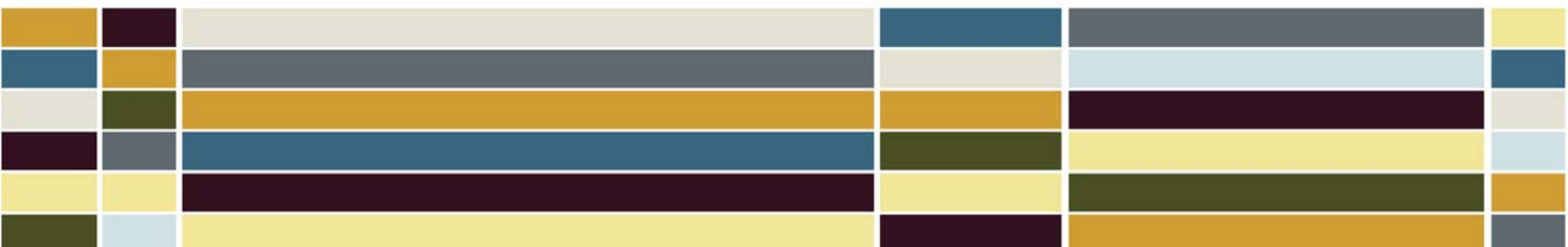


Table of Contents

	Page
1.0 Executive Summary.....	1
2.0 Introduction.....	10
3.0 Market Research.....	11
3.1 Residential Surveys.....	11
3.2 Household Audits.....	18
4.0 Residential Water Use Demand Analysis.....	22
5.0 Industrial, Commercial and Institutional (ICI) Water Use Demand Analysis.....	26
6.0 Evaluation of Distribution System Water Loss	28
6.1 Introduction.....	28
6.2 Water Supply and Distribution System Operation and Customer Meters.....	28
6.3 Water Loss Identification and Reduction Program.....	31
6.4 Equipment Requirements.....	35
6.5 Other Items.....	36
7.0 Development of Specifications for Leak Reduction Equipment.....	37
8.0 AWWA/IWA Water Audit and Water Balance.....	38
9.0 Identification and Evaluation of Water Conservation and Efficiency Program Alternatives.....	44
9.1 Comprehensive List of Water Savings Measures.....	45
9.2 Feasibility Screening of Measures.....	50
10.0 Strategy Implementation Plan.....	56
10.1 Capital Budget and Water Savings.....	57
10.2 Water Conservation & Efficiency Strategy Costs Breakdown.....	59
10.3 Staff Resources.....	60
11.0 Overall Water Savings.....	61
12.0 Maintenance.....	63
13.0 Monitoring and Evaluation.....	66
14.0 Energy Savings and Greenhouse Gas Emissions Reductions.....	68
15.0 Conclusions.....	69
15.1 Capital Budget and Water Savings.....	81
16.0 References and Resources.....	88

List of Appendices

- A. Specification for Leak Reduction Equipment**
- B. AWWA/IWA Water Audit and Water Balance Report**
- C. Costs and Water Savings Model**
- D. Individual Program Descriptions**
- E. Nipissar Lake Volume Study and Environmental Variable Study**

List of Tables

1.	Rankin Inlet 2009 Residential Customer Billed Consumption.....	1
2.	Capital Budget and Water Savings.....	6
3.	Overall Water Savings.....	7
4.	Comparison of Residential Savings and 2009 Residential Consumption	8
5.	Comparison of ICI Savings and 2009 ICI Billed Consumption.....	8
6.	Comparison of Municipal Savings and Water Loss Results.....	8
7.	Estimated Energy Savings and Associated Greenhouse Gas Emissions Reductions.....	9
8.	Rankin Inlet 2009 Customer Billed Consumption.....	22
9.	2009 Residential Per Capita Consumption based on Billing Data.....	23
10.	2009 Comparison of Residential Consumption based on Billing Data and based on Water Balance.....	24
11.	Breakdown of Housing by Housing Type – Rankin Inlet.....	24
12.	Breakdown of Housing Construction and Typical Toilet Flush Volumes	35
13.	Comprehensive List of Water Saving Measures.....	45
14.	Preliminary Screening Results.....	51
15.	Water Efficiency Measures Short List.....	54

16.	Results of Financial Screening of Water Efficiency Measures.....	55
17.	Capital Budget and Water Savings.....	57
18.	Water Consumption and Efficiency Strategy Costs Breakdown.....	59
19.	Overall Water Savings.....	61
20.	Comparison of Residential Savings and 2009 Residential Consumption Based on Billing Data and based on Water Balance.....	61
21.	Comparison of ICI Savings and 2009 ICI Billed Consumption.....	61
22.	Comparison of Municipal Savings and Water Loss Results.....	62
23.	Recommended Maintenance Budget.....	65
24.	Monitoring and Evaluation Budget.....	66
25.	Recommended Monitoring and Evaluation Activity.....	66
26.	Estimated Energy and Associated Greenhouse Gas Emissions Reductions	68
27.	Rankin Inlet 2009 Residential Customer Billed Consumption.....	69
28.	Results of Financial Screening of Water Efficiency Measures	79
29.	Capital Budget and Water Savings.....	81
30.	Overall Water Savings.....	82
31.	Comparison of Residential Savings and 2009 Residential Consumption Based on Billing Data and based on Water Balance.....	83
32.	Comparison of ICI Savings and 2009 ICI Billed Consumption.....	83
33.	Comparison of Municipal Savings and Water Loss Results.....	83
34.	Recommended Maintenance Budget	84
35.	Monitoring and Evaluation Budget.....	85
36.	Recommended Monitoring and Evaluation Activity.....	85

37.	Estimated Energy and Associated Greenhouse Gas Emissions Reductions	86

List of Figures

1.	Calculated Residential Per Capita Consumption and Water Balance...	2
2.	Comparison of Residential Per Capita Demand (lcd).....	2
3.	Breakdown of Billable Water Consumption.....	22
4.	Calculated Residential Per Capita Consumption and Water Balance..	23
5.	Comparison of Residential Per Capita Demand (lcd).....	24
6.	ICI Billed Water Consumption 2008, 2009.....	26
7.	2009 Annual Billed Water Consumption by Customer.....	27
8.	ICI Water Customers Sectors by Number of Customer Accounts.....	27
9.	Decision Tree for Screening Water Efficiency Measures.....	50
10.	Calculated Residential Per Capita Consumption and Water Balance..	70
11.	Comparison of Residential Per Capita Demand (lcd).....	70

1.0 Executive Summary

The implementation of the water efficiency strategy presented in this report will provide the Hamlet of Rankin Inlet with a significant amount of additional water supply capacity and waste water treatment capacity. This capacity, an estimated 597,000 litres per day, can be provided cost-effectively, at least 34% less costly than building new supply infrastructure. In addition, this additional supply capacity through water efficiency can be provided immediately without lengthy design and environmental assessment requirements.

In September 2009 the Government of Nunavut contracted FSC Architects & Engineers in conjunction with Resource Management Strategies Inc. (RMSi) to complete a Water Supply Capacity, Consumption & Conservation Study for the Hamlet of Rankin Inlet. The primary objective was to provide advisory services to optimize the water use in the community to ensure efficient and conservative water use, thereby optimizing the infrastructure and water resource.

Residential Water Use Demand Analysis

An analysis was completed to segregate water use into several categories, so that water use by single family properties, multi family units and the ICI sector could be identified. Customer billing data for the period from August 2006 to August 2009 was compared to:

- Rankin Inlet Business Directory provided by the Canada-Nunavut Business Service Centre
- Rankin Inlet House Numbering system Map, dated April 23rd 2002
- Satellite imaging of Rankin Inlet

The comparison was completed in order to identify the number of properties in each category, and to allocate a volume of use. Properties that were identified as residential housing but listed in the ICI sector was re-categorized as residential for the analysis.

Based on the data provided, a breakdown of the 2009 (Sept. 2008 to Aug. 2009) residential customer billed consumption is shown in the following Table 1.

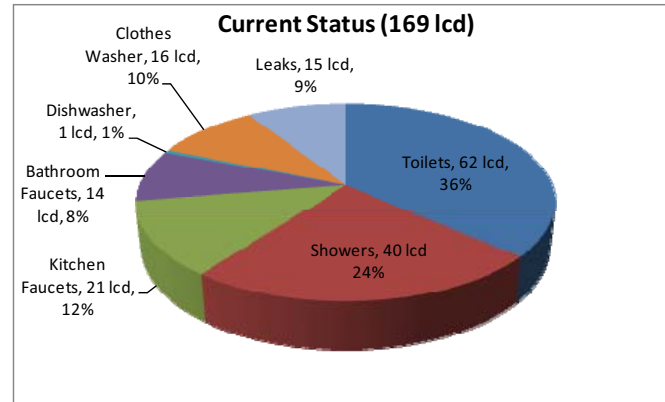
Table 1: Rankin Inlet 2009 Residential Customer Billed Consumption

Category	2009 Billed (litres)	Population 2009 est.	Water Use – Litres per Capita per Day (Lcd)
Residential	111,544,000	2,499	122

The billing analysis indicated that 75% of the overall billed water is to the residential sector. In addition using an estimated 2009 population of 2,499, the residential per capita consumption was 122 litres per capita per day (Lcd). A relatively low residential per capita consumption was expected in Rankin Inlet since there is minimal outdoor water use. However, the excessive water using fixtures and appliances found in the market research would indicate that the residential consumption should be significantly higher than what was indicated from the billing data. It was also observed that the age and technology (remote read) of the residential meters would support lower meter readings than the actual usage and the remote read technology could allow for unauthorized unbilled water use. Both of these factors were confirmed by GN CGS staff as concerns.

Using observations from the market research in addition to factors from the AWWA AWARF 1999 Residential End Uses Study, a residential water balance and a calculated per capita consumption was developed. The results of this calculation provided a residential per capita consumption of 169 Lcd. The water balance is shown below in Figure 1.

Figure 1: Calculated Residential per Capita Consumption and Water Balance



The calculated per capita consumption indicates that the actual residential consumption could be as much as 38% higher than that reported in the billing data. In order to compare this consumption level with other municipalities in Canada, and around the world, the following Figure 2 has been prepared:

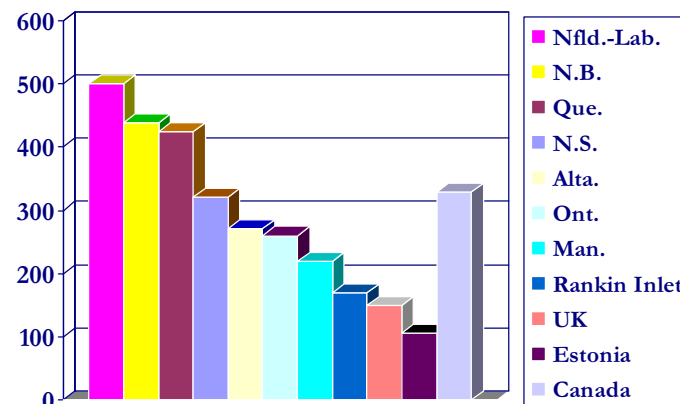


Figure 2: Comparison of Residential Per Capita Demand (Lcd)¹

Prior to 1994, toilet flush volumes were generally 20 litres or greater. The National Building Code or the National Plumbing Code does not address water conservation and as such do not provide required toilet flush volumes. In December 1995, the Government of Nunavut released its 2nd Edition of the Good Building Practices Guidelines. The Guidelines was provided as a supplement to the National Building Code to assist builders and developers with the construction in a northern climate. It is recommended that the GN considers updating the 1995 Guidelines with current proven water efficiency products such as high efficiency toilets and dual flush toilets in addition to lower flow rated showerheads and faucets. Such an update would ensure that all newly constructed homes would be as water efficient as possible.

¹ Municipal Water Use Survey, Environment Canada, 2004.

Industrial, Commercial and Institutional (ICI) Water Use Demand Analysis

According to the 2009 billing data provided, the industrial, commercial and institutional (ICI) sector represents approximately 25% of Rankin Inlets' bill water consumption. In 2009, the volume of billed water to the ICI sector was 35,128,000 litres, which is 30% more than 26,962,000 litres billed in 2008.

Further investigation of the billing data for 2009 produced the following discrepancies:

- Polar Bear Investments c/o Nanqu Inn – 7,842,000 litres additional in 2009
- Community & Government Services, Kivalliq – approximately 3,000,000 litres additional in 2009
- Rankin Inlet Airport – approximately 1,500,000 litres additional in 2009

The additional water volume represented by these 3 accounts more than offset the increase in water volume in 2009. In addition, similar to the residential water meters as large mechanical meters get older they tend to under-register due to wear. Due to the discrepancies in the billing data the confidence in the accuracy of the ICI billed water consumption is extremely low.

For the purpose of this analysis, it was assumed that the 2008 ICI billed volume of 26,962,000 litres was more representative and as such used as the corrected 2009 ICI volume.

Further analysis of the ICI billing data indicates that 35% of the customers consume 80% of the overall water for that sector.

AWWA/IWA Water Audit and Water Balance

As part of the Government of Nunavut's (GN) ongoing water loss management program, GN completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System. The project was completed for a full year from August 2008 to August 2009, based on available billing data. A copy of the report in its entirety can be found in Appendix B of this document.

The gathered data for 2009 was entered into the AWWA – WLCC (Water Loss Control Committee) software program. The results of the analysis are shown as follows:

Parameter	Value for 2009
Current Annual Real Losses (CARL)	145,000,000 litres
Unavoidable Annual Real Losses (UARL)	14,000,000 litres
Infrastructure Leakage Index (ILI)	10.17
System Input Volume	428,000,000 litres
Corrected Billed Water (corrected for estimated accuracy of billing system)	181,000,000 litres
Non-Revenue Water	247,000,000 litres
Volume of Non-Revenue Water - % of System Input Volume	57.7%

The financial results from the IWA software analysis are shown below:

Parameter	Value
<u>Annual Cost of Apparent Losses</u> Customer meter under registration Unauthorised consumption – based on estimated customer water and sewer rate of \$4.50 per 1,000 litres	\$52,215
<u>Annual Cost of Real Losses</u> <u>– Variable Production Cost</u> Based on estimated cost of \$0.35 per 1,000 litres	\$50,798

In any water system there will be a volume of leakage that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair – this is the Unavoidable Annual Real Losses (UARL). The IWA software uses the physical characteristics of the water distribution system (length of water mains and services, number of connections, average pressure) to make an estimate of UARL. The Current Annual Real Losses (CARL) are also calculated by the software, by taking the water supplied and deducting the calculated authorized consumption and apparent losses, to give CARL. The ratio of UARL to CARL is the Infrastructure Leakage Index (ILI).

The World Bank Target Matrix gives performance category A for an ILI 1 - 2; category B for ILI 2 – 4; category C for ILI 4 – 8; and category D for ILI greater than 8.

The Hamlet of Rankin Inlet Water System's ILI of 10.17 puts them in performance D category – very inefficient use of resources; leakage reduction programs imperative and high priority

Although operational and financial considerations may allow a long term ILI greater than 8.0, such a level of leakage is not an effective utilisation of water as a resource. The priority for the Hamlet of Rankin Inlet Water System should be to develop an active leak detection program to reduce water losses, and reduce the ILI to initially below 8.0, and then progressively reduce it further till it is in performance category B.

Strategy Implementation Plan

The recommended components of the plan include:

Residential Measures

- Visit all homes and apartments and install free of charge HET or dual flush toilets, low flow showerheads, kitchen aerators, bathroom aerators and water efficient clotheswashers. To eliminate toilet leakage in homes, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.

Industrial/Commercial/Institutional Measures

- Visit all businesses and institutions and install free of charge HET or dual flush toilets. To eliminate toilet leakage in businesses, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.

- Visit commercial kitchens and install free of charge low flow pre-rinse spray valves.
- Complete five (5) comprehensive water audits and offer a capacity buy-back rebate to any facility that implements all or some of the water saving recommendations.

Municipal Measures

- Design and implement five (5) district meter areas. Locate, quantify and repair the leakage within the water distribution system.

Public Education

- Distribution of booklets, leaflets, and fact sheets at community and environmental events.
- Distribution of a water efficiency bulletin in the water bills.
- Displays at community events.
- Develop and maintain a website to educate the public on water efficiency.
- Provide workshops and seminars to the public on water saving techniques both inside and outside the home.

Youth Education

- Develop and deliver a water efficiency education program based on curriculum requirements.
- Develop and facilitate a Children's Water Festival.

For reference individual business cases for each recommended water conservation and efficiency measure are provided in Appendix D of this report.

Table 2: Capital Budget and Water Savings (Litres per average day)

Residential	Water Saving Measure	Number of Product Installed	Total Cost	Total Program Savings (L/d)	Cost per litre
Installation	HET Toilets	768	\$ 707,921	96,903	\$ 7.31
Installation	Dual Flush Toilets	85	\$ 79,434	10,767	\$ 7.38
Installation	Low Flow Showerheads	854	\$ 103,208	42,246	\$ 2.44
Installation	Kitchen Faucets	776	\$ 55,096	15,644	\$ 3.52
Installation	Bathroom Faucets	854	\$ 49,664	18,376	\$ 2.70
Installation	Leakage Repair	854	\$ -	43,068	\$ -
Installation	Clotheswashers	776	\$ 970,000	14,356	\$ 67.57
Industrial, Commercial, Institutional					
Installation	HET Toilets	357	\$ 329,486	16,740	\$ 19.68
Installation	Dual Flush Toilets	40	\$ 37,850	1,860	\$ 20.35
Installation	Pre-Rinse Spray Valves	15	\$ 14,500	3,680	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	5	\$ 72,250	15,000	\$ 4.82
Municipal					
Installation	Leakage Reduction	5	\$ 275,000	287,500	\$ 0.96
Education					
Public Education (5 years)			\$ 150,000		
Youth Education (5 years)			\$ 180,000		
TOTAL			\$ 3,024,408	566,140	\$ 5.34

It is recommended that the above capital plan be supported by ongoing monitoring, evaluation and maintenance in order to initially verify the water savings and then to sustain them into the future.

The overall best practices capital program is budgeted at \$3,024,408 and is expected to save just over 566,000 litres of water per average day (l/d).

The cost per litre per day for the proposed plan is \$5.34. This compares well to the average cost per litre per average day capacity for new infrastructure, which is estimated at \$8.00. To add new water and wastewater infrastructure to deliver the equivalent capacity of 566,000 l/d would cost \$4.5 million based on the average \$8.00 per litre capacity cost.

Although some program measures did not meet the cost analysis, which includes clotheswashers, ICI HET toilets and ICI dual flush toilets, these program alternatives have been included due to the significant savings that they bring to the overall plan. However, it is important to note that even with the inclusion of these programs the overall plan remains more cost-effective than the cost of constructing future water and wastewater supply/treatment capacity.

Due to the difficulty in measuring water savings generated by education, there have been no savings attributed to the Broadscale Public or Youth Education programs in the plan. Technical solutions, such as low flush toilets and low flow showerheads will only achieve a portion of the potential water savings. Education designed to change habits and attitudes or residents towards water use will achieve the remaining savings. The American Water Works Association suggests that education programs can generate up to a 4 to 5% reduction in water demand by long-term education initiatives. In addition, education is necessary to ensure that water savings generated by the capital program are sustained. Since, education should be ongoing, 5 years of costing has been included.

Overall Water Savings

The overall water savings anticipated from the implementation of the recommended strategy is shown in Table 3 below.

Table 3: Overall Water Savings

Sector	litres/day	litres/year
Residential	241,360	88,096,000
ICI	37,280	13,607,000
Municipal	287,500	104,938,000
Total	566,140	206,641,000

The water saving plan will free up 206,641,000 litres/year of water supply capacity. This represents approximately 61% of the total water supplied in 2009.

In addition to providing water supply capacity, the plan will reduce demand on the wastewater system by 101,703,000 litres/year.

Residential

The water savings attributed to the residential sector was compared against 2009 billed consumption and the residential water balance that was developed. Results of this comparison are shown in Table 4.

Table 4: Comparison of Residential Savings and 2009 Residential Consumption based on Billing Data and based on Water Balance

Residential Sector	Per Capita Consumption (Lcd)	Residential Consumption 2009 (litres)	Residential Water Savings (litres)	Percent Savings
As per Billing Data	122	111,544,000	88,096,000	79%
As per Water Balance	169	154,151,000	88,096,000	57%

Industrial, Commercial and Institutional

The water savings attributed to the ICI sector was compared against 2009 corrected billed consumption. Results of this comparison are shown in Table 5.

Table 5: Comparison of ICI Savings and 2009 ICI Billed Consumption

ICI Sector	Corrected ICI Consumption 2009 (litres)	ICI Water Savings (litres)	Percent Savings
As per Billing Data	26,962,000	13,607,000	50%

Municipal

The water savings attributed to the Municipal leakage reduction program was compared against the water loss identified from the AWWA/IWA Water Audit and Water Balance results. Results of this comparison are shown in Table 6.

Table 6: Comparison of Municipal Savings and Water Loss Results

Municipal Sector	Estimated Water Loss 2009 (litres)	Municipal Water Savings (litres)	Percent Savings
As per Billing Data	145,000,000	104,938,000	72%

Energy Savings and Greenhouse Gas Emissions Reductions

The overall energy savings generated from water efficiency is in most cases more significant than the water savings. Water utilities are typically the largest consumer of electricity in a municipality. Electricity is used in the water and wastewater treatment processes but more significantly in the pumping/conveyance of water and wastewater. A recent study² completed by the Polis Project on Ecological Governance, University of Victoria evaluated historical data relating to water production and energy consumption from 7 municipalities in Ontario. The study completed case studies on the Town of Collingwood, the Regional Municipality of

² Maas, Carol. Greenhouse Gas and Energy Co-Benefits of Water Conservation, Polis Discussion Series Paper 08-01, November 2008, Polis Project on Ecological Governance, university of Victoria, Victoria, BC.

Durham and the City of Guelph. The study reported, that it takes 0.68 KWh of electricity for every 1,000 litres of water delivered to a customer and then returned through the wastewater process. The findings from this study were used to develop the energy savings and greenhouse gas emission reductions reported below.

Many of the water saving measures recommended in the strategy also reduce energy consumption at the customer's premise. For example, a low flow showerhead reduces not only water but reduces hot water. Oil or electricity has been used by the customer to generate the hot water. Energy savings will also be generated from the faucet aerators, clotheswashers, pre-rinse spray nozzles and the ICI Audit program.

Typically a residential customer who participates in the water efficiency program will see greater dollar savings in their energy bill as compared to their water bill. This is also an important linkage to emphasize when promoting the water efficiency programs to the public.

The reduction of water-use through an efficiency program and the associated energy savings provides significant greenhouse gas reductions. With climate-change in mind, most municipalities have set their own greenhouse gas reduction targets. Water efficiency can be a positive contributor to meeting those targets.

Although the participant's energy savings were not quantified as part of this project, the utility energy savings and greenhouse gas emission reductions are provided in Table 7 below.

Table 7 – Estimated Energy Savings and Associated Greenhouse Gas Emission Reductions

	Water Savings per Year (litres/yr)	Energy Savings per Year	CO2 Reductions per Year (tonnes/yr)
Overall Water Savings	206,641,000	130,022 KWh Electricity	78.0 tonnes

Assuming an electric rate of \$ 0.35 per KWh, the Hamlet of Rankin Inlet would reduce its electrical bill by approximately \$45,858 per year upon completion of the strategy. In addition, the greenhouse gas emissions reduction is equivalent to removing 14 cars from the road.

2.0 Introduction

Although water conservation and efficiency has been promoted by the Government of Nunavut for many years, the changing landscape has brought water efficiency to the forefront. Water Efficiency is recognised as a utility Best Management Practice (BMP) by the Federation of Canadian Municipalities (FCM), National Research Council (NRC) and the American Water Works Association (AWWA). The benefits of water efficiency are numerous:

- Water efficiency is the most cost effective alternative in generating additional water and wastewater capacity, sometimes as low as 25% of the cost of new infrastructure
- It can defer and sometimes eliminate new infrastructure projects
- Water savings from an efficiency program are quite often immediate, and can assist in bridging the gap in a water supply deficit area prior to the construction of a technical solution
- The pumping stations, tempered water and distribution system consume significant amounts of energy, water efficiency reduces that energy consumption and thus reduces greenhouse gas emissions
- Water efficiency can contribute to lower water and energy bills for residents and businesses

In September 2009 the Government of Nunavut contracted FSC Architects & Engineers in conjunction with Resource Management Strategies Inc. (RMSi) to complete a Water Supply Capacity, Consumption & Conservation Study for the Hamlet of Rankin Inlet. The primary objective was to provide advisory services to optimize the water use in the community to ensure efficient and conservative water use, thereby optimizing the infrastructure and water resource.

Tasks completed by the project team are as follows:

- Residential Market Research
 - Residential Survey
 - Household Audits
- Residential Water Use Demand Analysis
- Industrial, Commercial and Institutional (ICI) Water Use Demand Analysis
- Evaluation of Distribution System Water Loss
 - International Water Association / American Water Works Association (IWA / AWWA) Water Audit and Water Balance
- Development of Specifications for Leak Reduction Equipment
- Identification and Evaluation of Water Efficiency and Conservation Measures
- Water Use and Water Efficiency Report

3.0 Market Research

3.1 Residential Survey

Background

A market research study pertaining to water use habits in the Hamlet of Rankin Inlet was completed on behalf of Government of Nunavut. The study was completed to assist with future planning and improvement of water services for the community.

The survey questionnaire was designed to take approximately 20-30 minutes to complete. The questionnaire was available in Inuktitut and English. Four hundred copies of the survey were distributed to homes throughout Rankin Inlet during the week of October 21, 2009 with instructions to return the completed forms to the Hamlet Town Office by October 26, 2009. Ultimately, the deadline was extended to November 5th 2009.

To thank the residents who participated in the survey, a draw was held to win a new laptop computer on November 5th with the results announced on the local radio station.

In total, 62 completed survey responses were received. This statistically valid sample provides a confidence level of 95% +/-6%. All of the information gathered from the survey results were compiled and aggregated.

Observations

Q1. Thank for your participation. Where do you currently obtain water from...?

100% of the respondents indicated that their water was supplied through the municipal water distribution system. None of the respondents indicated that they received their water by truck delivery or that they had sewage holding tanks on site.

Q2. Do you use water in your home for commercial or business purposes?

None of the respondents used their properties for commercial or business purposes.

Q3. When you think about the environment in Rankin Inlet, what are the top 3 things that come to mind?

When asked about the environment, respondents indicated that they think primarily about water quality/pollution, water conservation and energy efficiency.

Water Quality/Pollution	68%
Water Conservation or Efficiency	67%
Energy Efficiency	60%
Waste Management/Recycling	30%
Air Pollution/Smog	23%
Water Shortages	20%

Poor Drainage	12%
Pesticide Use	8%
Flooding	3%

Q5. Using a scale of 1-10, where '1' means "Not Important" and '10' means "Very Important, how important is it for your household to save water?

Two-thirds of the respondents felt that saving water at home was very important.

Not Important (1-3)	7%
Important (4-7)	26%
Very Important (8-10)	67%

Q6. Compared to 5 years ago, has saving water in your household become

Over two-thirds of the respondents indicated that saving water in their household has become more important over the past 5 years.

Much more important	34%
Somewhat more important	36%
Somewhat less important	>1%
Much less important	0%
Has not changed	26%

Q7. Do you...?

Respondent's home ownership/rental arrangement was marginally different from results of 2006 Census

60% of the respondents rent their homes (compared to 69% in 2006 Census)

40% of the respondents own their homes (compared to 31% in 2006 Census)

Q8. How long have you lived at your current address?

Average length of time living in the current premise was 10 years.

Q9. Approximately how old is your home?

Average age of home was 22 years.

Q10. Is your home a...?

Respondents reported that,

Separate House	52%
Apartment	24%
Town House	23%
Duplex	1%

Q11. Using a scale of 1-10, where '1' means "Not At All", and '10' means "A Great Deal". How much has your household changed the way you save water in the past 5 years?

Once again, well over two-thirds of the respondents reported that they have changed the way they save water over the past 5 years. The most common reason for their actions was to save or conserve water, followed by to reduce their water utility bill.

Not at all (1-3)	33%
Somewhat (4-7)	39%
A great deal (8-10)	28%

Q12. Why hasn't your household changed the way you save water?

The most common reason among respondents was that they were not billed for water.

Q13. How does your household currently save water?

Low flow showerheads and full loads of dishwasher/clotheswasher machines were indicated as the most common approaches to saving water. Of interest, a quarter of the respondents indicated that they did not know how to save water. This indicates that a significant educational opportunity exists.

Use Low-flow shower heads	48%
Make sure full load in dishwasher/washing machine	48%
Use Water efficient appliances (washer, dishwasher)	38%
Use Low-flush toilets	30%
Don't know how we save water	26%

Q14. How many bathrooms do you have in your home?

Respondents indicated that on average they have 1.1 bathrooms per house.

Q15. How many bath tubs do you have in your home?

Respondents indicated that on average they have 1.0 bath tubs per house.

Q16. Some appliances and fixtures use more water and/or energy to operate. Do you consider these higher operating costs when making your buying decision?

Yes – 65%

No – 35%

SHOWERHEADS

Q17. How many showers are there in the home?

Respondents indicated that on average they have 1.1 showers per house.

Q18. How many are handheld type showerheads?

Respondents indicated that 42% of their showerheads are handheld type while the remaining 58% are fixed type.

Q19. How many showers per day does each person in the house take?

Based on the respondents, the average person in Rankin Inlet has 3.1 showers per week.

Q20. Are you happy with the performance of your shower?

An overwhelming 85% of the respondents indicated that they were happy with the performance of their showerheads. Good flow and pressure were given as the top reasons.

TOILETS

Q21. What do you think a low-flush toilet is?

45% of respondents did not know what a low flush toilet is. Once again, this indicates that an educational opportunity exists.

Don't know	45%
Uses less water than 'older/other' toilets	55%

Q22. What do you think a dual flush toilet is?

Although dual flush toilets are available from local retailers, 59% of respondents did not know what a dual flush toilet is.

Don't know	59%
Use less water than 'older/other' toilets	20%
Two handles for different amounts of water/flush	21%

Q23. How many toilets are there in your home?

Respondents indicated that on average they have 1.1 toilets per house.

Q24. How many 6.0 litre flush toilets are there in your home?

65% of the respondents indicated that they have 6.0 litre flush toilets in their homes. This does not mean that they actually do have 6.0 litre toilets, only that they think they do. As Q.21 pointed out, a high percentage of the residents do not know what low-flush or 6.0 litre flush are. Many people may think they have low flush toilets for a number reasons including poor flushing performance and the need to “double-flush”.

Q25. How many dual flush toilets are there in your home?

5% or 3 respondents indicated that they had dual-flush toilets in their homes. This response is considered to have a higher confidence level than Q.24 since dual flush toilets are physically different from regular flush toilets and can be readily identified.

Q26. How old are the toilets in your house?

On average, respondents indicated that their toilets were 11 years old.

Q27. How likely are you to replace a toilet in your home in the next 3 years?

Likely (4-5)	34%
Possibly (3)	22%
Not Likely (1-2)	44%

LEAKS/REPAIRS

Q28. If you have a leak or developed a leak in your faucets or toilet, how would it get repaired?

Two-thirds of the respondents indicated that they would hire a contractor or didn't know who they would get fix a leak. This corresponds very closely to the 60% of respondents who rent their homes. By indicating a contractor, they are most likely referring to the Housing Association.

Family member	11%
Family friend	5%
Contractor you hired	56%
Myself/Spouse	18%
Don't Know	10%

Q29. Do you currently have leaks in any plumbing fixtures in your home, such as a kitchen or bathroom faucet, toilet, shower head, etc.?

23% of respondents indicated that they currently has a leaking fixture. Most common fixture leaking was the kitchen faucet, then the bathroom faucet and then the toilet. Only 27% of those with leaks indicated that they would them fixed right away.

OTHER INDOOR USES

Q30. How many loads of laundry do you wash by hand per week?

Only 19% of the respondents indicating that they wash some of the laundry by hand. Those who wash some of the laundry by hand, on average wash 2.8 loads per week.

Q31. Do you have a washing machine?

An overwhelming 97% of respondents reported that they have a clothes washing machine.

Q32. Is your washing machine a...?

75% of the respondents indicated that they had a top loading clothes washer while 25% reported having the more water efficient front loading style.

Q33. Does you washing machine have an Energy Star label on it?

38% of the respondents indicated that their clothes washer had an Energy Star label on it. This seems extremely high since Energy Star labeling has only been out for a few years. There is a strong possibility the residents are confusing the EnerGuide label as the Energy Star. Perhaps some more research is necessary here, but also it indicates a possible educational opportunity.

Q34. How old is your washing machine?

On average, respondents indicated that their clothes washers were 4.8 years old.

Q35. How likely are you to replace your washing machine in the next 3 years?

Likely (4-5)	28%
Possibly (3)	20%
Not Likely (1-2)	52%

Q36. How likely are you to install a front loading washing machine at that time?

Likely (4-5)	28%
Possibly (3)	43%
Not Likely (1-2)	29%

Q37. How many loads of laundry do you do per week using your washing machine?

On average, respondents indicated that they wash 5.3 loads of laundry per week in the clothes washer.

Q38. How many loads of dishes do you wash by hand per week?

89% of the respondents indicated that they wash some or all of the dishes by hand. Those who wash some or all of the dishes by hand, on average wash 7.7 loads per week.

Q39. Do you have an automatic dishwasher?

Only 25% of respondents reported that they have an automatic dishwasher.

Q40. How many loads of dishes do you wash per week in the washer?

Of those respondents reporting to have an automatic dishwasher, they reported on average have doing 4.6 loads per weeks.

Q41. How old is your dishwasher?

Respondents indicated that the average age of their dishwasher was 4.7 years.

Q42. Do you have any other appliances that use water?

No other water consuming appliance or fixture was reported.

OUTDOOR WATER USE

Q43. Do you use any water outside?

85% of the respondents reported not using any water outside. For the 15% that reported using outside water, the main use was to wash the vehicles.

DEMOGRAPHICS

Respondent to this survey is: Male – 27% Female – 73%

a. Can you indicate which of the following age groups you fall into?

18-39 years	37%
40-49 years	29%
50-64 years	26%
65+ years	8%

b. **In total, how many people live in your household, including yourself and any children?**

On average, respondents reported 4.5 persons per household.

c. **Do you have access to the internet in your house?**

67% of respondents reported that they have internet in their homes.

d. **Would you be willing to participate the home visit component of this study?**

37% of the respondents indicated that they would participate in the home visit component of this study.

3.2 Household Audits

Background

To assist with the current market conditions evaluation, the team conducted ten (10) on-site household audits to determine type, repair and condition of water using appliances. During the audits toilet flush volumes were determined and showerhead and faucet flow rates were measured using a calibrated receptacle. Leakage, where visible, was identified and quantified. Makes and models of dishwashers and clothes washers were recorded.

The homeowner was also asked what type of toilets and fixtures they had in their home. (Eg., low flush toilets or regular; low flow showerheads or regular). These questions were asked in order to better understand the homeowner's perception to water efficient appliances and fixtures. For instance in past projects, we have found many homes where customers said that they do not have low-flow showerheads and would never have low-flow showerheads, however, during the actual audit; low-flow showerheads were found. In these cases, it was the homeowner's perception that a low-flow showerhead would provide a very weak, ineffective spray and since theirs did not, it could not be low-flow.

Additional questions were asked pertaining to usage patterns and outdoor water use.

Observations

Demographics

House Style: 60% detached single family
30% townhouse
10% apartments

Showering

- Average flow rate: 12.0 liters per minutes
- 0 (0%) of the showerheads were leaking

Kitchen Faucets

- Average flow rate: 8.1 liters per minutes
- 0 (0%) of the kitchen faucets were leaking

Toilets

- Average flush volume: 12.3 litres per flush
- 2 (20%) of the toilets were leaking

Bathroom Faucets

- Average flow rate: 7.0 liters per minutes
- 0 (0%) of the kitchen faucets were leaking

Dishwashers

- 20% of the homes had automatic dishwashers

Clothes Washer

- 100% of the homes had automatic clothes washers
- 20% of the homes had front loading machines
- 80% of the homes had top loading machines
- 20% of the machines were rated Energy Star

Summary

Showering

The average flow rate of showerhead was 12.1 litres per minute. This is significantly higher (60%) than the currently market available 7.6 litres per minute showerhead. In addition, residents use hot water for showers so any reduction in flowrate will also decrease the energy used to heat the water.

Faucets

Kitchen faucets were generally low flow with an average flow rate of 8.1 litre per minute. All kitchen faucets were threaded, so lower flow aerators could easily be installed. Even though the faucets have relatively low flow rates, 5.7 litre per minute aerators could be installed providing approximately 30% savings.

Bathroom faucets were found to have an average flow rate of 7.0 litres per minute. Once again this is relatively low, however 3.8 litre per minute aerators could easily be installed providing approximately 45% savings.

In addition, residents use hot water in kitchens and bathrooms so any reduction in flowrate of these faucets will also decrease the energy used to heat the water.

Toilets

The average flush volume of the toilets audited was 12.3 litres per flush. During visits to new construction sites and retailers it was observed that 6.0 litre flush toilets are the standard. One retailer also offered dual flush toilets which flush at a low flush with 3.0 litres and flush with 6.0 litres at a high flush for solids. Through performance testing, many toilet models have proven that they flush at 4.8 litres without compromising flushing performance. These toilets are called “High Efficiency Toilets” or HET’s. By replacing the existing toilets in Rankin Inlet with HET toilets, water savings of approximately 60% could be achieved.

Also observed during the audits was that 20% of the toilets were leaking. This level of leakage was expected is a common situation with toilets with flapper valves. After time, due to minerals in the water, chlorine or household cleaners, flappers deform and deteriorate allowing for, quite often, silent leaks. Education and an ongoing maintenance program can help reduce this leakage. Another solution would be the installation of flapper-less toilets. An HET toilet which happens to be flapper-less from one manufacturer has proven to be quite popular in municipal toilet rebate programs throughout North America.

Clothes Washing

All homes surveyed had a clothes washing machine. 20% had water efficient front-loading machines, which have only been readily available in the Ontario market for the past 10 to 15 years. The replacement of top loading washing machines with front loading Energy Star can provide up to 65% in water savings.

Dish Washing

20% of the homes survey had automatic dishwashers. Automatic dishwashers have proven to be an inefficient approach to washing dishes. Most dishwashers available on the market are considered water efficient with some models using as little as 14 litres per load of dishes. Although there are no municipalities offering rebates for the replacement of dishwashers, some municipalities in southern United States of rebates for residents to purchase a dishwasher if they don't already have one. These municipalities have proven through studies that a resident uses more water hand washing dishes as compared to an automatic dishwasher.

Leaks

Only some of the toilets were found to be leaking which is addressed above. All other fixtures and appliances were found to be leak free.

Recommendations to consider during program design

- Low-flow showerhead program
- Low flush toilet program
- Faucet aerator program targeting kitchen and bathroom faucets
- Front loading Energy Star clothes washing machine program

More general education is recommended on all water consuming appliance and fixtures in the home.

Educational material could cover all the programs listed above in addition to other water usages not covered by a program.

4.0 Residential Water Use Demand Analysis

An analysis was completed to segregate water use into several categories, so that water use by single family properties, multi family units and the ICI sector could be identified. Customer billing data for the period from August 2006 to August 2009 was compared to:

- Rankin Inlet Business Directory provided by the Canada-Nunavut Business Service Centre
- Rankin Inlet House Numbering system Map, dated April 23rd 2002
- Satellite imaging of Rankin Inlet

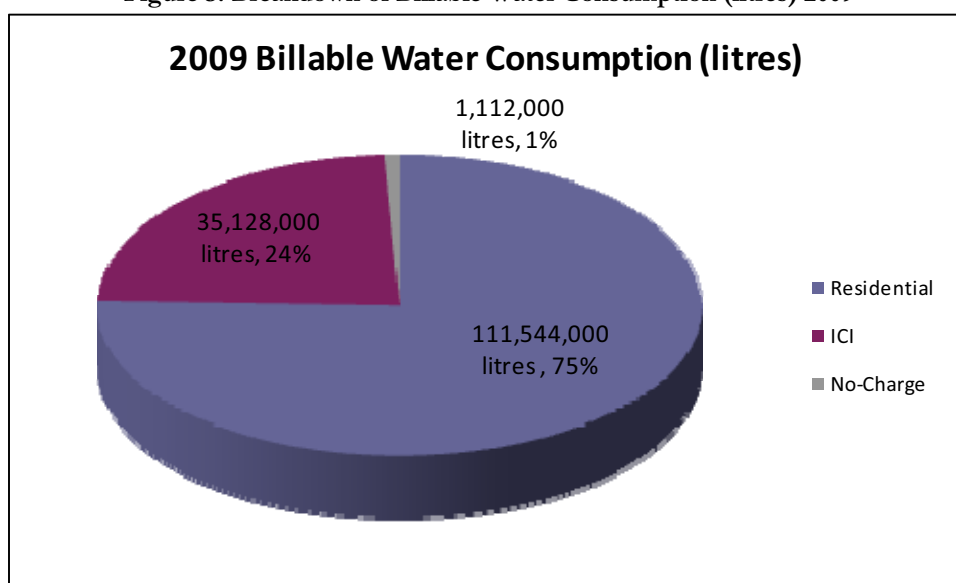
The comparison was completed in order to identify the number of properties in each category, and to allocate a volume of use. Properties that were identified as residential housing but listed in the ICI sector was re-categorized as residential for the analysis.

Based on the data provided, a breakdown of the 2009 (Sept. 2008 to Aug. 2009) customer billed consumption is shown in the following Table 8.

Table 8: Rankin Inlet 2009 Customer Billed Consumption

Category	2009 Billed (litres)	Population 2009 est.	Water Use – Litres per Capita per Day (Lcd)
Residential	111,544,000	2,499	122
ICI	35,128,000		
Not billed	1,112,000		
Total 2009 Billed Consumption	147,784,000		

Figure 3: Breakdown of Billable Water Consumption (litres) 2009



A detailed analysis of the residential sectors follows.

Residential Water Use Demand Analysis

Per Capita Water Use

The residential market sector includes housing which are detached, semi-detached, duplex, row or town and multi-story apartment housing. Each detached premise in this market sector is served with its own water meter. All multi-story apartment building and some multi-unit row housing were serviced by bulk meters, one large meter for all of the units in a facility. For 2009, based on the billing data provided, the Hamlet of Rankin Inlet residential water use was 122 litres per capita per day (Lcd).

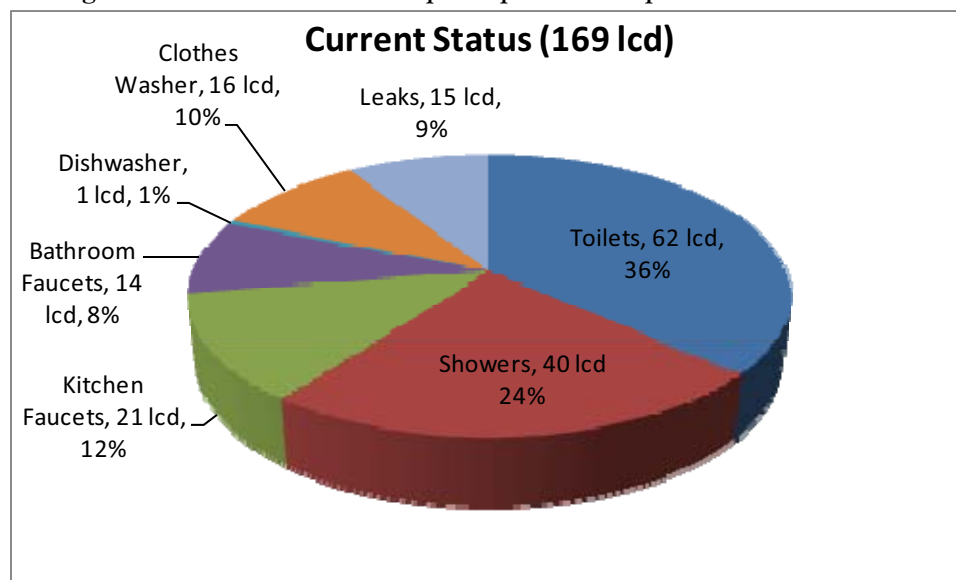
Table 9: 2009 Residential Per Capita Consumption based on Billing Data

Residential Sector	2009 Billable Consumption (litres)	Population 2009 est.	Per Capita Consumption (Lcd)
	111,544,000	2,499	122

The 2008 residential billed consumption at 115,165,000 litres was very similar, actually within 5%, of the 2009 consumption. It should be noted that due to the age and the technology (remote read) of the residential meters that the billed consumption is significantly lower than the actual consumption. This is discussed in more detailed in the Water Loss Mitigation report in the Appendix. Without testing a sample of meters for inaccuracies it is difficult to estimate the losses. As such, a residential water balance was developed as a comparison.

The residential water balance was developed using data from the AWWA AWARF Residential End Uses of Water Study completed in 1999 and local data collected from the market research completed in Rankin Inlet from October 26th to November 5th 2009. The results of the analysis are shown in Figure 4 below:

Figure 4: Calculated Residential per Capita Consumption and Water Balance



The above balance is based on current observations of the condition and efficiency of the existing water consuming fixtures and appliances, and the habits and attitudes of the residents as determined through the

market research. The balance indicates that the residential consumption could quite possibly be in the order of 169 lcd in Rankin Inlet under the existing conditions. This consumption is 38% higher than that calculated from the billing data as shown in Table 10.

Table 10: 2009 Comparison of Residential Consumption based on Billing Data and based on Water Balance

Residential Sector	Population 2009 est.	Per Capita Consumption (Lcd)	Residential Consumption 2009 (litres)	Percent Difference
As per Billing Data	2,499	122	111,544,000	
As per Water Balance	2,499	169	154,151,000	+38%

In order to compare this consumption level with other municipalities in Canada, and around the world, the following Figure 5 has been prepared:

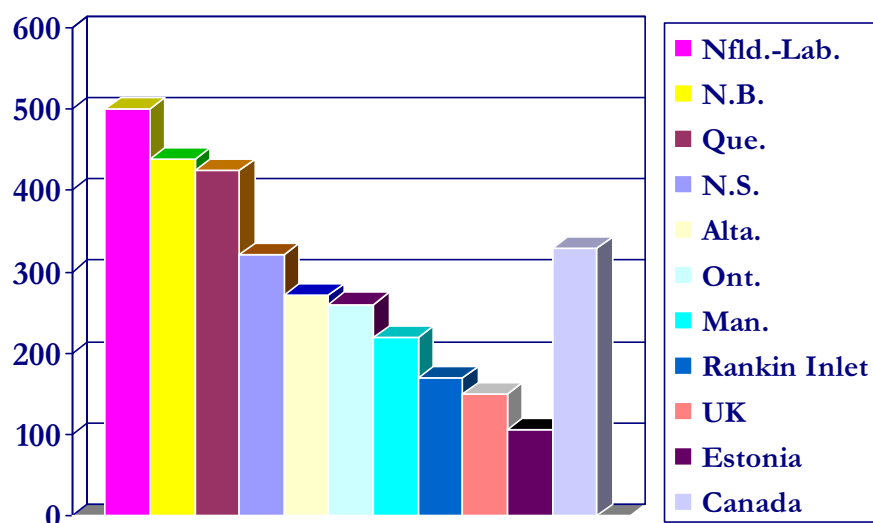


Figure 5: Comparison of Residential Per Capita Demand (l/cd)³

The Hamlet of Rankin Inlet has one of the lowest residential water demands in Canada even if the 169 Lcd is used for comparison. This is approximately 49% below the national average of 324 Lcd.

Property Types

Based on Statistics Canada 2006 Census data, the following is a breakdown of property types in Rankin Inlet:

Table 11: Breakdown of Housing by Housing Type – Rankin Inlet

Detached	Semi-Detached	Townhouse, Row House	Duplex	Apartments < 5 storeys	Total
409	47	214	12	94	776

³ Municipal Water Use Survey, Environment Canada, 2004.

New Construction and the Influence of Building Codes and Guideline on Toilet Flush Volumes

An analysis was completed to identify the number of homes and the corresponding period that the dwellings were constructed. The following Table 12 shows the breakdown of housing construction and the typical flush volume of the toilets:

Table 12: Breakdown of Housing Construction and Typical Toilet Flush Volumes

Period	Toilet Flush Volume	Number of Dwellings Built
Prior to 1981	≥ 20 litre	240
1981 to 1985	≥ 20 litre	145
1986 to 1993	≥ 20 litre	152
1994 to 1995	13.25 litre	38
1996 to 2006	6.0 litre	201

Prior to 1994, toilet flush volumes were generally 20 litres or greater. The National Building Code or the National Plumbing Code does not address water conservation and as such do not provide required toilet flush volumes. In December 1995, the Government of Nunavut released its 2nd Edition of the Good Building Practices Guidelines. The Guidelines was provided as a supplement to the National Building Code to assist builders and developers with the construction in a northern climate.

Recognizing the limited water supply and municipal distribution systems in Nunavut, the Guidelines introduced water conservation requirements as follows:

Section 4.8 Fixtures & Brass

Fixtures are generally required to be low consumption type to conserve water used and waste water produced.

Section 4.8.3 Sinks

All faucets should have flow restrictors to ensure low water use.

Section 4.8.4 Hand Basins

All faucets and showerheads are to have flow restrictors to ensure low water use.

Section 4.8.5 Toilets and Urinals

All toilet fixtures should low consumption type (4 to 9 litres per flush). All urinals are to be low water use type.

5.0 Industrial, Commercial and Institutional (ICI) Water Use Demand Analysis

The industrial, commercial, and institutional (ICI) sector represents approximately 25% of Rankin Inlet's billed water consumption. In 2009, the volume of billed water to the ICI sector was 35,128,000 litres. As indicated in Figure 6 below, this is approximately 23% above the 26,962,000 litres billed in 2008.

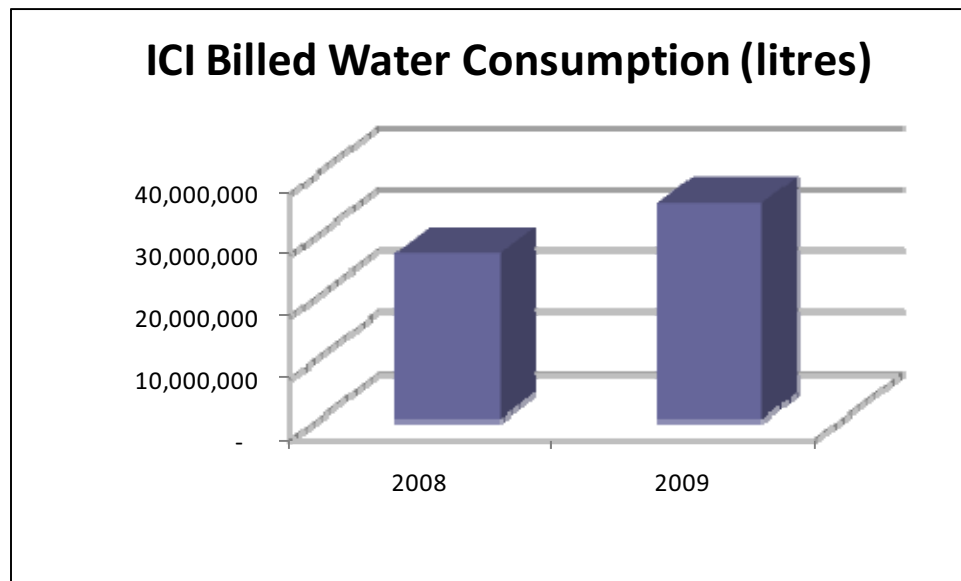


Figure 6: ICI Billed Water Consumption (litres) 2008, 2009

Further investigation of the billing data for 2009 produced the following discrepancies:

- Polar Bear Investments c/o Nanqu Inn – 7,842,000 litres additional in 2009
- Community & Government Services, Kivalliq – approximately 3,000,000 litres additional in 2009
- Rankin Inlet Airport – approximately 1,500,000 litres additional in 2009

The additional water volume represented by these 3 accounts more than offset the increase in water volume in 2009. In addition, similar to the residential water meters as large mechanical meters get older they tend to under-register due to wear. Due to the discrepancies in the billing data the confidence in the accuracy of the ICI billed water consumption is extremely low.

For the purpose of this analysis, it was assumed that the 2008 ICI billed volume of 26,962,000 litres was more representative and as such used as the corrected 2009 ICI volume.

Further analysis of 2009 billing ICI billing data indicates that 35% of the customers consume 80% of the overall water for that sector. The largest 22 customers collectively used 80% of the total ICI consumption as shown in Figure 7.

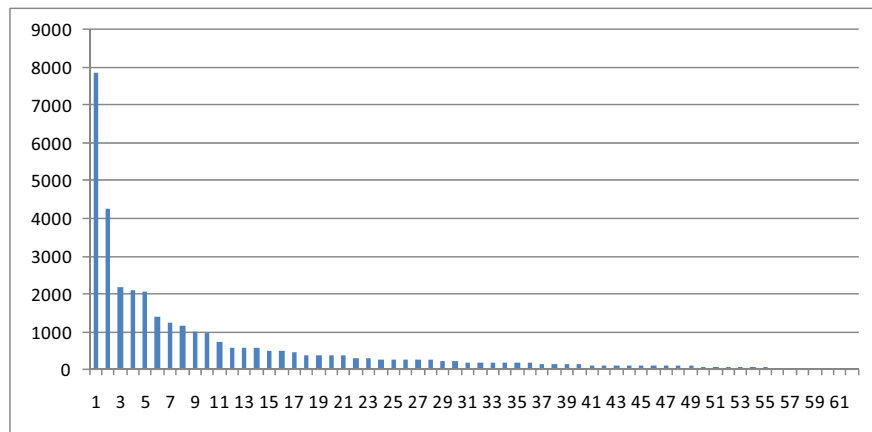
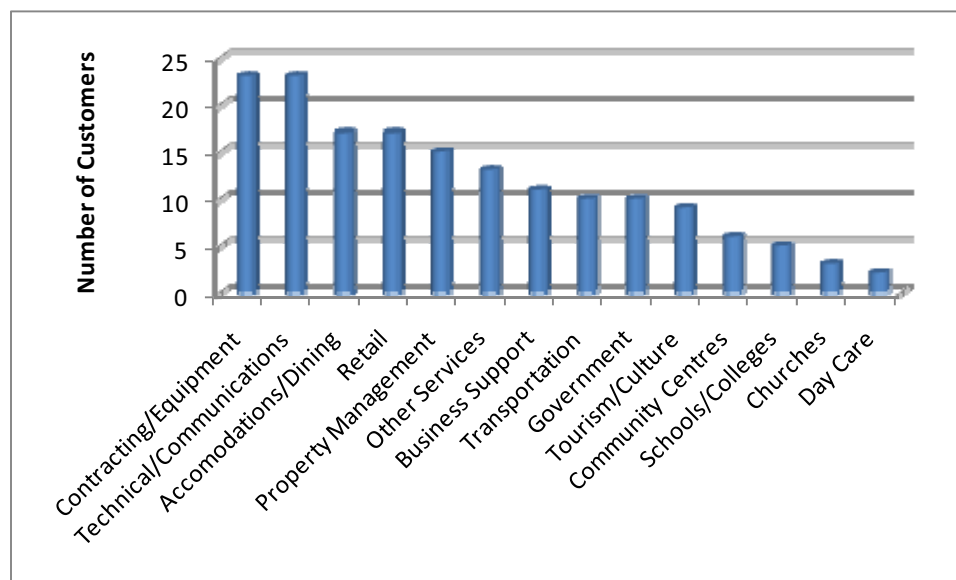


Figure 7: 2009 Annual Billed Water Consumption by Customer

Based on the Canada-Nunavut Business Service Centre directory, Rankin Inlet's ICI customers are collectively segmented in Figure 8.

Figure 8 –ICI Water Customer Sectors by Number of Customer Accounts



6.0 Evaluation of Distribution System Water Loss

6.1 Introduction

The Hamlet of Rankin Inlet water distribution system is complex with a pipework system to deliver tempered water to the customers, which is then returned back to Williamson Lake Water Treatment Plant. In addition, each customer has a looped service pipe with booster pump, to return the tempered water to the water distribution main.

A methodology of water loss reduction was developed after spending time with operations and other staff of both the Hamlet and the Government of Nunavut. Once the methodology had been established, the requirements for the most suitable equipment were made. In this way, the best solution of methodology and equipment was provided.

The methodology included a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, “Water Audits and Loss Control Programs”, which was published in May, 2009. In the M36 manual, this flow based method of identifying areas with leakage is called “District Meter Areas – DMAs”. The M36 manual has been completely re-written to include the very latest methodology and equipment, and is considered to be a North American Best Management Practice (BMP).

6.2 Water Supply and Distribution System Operation, and Customer Meters

Lake Nipissar Pump House

Currently water is taken from Lake Nipissar, which is located about two kilometres northwest of the community. Water is abstracted by two submersible pumps located at the end of the two intake pipes. At the Lake Nipissar Pump House, heated water is mixed with the abstracted water, and the resulting tempered water is transmitted to Williamson Lake Storage Tank. Water is heated at the Williamson Lake Pump House, and pumped to the Lake Nipissar Pump House for mixing with the abstracted water.

Williamson Lake Pump House

The watermain from Lake Nipissar enters the Williamson Lake Pump House, and then leaves the building and goes to the outside storage tank. A pipe from the outside storage tank enters the pump house and passes through a control valve which supplies the two wet wells.

The wet wells are approximately 3 metres in diameter, and 8 metres deep. There are two pumps in each wet well, which supply water to the water distribution loops, which are as follows:

- Town Loop 1 (Area 1)
- Town Loop 2 (Area 2)
- Nuvuk Loop (Area 6)
- Area 5
- Town Supply

In the Williamson Lake Pump House, the wet well pumps send water to a common delivery main which has an electromagnetic meter that records the total flow. The pressures in this common delivery main are controlled by a Pressure Reduction Valve (PRV). At the time of the site inspections in early November, 2009, the inlet pressure to the PRV was 85 psi (wet well pump discharge pressure), and the outlet pressure to the PRV was 60 psi (pressure to the distribution system loops). The loops are supplied as follows:

- Area 5 is supplied by a main passing across the top of the building from the common delivery main.
- A pipe is also connected to the common delivery main to supply Kivalliq.
- The common delivery main then leaves the pump house, and in a chamber outside, the supply to Area 6 is connected.
- Water then flows along the Town Supply Main, and after it passes the Hamlet offices, the Area 1 and Area 2 supply mains are connected in a chamber.

The water is then returned to Williamson Lake Pump House from the loops as follows:

- Area 5 enters at the back side of the building
- Areas 1, 2 and 6 are combined in a chamber, then returned to Williamson Lake Pump House in a single main

The return flow is regulated by a thermostatically controlled valve. If the return water temperature falls below a set value, the valve opens to increase the flow of heated water pumped into the mains. The valve closes to reduce the flow if the temperature is higher than a set point.

In the Williamson Lake Pump House there is a diesel fuelled boiler which heats water that is then used to provide:

- Hot water is injected into the wet well pumps common delivery main, just upstream of the Pressure Reduction valve (PRV)
- Hot water is transmitted to Nipissar Lake Pump House

There is also a heat recovery system from the Power Plant that is used to augment the local diesel fuelled boiler.

If high flows occur on the loops (caused by fire fighting, use of hydrants, or other causes), then there are automatic valves on three of the return lines that will open when the water pressure falls to set limits – these valves are normally closed. This effectively increases the available water in the looped systems. The three loops with valves, and the pressure that causes them to operate are as follows:

- Nuvuk Loop – valve starts to open when pressures fall to 26 psi
- New Town Loop (Loops 1 and 2??) - valve starts to open when pressures fall to 26 psi
- Old Town Loop (Town supply?) - valve starts to open when pressures fall to 10 psi

Water Distribution System

Tempered water is pumped to the five loops as described above. The water distribution system consists of older buried Utilidors, and newer shallow buried mains. The older Utilidors consist of 150 mm PVC watermains housed with 150 mm PVC sewer mains, in 600 mm galvanised corrugated metal pipe. The Utilidor is covered with 50mm of rigid polyurethane foam insulation. The new mains are shallow buried and consist of High Density Polyethylene (HDPE) pipe with 50 or 75 mm of polyurethane insulation covered with “Yellow Jacket” and in some cases “Black Jacket”. Most watermains are 200 mm in diameter and are series 160 HDPE.

In order to prevent freezing in the supply pipes to customer properties, each water service has a flow and return pipe, normally located side by side in the ground. Inside the property a pump operates continuously to recirculate the tempered water back into the water main, which then recirculates the water back to Williamson Lake Pump House.

To provide access to the water distribution system, there are chambers located approximately every 100 metres. These chambers contain the connections of various watermains, and also have drain valves and air valves.

Customer Meters

Rankin Inlet has customer water meters which are manufactured by Neptune. The meters are an older style, and when they were installed had a wire fixed from the meter register to the outside of the property. On the end of this wire was fitted a remote register, which has numbers which can be read by the meter reader. This type of remote, or ‘generator remote’ works by the meter sending a signal to change the remote register, as the internal meter register changes. They are prone to missing registrations, so that the remote register, which is typically used for billing, records a lower consumption than has actually passed through the water meter.

Some of these old remote registers have been replaced by a more modern “touch pad”, which is simply a device to send a signal to the internal meter register and obtain the reading. So, the actual internal meter reading is gathered.

Furthermore, in the south part of Area 1, new meters with radio read technology have been installed. These meters have a radio transmitter installed either on the meter, or very close to the meter, inside the property. The meters are read with a hand held device, that can receive the meter reading at a distance from the property – it can be driven along each street to obtain the readings if required.

The recorded metered consumption is likely to be less than the actual water produced, for the following reasons:

- Generator remotes recording a lower consumption than the water meter register
- Remote register wires broken
- Customers disconnecting remote wire
- Customers removing water meter and piping through
- Water meter under-registering – most meters under-register as they age

6.3 Water Loss Identification and Reduction Program

The methodology to identify and reduce water loss that is recommended, is a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, “Water Audits and Loss Control Programs”, which was published in May, 2009. In the M36 manual, this flow based method of identifying areas with leakage is called “District Meter Areas – DMAs”.

The Rankin Inlet water supply and distribution system is complex with its method of operation including return loops on the distribution mains, and return loops on the customer service lines. There is also the added operational need to maintain water temperatures above a level that will prevent freezing in both the distribution mains and customer services.

District Meter Areas Methodology

It is recommended that the water distribution loops be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage” or the flow at night that is expected, which is based on the following:

- Length of mains
- Average water pressure
- Number of customer services
- Number of hydrants
- Average number of people per house

With this information, the Legitimate Night Flow can be calculated in a. This legitimate night flow is the sum of flows, or losses from:

- Mains
- Public side of the customer service (main to curb stop)
- Private side of the customer service (curb stop to house)
- Residential night use (usually the largest number)
- Exceptional night use (institutional, commercial, industrial - ICI)

In DMA loops where the measured flow at night is significantly higher than the Legitimate Night Flow, these areas would then be targeted for acoustic leak detection.

It is likely that initially all the loops in Rankin Inlet will have measured flows significantly higher than the Legitimate Night Flow, because of the existence of bleeders, and leaks that may have been running for some

time. When DMAs are introduced for the first time in water distribution systems it is common for the flows to be high. The initial tasks are often to identify and eliminate this “backlog” of losses, to reduce water loss to economic levels.

District Meter Area Loops

It is recommended that six DMAs be established, as follows:

Area 5 DMA Loop

Install a flowmeter on the Area 5 supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building at the side.

Install a flowmeter on the Area 5 return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe

Nuvuk DMA Loop (Area 6)

In the chamber just outside the entrance door to Williamson Lake Pump House, install a flowmeter on the Area 6 supply pipe

Install a flowmeter on the Area 6 return pipe, which is located in a chamber in the system where the return pipes for Areas 1 and 2 combine – there is then a common return pipe to Williamson Lake Pumphouse for Areas 6, 1, 2.

Town DMA Loop 1 (Area 1)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 1 main

Install a flowmeter on the Area 1 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pumphouse.

Town DMA Loop 2 (Area 2)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 2 main

Install a flowmeter on the Area 2 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pumphouse.

Kivalliq DMA Loop

Install a flowmeter on the Kivalliq supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building.

Install a flowmeter on the Kivalliq return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe

DMA Town Supply

Because the Town Supply also is the feed pipe for Areas 1 and 2, the DMA flow will be calculated from the flows at other meters, as follows:

Town Supply = Existing common delivery main mag meter, minus metered flows for all other loops.

There is no return for the Town Supply, as it feeds Areas 1 and 2, which have return mains

Mains Between Nipissar Lake Pump House and Williamson Lake Pump House

As a future phase of the flow monitoring program, flow meters could be installed at both ends of the two watermain between Nipissar Lake Pump house and Williamson Lake Pump House

Acoustic Leak Detection

Once the loops with high water losses have been found, the next stage is to identify where the losses are and remove them. In Rankin Inlet the two main areas of losses are bleeders, and leaks on the watermain or services. There are generally two ways to do this, which are:

- For short periods of 5 minutes at night, close small sections of watermain on a loop, and record the drop in flow. For Rankin Inlet distribution system that would involve subtracting the return flow from the supply flow of the loop. ***This method is not recommended*** because when the section of the loop is closed, there would be no water supplied to customers, and hence the recirculation pumps on each customer service pipe would be running dry.
- ***Recommended*** - Use acoustic methods to listen for water loss noises in the loop. This would be a two phased approach of firstly establishing a small area which is “noisy”, with at least two fittings, but preferably more, with noise – this gives the “General Area of Losses”. Then secondly, from these noisy fittings “Pinpoint the Leak / Losses” – put the cross on the ground for a leak, or identify a customer service or watermain that is bleeding water to waste.

Because the watermain are a mixture of HDPE and PVC, which do not transmit leak noise as well as metallic pipes (cast iron, ductile iron), as many contact points as possible must be used to listen for leak noises. In addition, it is understood that the curb stop valves have a thermal insulating break, which also acts as an acoustic break, so that will make it more difficult to hear leaks from the curb stops.

General Area of Losses

There are a number of methods that are available to find the general area of losses, which are as follows:

- Use acoustic listening devices to manually listen for leaks on contact points on the watermain and services. The contact points are primarily the chambers on the water distribution system that are located approximately every 100m. Typically the devices are a listening stick with an audible sound, and some have noise indicators
- Install leak noise loggers on contact points, which will generally be on the watermain in the manholes. Typically, depending on manufacturer, the noise loggers will be left in place for one to 3 days. The leak noise logger will listen for leaks, and screen out and intermittent water use. The loggers can either be removed and downloaded, or some manufacturers have a radio module on the logger, so that it can be downloaded remotely, and the logger left in place.

- Correlating leak noise loggers can also be used, which go a stage further than a noise logger, and pinpoint the leak from the noises found

Because the watermains are in Utilidors or are insulated, the leak noise may be harder to find, as the characteristics of the leak noise may be muffled. In addition, if any running water is found, it in many cases may be some distance from the location of the actual leak, as the leaking water is travelling along inside the insulation or Utilidor before it is found.

Leak/Losses Pinpointing

Once at least two (but preferably 3 or more) fittings have been identified with a leak noise, the next stage is to pinpoint that leak, and put the cross on the ground for excavation and repair. Leak detection correlators are used to pinpoint the leak, and they operate as follows:

- Accelerometer sensors are attached to two fittings where a leak noise is present – this can be a valve, hydrant, curb stop, tapping etc
- Because the pipe materials are plastic, the leak noise will travel a shorter distance than in metallic pipe. In addition, the normal characteristics of the leak noise at the leak site may be muffled because of the pipe insulation. It is therefore recommended that “Hydrophones” be used. Hydrophones listen for the leak in the body of the water, and can be more successful in plastic pipes correlating leaks. They have to be attached to the pipe at hydrants, or other fittings, so that they are in contact with the water
- The sensors (accelerometers, or hydrophones) are attached to two outstations which transmit the leak noise information to a central processing unit
- The processing unit then analyses the signals, and gives the location of the leak

The process is not as simple as it has been described, as the operator has to enter data about the pipe (diameter, material, distance between leak noise locations), and also can apply a number of filters to obtain a better correlation. Furthermore, it is good practice to complete additional correlations using other contact points that have a leak noise, and in this way several locations of the leak can be established. This process improves the accuracy of the correlation, as the objective is to get the several correlations to give the leak locations close to each other.

The final step is to listen to the located leak from the surface, with a ground microphone, to confirm the location of the leak. Again this may prove more difficult in Rankin Inlet because of the nature of the distribution system which is wrapped / in Utilidors, plus the watermain is deep in some locations.

Bleeders on Customer Services and Distribution System

If the water loss is a bleeder at a water service the pinpointing will indicate a loss at the corporation stop / curb stop of the service. Once this is identified, staff can investigate the bleeder further.

Although customers have to obtain a bleeder permit, all of them may not have done so. Once the bleeder is identified, steps can be taken to assist the customer to correct the problem on the services, and ensure that the recirculation system is put back into operation.

For bleeders on the water distribution system, they will be initially identified as leaks, if they are not already known. Depending on the location and function, the following measures should be considered:

- For all locations, complete a calculation of the approximate volume of water in the mains that are being kept fresh. Then calculate the flow rate required to exchange that volume of water in say 24 hours, or other agreed time period
- Shut off the bleeder, or
- Reduce the flow rate, or
- Install an automatic flushing device, or
- Where possible, for branches left open, install a flowmeter

6.4 Equipment Requirements

Leak Detection Equipment

Acoustic Listening Devices

It is recommended that an electronic listening device be used which includes a listening stick and a ground microphone. The kit also includes a processing unit with display, and headphones.

Leak Noise Loggers

In addition to the acoustic listening equipment, leak noise loggers can be used. They normally come in sets, and depending on manufacturer, can be typically be in sets of 6, 12, 15. The loggers are attached to contact points on the watermains, such as valves and hydrants, and are normally left in position for between one and three days, depending on manufacturer. The options for downloading the loggers include manual retrieval; drive by radio reading; and a fixed network radio system where the data is transmitted to an office computer.

If noise loggers are to be employed, it is recommended that a set of about 12 be used initially to see how applicable they are to the Rankin Inlet water distribution system

Leak Detection Correlators

One leak noise correlator is required to pinpoint the leaks. There are effectively three main types, and their selection depends on customer preference and field conditions. The three main types of processor are:

- Stand alone units for use outside in most elements. Generally robust equipment for use outside
- Hand held PDA small units
- Units where the software is loaded onto laptop computer

It is further recommended that a set of Hydrophones be purchased to correlate for leaks via the body of water in the pipe.

Flow Monitoring Equipment

Most of the existing flowmeters at Lake Nipissar Pump House and Williamson Lake Pump House are Signet paddle wheel flowmeters. In addition, there are two Unimag magnetic flowmeters as follows:

- At Nipissar Lake Pump House, which measures the total flow pumped from the lake
- At Williamson Lake Pump House, which measures the total flow pumped into the distribution system loops – this includes the water consumed, losses, and water recirculated back to the pump house

For each of the distribution loops, in order to measure the volume of water supplied to customers and losses (leakage and bleeders), it will be necessary to measure the flow at the start of each individual loop, and measure the flow on the return of each loop.

As described in section 3.2, some of the flowmeter locations are in the Williamson Lake Pump House, and some are in chambers in the water distribution system. A site survey will be required to establish the best meter required for the site conditions. The flowmetering options that are recommended are as follows:

Electromagnetic (mag) Flowmeters

An electromagnetic flowmeter, similar to the two existing Unimag mag flowmeters. These meters are powered by mains electricity. For the locations where the meter is installed in the water distribution system chambers, battery powered meters can be used.

Insertion Flowmeters

Insertion magnetic flowmeters are recommended, which are battery powered and have an integral data logger for flow and pressure. These instruments are installed through 2 inch diameter “hot taps” (under pressure tapings), so no isolating of mains, and cutting of pipe is required. These meters will be applicable where there is not sufficient space to install a magnetic flowmeter, or where it is difficult to shut down the watermain.

Clamp on Ultrasonic Flowmeters

At locations where it is not desired to either cut the main to install a magnetic flowmeter, or install a “hot tap”, then a clamp on ultrasonic flowmeter can be used.

6.5 Other Items

Instruments Calibration

There are a large number of instruments located at Nipissar Pump House and Williamson Lake Pump House, and consist of flowmeters, temperature monitors, pressure monitors, and other instruments. It was not clear if these instruments are regularly calibrated.

It is recommended that the flowmeters be calibrated annually, and a tag detailing the calibration date be attached to the flowmeter. The frequency of calibration of the other instruments should reviewed, and calibration completed as recommended by the manufacturers.

7.0 Development of Specifications for Leak Reduction Equipment

As part of this assignment, the consultant prepared a specification for leak reduction equipment. The purpose of the specification is to be used in a tendering process by the Government of Nunavut. The specification in its entirety can be found in Appendix A of this report.

8.0 AWWA/IWA Water Audit and Water Balance

Introduction

As part of the Government of Nunavut's (GN) ongoing water loss management program, GN completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System. The project was completed for a full year from August 2008 to August 2009, based on available billing data. A copy of the report in its entirety can be found in Appendix B of this document.

Completion of an IWA Water Audit and Water Balance is an integral part of the water loss management methodology, in the new AWWA Manual "M36 Water Audits and Loss Control Programs", which was published in May, 2009. An IWA Water Audit and Water Balance is considered to be the North American Best Management Practice (BMP) for water loss management, and is recommended that is completed annually.

The IWA Water Audit and Water Balance quantifies Revenue and Non Revenue Water, and identifies where to reduce water loss and increase revenue.

Summary of Gathered Data

A questionnaire was provided, and data gathered for the 2009 balance (August 2008 to August 2009). At the time of writing the draft report, there is still data that has not been provided by GN, so estimates of the values have been made. Once the data has been received, the analysis can be updated for the final report.

The data was entered into a series of spreadsheets and analysis completed to provided the totals required for the IWA software data entry. A summary of the "Old" Unaccounted For Water (UFW) percentage is shown in the table below. The volume accounted for as part of the IWA balance is included, and deducted from the traditional unaccounted for water volume, as shown in the table:

Item	Total Volume for 2009 (litres)
Total Water Supplied (corrected for accuracy)	427,770,000
Total Billed Consumption (corrected for billing data and meter accuracy)	190,200,000*
IWA Accounted For Water	90,956,000
Unaccounted For Water	146,613,000
Unaccounted For Water (UFW) Percentage	34.3%

*The corrected billed metered consumption derived through a water balance analysis shown in Sections 4 and 5 of this report was 181,143,000 litres in 2009. As part of the IWA analysis, it was estimated that the customer meters were under-registering by 5%, or 9,057,000 litres. This then gave a Total Corrected Billed Consumption of 190,200,000, as shown in the table above.

IWA Software Analysis

The gathered data for 2009 was entered into the AWWA – WLCC (Water Loss Control Committee) software program. The results of the analysis are shown as follows:

Parameter	Value for 2009
Current Annual Real Losses (CARL)	145,000,000 litres
Unavoidable Annual Real Losses (UARL)	14,000,000 litres
Infrastructure Leakage Index (ILI)	10.17
System Input Volume	428,000,000 litres
Revenue Water (corrected for estimated accuracy of billing system)	181,000,000 litres
Non-Revenue Water	247,000,000 litres
Volume of Non-Revenue Water - % of System Input Volume	57.7%

The financial results from the IWA software analysis are shown below:

Parameter	Value
<u>Annual Cost of Apparent Losses</u> Customer meter under registration Unauthorised consumption – based on estimated customer water and sewer rate of \$4.50 per 1,000 litres	\$52,215
<u>Annual Cost of Real Losses</u> <u>– Variable Production Cost</u> Based on estimated cost of \$0.35 per 1,000 litres	\$50,798

IWA Software Analysis Summary

In any water system there will be a volume of leakage that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair – this is the Unavoidable Annual Real Losses (UARL). The IWA software uses the physical characteristics of the water distribution system (length of water mains and services, number of connections, average pressure) to make an estimate of UARL. The Current Annual Real Losses (CARL) are also calculated by the software, by taking the water supplied and deducting the calculated authorized consumption and apparent losses, to give CARL. The ratio of UARL to CARL is the Infrastructure Leakage Index (ILI).

The World Bank Target Matrix gives performance category A for an ILI 1 - 2; category B for ILI 2 – 4; category C for ILI 4 – 8; and category D for ILI greater than 8.

The Hamlet of Rankin Inlet Water System's ILI of 10.17 puts them in performance D category – very inefficient use of resources; leakage reduction programs imperative and high priority

Although operational and financial considerations may allow a long term ILI greater than 8.0, such a level of leakage is not an effective utilisation of water as a resource. The priority for the Hamlet of Rankin Inlet Water System should be to develop an active leak detection program to reduce water losses, and reduce the

ILI to initially below 8.0, and then progressively reduce it further till it is in performance category B.

Recommendations

Source Meters

At the Lake Nipissar Pump House there are a number of meters, which include Signet paddle wheel meters and one Unimag electromagnetic. It is recommended that the Unimag meter be set up to record and save the daily total volumes abstracted, and these values be used for the total water abstracted. Locally it has been set up to manually record the total flow in the record book at the pump house.

An on site in-situ test procedure can be completed for some manufactured mag meters, so this should be investigated, to see if it is available for the Unimag meter. Testing could include primary coils/electrodes/circuitry, cables and full electronic check.

Customer Meters

Rankin Inlet has customer water meters which are manufactured by Neptune. The meters are an older style, and when they were installed had a wire fixed from the meter register to the outside of the property. On the end of this wire was fitted a remote register, which has numbers which can be read by the meter reader. This type of remote, or ‘generator remote’ works by the internal meter register sending a signal to change the remote register. They are prone to missing registrations, so that the remote register, which is typically used for billing, records a lower consumption than has actually passed through the water meter.

Some of these old remote registers have been replaced by a more modern “touch pad”, which is simply a device to send a signal to the internal meter register and obtain the reading. So, the actual internal meter reading is collected.

Furthermore, in the south part of Area 1, new meters with radio read technology have been installed. These meters have a radio transmitter installed either on the meter, or very close to the meter, inside the property. The meters are read with a hand held device, that can receive the meter reading at a distance from the property – it can be driven along each street to obtain the readings if required.

The recorded metered consumption is likely to be less than the actual water produced, for the following reasons:

- Generator remotes recording a lower consumption than the water meter register
- Remote register wires broken
- Customers disconnecting remote wire
- Customers removing water meter and piping through
- Water meter under-registering – most meters under-register as they age

For the Hamlet of Rankin Inlet, which has relatively old customer meters, the estimated overall customer under-registration was 5%, which represents a loss in billable volume of 9,057,000 litres per year. To determine a more accurate estimate of meter accuracy, it is recommended that a random sample of meters be removed and tested. A sample of 217 meters will give an error margin of 5%, with a 95% confidence level in the data.

Normally this type of random sampling and testing of customer meters is completed for the smaller 5/8" residential meters. Testing these residential meters should typically be repeated every 5 to 10 years, using a statistically valid sample of meters.

For the larger ICI meters, they should be tested more frequently than residential meters, because of the larger volumes being measured and the associated revenue. Testing of ICI meters should be as frequent as once every year for the very large volume meters, and between every 2 to 5 years for the remainder.

Active Leak Detection

The methodology to identify and reduce water loss that is recommended, is a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, "Water Audits and Loss Control Programs". In the M36 manual, this flow based method of identifying areas with leakage is called "District Meter Areas – DMAs".

The Rankin Inlet water supply and distribution system is complex with its method of operation including return loops on the distribution mains, and return loops on the customer service lines. There is also the added operational need to maintain water temperatures above a level that will prevent freezing in both the distribution mains and customer services.

Leakage can be split into three types; namely:

- Leakage from Reported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Passive Leak Detection and Repair
- Leakage from Unreported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Active Leak Detection and Repair
- Background Leakage (composed of primarily weeps from joints and gaskets rather than holes in pipes) – utility activity often referred to as Active Leakage Reduction

One of the most reliable and long established methodologies to help identify water loss is to split the network into small sectors often referred to as District Meter Areas (DMAs). Where possible areas are designed so that they can be fed through one metered water feed throughout the day and night, although because of fire flow requirements, sometimes two feeds are required.

In these DMAs the flow entering the area, and key pressures are data logged, typically for a seven day period. The estimated legitimate night use is estimated, and compared with the measured night flow, which identifies areas with potential leakage, and the approximate volume of that leakage

By operating the Temporary DMAs, the system backlog leaks can be identified and repaired.

In the process of operating the Temporary DMAs, flow and pressure logged data will be gathered, and along with the number and volume of leakage found, potential areas for converting to Permanent DMAs can be established. If some of the DMAs have high pressure, or significant pressure variations, then they can be considered for Pressure Management.

As summary of the operation of the types of DMAs is provided as follows:

- **Temporary DMAs**, where they are typically operated for a seven day period initially, and the flows at night, between 2.00 and 4.00 am (Minimum Night Flow - MNF) are compared to what flow would be expected from the area. Only in areas of high MNF are leaks looked for in a two step process – step one, narrow the leak down to the General Area of the leak, and step two, Pinpoint the leak (blue cross on the ground). There are a number of methods employed to find the general area of leak, which include night time step testing, when sections of the DMA are closed off for short periods, and the change in flow at the DMA flowmeter inspected for high drops in flow, indicating a potential leak. Another method to find the general area of the leak is to use noise loggers, which listen for leaks. Finally the leak is pinpointed using leak noise correlators, and ground microphones to confirm the location of the leak
- **Permanent DMAs used for Leak Notification**, where the DMA is permanently isolated from the rest of the distribution system, and night time flows monitored on a daily basis. When the Minimum Night Flow (MNF) reaches a predetermined level (Entry Level), then leak detection is completed in that DMA – general area of the leak, and pinpointing the leak. Leak detection and repair is continued until the leakage has been reduced to an acceptable amount (Exit Level), as recorded on the permanent DMA flowmeter
- **Permanent DMAs used for Leak Notification and Pressure Management**, where in addition to the leak detection activities, pressure management is introduced. This is completed by installing a Pressure Reduction Valve (PRV), which is used to control the pressure so the at “off peak” demand times, the pressure is not allowed to increase, and a less variable pressure is delivered to the DMA. This method of operation has the dual benefit of reducing Background Leakage (small leaks that are not economic to find and repair), and also reduces main breaks

District Meter Area Loops

It is recommended that the water distribution loops be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage” or the flow at night that is expected.

In DMA loops where the measured flow at night is significantly higher than the Legitimate Night Flow, these areas would then be targeted for acoustic leak detection.

It is likely that initially all the loops in Rankin Inlet will have measured flows significantly higher than the Legitimate Night Flow, because of the existence of bleeders, and leaks that may have been running for some time. When DMAs are introduced for the first time in water distribution systems it is common for the flows to be high. The initial tasks are often to identify and eliminate this “backlog” of losses, to reduce water loss to economic levels.

It is recommended that six DMAs be established, as follows:

- Area 5 DMA Loop
- Nuvuk DMA Loop (Area 6)
- Town DMA Loop 1 (Area 1)
- Town DMA Loop 2 (Area 2)
- Kivalliq DMA Loop
- DMA Town Supply

In addition, the mains between Nipissar Lake Pump House and Williamson Lake Pump House should be included in a future phase of the flow monitoring program.

Bleeders on Customer Services and Distribution Mains

If the water loss is a bleeder at a water service the leak pinpointing will indicate a loss at the corporation stop / curb stop of the service. Once this is identified, staff can investigate the bleeder further.

Although customers have to obtain a bleeder permit, all of them may not have done so. Once the bleeder is identified, steps can be taken to assist the customer to correct the problem on the services, and ensure that the recirculation system is put back into operation.

For bleeders on the water distribution system, they will be initially identified as leaks, if they are not already known. Depending on the location and function, the following measures should be considered:

- For all locations, complete a calculation of the approximate volume of water in the mains that are being kept fresh. Then calculate the flow rate required to exchange that volume of water in say 24 hours, or other agreed time period
- Shut off the bleeder, or
- Reduce the flow rate, or
- Install an automatic flushing device, or
- Where possible, for branches left open, install a flowmeter

9.0 Identification and Evaluation of Water Efficiency and Conservation Measures

The following Table 13 provides a comprehensive list of water efficiency alternatives evaluated as part of the Water Consumption and Conservation Study.

9.1 Table 13: Comprehensive List of Water Saving Measures

Indoor Measures	Common Practice with North American Municipal Programs	Description
Toilet flapper valve replacement	No	This measure is easy to promote and has been used in the past as an alternative to the ULF Toilet program. These flappers require maintenance to ensure water savings are sustained. The early closing flapper can be adjusted to save different amounts of water, but generally save anywhere from 2 to 4 litres/flush. The major issue is that you are altering an engineered product and as such may affect performance and warranty.
Toilet variable flush device	No	These adjustable devices are usually attached to the over flow tube in the toilet tank. The flush device moves up and down with the level of the water in the tank. When the toilet is flushed the device travels down with the water level until it pushes the flapper down causing it to close early thus saving 2 to 4 litres of water per flush.
Toilet tank displacement devices	Yes	Tank displacement devices consist of toilet dams, tank bags or bottles filled with sand. These devices displace the equivalent volume of water in the toilet tank saving usually 2 to 3 litres per flush.
6L toilet installation	Yes	This is a very popular residential water efficiency measure. Many homes still use 20 and 13 litre/flush toilets. This measure would replace those with 6 litre/flush toilets. Early model Ultra Low Flush (or ULF) toilets have faced many customer complaints about quality and reliability. The newer model ULF toilets have taken those complaints into consideration and are much more accepted than the previous models. As with many in-home water efficiency measures ongoing proactive maintenance is the key to sustaining water efficiency and savings. This measure would only apply to homes and buildings built before 2005 when the Good Building Practices Guidelines was introduced in Nunavut.
High Efficiency (HET) toilet	Yes	Relatively new in the North American market and similar to ultra-low flush toilets; high efficiency flush toilets are designed to flush with 4.8 litres of water. Generally these toilets are tamper-proof so that the flush volumes cannot be increased.
Dual flush toilet installation	Yes	The popularity of this residential water efficiency measure is ever increasing. Also popular in Australia, the largest percentage of new toilet installations in Europe and the UK are dual flush toilets. This measure would replace the regular flush (13 to 20 litre flush volume) toilets with dual flush toilet that either flushes 3 litres for liquids or 6 litres for solids. Dual flush toilets are primarily manufactured in Australia and Europe. This measure would only apply to homes and buildings built before 2005 when the Good Building Practices Guidelines was introduced in Nunavut.
Showerhead replacement	Yes	Older showerheads can use as much as 20 litres of water/minute. Low flow models use less than 9.5 litres per minute providing a substantial saving in both water and energy. This measure would only apply to homes and buildings built before 2005 when the Good Building Practices Guidelines was introduced in Nunavut.

Indoor Measures	Common Practice with North American Municipal Programs	Description
Showerhead flow restrictors	No	Flow restrictors are commonly small plastic inserts, which replace the rubber washer in the threaded connector of the showerheads to restrict flow.
Showerheads in-line regulator	No	Requiring a plumber for installation, in-line regulators are fitted into the existing water line to the showerhead. Flow regulators can decrease the flow rate from 20 litres per minute to as low as 5 litres per minute.
Water efficient clothes washer	Yes	Traditional top-loading washing machines use 132 to 240 litres of water per wash. The water efficient front-loading washing machines use 50 to 120 litres of water per wash. This amounts to a 40% reduction in water use. Top loading washing machines have made water-saving improvements in this last few years, but the front loading washers are still recognized as the most water and energy efficient. This measure is often promoted with educational material and incentives, as price is often a limiting factor for most consumers, although the price has been reducing in recent years.
Water efficient dish washer	No	The water savings between older automatic dishwashers and newer models is insignificant. Interestingly, studies have shown that families use less water for dish washing with an automatic washer as compared to hand washing.
Faucet aerator installation	Yes	Faucets can account for 23% of the overall water consumption per capita. Regular faucets can easily flow at 20 litres per minute with some as high as 40 litres per minute. Aerators can bring the flow down below 8.35 litres per minute also providing significant energy savings. Simple threaded devices that add air to the water flowing from a faucet.
Faucet flow restrictor installation	No	Flow restrictors are commonly small plastic inserts, which replace the rubber washer in the threaded connector of the faucet to restrict flow.
Automatic motion sensor faucet	No	There is no evidence that these faucets save water. They are equipped with infrared sensors which sense when the hand is under the tap and when it is pulled away from the tap. This type of faucet is popular in public areas where hygiene can be a concern because the person does not need to touch the tap at any time. Normally found in institutional settings.
Automatic push and touch faucet	No	Push or touch faucets can save a significant amount of water. They work by simply pressing or in the case of the more sophisticated models by touching the faucet to allow water to run. Water will flow for a pre-set time period, which is adjustable. Found mainly in institutions and commercial settings.
Faucet in-line regulator	No	Requiring a plumber for installation, in-line regulators are fitted into the existing water line to the faucet. Flow regulators can decrease the flowrate from 20 litres per minute to as low as 5 litres per minute.
Leakage repair	Yes	The A.W.W.A. (American Water Works Association) Residential End Use Study completed in 1999 concluded that 24 litres/capita/day is associated with indoor home leakage. The recent data logging study indicated that leakage has increased as high as 47 litres/capita/day. The major cause was toilet flappers. Residential audits as well as new water-efficient fixtures can reduce residential leakage. A leakage reduction program for the ICI sector includes auditing, leak detection and repairs.

Indoor Measures	Common Practice with North American Municipal Programs	Description
Garburator restrictions	No	Garburators, or sink waste disposal units, use water from the kitchen faucet every time they are operated, and can potentially increase organic loads at wastewater treatment plants. The best solution for the environment is to remove these units and encourage composting. Effective methods to encourage this are public education and in some cases offering an incentive for removed garburators. By-laws can also deter newly constructed facilities and homes from installing garburators in the first place.
Hot water recirculation	No	When a hot water faucet is turned on it can sometimes take several seconds to several minutes before hot water actually comes out of the tap. This can waste a lot of water. A hot water recirculating system uses a small pump to decrease the amount of time it takes for hot water to reach the faucet.
Water efficient water softener	No	Water Softeners are common in areas where groundwater is used to service the community. Many people install water softeners to reduce the calcium and magnesium bicarbonates. This is generally an aesthetic preference that many people have. Water softeners need to recharge on a regular basis, sometimes as much as once per day using from 140-400 litres of water at a time. Water-efficient models are available as well as magnetic types of water softeners. These can be encouraged through educational material and incentives.
Humidifier controller	No	Most older style flow through humidifiers can use up to 400 litres/day. This style has water constantly running to help keep the humidifier's mechanism clear of minerals and sediment. This older style of humidifier has an efficiency range of about 20-30%. Efficient models are available that will operate whenever the blower fan is on and not during the cooling season.
Air conditioning condensate	No	The water captured in air conditioning units and dehumidifier units can easily be used for non-potable purposes.
Grey water reuse	No	Grey water is the wastewater from bathing, doing laundry and dishes. This water can be reused to water lawns or flush toilets. Grey water reuse systems are generally not very well accepted in Canada due to fear of cross contamination and hygiene reasons. The biggest barriers against this measure are regulatory and cost effectiveness.
Floor drain primer water	No	In the last 20 years a very common practice in the residential construction industry has been the installation of a bleed line from a tap to drip water into a basement floor drain trap. This was done to keep the drain trap full of water so hazardous gases cannot seep up through the drain into the house. There are drain covers available that will let water drain through but not let gases escape into the house. This can eliminate the constantly flowing bleed line.

Indoor Measures	Common Practice with North American Municipal Programs	Description
Metering and sub-metering	Yes	A water-metering program for all customers is one of the first and most important programs that should be undertaken to account for all water used in a distribution system. Because a metering program can take years to complete it is suggested that high volume users and new development be metered first. Financial planning should accompany a metering program. Sub-metering involves metering individual units in a multi-residential or multi-user location. In apartment buildings, for example, the whole building is usually metered and then the resident only pays a percentage of the monthly bill rather than the actual amount they used. Sub-metering makes water users more aware of how much water they actually use, and in turn, tenants who use less water can benefit from lower water costs.
Household indoor audits	No	An indoor household audit conducted by an experienced water efficiency practitioner can identify cost effective water saving opportunities within the home. The audit itself does not save water but by implementing the recommendations, water savings can be realized. In some cases, the auditor can install the measures during the actual audit thus reducing overall costs.
Commercial food rinse nozzle	Yes	This measure consists of the installation low-flow, high efficiency, high-pressure pre-rinse spray valves typically found in restaurants, cafeterias and institutions. Based on the success of the Rinse & Save program implemented by the California Urban Water Conservation Council in 2003, many municipalities across North America have launched similar programs. In addition to water savings, the pre-rinse valve can provide significant energy savings and greenhouse gas reductions.
Urinal Flush Controls	Yes	Urinals with flush valves can be either adjusted to flush with lower volumes or the flush valves replaced with water efficient, sometime motion sensor type valves. Urinals with tank type flushing can be retrofitted with automatic flush controls that save significant water.
Low Water Urinals	Yes	Waterless urinals described below can save a very large amount of water but are relatively new on the market. Further research is required but some property managers have reported a build up of uric acid deposits in the urinal drains, which can block flushing. Low water urinals, while using some water, provide significant savings while providing enough drain water to prevent the build up of deposits.
Waterless Urinals	No	Waterless urinals can save a very large amount of water each year (upwards of 45,000 gallons). They are designed to operate and function without any water whatsoever while maintaining a sanitary standard. The urine drains through a liquid chemical trap eliminating odours. Ongoing maintenance is required to ensure that the liquid chemical is replenished. Further research is required but some property managers have reported a build up of uric acid deposits in the urinal drains, which can block flushing.
Process water reuse	Yes	Many ICI facilities have water uses that can be met with non-potable water. For many processes, filtered but otherwise untreated water can be used. Rinse water from laundry, car wash rinses and cooling towers could all be used again in the same process, or if applicable, could be used on applications like irrigation.

Indoor Measures	Common Practice with North American Municipal Programs	Description
Eliminate once through cooling	Yes	Single-pass or once through cooling systems are an excellent opportunity to save water. In systems with single-pass cooling the water is circulated through a piece of equipment once and then disposed of down a drain. These systems can be modified to eliminate the use of water altogether. Some municipalities restrict the use of once through cooling with bylaws.
Cooling tower optimization	Yes	Cooling towers help regulate temperature by rejecting heat from air conditioning systems or by cooling hot equipment. Water is lost through evaporation and bleed-off. Often, water from other equipment within a facility can be reused for cooling tower purposes with little or no treatment.
Car wash rinse water reuse	Yes	Depending on the type of recycling system, reclaiming and filtering wash water for reuse reduces the amount of fresh water needed by 50-60% in bay washes, 50-90% in conveyor touch washes, and 20-90% in conveyor touch-less washes. This measure can save a significant amount of water.
ICI audits	Yes	Industrial, commercial and institutional audits are completed by competent consultants with experience in industrial processes and water use. The audits are designed to provide the facility manager with a report of water use in the facility and a list of cost effective water saving measures (previously described above) that can be implemented. Audits in themselves do not save water. The measures implemented as a result of an audit save water. As such, indoor audits provide an excellent delivery mechanism.
Public and Youth Education	Yes	This measure can be targeted at many different sectors such as: residential, ICI (Industrial, Commercial, Institutional), and school programs. It is an attempt to alter people's attitudes and habits about water use in hope that they adopt a water efficient behaviour. Some of the habits that can be affected include; turning faucets off when washing dishes or brushing teeth, fixing leaking fixtures quickly, and reducing lawn-watering frequency. Public education and awareness can also increase the effectiveness of other measures when paired together. For example, most residents will be more willing to install a water-efficient showerhead after a city wide "Water Conservation Week" has taken place. Public education can include school programs, workshops, newspapers and flyers, audits, websites, television and much more.

9.2 Feasibility Screening of Measures

Technical - Some water efficiency measures are not suitable for local conditions and programming. They may not meet local codes, standards or regulations. They may not be performance tested or proven technology. They may not be market ready or available. For instance, replacing an existing toilet flapper valve with a more efficient model alters an engineered product and could negatively affect performance and the toilet's ability to remove waste.

Potential – Is there a large enough potential in the market sector to justify a program? For example, newly constructed homes generally do not have a central humidifier and as such there would be no market for a water efficiency humidifier program in the new construction sector.

Achievable – Once it has been identified that there is a large potential market for a particular measure, is there an expectation that a large percentage will implement the measure based on reasonable incentives and program delivery? For example, although there may be a large potential for the installation of in-line regulators for showers, homeowners would be reluctant to install them since the wall would have to be opened at significant cost and inconvenience.

Social Impact – Once it has been established that there is a significant achievable opportunity for a particular measure, are there any elements of the program that would affect society negatively. For instance, would implementing a particular program affect local employment? Put an undue financial burden on a family?

Environmental Impact – Are there any environmental impacts attributed to a particular measure? For instance if a particular measure used batteries for operating would there be an issue with disposing of the used batteries.

A decision tree, shown in following Figure 9, was developed to illustrate the screening process.

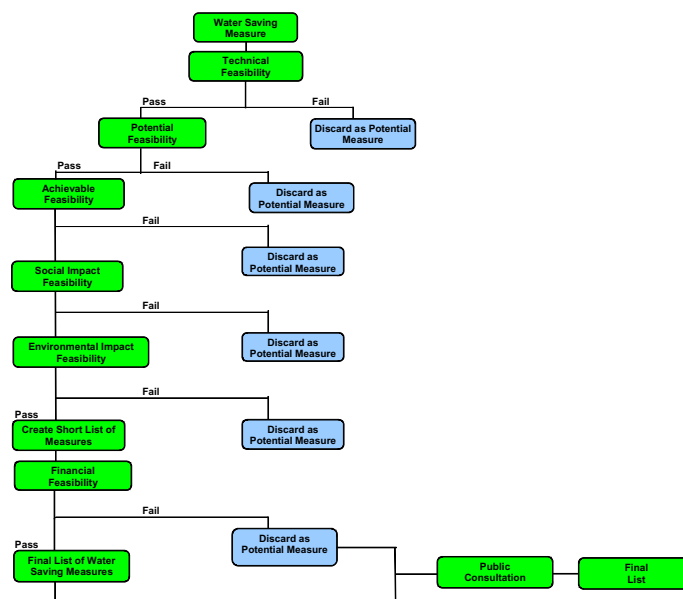


Figure 9: Decision Tree for Screening Water Efficiency Measures

Results of Preliminary Screening

The results of the preliminary screening are shown in the following Table 14. Those measures that passed the screening are highlighted in green.

Table 14: Preliminary Screening Results

Residential Sector	Technical	Potential	Achievable	Social	Environmental
Toilet flapper valve replacement	x	x	x	x	x
Toilet variable flush device	x	x	x	x	x
Toilet tank displacement devices	x	x	x	x	x
6L toilet installation	✓	✓	x	x	x
High efficiency (HET) toilet installation	✓	✓	✓	✓	✓
Dual flush toilet installation	✓	✓	✓	✓	✓
Showerhead replacement	✓	✓	✓	✓	✓
Showerhead flow restrictors	x	x	x	x	x
Showerheads in-line regulator	✓	✓	x	x	x
Water efficient clothes washer	✓	✓	✓	✓	✓
Water efficient dish washer	✓	✓	x	x	x
Faucet aerator installation	✓	✓	✓	✓	✓
Faucet flow restrictor installation	x	x	x	x	x
Automatic motion sensor faucet	x	x	x	x	x
Automatic push and touch faucet	✓	✓	x	x	x
Faucet in-line regulator	✓	✓	x	x	x
Leakage repair	✓	✓	✓	✓	✓
Garburator restrictions	x	x	x	x	x
Hot water recirculation	x	x	x	x	x
Water efficient water softener	✓	x	x	x	x
Humidifier controller	✓	x	x	x	x
Air conditioning condensate recovery	x	x	x	x	x
Grey water reuse	x	x	x	x	x
Floor drain primer water	x	x	x	x	x
Metering and submetering	✓	x	x	x	x

Industrial, Commercial and Institutional	Technical	Potential	Achievable	Social	Environmental
Toilet flapper valve replacement	x	x	x	x	x
Toilet variable flush device	x	x	x	x	x
Toilet tank displacement devices	x	x	x	x	x
6L toilet installation	✓	✓	x	x	x
High efficiency (HET) toilet installation	✓	✓	✓	✓	✓
Dual flush toilet installation	✓	✓	✓	✓	✓
Showerhead replacement	✓	✓	✓	✓	✓
Showerhead flow restrictors	x	x	x	x	x
Showerheads in-line regulator	✓	✓	x	x	x
Water efficient clothes washer	✓	✓	✓	✓	✓
Water efficient dish washer	✓	✓	✓	✓	✓
Faucet aerator installation	✓	✓	✓	✓	✓
Faucet flow restrictor installation	x	x	x	x	x
Automatic motion sensor faucet	✓	x	x	x	x
Automatic push and touch faucet	✓	x	x	x	x
Faucet in-line regulator	✓	✓	x	x	x
Leakage repair	✓	✓	✓	✓	✓
Garburator restrictions	x	x	x	x	x
Pre-rinse spray valve	✓	✓	✓	✓	✓
Hot water recirculation	✓	✓	✓	✓	✓
Water efficient water softener	✓	✓	✓	✓	✓
Humidifier controller	✓	✓	✓	✓	✓
Process water	✓	✓	✓	✓	✓
Cooling tower optimization	✓	✓	✓	✓	✓
Air conditioning condensate recovery	✓	✓	✓	✓	✓
Grey water reuse	✓	✓	✓	✓	✓
Floor drain primer water	✓	✓	✓	✓	✓
Metering and submetering	✓	✓	✓	✓	✓

Municipal	Technical	Potential	Achievable	Social	Environmental
Distribution leakage reduction	✓	✓	✓	✓	✓

For reference, the additional rationale for specific measures not passing the screening process are noted below:

Residential

Toilet flapper valve replacement - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing toilet with a water efficient model is considered the best practice.

Toilet variable flush device - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing toilet with a water efficient model is considered the best practice.

Toilet tank displacement device - Technical

- Alters an engineered product which could adversely affect the product's performance. Can cause operational issues with flush mechanism. Replacement of the existing toilet with a water efficient model is considered the best practice.

6 Litre flush toilet - Achievable

- The HET 4.8 Litre flush toilet has proven to be an effective toilet and is quickly becoming the standard in North America.

Showerhead flow restrictors - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing showerhead with a water efficient model is considered the best practice.

Showerhead in-line regulator - Achievable

- Requires a plumber to cut the existing water line and insert regulator. Difficult to access existing plumbing and as such would have very low uptake.

Water efficient dishwasher - Achievable

- Any dishwasher purchased on the market is Energy Star rated and thus water efficient. Very few households in Rankin Inlet have automatic dishwashers.

Faucet flow restrictor installation - Technical

- Flow restrictor decreases the flow rate and performance of the faucet as compared to an aerator which adds to air to improve performance.

Automatic motion sensor faucet - Technical

- More appropriate for commercial applications for hygienic reasons. No evidence of water savings.

Automatic push and touch faucet - Achievable

- More appropriate for schools and other institutions. Not marketable in a residential sector.

Faucet in-line regulator - Achievable

- Requires a plumber to cut the existing water line and insert regulator. Difficult to access existing plumbing and as such would have very low uptake.

Garburator restrictions - Technical

- Not enough data to justify as a water efficiency measure.

Hot water recirculation - Technical

- Studies have indicated that savings are minimal for this measure.

Water efficient water softeners - Technical

- Not enough data to justify as a water efficiency measure. There are no water softening units in homes in Rankin Inlet.

Humidifier controllers - Technical

- Not enough data to justify as a water efficiency measure. There are no central humidifier units in homes in Rankin Inlet.

Air conditioning condensate recovery - Technical

- Not enough data to justify as a water efficiency measure. There are no air conditioning units in homes in Rankin Inlet.

Grey water reuse - Technical

- Not enough data to justify as a water efficiency measure. Concerns over health and cross connections issues.

Floor drain primer water - Technical

- Not enough data to justify as a water efficiency measure.

Metering and sub metering - Potential

- The Hamlet of Rankin Inlet is fully metered.

Industrial, Commercial and Institutional

Toilet flapper valve replacement - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing toilet with a water efficient model is considered the best practice.

Toilet variable flush device - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing toilet with a water efficient model is considered the best practice.

Toilet tank displacement device - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing toilet with a water efficient model is considered the best practice.

6 Litre flush toilet - Achievable

- The HET 4.8 Litre flush toilet has proven to be an effective toilet and is quickly becoming the standard in North America.

Showerhead flow restrictors - Technical

- Alters an engineered product which could adversely affect the product's performance. Replacement of the existing showerhead with a water efficient model is considered the best practice.

Showerhead in-line regulator - Achievable

- Requires a plumber to cut the existing water line and insert regulator. Difficult to access existing plumbing and as such would have very low uptake.

Faucet flow restrictor installation - Technical

- Flow restrictor decreases the flow rate and performance of the faucet as compared to an aerator which adds to air to improve performance.

Automatic motion sensor faucet - Technical

- More appropriate for commercial applications for hygienic reasons. No evidence of water savings.

Automatic push and touch faucet - Achievable

- More appropriate for schools and other institutions. No evidence of water savings.

Faucet in-line regulator - Achievable

- Requires a plumber to cut the existing water line and insert regulator. Difficult to access existing plumbing and as such would have very low uptake.

Garburator restrictions

- Not enough data to justify as a water efficiency measure.

Table 52: Water Efficiency Measures Short List

Residential Water Efficiency Measures		
High Efficiency (HET) toilet installation	Water efficient clothes washing machines	Showerhead replacement
Dual flush toilet installations	Kitchen faucet aerator installation	Bathroom faucet aerator installation
Leakage repair		
Industrial/Commercial/ Institutional Measures		
High Efficiency (HET) toilet installation	Water efficient clothes washing machines	Commercial food rinse nozzle
Dual flush toilet installations	Water efficient dish washing machines	ICI audits
Municipal		
Distribution leakage reduction		

Financial Feasibility of Water Efficiency Measures

Utilizing a spreadsheet model (see Appendix C), water savings and implementation costs were derived for each measure displayed on the short list. The savings and costs were then used to determine the cost effectiveness of each measure. The cost-effectiveness of a measure, or its cost/benefit ratio, is determined by comparing the program cost to the cost of future infrastructure expansion to deliver a similar quantity of water. The water savings for each measure was determined using a number of resources from engineering estimates to actual verified results from water efficiency programs in North America. Much information was gathered from programs that have been implemented and monitored for the last five to ten years in the Region of Waterloo, Region of York and the City of Toronto.

Depending on the measure and delivery mechanism program costs may include; equipment, installation, rebates, training, program marketing and project management as applicable. Based on related program costs a cost per litre of water per average day saved was determined for each conservation and efficiency alternative. This cost was then compared to the cost of constructing additional infrastructure to gain one litre per average day of additional water and wastewater capacity. It is important to note that calculated cost relating to construction of an additional litre of water and wastewater capacity does not include the cost of debt financing of construction projects. It is also important to note, that this figure does not include the cost of additional infrastructure required for the distribution/conveyance of water and wastewater to and from newly serviced areas such as water/wastewater mains, pumping stations or system reservoirs. In southern Ontario, the combined water and wastewater construction cost per litre per average day of additional capacity ranges from approximately \$2.00 to \$8.10. Without additional data, the consultant has assumed that the costs in Rankin Inlet are 2 times that of southern Ontario or a range of \$4.00 to \$16.20. For the purpose of this financial analysis the combined water and wastewater construction cost of \$8.00 per litre per average day of additional capacity was utilized.

The outcome of the financial analysis is shown in the following Table 16. The measures that did not pass the financial test are highlighted in yellow.

Table 16: Results of Financial Screening of Water Efficiency Measures

Residential	Water Efficiency Measure	Cost per Participant	Savings per Participant (L/d)	Cost per litre
Installation	HET Toilets	\$ 1,014	139	\$ 7.31
Installation	Dual Flush Toilets	\$ 1,024	139	\$ 7.38
Installation	Low Flow Showerheads	\$ 133	54	\$ 2.44
Installation	Kitchen Faucets	\$ 71	20	\$ 3.52
Installation	Bathroom Faucets	\$ 64	24	\$ 2.70
Installation	Leakage Repair	\$ -	56	\$ -
Installation	Clotheswashers	\$ 1,250	19	\$ 67.57
ICI				
Installation	HET Toilets	\$ 7,381	375	\$ 19.68
Installation	Dual Flush Toilets	\$ 7,631	375	\$ 20.35
Installation	Pre-Rinse Spray Valves	\$ 1,450	368	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	\$ 72,250	15,000	\$ 4.82
Municipal				
Installation	Leakage Reduction	\$ 55,000	57,500	\$ 0.96

Recommended List of Measures to Include in Strategy

Three measures including residential clotheswashers, ICI HET toilets and ICI dual flush toilets did not pass the financial screening but are recommended to remain on the short list for inclusion in the strategy. These measures provide substantial water savings and their inclusion provides a comprehensive strategy. As demonstrated in the next section, the inclusion of these three measures does not affect the overall cost-effectiveness of the strategy.

10.0 Strategy Implementation Plan

The recommended components of the plan include:

Residential Measures

- Visit all homes and apartments and install free of charge HET or dual flush toilets, low flow showerheads, kitchen aerators, bathroom aerators and water efficient clotheswashers. To eliminate toilet leakage in homes, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.

Industrial/Commercial/Institutional Measures

- Visit all businesses and institutions and install free of charge HET or dual flush toilets. To eliminate toilet leakage in businesses, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.
- Visit commercial kitchens and install free of charge low flow pre-rinse spray valves.
- Complete five (5) comprehensive water audits and offer a capacity buy-back rebate to any facility that implements all or some of the water saving recommendations.

Municipal Measures

- Design and implement five (5) district meter areas. Locate, quantify and repair the leakage within the water distribution system.

Public Education

- Distribution of booklets, leaflets, and fact sheets at community and environmental events.
- Distribution of a water efficiency bulletin in the water bills.
- Displays at community events.
- Develop and maintain a website to educate the public on water efficiency.
- Provide workshops and seminars to the public on water saving techniques both inside and outside the home.

Youth Education

- Develop and deliver a water efficiency education program based on curriculum requirements.
- Develop and facilitate a Children’s Water Festival.

For reference individual business cases for each recommended water conservation and efficiency measure are provided in Appendix D of this report.

10.1 Table 17: Capital Budget and Water Savings (Litres per average day)

Residential	Water Saving Measure	Number of Product Installed	Total Cost	Total Program Savings (L/d)	Cost per litre
Installation	HET Toilets	768	\$ 707,921	96,903	\$ 7.31
Installation	Dual Flush Toilets	85	\$ 79,434	10,767	\$ 7.38
Installation	Low Flow Showerheads	854	\$ 103,208	42,246	\$ 2.44
Installation	Kitchen Faucets	776	\$ 55,096	15,644	\$ 3.52
Installation	Bathroom Faucets	854	\$ 49,664	18,376	\$ 2.70
Installation	Leakage Repair	854	\$ -	43,068	\$ -
Installation	Clotheswashers	776	\$ 970,000	14,356	\$ 67.57
Industrial, Commercial, Institutional					
Installation	HET Toilets	357	\$ 329,486	16,740	\$ 19.68
Installation	Dual Flush Toilets	40	\$ 37,850	1,860	\$ 20.35
Installation	Pre-Rinse Spray Valves	15	\$ 14,500	3,680	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	5	\$ 72,250	15,000	\$ 4.82
Municipal					
Installation	Leakage Reduction	5	\$ 275,000	287,500	\$ 0.96
Education					
Public Education (5 years)			\$ 150,000		
Youth Education (5 years)			\$ 180,000		
TOTAL			\$ 3,024,408	566,140	\$ 5.34

It is recommended that the above capital plan be supported by ongoing monitoring, evaluation and maintenance in order to initially verify the water savings and then to sustain them into the future.

The overall best practices capital program is budgeted at \$3,024,408 and is expected to save just over 566,000 litres of water per average day (l/d).

The cost per litre per day for the proposed plan is \$5.34. This compares well to the average cost per litre per average day capacity for new infrastructure, which is estimated at \$8.00. To add new water and wastewater infrastructure to deliver the equivalent capacity of 566,000 l/d would cost \$4.5 million based on the average \$8.00 per litre capacity cost.

Although some program measures did not meet the cost analysis, which includes clotheswashers, ICI HET toilets and ICI dual flush toilets, these program alternatives have been included due to the significant savings that they bring to the overall plan. However, it is important to note that even with the inclusion of these programs the overall plan remains more cost-effective than the cost of constructing future water and wastewater supply/treatment capacity.

Due to the difficulty in measuring water savings generated by education, there have been no savings attributed to the Broadscale Public or Youth Education programs in the plan. Technical solutions, such as low flush toilets and low flow showerheads will only achieve a portion of the potential water savings. Education designed to change habits and attitudes or residents towards water use will achieve the remaining savings. The American Water Works Association suggests that education programs can generate up to a 4 to 5% reduction in water demand by long-term education initiatives. In addition, education is necessary to ensure that water savings generated by the capital program are sustained. Since, education should be ongoing, 5 years of costing has been included.

Included in the costs for the plan are:

- Equipment
- Installation
- Marketing
- Program management and administration
- Project management

A breakdown of the costs by market sector is provided in the table on the following page.

10.2 Table 18: Water Conservation and Efficiency Strategy Costs Breakdown

		Number Product Installed	Equipment & Installation	Marketing	Program Management & Administration	Project Management	Total Cost	Total Program Savings (L/d)
Residential								
Installation	HET Toilets	768	\$ 641,572.59	\$ 10,476.00	\$ 41,904.00	\$ 13,968.00	\$ 707,920.59	96,903
Installation	Dual Flush Toilets	85	\$ 71,285.84	\$ 1,164.00	\$ 5,432.00	\$ 1,552.00	\$ 79,433.84	10,767
Installation	Low Flow Showerheads	854	\$ 64,408.00	\$ 7,760.00	\$ 23,280.00	\$ 7,760.00	\$ 103,208.00	42,246
Installation	Kitchen Faucets	776	\$ 25,608.00	\$ 7,760.00	\$ 15,520.00	\$ 6,208.00	\$ 55,096.00	15,644
Installation	Bathroom Faucets	854	\$ 20,176.00	\$ 7,760.00	\$ 15,520.00	\$ 6,208.00	\$ 49,664.00	18,376
Installation	Leakage Repair	854	\$ -	\$ -	\$ -	\$ -	\$ -	43,068
Installation	Clotheswashers	776	\$ 931,200.00	\$ 7,760.00	\$ 23,280.00	\$ 7,760.00	\$ 970,000.00	14,356
Industrial, Commercial, Institutional								
Installation	HET Toilets	357	\$ 298,238.05	\$ 8,928.00	\$ 17,856.00	\$ 4,464.00	\$ 329,486.05	16,740
Installation	Dual Flush Toilets	40	\$ 33,137.56	\$ 1,488.00	\$ 2,480.00	\$ 744.00	\$ 37,849.56	1,860
Installation	Pre-Rinse Spray Valves	15	\$ 3,750.00	\$ 3,000.00	\$ 7,000.00	\$ 750.00	\$ 14,500.00	3,680
Installation	ICI Audits and Capacity Buy-back	5	\$ 60,500.00	\$ -	\$ 7,500.00	\$ 4,250.00	\$ 72,250.00	15,000
Municipal								
Installation	Leakage Reduction	5	\$ 250,000.00	\$ -	\$ 15,000.00	\$ 10,000.00	\$ 275,000.00	287,500
Education								
Public Education (5 years)							\$ 150,000.00	
Youth Education (5 years)							\$ 180,000.00	

10.3 Staff Resources

The implementation of the plan would require the following staff resources which has been included in the budget.

Position	Annual Expense
Project Manager (x1), part time	\$64,000
Program Coordinator (x2)	\$175,000

Responsibilities and duties of recommended staff:

Project Manager – responsible for overall development, implementation, evaluation and reporting of the Water Conservation and Efficiency Strategy. Staff recruitment, training, coaching and evaluation.

Program Co-ordinator – responsible for the development, implementation and evaluation of:

- Residential sector
- Education

Program Co-ordinator – responsible for the development, implementation and evaluation of:

- ICI sector
- Municipal Leakage Program

11.0 Overall Water Savings

Overall

The overall water savings anticipated from the implementation of the recommended strategy is shown in Table 19 below.

Table 19: Overall Water Savings

Sector	litres/day	litres/year
Residential	241,360	88,096,000
ICI	37,280	13,607,000
Municipal	287,500	104,938,000
Total	566,140	206,641,000

The water saving plan will free up 206,641,000 litres/year of water supply capacity. This represents 61% of the total water supplied in 2009.

In addition to providing water supply capacity, the plan will reduce demand on the wastewater system by 101,703,000 litres/year.

Residential

The water savings attributed to the residential sector was compared against 2009 billed consumption and the residential water balance that was developed. Results of this comparison is shown in Table 20.

Table 20: Comparison of Residential Savings and 2009 Residential Consumption based on Billing Data and based on Water Balance

Residential Sector	Per Capita Consumption (Lcd)	Residential Consumption 2009 (litres)	Residential Water Savings (litres)	Percent Savings
As per Billing Data	122	111,544,000	88,096,000	79%
As per Water Balance	169	154,151,000	88,096,000	57%

Industrial, Commercial and Institutional

The water savings attributed to the ICI sector was compared against 2009 billed consumption. Results of this comparison are shown in Table 21.

Table 21: Comparison of ICI Savings and 2009 ICI Billed Consumption

ICI Sector	Corrected ICI Consumption 2009 (litres)	ICI Water Savings (litres)	Percent Savings
As per Billing Data	26,962,000	13,607,000	50%

Municipal

The water savings attributed to the Municipal leakage reduction program was compared against the water loss identified from the AWWA/IWA Water Audit and Water Balance results. Results of this comparison are shown in Table 22.

Table 22: Comparison of Municipal Savings and Water Loss Results

Municipal Sector	Estimated Water Loss 2009 (litres)	Municipal Water Savings (litres)	Percent Savings
As per Billing Data	145,000,000	104,938,000	72%

12.0 Maintenance

Water savings generated from the efficiency program should be viewed in the same manner as constructing a new water treatment facility. If the Hamlet of Rankin Inlet were to design and build new infrastructure to deliver 566,000 l/d, a budget for a maintenance program would be included to ensure that the facility continues to deliver 566,000 l/d in the future. The Hamlet's water conservation and efficiency strategy is no different. If it was designed to save 566,000 l/d, maintenance would be required to sustain the savings into the foreseeable future.

Water efficiency has been identified as a viable cost-effective supply of water. Maintenance will be essential to ensure that the savings are sustained. Each component of the water efficiency strategy should have three basic elements; tracking of activity, savings validation and finally maintenance of products and services provided.

One of the largest components of the proposed conservation and water efficiency strategy, from both a savings and budget perspective, are the programs related to the residential sector. The Hamlet would implement these programs through direct installation in qualifying homes and apartments within the Hamlet.

The maintenance element of the program will ensure that if a water efficiency program participant has a performance problem with the new equipment installed, new replacement parts will be available to the participant.

To sustain water savings within the ICI sector, follow up visits should be scheduled periodically to ensure that the water saving capital equipment that was installed and any procedural changes made as a result of the water efficiency program are still in place, working effectively and saving the same amount of water as originally verified.

Just like a new treatment plant, water efficiency measures have to be maintained. This will be in several formats, including:

- Education of water users
- Tracking of all participants and non-participants
- Customer call centre to respond to enquiries
- Recommendations for replacement products or service

A comprehensive maintenance program is an integral part of the strategy during the capital program and beyond. It is recommended that a customer service representative be established that would field incoming calls regarding the program. A customer with a problem will speak to a program representative directly. The program representative will have access to a database which contains participant information such as name, address, phone numbers, number of showers in the home, number of toilets in the home, products installed, date of installation and name of installer.

The importance of tracking activity from a customer satisfaction perspective, from a product performance perspective to a program performance perspective cannot be over-emphasized. Just like it pays to put that front-end time investment in the development of the scope of work...the same holds true for a tracking

system. It is recommended that two levels of tracking, ATS and SRS be developed for the installation activity. ATS or the Activity Tracking System monitors the day-to-day activity. It will be located and maintained by the Hamlet's Water Efficiency Program customer service representative. On a daily basis, all calls received, all installs completed, any maintenance work completed will be tracked in ATS. A number of management reports will be able to be called up at any time or ad hoc queries can be generated. Each month, the information gathered in ATS will be downloaded into SRS, the Summary Reporting System. Just as its name implies, this will be a high level reporting system used for management reports indicating costs, participants, estimated water savings and variance to budgets and forecasts.

Few utilities implement maintenance, monitoring and evaluation programs to the extent that is recommended. Most utilities implement water efficiency capital programs with no thought to sustaining the savings into the long term or without any serious evaluation research. They quite often rely on engineering estimates for calculating savings while not considering the significant number of externalities that effect water savings. The energy sector has done a much better job in monitoring and evaluation but even they fall short on maintenance. Few, if any, energy utilities maintain the savings that they have achieved from their capital programs.

The elements included in the maintenance program would include:

Residential Sector

Significant water savings products will be installed by Rankin Inlet's water conservation and efficiency strategy. These products should be maintained through a "pick-up" service. If a resident or business requires a replacement part they simply stop by the customer service centre that would provide the appropriate parts directly to the customer.

Industrial/Commercial/Institutional Sector

In addition to maintaining the products installed in small commercial businesses it is anticipated that 1 ICI customers will participate in the water saving audits and capacity buy-back program. Over the course of the plan, a consultant who will be similar to a key-account manager will visit each of the facilities periodically. The purpose of the visit will be to ensure that the water measures implemented are still in place and still providing savings as designed. In addition the consultant will meet with the facility staff to ensure proper operating procedures design to achieve maximum savings are being practiced. The budget allows for 1 site visit per year during a five year period.

Distribution Leakage Reduction

It is recommended as good practice to complete an AWWA / IWA Water Audit and Water Balance every year – this is often referred to as the "Top Down" approach to water loss management.

It is also recommended that the temporary District Meter Areas (DMAs) be operated on a regular basis, which can be either every year, or every two to three years. It is also recommended that with the information gathered as part of the operation of the temporary DMAs, that consideration be given to establishing permanent DMAs, for either continuous water loss monitoring, or the next stage of flow modulation to

reduce background leakage (small leaks that are not economic to find and repair). The DMA approach is often referred to as the “Bottom UP” approach.

The maintenance budget has been established to accommodate two (2) DMA maintenance runs in year 3 and three (3) in year 4. This will ensure that no DMA goes without maintenance for more than three years.

The recommended maintenance budget is found in Table 23 below.

Table 23: Recommended Maintenance Budget

Five Year Maintenance Plan			Year 1	Year 2	Year 3	Year 4	Year 5	Total
			Costs	Costs	Costs	Costs	Costs	
Residential			\$ 17,107.69	\$ 18,215.38	\$ 22,646.14	\$ 25,969.21	\$ 29,292.28	\$ 113,230.70
Industrial/Commercial/Institutional			\$ 12,437.00	\$ 12,874.00	\$ 22,122.00	\$ 23,433.00	\$ 27,704.00	\$ 98,570.00
Distribution Leakage Reduction						\$ 60,000.00	\$ 90,000.00	\$ 150,000.00
Total			\$ 29,544.69	\$ 31,089.38	\$ 44,768.14	\$ 109,402.21	\$ 146,996.28	\$ 361,800.70

13.0 Monitoring and Evaluation

It is important to have a monitoring and evaluation program to ensure that the water savings are achieved initially, and that those savings are sustained over time.

In the residential and small commercial markets it is recommended that on-site monitoring be carried out 30 days before the measure installation and 30 days after the measure has been installed. Monitoring can be accomplished with the installation of data loggers on the water meters. These units are small and unobtrusive. The data logging study will verify the actual savings attributed to the water saving measures. This analysis should be completed in the first year of the capital program to verify the expected water savings.

Also of importance is the ongoing monitoring for persistence or sustainability. All products wear out or fail in time. Participants may have the tendency to install a high water consuming device when their water saving device fails. This may happen due to lack of knowledge or the availability of water saving products at retail stores. In order to measure this erosion in savings it is recommended that statistically valid audits of participants be carried out throughout a five year period. The auditor would visit the home or business and inspect the water savings products that were installed. The auditor would observe if the products are still installed, working properly and saving water. Audits could be completed in Year 5.

The Table 24 below provides the monitoring and evaluation by year for the five year period.

Table 24: Monitoring and Evaluation Budget

Five Year Monitoring and Evaluation Plan	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	Costs	Costs	Costs	Costs	Costs	Costs
Residential	\$ 157,500				\$ 30,000	\$ 187,500
Industrial, Commercial and Institutional	\$ 78,000				\$ 7,200	\$ 85,200
Total	\$ 235,500	\$ -	\$ -	\$ -	\$ 37,200	\$ 272,700

The Table 25 below provides the activities to be undertaken from the Monitoring and Evaluation plan.

Table 25: Recommended Monitoring and Evaluation Activity

	Number of Participants to be Monitored	Number of Persistence Audits in Year 5
Residential		
HET Toilets	30	125
DF Toilets	15	25
Clothes Washers	30	150
Showers, Faucets, Leakage	30	150
Industrial, Commercial and Institutional		
HET Toilets	20	60
DF Toilets	10	20
Pre Rinse Spray Valves	10	10
Capacity Buy Back	Included in Capital Program	

It is important to note that the long-term costs of water savings monitoring could be drastically reduced with the introduction of automated meter ready (AMR) technology in place of the collection of the Hamlet's

current customer water use reading system. The introduction of AMR technologies would provide the utility with enhanced customer water use data (based on the frequency of water use reporting) and added customer services tools to proactively identify private side leakage or meter reading errors. With the introduction of this technology it is expected that the required monitoring program would be less labour intensive for staff and be less intrusive for sites being monitored through the process.

14.0 Energy Savings and Greenhouse Gas Emissions Reductions

The overall energy savings generated from water efficiency is in most cases more significant than the water savings. Water utilities are typically the largest consumer of electricity in a municipality. Electricity is used in the water and wastewater treatment processes but more significantly in the pumping/conveyance of water and wastewater. A recent study⁴ completed by the Polis Project on Ecological Governance, University of Victoria evaluated historical data relating to water production and energy consumption from 7 municipalities in Ontario. The study completed case studies on the Town of Collingwood, the Regional Municipality of Durham and the City of Guelph. The study reported, that it takes 0.68 KWh of electricity for every 1,000 litres of water delivered to a customer and then returned through the wastewater process. The findings from this study were used to develop the energy savings and greenhouse gas emission reductions reported below.

Many of the water saving measures recommended in the strategy also reduce energy consumption at the customer's premise. For example, a low flow showerhead reduces not only water but reduces hot water. Oil or electricity has been used by the customer to generate the hot water. Energy savings will also be generated from the faucet aerators, clotheswashers, pre-rinse spray nozzles and the ICI Audit program.

Typically a residential customer who participates in the water efficiency program will see greater dollar savings in their energy bill as compared to their water bill. This is also an important linkage to emphasize when promoting the water efficiency programs to the public.

The reduction of water-use through an efficiency program and the associated energy savings provides significant greenhouse gas reductions. With climate-change in mind, most municipalities have set their own greenhouse gas reduction targets. Water efficiency can be a positive contributor to meeting those targets.

Although the participant's energy savings were not quantified as part of this project, the utility energy savings and greenhouse gas emission reductions are provided in Table 26 below.

Table 26 – Estimated Energy Savings and Associated Greenhouse Gas Emission Reductions

	Water Savings per Year (litres/yr)	Energy Savings per Year	CO2 Reductions per Year (tonnes/yr)
Overall Water Savings	206,641,000	130,022 KWh Electricity	78.0 tonnes

Assuming an electric rate of \$ 0.35 per KWh, the Hamlet of Rankin Inlet would reduce its electrical bill by approximately \$45,858 per year upon completion of the strategy. In addition, the greenhouse gas emissions reduction is equivalent to removing 14 cars from the road.

⁴ Maas, Carol. Greenhouse Gas and Energy Co-Benefits of Water Conservation, Polis Discussion Series Paper 08-01, November 2008, Polis Project on Ecological Governance, university of Victoria, Victoria, BC.

15.0 Conclusions

Market Research – Residential Surveys

Overall, 62 residential surveys were completed from October 21st to November 5th 2009. When asked about the environment, respondents indicated that they think primarily about water quality/pollution followed very closely by water conservation and efficiency.

When asked why their household has not changed the way it saves water, the most common response was that they were not billed for their water. This is certainly true for the residents who rent their homes from the Rankin Inlet Housing Association. The Statistics Canada 2006 Census indicates that 69% of the households in Rankin Inlet are rented properties. This group, unaffected by a water bill, will require other motivations and incentives to participate in a water efficiency strategy.

In addition to providing information on the habits and attitudes of Rankin Inlet residents, the survey provided quantified data that was used in the potential water savings model.

Market Research – Household Audits

During the week of November 2nd 2009, the project team completed ten (10) household audits in Rankin Inlet. During the audits, it was determined that toilets had an average flush volume of 13.3 litres, showerheads had an average flow rate of 12.0 litres per minute, kitchen faucets had an average flow rate of 8.1 litres per minute and bathroom faucets had an average flow rate of 7.0 litres per minute. It was observed that in general, every water consuming fixture or appliance in the homes in Rankin Inlet provides a water saving opportunity ranging from 30% to 65% reductions. The data collected from the household audits were used in the potential water savings model.

Residential Water Use Demand Analysis

An analysis was completed to segregate water use into several categories, so that water use by single family properties, multi family units and the ICI sector could be identified. Customer billing data for the period from August 2006 to August 2009 was compared to:

- Rankin Inlet Business Directory provided by the Canada-Nunavut Business Service Centre
- Rankin Inlet House Numbering system Map, dated April 23rd 2002
- Satellite imaging of Rankin Inlet

The comparison was completed in order to identify the number of properties in each category, and to allocate a volume of use. Properties that were identified as residential housing but listed in the ICI sector was re-categorized as residential for the analysis.

Based on the data provided, a breakdown of the 2009 (Sept. 2008 to Aug. 2009) residential customer billed consumption is shown in the following Table 27.

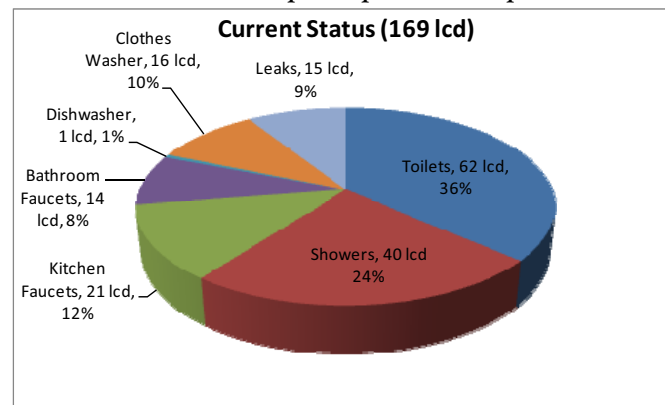
Table 27: Rankin Inlet 2009 Residential Customer Billed Consumption

Category	2009 Billed (litres)	Population 2009 est.	Water Use – Litres per Capita per Day (Lcd)
Residential	111,544,000	2,499	122

The billing analysis indicated that 75% of the overall billed water is to the residential sector. In addition using an estimated 2009 population of 2,499, the residential per capita consumption was 122 litres per capita per day (Lcd). A relatively low residential per capita consumption was expected in Rankin Inlet since there is minimal outdoor water use. However, the excessive water using fixtures and appliances found in the market research would indicate that the residential consumption should be significantly higher than what was indicated from the billing data. It was also observed that the age and technology (remote read) of the residential meters would support lower meter readings than the actual usage and the remote read technology could allow for unauthorized unbilled water use. Both of these factors were confirmed by GN CGS staff as concerns.

Using observations from the market research in addition to factors from the AWWA AWARF 1999 Residential End Uses Study, a residential water balance and a calculated per capita consumption was developed. The results of this calculation provided a residential per capita consumption of 169 Lcd. The water balance is shown below in Figure 10.

Figure 10: Calculated Residential per Capita Consumption and Water Balance



The calculated per capita consumption indicates that the actual residential consumption could be as much as 38% higher than that reported in the billing data. In order to compare this consumption level with other municipalities in Canada, and around the world, the following Figure 11 has been prepared:

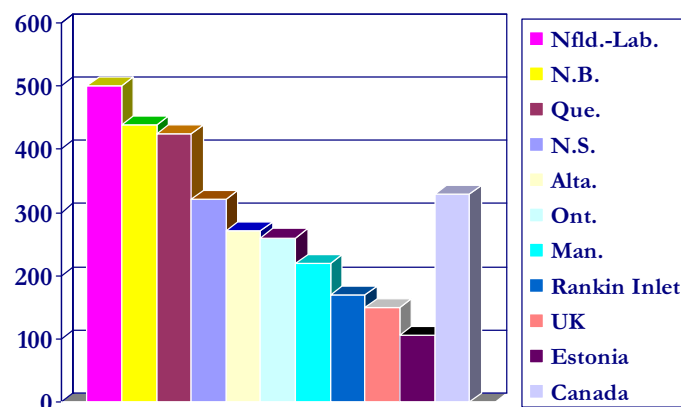


Figure 11: Comparison of Residential Per Capita Demand (lcd)⁵

⁵ Municipal Water Use Survey, Environment Canada, 2004.

Prior to 1994, toilet flush volumes were generally 20 litres or greater. The National Building Code or the National Plumbing Code does not address water conservation and as such do not provide required toilet flush volumes. In December 1995, the Government of Nunavut released its 2nd Edition of the Good Building Practices Guidelines. The Guidelines was provided as a supplement to the National Building Code to assist builders and developers with the construction in a northern climate. It is recommended that the GN considers updating the 1995 Guidelines with current proven water efficiency products such as high efficiency toilets and dual flush toilets in addition to lower flow rated showerheads and faucets. Such an update would ensure that all newly constructed homes would be as water efficient as possible.

Industrial, Commercial and Institutional (ICI) Water Use Demand Analysis

According to the 2009 billing data provided, the industrial, commercial and institutional (ICI) sector represents approximately 25% of Rankin Inlets' bill water consumption. In 2009, the volume of billed water to the ICI sector was 35,128,000 litres, which is 30% more than 26,962,000 litres billed in 2008.

Further investigation of the billing data for 2009 produced the following discrepancies:

- Polar Bear Investments c/o Nanqu Inn – 7,842,000 litres additional in 2009
- Community & Government Services, Kivalliq – approximately 3,000,000 litres additional in 2009
- Rankin Inlet Airport – approximately 1,500,000 litres additional in 2009

The additional water volume represented by these 3 accounts more than offset the increase in water volume in 2009. In addition, similar to the residential water meters as large mechanical meters get older they tend to under-register due to wear. Due to the discrepancies in the billing data the confidence in the accuracy of the ICI billed water consumption is extremely low.

Further analysis of 2009 billing ICI billing data indicates that 35% of the customers consume 80% of the overall water for that sector. For the purpose of this analysis, it was assumed that the 2008 ICI billed volume of 26,962,000 litres was more representative and as such used as the corrected 2009 ICI volume.

Evaluation of Distribution System Water Loss

It is recommended that the water distribution loops be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage” or the flow at night that is expected, which is based on the following:

- Length of mains
- Average water pressure
- Number of customer services
- Number of hydrants
- Average number of people per house

With this information, the Legitimate Night Flow can be calculated in a. This legitimate night flow is the sum of flows, or losses from:

- Mains
- Public side of the customer service (main to curb stop)
- Private side of the customer service (curb stop to house)
- Residential night use (usually the largest number)
- Exceptional night use (institutional, commercial, industrial - ICI)

In DMA loops where the measured flow at night is significantly higher than the Legitimate Night Flow, these areas would then be targeted for acoustic leak detection.

It is likely that initially all the loops in Rankin Inlet will have measured flows significantly higher than the Legitimate Night Flow, because of the existence of bleeders, and leaks that may have been running for some time. When DMAs are introduced for the first time in water distribution systems it is common for the flows to be high. The initial tasks are often to identify and eliminate this “backlog” of losses, to reduce water loss to economic levels.

It is recommended that six DMAs be established, as follows:

Area 5 DMA Loop

Install a flowmeter on the Area 5 supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building at the side.

Install a flowmeter on the Area 5 return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe

Nuvuk DMA Loop (Area 6)

In the chamber just outside the entrance door to Williamson Lake Pump House, install a flowmeter on the Area 6 supply pipe

Install a flowmeter on the Area 6 return pipe, which is located in a chamber in the system where the return pipes for Areas 1 and 2 combine – there is then a common return pipe to Williamson Lake Pumphouse for Areas 6, 1, 2.

Town DMA Loop 1 (Area 1)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 1 main

Install a flowmeter on the Area 1 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pumphouse.

Town DMA Loop 2 (Area 2)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 2 main

Install a flowmeter on the Area 2 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pump House.

Kivalliq DMA Loop

Install a flowmeter on the Kivalliq supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building.

Install a flowmeter on the Kivalliq return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe

DMA Town Supply

Because the Town Supply also is the feed pipe for Areas 1 and 2, the DMA flow will be calculated from the flows at other meters, as follows:

Town Supply = Existing common delivery main mag meter, minus metered flows for all other loops.

There is no return for the Town Supply, as it feeds Areas 1 and 2, which have return mains

Mains Between Nipissar Lake Pump House and Williamson Lake Pump House

As a future phase of the flow monitoring program, flow meters could be installed at both ends of the two watermain between Nipissar Lake Pump house and Williamson Lake Pump House

Once the loops with high water losses have been found, the next stage is to identify where the losses are and remove them. In Rankin Inlet the two main areas of losses are bleeders, and leaks on the watermain or services. There are generally two ways to do this, which are:

- For short periods of 5 minutes at night, close small sections of watermain on a loop, and record the drop in flow. For Rankin Inlet distribution system that would involve subtracting the return flow from the supply flow of the loop. ***This method is not recommended*** because when the section of the loop is closed, there would be no water supplied to customers, and hence the recirculation pumps on each customer service pipe would be running dry.
- ***Recommended*** - Use acoustic methods to listen for water loss noises in the loop. This would be a two phased approach of firstly establishing a small area which is “noisy”, with at least two fittings, but preferably more, with noise – this gives the “General Area of Losses”. Then secondly, from these noisy fittings “Pinpoint the Leak / Losses” – put the cross on the ground for a leak, or identify a customer service or watermain that is bleeding water to waste.

Because the watermain are a mixture of HDPE and PVC, which do not transmit leak noise as well as metallic pipes (cast iron, ductile iron), as many contact points as possible must be used to listen for leak noises. In addition, it is understood that the curb stop valves have a thermal insulating break, which also acts as an acoustic break, so that will make it more difficult to hear leaks from the curb stops.

If the water loss is a bleeder at a water service the pinpointing will indicate a loss at the corporation stop / curb stop of the service. Once this is identified, staff can investigate the bleeder further.

Although customers have to obtain a bleeder permit, all of them may not have done so. Once the bleeder is identified, steps can be taken to assist the customer to correct the problem on the services, and ensure that the recirculation system is put back into operation.

For bleeders on the water distribution system, they will be initially identified as leaks, if they are not already known. Depending on the location and function, the following measures should be considered:

- For all locations, complete a calculation of the approximate volume of water in the mains that are being kept fresh. Then calculate the flow rate required to exchange that volume of water in say 24 hours, or other agreed time period
- Shut off the bleeder, or
- Reduce the flow rate, or
- Install an automatic flushing device, or
- Where possible, for branches left open, install a flowmeter

Acoustic Listening Devices

It is recommended that an electronic listening device be used which includes a listening stick and a ground microphone. The kit also includes a processing unit with display, and headphones.

Leak Noise Loggers

In addition to the acoustic listening equipment, leak noise loggers can be used. They normally come in sets, and depending on manufacturer, can be typically be in sets of 6, 12, 15. The loggers are attached to contact points on the watermain, such as valves and hydrants, and are normally left in position for between one and three days, depending on manufacturer. The options for downloading the loggers include manual retrieval; drive by radio reading; and a fixed network radio system where the data is transmitted to an office computer.

If noise loggers are to be employed, it is recommended that a set of about 12 be used initially to see how applicable they are to the Rankin Inlet water distribution system

Leak Detection Correlators

One leak noise correlator is required to pinpoint the leaks. There are effectively three main types, and their selection depends on customer preference and field conditions. The three main types of processor are:

- Stand alone units for use outside in most elements. Generally robust equipment for use outside
- Hand held PDA small units
- Units where the software is loaded onto laptop computer

It is further recommended that a set of Hydrophones be purchased to correlate for leaks via the body of water in the pipe.

For each of the distribution loops, in order to measure the volume of water supplied to customers and losses (leakage and bleeders), it will be necessary to measure the flow at the start of each individual loop, and measure the flow on the return of each loop. As described in section 3.2, some of the flowmeter locations are in the Williamson Lake Pump House, and some are in chambers in the water distribution system. A site survey will be required to establish the best meter required for the site conditions.

The flowmetering options that are recommended are as follows:

Electromagnetic (mag) Flowmeters

An electromagnetic flowmeter, similar to the two existing Unimag mag flowmeters. These meters are powered by mains electricity. For the locations where the meter is installed in the water distribution system chambers, battery powered meters can be used.

Insertion Flowmeters

Insertion magnetic flowmeters are recommended, which are battery powered and have an integral data logger for flow and pressure. These instruments are installed through 2 inch diameter “hot taps” (under pressure tapings), so no isolating of mains, and cutting of pipe is required. These meters will be applicable where there is not sufficient space to install a magnetic flowmeter, or where it is difficult to shut down the watermain.

Clamp on Ultrasonic Flowmeters

At locations where it is not desired to either cut the main to install a magnetic flowmeter, or install a “hot tap”, then a clamp on ultrasonic flowmeter can be used.

It is recommended that the flowmeters be calibrated annually, and a tag detailing the calibration date be attached to the flowmeter. The frequency of calibration of the other instruments should reviewed, and calibration completed as recommended by the manufacturers.

Development of Specifications for Leak Reduction Equipment

As part of this assignment, the consultant prepared a specification for leak reduction equipment. The purpose of the specification is to be used in a tendering process by the Government of Nunavut. The specification in its entirety can be found in Appendix A of this report.

AWWA/IWA Water Audit and Water Balance

As part of the Government of Nunavut’s (GN) ongoing water loss management program, GN completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System. The project was completed for a full year from August 2008 to August 2009, based on available billing data. A copy of the report in its entirety can be found in Appendix B of this document.

The gathered data for 2009 was entered into the AWWA – WLCC (Water Loss Control Committee) software program. The results of the analysis are shown as follows:

Parameter	Value for 2009
Current Annual Real Losses (CARL)	145,000,000 litres
Unavoidable Annual Real Losses (UARL)	14,000,000 litres
Infrastructure Leakage Index (ILI)	10.17
System Input Volume	428,000,000 litres
Revenue Water (corrected for estimated accuracy of billing system)	181,000,000 litres
Non-Revenue Water	247,000,000 litres
Volume of Non-Revenue Water - % of System Input Volume	57.7%

The financial results from the IWA software analysis are shown below:

Parameter	Value
<u>Annual Cost of Apparent Losses</u>	\$52,215
Customer meter under registration	
Unauthorised consumption – based on estimated customer water and sewer rate of \$4.50 per 1,000 litres	
<u>Annual Cost of Real Losses</u>	\$50,798
<u>– Variable Production Cost</u>	
Based on estimated cost of \$0.35 per 1,000 litres	

In any water system there will be a volume of leakage that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair – this is the Unavoidable Annual Real Losses (UARL). The IWA software uses the physical characteristics of the water distribution system (length of water mains and services, number of connections, average pressure) to make an estimate of UARL. The Current Annual Real Losses (CARL) are also calculated by the software, by taking the water supplied and deducting the calculated authorized consumption and apparent losses, to give CARL. The ratio of UARL to CARL is the Infrastructure Leakage Index (ILI).

The World Bank Target Matrix gives performance category A for an ILI 1 - 2; category B for ILI 2 – 4; category C for ILI 4 – 8; and category D for ILI greater than 8.

The Hamlet of Rankin Inlet Water System's ILI of 10.17 puts them in performance D category – very inefficient use of resources; leakage reduction programs imperative and high priority

Although operational and financial considerations may allow a long term ILI greater than 8.0, such a level of leakage is not an effective utilisation of water as a resource. The priority for the Hamlet of Rankin Inlet Water System should be to develop an active leak detection program to reduce water losses, and reduce the ILI to initially below 8.0, and then progressively reduce it further till it is in performance category B.

At the Lake Nipissar Pump House there are a number of meters, which include Signet paddle wheel meters and one Unimag electromagnetic. It is recommended that the Unimag meter be set up to record and save the daily total volumes abstracted, and these values be used for the total water abstracted. Locally it has been set up to manually record the total flow in the record book at the pump house.

An on site in-situ test procedure can be completed for some manufactured mag meters, so this should be investigated, to see if it is available for the Unimag meter. Testing could include primary coils/electrodes/circuitry, cables, full electronic check.

For the Hamlet of Rankin Inlet, which has relatively old customer meters, the estimated overall customer under-registration was 5%, which represents a loss in billable volume of 9,057,000 litres per year. To determine a more accurate estimate of meter accuracy, it is recommended that a random sample of meters be removed and tested. A sample of 217 meters will give an error margin of 5%, with a 95% confidence level in the data.

Normally this type of random sampling and testing of customer meters is completed for the smaller 5/8" residential meters. Testing these residential meters should typically be repeated every 5 to 10 years, using a statistically valid sample of meters.

For the larger ICI meters, they should be tested more frequently than residential meters, because of the larger volumes being measured and the associated revenue. Testing of ICI meters should be as frequent as once every year for the very large volume meters, and between every 2 to 5 years for the remainder.

The methodology to identify and reduce water loss that is recommended, is a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, "Water Audits and Loss Control Programs". In the M36 manual, this flow based method of identifying areas with leakage is called "District Meter Areas – DMAs".

The Rankin Inlet water supply and distribution system is complex with its method of operation including return loops on the distribution mains, and return loops on the customer service lines. There is also the added operational need to maintain water temperatures above a level that will prevent freezing in both the distribution mains and customer services.

Leakage can be split into three types; namely:

- Leakage from Reported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Passive Leak Detection and Repair
- Leakage from Unreported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Active Leak Detection and Repair
- Background Leakage (composed of primarily weeps from joints and gaskets rather than holes in pipes) – utility activity often referred to as Active Leakage Reduction

One of the most reliable and long established methodologies to help identify water loss is to split the network into small sectors often referred to as District Meter Areas (DMAs). Where possible areas are designed so that they can be fed through one metered water feed throughout the day and night, although because of fire flow requirements, sometimes two feeds are required.

In these DMAs the flow entering the area, and key pressures are data logged, typically for a seven day period. The estimated legitimate night use is estimated, and compared with the measured night flow, which identifies areas with potential leakage, and the approximate volume of that leakage.

By operating the Temporary DMAs, the system backlog leaks can be identified and repaired.

In the process of operating the Temporary DMAs, flow and pressure logged data will be gathered, and along with the number and volume of leakage found, potential areas for converting to Permanent DMAs can be established. If some of the DMAs have high pressure, or significant pressure variations, then they can be considered for Pressure Management.

As summary of the operation of the types of DMAs is provided as follows:

- *Temporary DMAs*, where they are typically operated for a seven day period initially, and the flows at night, between 2.00 and 4.00 am (Minimum Night Flow - MNF) are compared to what flow would be expected from the area. Only in areas of high MNF are leaks looked for in a two step process – step one, narrow the leak down to the General Area of the leak, and step two, Pinpoint the leak (blue cross on the ground). There are a number of methods employed to find the general area of leak, which include night time step testing, when sections of the DMA are closed off for short periods, and the change in flow at the DMA flowmeter inspected for high drops in flow, indicating a potential leak. Another method to find the general area of the leak is to use noise loggers, which listen for leaks. Finally the leak is pinpointed using leak noise correlators, and ground microphones to confirm the location of the leak.
- *Permanent DMAs used for Leak Notification*, where the DMA is permanently isolated from the rest of the distribution system, and night time flows monitored on a daily basis. When the Minimum Night Flow (MNF) reaches a predetermined level (Entry Level), then leak detection is completed in that DMA – General Area of the leak, and Pinpointing the leak. Leak detection and repair is continued until the leakage has been reduced to an acceptable amount (Exit Level), as recorded on the permanent DMA flowmeter.
- *Permanent DMAs used for Leak Notification and Pressure Management*, where in addition to the leak detection activities, pressure management is introduced. This is completed by installing a Pressure Reduction Valve (PRV), which is used to control the pressure so the at “off peak” demand times, the pressure is not allowed to increase, and a less variable pressure is delivered to the DMA. This method of operation has the dual benefit of reducing Background Leakage (small leaks that are not economic to find and repair), and also reduces main breaks.

Identification and Evaluation of Water Efficiency and Conservation Measures

Over twenty-five water efficiency measures practised around the world were screened for their applicability in Rankin Inlet. Twelve measures passed the technical, potential, achievable, social, environmental feasibility tests.

Utilizing a spreadsheet model (see Appendix C), water savings and implementation costs were derived for each measure displayed on the short list. The savings and costs were then used to determine the cost effectiveness of each measure. The cost-effectiveness of a measure, or its cost/benefit ratio, is determined by comparing the program cost to the cost of future infrastructure expansion to deliver a similar quantity of water. The water savings for each measure was determined using a number of resources from engineering estimates to actual verified results from water efficiency programs in North America. Much information was gathered from programs that have been implemented and monitored for the last five to ten years in the Region of Waterloo, Region of York and the City of Toronto.

Depending on the measure and delivery mechanism program costs may include; equipment, installation, rebates, training, program marketing and project management as applicable. Based on related program costs a cost per litre of water per average day saved was determined for each conservation and efficiency alternative. This cost was then compared to the cost of constructing additional infrastructure to gain one litre per average day of additional water and wastewater capacity. It is important to note that calculated cost relating to construction of an additional litre of water and wastewater capacity does not include the cost of debt financing of construction projects. It is also important to note, that this figure does not include the cost of additional infrastructure required for the distribution/conveyance of water and wastewater to and from newly serviced areas such as water/wastewater mains, pumping stations or system reservoirs. In southern Ontario, the combined water and wastewater construction cost per litre per average day of additional capacity

ranges from approximately \$2.00 to \$8.10. Without additional data, the consultant has assumed that the costs in Rankin Inlet are 2 times that of southern Ontario or a range of \$4.00 to \$16.20. For the purpose of this financial analysis the combined water and wastewater construction cost of \$8.00 per litre per average day of additional capacity was utilized.

The outcome of the financial analysis is shown in the following Table 28. The measures that did not pass the financial test are highlighted in yellow.

Table 28 Results of Financial Screening of Water Efficiency Measures

Residential	Water Efficiency Measure	Cost per Participant	Savings per Participant (L/d)	Cost per litre
Installation	HET Toilets	\$ 1,014	139	\$ 7.31
Installation	Dual Flush Toilets	\$ 1,024	139	\$ 7.38
Installation	Low Flow Showerheads	\$ 133	54	\$ 2.44
Installation	Kitchen Faucets	\$ 71	20	\$ 3.52
Installation	Bathroom Faucets	\$ 64	24	\$ 2.70
Installation	Leakage Repair	\$ -	56	\$ -
Installation	Clotheswashers	\$ 1,250	19	\$ 67.57
ICI				
Installation	HET Toilets	\$ 7,381	375	\$ 19.68
Installation	Dual Flush Toilets	\$ 7,631	375	\$ 20.35
Installation	Pre-Rinse Spray Valves	\$ 1,450	368	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	\$ 72,250	15,000	\$ 4.82
Municipal				
Installation	Leakage Reduction	\$ 55,000	57,500	\$ 0.96

Three measures including residential clotheswashers, ICI HET toilets and ICI dual flush toilets did not pass the financial screening but are recommended to remain on the short list for inclusion in the strategy. These measures provide substantial water savings and their inclusion provides a comprehensive strategy. As demonstrated in the next section, the inclusion of these three measures does not affect the overall cost-effectiveness of the strategy.

Strategy Implementation Plan

The recommended components of the plan include:

Residential Measures

- Visit all homes and apartments and install free of charge HET or dual flush toilets, low flow showerheads, kitchen aerators, bathroom aerators and water efficient clotheswashers. To eliminate toilet leakage in homes, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.

Industrial/Commercial/Institutional Measures

- Visit all businesses and institutions and install free of charge HET or dual flush toilets. To eliminate toilet leakage in businesses, it is recommended that only “flapperless” type toilets be installed. These are proven products and readily available in the market.
- Visit commercial kitchens and install free of charge low flow pre-rinse spray valves.

- Complete five (5) comprehensive water audits and offer a capacity buy-back rebate to any facility that implements all or some of the water saving recommendations.

Municipal Measures

- Design and implement five (5) district meter areas. Locate, quantify and repair the leakage within the water distribution system.

Public Education

- Distribution of booklets, leaflets, and fact sheets at community and environmental events.
- Distribution of a water efficiency bulletin in the water bills.
- Displays at community events.
- Develop and maintain a website to educate the public on water efficiency.
- Provide workshops and seminars to the public on water saving techniques both inside and outside the home.

Youth Education

- Develop and deliver a water efficiency education program based on curriculum requirements.
- Develop and facilitate a Children's Water Festival.

For reference individual business cases for each recommended water conservation and efficiency measures are provided in Appendix D of this report.

15.1 Table 29: Capital Budget and Water Savings (Litres per average day)

Residential	Water Saving Measure	Number of Product Installed	Total Cost	Total Program Savings (L/d)	Cost per litre
Installation	HET Toilets	768	\$ 707,921	96,903	\$ 7.31
Installation	Dual Flush Toilets	85	\$ 79,434	10,767	\$ 7.38
Installation	Low Flow Showerheads	854	\$ 103,208	42,246	\$ 2.44
Installation	Kitchen Faucets	776	\$ 55,096	15,644	\$ 3.52
Installation	Bathroom Faucets	854	\$ 49,664	18,376	\$ 2.70
Installation	Leakage Repair	854	\$ -	43,068	\$ -
Installation	Clotheswashers	776	\$ 970,000	14,356	\$ 67.57
Industrial, Commercial, Institutional					
Installation	HET Toilets	357	\$ 329,486	16,740	\$ 19.68
Installation	Dual Flush Toilets	40	\$ 37,850	1,860	\$ 20.35
Installation	Pre-Rinse Spray Valves	15	\$ 14,500	3,680	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	5	\$ 72,250	15,000	\$ 4.82
Municipal					
Installation	Leakage Reduction	5	\$ 275,000	287,500	\$ 0.96
Education					
Public Education (5 years)			\$ 150,000		
Youth Education (5 years)			\$ 180,000		
TOTAL			\$ 3,024,408	566,140	\$ 5.34

It is recommended that the above capital plan be supported by ongoing monitoring, evaluation and maintenance in order to initially verify the water savings and then to sustain them into the future.

The overall best practices capital program is budgeted at \$3,024,408 and is expected to save just over 566,000 litres of water per average day (l/d).

The cost per litre per day for the proposed plan is \$5.34. This compares well to the average cost per litre per average day capacity for new infrastructure, which is estimated at \$8.00. To add new water and wastewater infrastructure to deliver the equivalent capacity of 566,000 l/d would cost \$4.5 million based on the average \$8.00 per litre capacity cost.

Although some program measures did not meet the cost analysis, which includes clotheswashers, ICI HET toilets and ICI dual flush toilets, these program alternatives have been included due to the significant savings that they bring to the overall plan. However, it is important to note that even with the inclusion of these programs the overall plan remains more cost-effective than the cost of constructing future water and wastewater supply/treatment capacity.

Due to the difficulty in measuring water savings generated by education, there have been no savings attributed to the Broudscale Public or Youth Education programs in the plan. Technical solutions, such as low flush toilets and low flow showerheads will only achieve a portion of the potential water savings. Education designed to change habits and attitudes or residents towards water use will achieve the remaining savings. The American Water Works Association suggests that education programs can generate up to a 4 to 5% reduction in water demand by long-term education initiatives. In addition, education is necessary to ensure that water savings generated by the capital program are sustained. Since, education should be ongoing, 5 years of costing has been included.

Overall Water Savings

The overall water savings anticipated from the implementation of the recommended strategy is shown in Table 30 below.

Table 30: Overall Water Savings

Sector	litres/day	litres/year
Residential	241,360	88,096,000
ICI	37,280	13,607,000
Municipal	287,500	104,938,000
Total	566,140	206,641,000

The water saving plan will free up 206,641,000 litres/year of water supply capacity. This represents 61% of the total water supplied in 2009.

In addition to providing water supply capacity, the plan will reduce demand on the wastewater system by 101,703,000 litres/year.

Residential

The water savings attributed to the residential sector was compared against 2009 billed consumption and the residential water balance that was developed. Results of this comparison are shown in Table 31.

Table 31: Comparison of Residential Savings and 2009 Residential Consumption based on Billing Data and based on Water Balance

Residential Sector	Per Capita Consumption (Lcd)	Residential Consumption 2009 (litres)	Residential Water Savings (litres)	Percent Savings
As per Billing Data	122	111,544,000	88,096,000	79%
As per Water Balance	169	154,151,000	88,096,000	57%

Industrial, Commercial and Institutional

The water savings attributed to the ICI sector was compared against 2009 billed consumption. Results of this comparison are shown in Table 32.

Table 32: Comparison of ICI Savings and 2009 ICI Billed Consumption

ICI Sector	Corrected ICI Consumption 2009 (litres)	ICI Water Savings (litres)	Percent Savings
As per Billing Data	26,962,000	13,607,000	50%

Municipal

The water savings attributed to the Municipal leakage reduction program was compared against the water loss identified from the AWWA/IWA Water Audit and Water Balance results. Results of this comparison are shown in Table 33.

Table 33: Comparison of Municipal Savings and Water Loss Results

Municipal Sector	Estimated Water Loss 2009 (litres)	Municipal Water Savings (litres)	Percent Savings
As per Billing Data	145,000,000	104,938,000	72%

Maintenance

Water savings generated from the efficiency program should be viewed in the same manner as constructing a new water treatment facility. If the Hamlet of Rankin Inlet were to design and build new infrastructure to deliver 566,000 l/d, a budget for a maintenance program would be included to ensure that the facility continues to deliver 566,000 l/d in the future. The Hamlet's water conservation and efficiency strategy is no different. If it was designed to save 566,000 l/d, maintenance would be required to sustain the savings into the foreseeable future.

Water efficiency has been identified as a viable cost-effective supply of water. Maintenance will be essential to ensure that the savings are sustained. Each component of the water efficiency strategy should have three

basic elements; tracking of activity, savings validation and finally maintenance of products and services provided. The elements included in the maintenance program would include:

Residential Sector

Significant water savings products will be installed by Rankin Inlet's water conservation and efficiency strategy. These products should be maintained through a "pick-up" service. If a resident or business requires a replacement part they simply stop by the customer service centre that would provide the appropriate parts directly to the customer.

Industrial/Commercial/Institutional Sector

In addition to maintaining the products installed in small commercial businesses it is anticipated that 1 ICI customers will participate in the water saving audits and capacity buy-back program. Over the course of the plan, a consultant who will be similar to a key-account manager will visit each of the facilities periodically. The purpose of the visit will be to ensure that the water measures implemented are still in place and still providing savings as designed. In addition the consultant will meet with the facility staff to ensure proper operating procedures design to achieve maximum savings are being practiced. The budget allows for 1 site visit per year during a five year period.

Distribution Leakage Reduction

It is recommended as good practice to complete an AWWA / IWA Water Audit and Water Balance every year – this is often referred to as the "Top Down" approach to water loss management.

It is also recommended that the temporary District Meter Areas (DMAs) be operated on a regular basis, which can be either every year, or every two to three years. It is also recommended that with the information gathered as part of the operation of the temporary DMAs, that consideration be given to establishing permanent DMAs, for either continuous water loss monitoring, or the next stage of flow modulation to reduce background leakage (small leaks that are not economic to find and repair). The DMA approach is often referred to as the "Bottom UP" approach.

The maintenance budget has been established to accommodate two (2) DMA maintenance runs in year 3 and three (3) in year 4. This will ensure that no DMA goes without maintenance for more than three years.

The recommended maintenance budget is found in Table 34 below.

Table 34: Recommended Maintenance Budget

Five Year Maintenance Plan	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	Costs	Costs	Costs	Costs	Costs	
Residential	\$ 17,107.69	\$ 18,215.38	\$ 22,646.14	\$ 25,969.21	\$ 29,292.28	\$ 113,230.70
Industrial/Commercial/Institutional	\$ 12,437.00	\$ 12,874.00	\$ 22,122.00	\$ 23,433.00	\$ 27,704.00	\$ 98,570.00
Distribution Leakage Reduction				\$ 60,000.00	\$ 90,000.00	\$ 150,000.00
Total	\$ 29,544.69	\$ 31,089.38	\$ 44,768.14	\$ 109,402.21	\$ 146,996.28	\$ 361,800.70

Monitoring and Evaluation

In the residential and small commercial markets it is recommended that on-site monitoring be carried out 30 days before the measure installation and 30 days after the measure has been installed. Monitoring can be accomplished with the installation of data loggers on the water meters. These units are small and unobtrusive. The data logging study will verify the actual savings attributed to the water saving measures. This analysis should be completed in the first year of the capital program to verify the expected water savings.

Also of importance is the ongoing monitoring for persistence or sustainability. All products wear out or fail in time. Participants may have the tendency to install a high water consuming device when their water saving device fails. This may happen due to lack of knowledge or the availability of water saving products at retail stores. In order to measure this erosion in savings it is recommended that statistically valid audits of participants be carried out throughout a five year period. The auditor would visit the home or business and inspect the water savings products that were installed. The auditor would observe if the products are still installed, working properly and saving water. Audits could be completed in Year 5.

The Table 35 below provides the monitoring and evaluation by year for the five year period.

Table 35: Monitoring and Evaluation Budget

Five Year Monitoring and Evaluation Plan	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	Costs	Costs	Costs	Costs	Costs	Costs
Residential	\$ 157,500				\$ 30,000	\$ 187,500
Industrial, Commercial and Institutional	\$ 78,000				\$ 7,200	\$ 85,200
Total	\$ 235,500	\$ -	\$ -	\$ -	\$ 37,200	\$ 272,700

The Table 36 below provides the activities to be undertaken from the Monitoring and Evaluation plan.

Table 36: Recommended Monitoring and Evaluation Activity

	Number of Participants to be Monitored	Number of Persistence Audits in Year 5
Residential		
HET Toilets	30	125
DF Toilets	15	25
Clothes Washers	30	150
Showers, Faucets, Leakage	30	150
Industrial, Commercial and Institutional		
HET Toilets	20	60
DF Toilets	10	20
Pre Rinse Spray Valves	10	10
Capacity Buy Back	Included in Capital Program	

It is important to note that the long-term costs of water savings monitoring could be drastically reduced with the introduction of automated meter ready (AMR) technology in place of the collection of the Hamlet's current customer water use reading system. The introduction of AMR technologies would provide the utility with enhanced customer water use data (based on the frequency of water use reporting) and added customer services tools to proactively identify private side leakage or meter reading errors. With the introduction of this technology it is expected that the required monitoring program would be less labour intensive for staff and be less intrusive for sites being monitored through the process.

Energy Savings and Greenhouse Gas Emissions Reductions

The overall energy savings generated from water efficiency is in most cases more significant than the water savings. Water utilities are typically the largest consumer of electricity in a municipality. Electricity is used in the water and wastewater treatment processes but more significantly in the pumping/conveyance of water and wastewater. A recent study⁶ completed by the Polis Project on Ecological Governance, University of Victoria evaluated historical data relating to water production and energy consumption from 7 municipalities in Ontario. The study completed case studies on the Town of Collingwood, the Regional Municipality of Durham and the City of Guelph. The study reported, that it takes 0.68 KWh of electricity for 1,000 litres of water delivered to a customer and then returned through the wastewater process. The findings from this study were used to develop the energy savings and greenhouse gas emission reductions reported below.

Many of the water saving measures recommended in the strategy also reduce energy consumption at the customer's premise. For example, a low flow showerhead reduces not only water but reduces hot water. Oil or electricity has been used by the customer to generate the hot water. Energy savings will also be generated from the faucet aerators, clotheswashers, pre-rinse spray nozzles and the ICI Audit program.

Typically a residential customer who participates in the water efficiency program will see greater dollar savings in their energy bill as compared to their water bill. This is also an important linkage to emphasize when promoting the water efficiency programs to the public.

The reduction of water-use through an efficiency program and the associated energy savings provides significant greenhouse gas reductions. With climate-change in mind, most municipalities have set their own greenhouse gas reduction targets. Water efficiency can be a positive contributor to meeting those targets.

Although the participant's energy savings were not quantified as part of this project, the utility energy savings and greenhouse gas emission reductions are provided in Table 37 below.

Table 37 – Estimated Energy Savings and Associated Greenhouse Gas Emission Reductions

	Water Savings per Year (litres/yr)	Energy Savings per Year	CO2 Reductions per Year (tonnes/yr)
Overall Water Savings	206,641,000	130,022 KWh Electricity	78.0 tonnes

Assuming an electric rate of \$ 0.35 per KWh, the Hamlet of Rankin Inlet would reduce its electrical bill by approximately \$45,858 per year upon completion of the strategy. In addition, the greenhouse gas emissions reduction is equivalent to removing 14 cars from the road.

Final Words

The implementation of the water efficiency strategy presented in this report will provide the Hamlet of Rankin Inlet with a significant amount of additional water supply capacity and waste water treatment capacity. This capacity, an estimated 566,000 litres per day, can be provided cost-effectively, at least 34% less costly than building new supply infrastructure. In addition, this additional supply capacity through water efficiency can be provided immediately without lengthy design and environmental assessment requirements.

⁶ Maas, Carol. Greenhouse Gas and Energy Co-Benefits of Water Conservation, Polis Discussion Series Paper 08-01, November 2008, Polis Project on Ecological Governance, university of Victoria, Victoria, BC.

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APPENDICES

A. Specification for Leak Reduction Equipment

B. AWWA/IWA Water Audit and Water Balance Report

C. Costs and Water Savings Model

D. Individual Program Descriptions

E. Nipissar Lake Volume Study and Environmental Variable Study

APPENDIX A

Specifications for Equipment for Water Loss Reduction

1.0 Introduction

The Government of Nunavut (GN), Department of Community and Government Services, is seeking quotations for Water Loss Reduction Equipment for the Hamlet of Rankin Inlet, Nunavut.

The equipment will be used to identify water loss in Rankin Inlet, and the methodology employed will be as recommended in the American Water Works Association (AWWA) Manual, M36, “Water Audits and Loss Control Programs”, which was published in May, 2009. The methodology is a flow based method of identifying areas with leakage is called “District Meter Areas – DMAs”.

The equipment must be suitable for operation in the cold climate of Rankin Inlet. In addition, warranties, delivery times, after sales support, and training in the use of the equipment are considered to be very important for GN.

2.0 Water Distribution System Description

The water distribution system consists of older buried Utilidors, and newer shallow buried mains. In order to prevent freezing the water distribution system water is tempered by adding heated water, and is recirculated back to Williamson Lake Pump House. If the return water temperature falls below a set limit, further heated water is added.

The older Utilidors consist of 150 mm PVC watermains housed with 150 mm PVC sewer mains, in 600 mm galvanised corrugated metal pipe. The Utilidor is covered with 50mm of rigid polyurethane foam insulation. The new mains are shallow buried and consist of High Density Polyethylene (HDPE) pipe with 50 or 75 mm of polyurethane insulation covered with “Yellow Jacket” and in some cases “Black Jacket”. Most watermains are 200 mm in diameter and are series 160 HDPE.

In order to prevent freezing in the supply pipes to customer properties, each water service has a flow and return pipe, normally located side by side in the ground. Inside the property a pump operates continuously to recirculate the tempered water back into the water main, which then recirculates the water back to Williamson Lake Pump House.

To provide access to the water distribution system, there are chambers located approximately every 100 metres. These chambers contain the connections of various watermains, and also have drain valves and air valves.

Tempered water is pumped to the five loops as follows:

- Town Loop 1 (Area 1)
- Town Loop 2 (Area 2)
- Nuvuk Loop (Area 6)
- Area 5
- Town Supply

In the Williamson Lake Pump House, the wet well pumps send water to a common delivery main which has a mag meter that records the total flow. The pressures in this common delivery main are controlled by a Pressure Reduction Valve (PRV). The loops are supplied as follows:

- Area 5 is supplied by a main passing across the top of the building from the common delivery main.
- A pipe is also connected to the common delivery main to supply Kivalliq.
- The common delivery main then leaves the pump house, and in a chamber outside the supply to Area 6 is connected.
- Water then flows along the Town Supply main, and after it passes the Hamlet offices, the Area 1 and Area 2 supply mains are connected in a chamber.

The water is then returned to Williamson Lake Pump House from the loops as follows:

- Area 5 enters at the back side of the building
- Areas 1, 2 and 6 are combined in a chamber, then returned to Williamson Lake Pump House in a single main

3.0 Methodology Description

3.1 District Meter Area (DMA) Loops

The distribution main loops are to be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage”, or the flow at night that is expected.

The six DMAs to be established, as follows:

Area 5 DMA Loop

Install a flowmeter on the Area 5 supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building at the side.

Install a flowmeter on the Area 5 return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe.

Nuvuk DMA Loop (Area 6)

In the chamber just outside the entrance door to Williamson Lake Pump House, install a flowmeter on the Area 6 supply pipe.

Install a flowmeter on the Area 6 return pipe, which is located in a chamber in the system where the return pipes for Areas 1 and 2 combine – there is then a common return pipe to Williamson Lake Pumphouse for Areas 6, 1, 2.

Town DMA Loop 1 (Area 1)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 1 main.

Install a flowmeter on the Area 1 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pumphouse.

Town DMA Loop 2 (Area 2)

In a chamber past the Hamlet offices, the water that is transmitted along the Town Supply then feeds Areas 1 and 2. Install a flowmeter on the Area 2 main.

Install a flowmeter on the Area 2 return pipe, which is located in a chamber in the system where the return pipes for Areas 1, 2 and 6 combine – there is then a common return pipe to Williamson Lake Pumphouse.

Kivalliq DMA Loop

Install a flowmeter on the Kivalliq supply pipe in Williamson Lake Pump House, between the wet well pumps delivery main, after the existing mag meter; and where the pipe leaves the building.

Install a flowmeter on the Kivalliq return pipe, where it enters the Williamson Lake Pump House, before the pipe joins the common return pipe.

DMA Town Supply

Because the Town Supply also is the feed pipe for Areas 1 and 2, the DMA flow will be calculated from the flows at other meters, as follows:

Town Supply = Existing common delivery main mag meter, minus metered flows for all other loops.

There is no return for the Town Supply, as it feeds Areas 1 and 2, which have return mains.

Mains Between Nipissar Lake Pump House and Williamson Lake Pump House

In the future, flow meters may be installed at both ends of the two watermains between Nipissar Lake Pump house and Williamson Lake Pump House.

3.2 Acoustic Leak Detection

Once the loops with high water losses have been found, the next stage is to identify where the losses are and remove them. In Rankin Inlet the two main areas of losses are bleeders, and leaks on the watermains or services.

Acoustic methods are to be used to listen for water loss noises in the loop. This is a two phased approach of firstly establishing a small area which is “noisy”, with at least two fittings, but preferably more, – this gives the “General Area of Losses”. Then secondly, from these noisy fittings “Pinpoint the Leak / Losses” – put the cross on the ground for a leak, or identify a customer service or watermain that is bleeding water to waste.

4.0 Equipment Specification

4.1 Leak Detection Equipment

Acoustic Listening Kit – One Set

Electronic listening device to include:

- Listening stick
- Ground microphone
- Processing unit with display
- Headphones
- Filter options for different frequency ranges, and different pipe materials
- Rechargeable batteries, with charging unit
- Carrying case

Leak Noise Loggers – 12 number, or standard kits

Leak Noise Loggers to include:

- Noise loggers
- Carrying case
- Software

Upto three downloading options:

- Manual download
- Radio reading with walk by / drive by unit
- Network to transmit data direct to office computer

Following the use of the noise loggers, additional units may be purchased if they are effective in finding water loss on the Rankin Inlet water distribution system.

Leak Detection Correlators – **One Number**

Leak Detection Correlator to include:

- Processing unit
- Two accelerometers
- Two hydrophones
- Two outstations
- Carrying case
- Software

Three main types of processor will be considered:

- Stand alone units for use outside in most elements. Generally robust equipment for use outside
- Hand held PDA small units
- Units where the software is loaded onto laptop computer

4.2 Flow Monitoring Equipment

Electromagnetic Flowmeters – **upto 14 units**

Electromagnetic flowmeters:

- For pipe diameters between 50 mm (2 inch) and 200 mm (8 inch) diameter
- Mains operated
- Give a battery operated option if available
- Data logger to be included – specify memory and other features
- Pressure monitoring and logging capability, if available
- Provide accuracy, flow range, approvals information

Insertion Flowmeters – **upto 6 units**

Insertion flowmeters:

- For pipe diameters between 50 mm (2 inch) and 300 mm (12 inch) diameter
- Electromagnetic, single point velocity meter
- Battery operated
- Flow data logger to be included – specify memory and other features
- Flow profiling software, if available
- Pipe diameter gauging rod
- Pressure data logger to be included – specify accuracy of pressure sensor
- Communication cables
- Software
- Provide accuracy, flow / pressure range, approvals information
- Include for on site installation of flowmeters at tapings provided by GN

Clamp on Ultrasonic Flowmeters – upto 14 units

Clamp on ultrasonic flowmeters:

- For pipe diameters between 50 mm (2 inch) and 300 mm (12 inch) diameter
- Mains operated
- Give a battery operated option if available
- Flow data logger to be included
- Pressure monitoring and logging capability, if available – specify accuracy of pressure sensor
- Communication cables
- Software
- Pipe thickness gauge
- Provide accuracy, flow / pressure range, approvals information
- Include for on site installation

5.0 Training Requirements

GN consider the training of staff in the use of the equipment to be critical. Provide the following training:

- Three days in total at Rankin Inlet for the Leak Detection and Flow Monitoring Equipment – if a different amount of time is required, please indicate and price accordingly
- Training to include classroom instruction and hands on use of the equipment on site
- Provide three sets of training manuals and materials

6.0 Support, Warranties, Delivery Times

Ongoing Support

Indicate the following in the quotation:

- Location of support staff
- Time from support request to response by phone / e mail
- Indicate if support weekdays only, or 7 days per week, and hours available
- Cost of ongoing support

Warranties

- Provide full details of warranties, including

Delivery Times

- Provide time from receipt of order to delivery

Quotation Form

Please provide a menu of equipment prices for specified equipment that GN will select from. It is anticipated that most of the leak detection equipment and up to 14 flowmeters will be purchased. Provide prices, excluding applicable taxes

Leak Detection Equipment

Item Description	Number	Price Each Item	Total Price
Acoustic Listening Kit	1		
Leak Noise Loggers	12		
Leak Detection Correlator	1		

Flow Monitoring Equipment

Item Description	Pipe Diameter	Number	Price Each Item	Total Price
Electromagnetic Flowmeter– Mains Power	50 mm	2		
Electromagnetic Flowmeter– Mains Power	100 mm	2		
Electromagnetic Flowmeter– Mains Power	150 mm	5		
Electromagnetic Flowmeter– Mains Power	200 mm	5		
Electromagnetic Flowmeter–Battery Power	50 mm	2		
Electromagnetic Flowmeter–Battery Power	100 mm	2		
Electromagnetic Flowmeter–Battery Power	150 mm	5		
Electromagnetic Flowmeter–Battery Power	200 mm	5		
Insertion Flowmeter	50 mm to 200 mm	6		
Clamp on Ultrasonic Flowmeter	50 mm to 200 mm	2		
Clamp on Ultrasonic Flowmeter	50 mm to 200 mm	6		
Clamp on Ultrasonic Flowmeter	50 mm to 200 mm	10		
Clamp on Ultrasonic Flowmeter	50 mm to 200 mm	14		

Training

Please provide the cost for training, to include preparation of all materials, three days training at Rankin Inlet (in classroom and on site), and all expenses (travel, accommodation, food etc).

If three days at Rankin Inlet is not appropriate, please provide additional information and quotation as well.

Item Description	Number	Price Each Item	Total Price
Training for 3 days at Rankin Inlet	1		

Information for GN

Sample of Leak Detection Manufacturers

Halma Water Management

Palmer Leak Detection Equipment

<http://www.hwm-water.com/>

Primayer

Primayer Aqua Technology Solutions

<http://www.primayer.co.uk/index.htm>

Gutermann International

<http://www.gutermann-uk.com/>

Fuji Tecom Inc

<http://www.fujitecom.com/>

Sewerin

<http://www.sewerin.com/en/about-us.html>

Sample of Flow Monitoring Manufacturers

Elster Metering

<http://www.elstermetering.com/>

ABB Metering

<http://www.abb.com/>

Endress + Hauser

<http://www.us.endress.com/>

Unimag Meter

<http://www.emcoflow.com/Documents/SL-UNIMAGNFP-350-01.pdf>

Halma Water Management

<http://www.hwm-water.com/>

Primayer

<http://www.primayer.co.uk/index.htm>

Appendix B

Government of Nunavut

**American Water Works Association (AWWA) / International Water Association
(IWA)**

Water Audit and Water Balance

For

Hamlet of Rankin Inlet Water System

Final Report

March, 2010

Table of Contents

	Page
Executive Summary.....	3
1.0 Introduction.....	9
2.0 IWA Water Audit and Water Balance Methodology.....	9
2.1 Unbilled Authorised Consumption.....	9
2.2 Apparent Losses.....	10
2.3 Real Losses.....	11
2.4 Definitions.....	11
3.0 Summary of Gathered Data.....	12
4.0 IWA Software Analysis.....	14
5.0 IWA Software Analysis Summary.....	16
6.0 Recommendations.....	17
6.1 Source Meters.....	17
6.2 Customer Meters.....	17
6.3 Water Loss Identification and Reduction Program.....	19
6.3.1 Summary of DMA Methodology.....	19
6.3.2 District Meter Area Loops.....	20
6.3.3 Bleeders on Customer Services and Distribution System	21

List of Appendices

- A. Hamlet of Rankin Inlet Water System 2009 Water Balance Questionnaire**
- B. Hamlet of Rankin Inlet Water System 2009 Gathered Data Spreadsheet**
- C. Hamlet of Rankin Inlet Water System 2009 IWA Software Analysis**

Executive Summary

Introduction

As part of the Government of Nunavut's (GN) ongoing water loss management program, GN completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System. The project was completed for a full year from August 2008 to August 2009, based on available billing data. A copy of the report in its entirety can be found in Appendix B of this document.

Completion of an IWA Water Audit and Water Balance is an integral part of the water loss management methodology, in the new AWWA Manual "M36 Water Audits and Loss Control Programs", which was published in May, 2009. An IWA Water Audit and Water Balance is considered to be the North American Best Management Practice (BMP) for water loss management, and is recommended that is completed annually.

The IWA Water Audit and Water Balance quantifies Revenue and Non Revenue Water, and identifies where to reduce water loss and increase revenue.

Summary of Gathered Data

A questionnaire was provided, and data gathered for the 2009 balance (August 2008 to August 2009). At the time of writing the draft report, there is still data that has not been provided by GN, so estimates of the values have been made. Once the data has been received, the analysis can be updated for the final report.

The data was entered into a series of spreadsheets and analysis completed to provided the totals required for the IWA software data entry. A summary of the "Old" Unaccounted For Water (UFW) percentage is shown in the table below. The volume accounted for as part of the IWA balance is included, and deducted from the traditional unaccounted for water volume, as shown in the table:

Item	Total Volume for 2009 (litres)
Total Water Supplied (corrected for accuracy)	427,770,000
Total Billed Consumption (corrected for estimated accuracy of customer meters)	190,200,000
IWA Accounted For Water	90,956,000
Unaccounted For Water	146,613,000
Unaccounted For Water (UFW) Percentage	34.3%

IWA Software Analysis

The gathered data for 2009 was entered into the AWWA – WLCC (Water Loss Control Committee) software program. The results of the analysis are shown as follows:

Parameter	Value for 2009
Current Annual Real Losses (CARL)	145,000,000 litres
Unavoidable Annual Real Losses (UARL)	14,000,000 litres
Infrastructure Leakage Index (ILI)	10.17
System Input Volume	428,000,000 litres
Revenue Water (corrected for estimated accuracy of billing system)	181,000,000 litres
Non-Revenue Water	247,000,000 litres
Volume of Non-Revenue Water - % of System Input Volume	57.7%

The financial results from the IWA software analysis are shown below:

Parameter	Value
<u>Annual Cost of Apparent Losses</u> Customer meter under registration Unauthorised consumption – based on estimated customer water and sewer rate of \$4.50 per 1,000 litres	\$52,215
<u>Annual Cost of Real Losses</u> <u>– Variable Production Cost</u> Based on estimated cost of \$0.35 per 1,000 litres	\$50,798

IWA Software Analysis Summary

In any water system there will be a volume of leakage that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair – this is the Unavoidable Annual Real Losses (UARL). The IWA software uses the physical characteristics of the water distribution system (length of water mains and services, number of connections, average pressure) to make an estimate of UARL. The Current Annual Real Losses (CARL) are also calculated by the software, by taking the water supplied and deducting the calculated authorized consumption and apparent losses, to give CARL. The ratio of UARL to CARL is the Infrastructure Leakage Index (ILI).

The World Bank Target Matrix gives performance category A for an ILI 1 - 2; category B for ILI 2 – 4; category C for ILI 4 – 8; and category D for ILI greater than 8.

The Hamlet of Rankin Inlet Water System's ILI of 10.17 puts them in performance D category – very inefficient use of resources; leakage reduction programs imperative and high priority

Although operational and financial considerations may allow a long term ILI greater than 8.0, such a level of leakage is not an effective utilisation of water as a resource. The priority for the Hamlet of Rankin Inlet Water System should be to develop an active leak detection program to reduce water losses, and reduce the ILI to initially below 8.0, and then progressively reduce it further till it is in performance category B.

Recommendations

Source Meters

At the Lake Nipissar Pump House there are a number of meters, which include Signet paddle wheel

meters and one Unimag electromagnetic. It is recommended that the Unimag meter be set up to record and save the daily total volumes abstracted, and these values be used for the total water abstracted. Locally it has been set up to manually record the total flow in the record book at the pump house.

An on site in-situ test procedure can be completed for some manufactured mag meters, so this should be investigated, to see if it is available for the Unimag meter. Testing could include primary coils/electrodes/circuitry, cables and full electronic check.

Customer Meters

Rankin Inlet has customer water meters which are manufactured by Neptune. The meters are an older style, and when they were installed had a wire fixed from the meter register to the outside of the property. On the end of this wire was fitted a remote register, which has numbers which can be read by the meter reader. This type of remote, or ‘generator remote’ works by the internal meter register sending a signal to change the remote register. They are prone to missing registrations, so that the remote register, which is typically used for billing, records a lower consumption than has actually passed through the water meter.

Some of these old remote registers have been replaced by a more modern “touch pad”, which is simply a device to send a signal to the internal meter register and obtain the reading. So, the actual internal meter reading is collected.

Furthermore, in the south part of Area 1, new meters with radio read technology have been installed. These meters have a radio transmitter installed either on the meter, or very close to the meter, inside the property. The meters are read with a hand held device, that can receive the meter reading at a distance from the property – it can be driven along each street to obtain the readings if required.

The recorded metered consumption is likely to be less than the actual water produced, for the following reasons:

- Generator remotes recording a lower consumption than the water meter register
- Remote register wires broken
- Customers disconnecting remote wire
- Customers removing water meter and piping through
- Water meter under-registering – most meters under-register as they age

For the Hamlet of Rankin Inlet, which has relatively old customer meters, the estimated overall customer under-registration was 5%, which represents a loss in billable volume of 9,057,000 litres per year. To determine a more accurate estimate of meter accuracy, it is recommended that a random sample of meters be removed and tested. A sample of 217 meters will give an error margin of 5%, with a 95% confidence level in the data.

Normally this type of random sampling and testing of customer meters is completed for the smaller 5/8” residential meters. Testing these residential meters should typically be repeated every 5 to 10 years, using a statistically valid sample of meters.

For the larger ICI meters, they should be tested more frequently than residential meters, because of the larger volumes being measured and the associated revenue. Testing of ICI meters should be as frequent as once every year for the very large volume meters, and between every 2 to 5 years for the remainder.

Active Leak Detection

The methodology to identify and reduce water loss that is recommended, is a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, “Water Audits and Loss Control Programs”. In the M36 manual, this flow based method of identifying areas with leakage is called “District Meter Areas – DMAs”.

The Rankin Inlet water supply and distribution system is complex with its method of operation including return loops on the distribution mains, and return loops on the customer service lines. There is also the added operational need to maintain water temperatures above a level that will prevent freezing in both the distribution mains and customer services.

Leakage can be split into three types; namely:

- Leakage from Reported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Passive Leak Detection and Repair
- Leakage from Unreported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Active Leak Detection and Repair
- Background Leakage (composed of primarily weeps from joints and gaskets rather than holes in pipes) – utility activity often referred to as Active Leakage Reduction

One of the most reliable and long established methodologies to help identify water loss is to split the network into small sectors often referred to as District Meter Areas (DMAs). Where possible areas are designed so that they can be fed through one metered water feed throughout the day and night, although because of fire flow requirements, sometimes two feeds are required.

In these DMAs the flow entering the area, and key pressures are data logged, typically for a seven day period. The estimated legitimate night use is estimated, and compared with the measured night flow, which identifies areas with potential leakage, and the approximate volume of that leakage

By operating the Temporary DMAs, the system backlog leaks can be identified and repaired.

In the process of operating the Temporary DMAs, flow and pressure logged data will be gathered, and along with the number and volume of leakage found, potential areas for converting to Permanent DMAs can be established. If some of the DMAs have high pressure, or significant pressure variations, then they can be considered for Pressure Management.

As summary of the operation of the types of DMAs is provided as follows:

- **Temporary DMAs**, where they are typically operated for a seven day period initially, and the flows at night, between 2.00 and 4.00 am (Minimum Night Flow - MNF) are compared to what flow would be expected from the area. Only in areas of high MNF are leaks looked for in a two step process – step one, narrow the leak down to the General Area of the leak, and step two, Pinpoint the leak (blue cross on the ground). There are a number of methods employed to find the general area of leak, which include night time step testing, when sections of the DMA are closed off for short periods, and the change in flow at the DMA flowmeter inspected for high drops in flow, indicating a potential leak. Another method to find the general area of the leak is to use noise loggers, which listen for leaks. Finally the leak is pinpointed using leak noise correlators, and ground microphones to confirm the location of the leak
- **Permanent DMAs used for Leak Notification**, where the DMA is permanently isolated from the rest of the distribution system, and night time flows monitored on a daily basis. When the Minimum Night Flow (MNF) reaches a predetermined level (Entry Level), then

leak detection is completed in that DMA – general area of the leak, and pinpointing the leak. Leak detection and repair is continued until the leakage has been reduced to an acceptable amount (Exit Level), as recorded on the permanent DMA flowmeter

- **Permanent DMAs used for Leak Notification and Pressure Management**, where in addition to the leak detection activities, pressure management is introduced. This is completed by installing a Pressure Reduction Valve (PRV), which is used to control the pressure so that at “off peak” demand times, the pressure is not allowed to increase, and a less variable pressure is delivered to the DMA. This method of operation has the dual benefit of reducing Background Leakage (small leaks that are not economic to find and repair), and also reduces main breaks

District Meter Area Loops

It is recommended that the water distribution loops be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage” or the flow at night that is expected.

In DMA loops where the measured flow at night is significantly higher than the Legitimate Night Flow, these areas would then be targeted for acoustic leak detection.

It is likely that initially all the loops in Rankin Inlet will have measured flows significantly higher than the Legitimate Night Flow, because of the existence of bleeders, and leaks that may have been running for some time. When DMAs are introduced for the first time in water distribution systems it is common for the flows to be high. The initial tasks are often to identify and eliminate this “backlog” of losses, to reduce water loss to economic levels.

It is recommended that six DMAs be established, as follows:

- Area 5 DMA Loop
- Nuvuk DMA Loop (Area 6)
- Town DMA Loop 1 (Area 1)
- Town DMA Loop 2 (Area 2)
- Kivalliq DMA Loop
- DMA Town Supply

In addition, the mains between Nipissar Lake Pump House and Williamson Lake Pump House should be included in a future phase of the flow monitoring program.

Bleeders on Customer Services and Distribution Mains

If the water loss is a bleeder at a water service the leak pinpointing will indicate a loss at the corporation stop / curb stop of the service. Once this is identified, staff can investigate the bleeder further.

Although customers have to obtain a bleeder permit, all of them may not have done so. Once the bleeder is identified, steps can be taken to assist the customer to correct the problem on the services, and ensure that the recirculation system is put back into operation.

For bleeders on the water distribution system, they will be initially identified as leaks, if they are not already known. Depending on the location and function, the following measures should be considered:

- For all locations, complete a calculation of the approximate volume of water in the mains that are being kept fresh. Then calculate the flow rate required to exchange that volume of water in say 24 hours, or other agreed time period
- Shut off the bleeder, or
- Reduce the flow rate, or
- Install an automatic flushing device, or
- Where possible, for branches left open, install a flowmeter

1.0 Introduction

As part of the Government of Nunavut's (GN) ongoing water loss management program, GN completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System. The project was performed by Kingsley Blease, and the water balance made for a full year from August 2008 to August 2009, because billing data was available for this time period.

Completion of an IWA Water Audit and Water Balance is an integral part of the water loss management methodology, in the new AWWA Manual "M36 Water Audits and Loss Control Programs", which was published in May, 2009. An IWA Water Audit and Water Balance is considered to be the North American Best Management Practice (BMP) for water loss management, and is recommended that is completed annually.

2.0 IWA Water Audit and Water Balance Methodology

A summary will first be given of the IWA Water Audit and Water Balance Methodology, which identifies the categories of Revenue and Non Revenue Water. Revenue Water can either be metered or non metered, and in the Hamlet of Rankin Inlet Water System it is all metered. There is a range of different types of Non Revenue Water (NRW) that may or may not be significant, and they have been summarised in the following three categories by the IWA methodology:

2.1 Unbilled Authorised Consumption

Unbilled metered, Unbilled unmetered

The following uses are unbilled and can be metered or unmetered, according to local practice:

- Fire fighting
- Flushing of mains and sewers
- Bleeders on watermains and customer services
- Cleaning storage tanks
- Filling water tankers
- Water taken from hydrants
- Street cleaning
- Parks irrigation
- Public fountains
- Frost protection
- Building water for construction

2.2 Apparent Losses

Unauthorised consumption

Theft

- Not opening an account
- Self connecting / disconnecting meter
- Tampering with meter or remote
- Use of false names
- Illegal connections and by passes
- Unauthorised use of fire hydrants

Detecting theft

- Active accounts with no usage
- Inactive accounts with usage
- Periodic review of all inactive accounts
- Meter reader observations
- Inspection of unmetered fire lines
- Review of billing records

Metering inaccuracies

System input meters

- Details of meters, and calibration history

Under / over registration of customer meters

- Any testing of commercial or residential meters

Accounting procedure errors

- Difference between dates of source meter readings and customer readings
- Identify accounts not being billed – quantify reasons why
- Identify active accounts with no consumption for the last 6 months, could be stuck meter, remote problem or theft
- Identify inactive accounts with usage (occupied, but not opened an account, or vacant with leakage)
- Misread meters
- Incorrect estimates
- Stopped meters – particularly compound meters (stuck small side – all usage on large side; stuck large side, with most usage on small side)
- Stopped meters – track monthly revenue changes, versus same month in previous year
- Adjustments to original meter readings
- Unit conversions
- Improper calculations
- Computer programming errors

2.3 Real Losses

Leakage on distribution and transmission mains

- Holes and cracks in mains

- Joints
- Drain valves left open, leaking

Leakage and overflows at storage tanks

- Buried reservoirs structures
- Drain valves left open, leaking
- Overflows

Leakage on service connections up to the point of customer metering

- Holes in service pipes
- Joints

2.4 Definitions

It is the Real Losses that the leak detection techniques target, referred to as Current Annual Real Losses (CARL). Within these Real Losses there is a volume of water that is unavoidable, even with the most comprehensive leak detection program – this is called Unavoidable Annual Real Losses (UARL). So the difference between CARL and UARL, is the Real Losses that is targeted for reduction. This difference, or ratio of CARL to UARL is referred to as the Infrastructure Leakage Index (ILI).

For the management of these Real Losses, there are four areas to look at. They are as follows:

- Active leak detection
- Speed and quality of repairs
- Pressure management
- Pipeline and asset management

3.0 Summary of Gathered Data

The gathered data for the 2009 balance (August 2008 to August 2009), is shown in the Questionnaire in **Appendix A**. The data was entered into a series of spreadsheets which are included as **Appendix B**. At the time of writing the draft report, there is still data that has not been provided by GN, so estimates of the values have been made. Once the data has been received, the analysis can be updated for the final report.

The spreadsheets were developed to match the IWA software data entry pages with the summary and totals shown in the table below. The balance was completed in metric units, hence the recorded volumes are in m3.

No	Balance Item	Total for 2009	Units	Comments
1	Water Supplied	427,770,000	litres	
2	Source Meter Accuracy		litres	Accuracy not known
3	Water Imported	0		
4	Water Exported	0		
5	Billed Metered (corrected for estimated accuracy of billing system)	181,143,000	litres	
6	Billed Unmetered	0	litres	
7	Unbilled Metered	0		
8	Unbilled Unmetered	89,887,000	litres	
9	Unauthorised Consumption	1,069,000	litres	IWA default of 0.25% of water supplied
10	Customer Meter Inaccuracies (under registering)	7,389,000	litres	Estimated at 5% under registration
11	Data Handling Errors			
12	Length of Mains	40	km	Estimated
13	Number of Services	580		Estimated
14	Av Length of Customer Service	15.2	m	Curb stop to house
15	Av Operating Pressure	28	m	(40 psi)
16	Annual Operating Cost	\$750,000		Estimated
17	Variable Production Cost	\$0.35		Estimated - Per 1,000 litres
18	Customer Rates	\$4.50		Estimated - Per 1,000 litres, water and sewer

The “Old” Unaccounted For Water (UFW) percentage is shown in the table below. The volume accounted for as part of the IWA balance is included, and deducted from the traditional unaccounted for water volume, as shown in the table:

Item	Total Volume for 2009 (litres)
Total Water Supplied (corrected for accuracy)	427,770,000
Total Billed Consumption (corrected for estimated accuracy of customer meters)	190,200,000
IWA Accounted For Water	90,956,000
Unaccounted For Water	146,613,000
Unaccounted For Water (UFW) Percentage	34.3%

4.0 IWA Software Analysis

The gathered data for 2009 was entered into the AWWA – WLCC (American Water Works Association – Water Loss Control Committee) software program, which is included as **Appendix C**.

All volumes for this program were entered as Megalitres (ML) - 1,000,000 litres.

The Results of the IWA software analysis are shown in the following table:

Parameter	Value for 2009
Current Annual Real Losses (CARL)	145 ML
Unavoidable Annual Real Losses (UARL)	14 ML
Infrastructure Leakage Index (ILI)	10.17
System Input Volume	428 ML
Revenue Water (corrected for estimated accuracy of billing system)	181 ML
Non-Revenue Water	247 ML
Volume of Non-Revenue Water - % of System Input Volume	57.7%

The comparison can be seen between the ‘Old’ Unaccounted For Water (UFW) percentage, with the IWA accounted for volume included, and the Volume of Non-Revenue Water expressed as a percentage of System Input Volume:

- “Old UFW – 34.3% of System Input Volume
- Volume of Non-Revenue Water – 57.7% of System Input Volume

The financial results from the IWA software analysis are shown below:

Parameter	Value
<u>Annual Cost of Apparent Losses</u> Customer meter under registration Unauthorised consumption – based on estimated customer water and sewer rate of \$4.50 per 1,000 litres	\$52,215
<u>Annual Cost of Real Losses</u> <u>– Variable Production Cost</u> Based on estimated cost of \$0.35 per 1,000 litres	\$50,798

The AWWA / IWA software was upgraded in May, 2009, and one of the main upgrades in the new version is the data grading capability. This feature provides a basic validation of the results from the Reporting Worksheet – this is the worksheet where the data is entered. Each of the data inputs on the Reporting Worksheet has an input box to accept a grading value ranged from 1 to 10.

A grading of 10 represents highly reliable, well validated data, while grade of 1 reflects very crude data such as rough estimates. Each grading is identified by specific criteria listed on the Grading Matrix Worksheet, or the auditor may simply hover over the data grading input cell to display the criteria.

Once all the grading cells have been entered, a composite grading score is calculated and displayed at the bottom of the Reporting Worksheet. The composite grading is based upon a scale of 100: this score can then be used to assess a basic validation for the audit. The auditor can determine the status of the utility's data quality by reviewing the Loss Control Planning Worksheet. This worksheet provides planning guidance to the water utility.

Utilities with lower composite grading should focus program efforts on data collection and validation, until data quality becomes more reliable. Utilities with higher composite gradings can trust their data to serve as the basis for budgetary decisions on major loss control initiatives, such as leakage management controls, or wholesale customer meter replacement. Reliable data can also be benchmarked against data from other utilities with reliable data.

For the Hamlet of Rankin Inlet Water System, the composite score was 42, which is a lower composite score, indicating that more accurate data is required. This is to be expected, as some of the data was estimated. When the data is received from GN, then the data quality will improve.

5.0 IWA Software Analysis Summary

In any water system there will be a volume of leakage that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair – this is the Unavoidable Annual Real Losses (UARL). The IWA software uses the physical characteristics of the water distribution system (length of water mains and services, number of connections, average pressure) to make an estimate of UARL. The Current Annual Real Losses (CARL) are also calculated by the software, by taking the water supplied and deducting the calculated authorized consumption and apparent losses, to give CARL. The ratio of UARL to CARL is the Infrastructure Leakage Index (ILI).

The World Bank Target Matrix for ILI shows that the Hamlet of Rankin Inlet Water System's ILI of 10.17 puts them in performance D category – very inefficient use of resources; leakage reduction programs imperative and high priority, as shown in the following table:

ILI Range	Performance Category	Real Loss Management
1-2	A	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost effective improvement
2-4	B	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network management
4-8	C	Poor leakage record, tolerable only if water is plentiful and cheap; even then, analyse level and nature of leakage and intensify leakage reduction efforts
>8	D	Very inefficient use of resources; leakage reduction programs imperative and high priority

Although operational and financial considerations may allow a long term ILI greater than 8.0, such a level of leakage is not an effective utilisation of water as a resource. The priority for the Hamlet of Rankin Inlet Water System should be to develop an active leak detection program to reduce water losses, and reduce the ILI to initially below 8.0, and then progressively reduce it further till it is in performance category B.

6.0 Recommendations

6.1 Source Meters

At the Lake Nipissar Pump House there are a number of meters, which include Signet paddle wheel meters and one Unimag electromagnetic. It is recommended that the Unimag meter be set up to record and save the daily total volumes abstracted, and these values be used for the total water abstracted. Locally it has been set up to manually record the total flow in the record book at the pump house.

An on site in-situ test procedure can be completed for some manufactured mag meters, so this should be investigated, to see if it is available for the Unimag meter. Testing could include primary coils/electrodes/circuitry, cables, full electronic check

6.2 Customer Meters

Rankin Inlet has customer water meters which are manufactured by Neptune. The meters are an older style, and when they were installed had a wire fixed from the meter register to the outside of the property. On the end of this wire was fitted a remote register, which has numbers which can be read by the meter reader. This type of remote, or ‘generator remote’ works by the meter sending a signal to change the remote register, as the internal meter register changes. They are prone to missing registrations, so that the remote register, which is typically used for billing, records a lower consumption than has actually passed through the water meter.

Some of these old remote registers have been replaced by a more modern “touch pad”, which is simply a device to send a signal to the internal meter register and obtain the reading. So, the actual internal meter reading is gathered.

Furthermore, in the south part of Area 1, new meters with radio read technology have been installed. These meters have a radio transmitter installed either on the meter, or very close to the meter, inside the property. The meters are read with a hand held device, that can receive the meter reading at a distance from the property – it can be driven along each street to obtain the readings if required.

The recorded metered consumption is likely to be less than the actual water produced, for the following reasons:

- Generator remotes recording a lower consumption than the water meter register
- Remote register wires broken
- Customers disconnecting remote wire
- Customers removing water meter and piping through
- Water meter under-registering – most meters under-register as they age

Based on experience, and reference to manufacturer’s information, the potential under-registration of customer meters based on age was derived, as shown in the following table:

Age of Meter	Potential Under – Registration
Years	Percentage
0 to 5	0%
5 to 10	2%

10 to 15	4%
15 to 20	5%
20 to 25	8%
25 +	10%

For the Hamlet of Rankin Inlet, which has relatively old customer meters, the estimated overall customer under-registration was 5%, which represents a loss in billable volume of 9,057,000 litres per year. To determine a more accurate estimate of meter accuracy, it is recommended that a random sample of meters be removed and tested.

The sample should be taken from meters of all ages across the Hamlet of Rankin Inlet Water System, to ensure that it is as representative as possible. Meters that have been changed for maintenance or repair should not be included in the sample, as they may not be representative.

Referring to the following chart, it can be seen that a sample of 217 meters will give an error margin of 5%, with a 95% confidence level in the data.

Simple Random Sample											
With a 95% confidence level and 50% estimate of population proportion											
Population size – error margin	Unlimited	1,000,000	500,000	250,000	100,000	10,000	5,000	3,500	1,000	500	100
1%	9,604	9,513	9,423	9,249	8,762	4,899	3,288	2,565	906	475	99
2%	2,401	2,395	2,390	2,378	2,345	1,936	1,622	11,424	706	414	96
3%	1,067	1,066	1,065	1,063	1,056	964	879	818	516	340	91
4%	600	600	600	599	597	566	536	512	375	273	86
5%	384	384	384	384	383	370	357	346	278	217	79
6%	267	267	267	266	266	260	253	248	211	174	73
7%	196	196	196	196	196	192	189	186	164	141	66
8%	150	150	150	150	150	148	146	144	130	115	60
9%	119	119	119	119	118	117	116	115	106	96	54
10%	96	96	96	96	96	95	94	93	88	81	49
11%	79	79	79	79	79	79	78	78	74	68	44
12%	67	67	67	67	67	66	66	65	63	59	40

Reference: Chakrapani: C&K Deal, Market Research: Methods and Canadian Practice, 1992

Normally this type of random sampling and testing of customer meters is completed for the smaller 5/8" residential meters. Testing these residential meters should typically be repeated every 5 to 10 years, using a statistically valid sample of meters.

For the larger ICI meters, they should be tested more frequently than residential meters, because of the larger volumes being measured and the associated revenue. Testing of ICI meters should be as frequent as once every year for the very large volume meters, and between every 2 to 5 years for the remainder.

6.3 Water Loss Identification and Reduction Program

The methodology to identify and reduce water loss that is recommended, is a combination of flow based identification of areas with leakage and other losses, along with methods of acoustic leak detection. This approach forms the core of the AWWA Manual, M36, “Water Audits and Loss Control Programs”, which was published in May, 2009. In the M36 manual, this flow based method of identifying areas with leakage is called “District Meter Areas – DMAs”.

The Rankin Inlet water supply and distribution system is complex with its method of operation including return loops on the distribution mains, and return loops on the customer service lines. There is also the added operational need to maintain water temperatures above a level that will prevent freezing in both the distribution mains and customer services.

6.3.1 Summary of DMA Methodology

Leakage can be split into three types; namely:

- Leakage from Reported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Passive Leak Detection and Repair
- Leakage from Unreported main breaks, valve and hydrant leaks and service leaks – utility activity often referred to as Active Leak Detection and Repair
- Background Leakage (composed of primarily weeps from joints and gaskets rather than holes in pipes) – utility activity often referred to as Active Leakage Reduction

One of the most reliable and long established methodologies to help identify water loss is to split the network into small sectors often referred to as District Meter Areas (DMAs). Where possible areas are designed so that they can be fed through one metered water feed throughout the day and night, although because of fire flow requirements, sometimes two feeds are required.

In these DMAs the flow entering the area, and key pressures are data logged, typically for a seven day period. The estimated legitimate night use is estimated, and compared with the measured night flow, which identifies areas with potential leakage, and the approximate volume of that leakage

By operating the Temporary DMAs, the system backlog leaks can be identified and repaired.

In the process of operating the Temporary DMAs, flow and pressure logged data will be gathered, and along with the number and volume of leakage found, potential areas for converting to Permanent DMAs can be established. If some of the DMAs have high pressure, or significant pressure variations, then they can be considered for Pressure Management.

As summary of the operation of the types of DMAs is provided as follows:

- Temporary DMAs, where they are typically operated for a seven day period initially, and the flows at night, between 2.00 and 4.00 am (Minimum Night Flow - MNF) are compared to what flow would be expected from the area. Only in areas of high MNF are leaks looked for in a two step process – step one, narrow the leak down to the General Area of the leak, and step two, Pinpoint the leak (blue cross on the ground). There are a number of methods employed to find the general area of leak, which include night time step testing, when sections of the DMA are closed off for short periods, and the change in flow at the DMA flowmeter inspected for high drops in flow, indicating a potential leak. Another method to find the general area of the leak is to use noise loggers, which listen for leaks. Finally the

leak is pinpointed using leak noise correlators, and ground microphones to confirm the location of the leak

- Permanent DMAs used for Leak Notification, where the DMA is permanently isolated from the rest of the distribution system, and night time flows monitored on a daily basis. When the Minimum Night Flow (MNF) reaches a predetermined level (Entry Level), then leak detection is completed in that DMA – General Area of the leak, and Pinpointing the leak. Leak detection and repair is continued until the leakage has been reduced to an acceptable amount (Exit Level), as recorded on the permanent DMA flowmeter
- Permanent DMAs used for Leak Notification and Pressure Management, where in addition to the leak detection activities, pressure management is introduced. This is completed by installing a Pressure Reduction Valve (PRV), which is used to control the pressure so the at “off peak” demand times, the pressure is not allowed to increase, and a less variable pressure is delivered to the DMA. This method of operation has the dual benefit of reducing Background Leakage (small leaks that are not economic to find and repair), and also reduces main breaks

6.3.2 District Meter Area Loops

It is recommended that the water distribution loops be established as District Meter Areas (DMAs), so that the flows in each individual loop can be monitored, particularly the flows at night, to identify leakage, bleeders and other losses. To achieve this, the flows at the start of each individual loop will have to be metered, and the flows on the return of each loop must also be metered.

In each of these DMA loops, the flow at night, typically between 2.00 am and 4.00 am will be recorded each night. This will then be compared to the “Legitimate Night Usage” or the flow at night that is expected.

In DMA loops where the measured flow at night is significantly higher than the Legitimate Night Flow, these areas would then be targeted for acoustic leak detection.

It is likely that initially all the loops in Rankin Inlet will have measured flows significantly higher than the Legitimate Night Flow, because of the existence of bleeders, and leaks that may have been running for some time. When DMAs are introduced for the first time in water distribution systems it is common for the flows to be high. The initial tasks are often to identify and eliminate this “backlog” of losses, to reduce water loss to economic levels.

It is recommended that six DMAs be established, as follows:

- Area 5 DMA Loop
- Nuvuk DMA Loop (Area 6)
- Town DMA Loop 1 (Area 1)
- Town DMA Loop 2 (Area 2)
- Kivalliq DMA Loop
- DMA Town Supply

In addition, the mains between Nipissar Lake Pump House and Williamson Lake Pump House should be included in a future phase of the flow monitoring program.

6.3.3 Bleeders on Customer Services and Distribution System

If the water loss is a bleeder at a water service the leak pinpointing will indicate a loss at the corporation stop / curb stop of the service. Once this is identified, staff can investigate the bleeder further.

Although customers have to obtain a bleeder permit, all of them may not have done so. Once the bleeder is identified, steps can be taken to assist the customer to correct the problem on the services, and ensure that the recirculation system is put back into operation.

For bleeders on the water distribution system, they will be initially identified as leaks, if they are not already known. Depending on the location and function, the following measures should be considered:

- For all locations, complete a calculation of the approximate volume of water in the mains that are being kept fresh. Then calculate the flow rate required to exchange that volume of water in say 24 hours, or other agreed time period
- Shut off the bleeder, or
- Reduce the flow rate, or
- Install an automatic flushing device, or
- Where possible, for branches left open, install a flowmeter

APPENDIX A

Government of Nunavut Hamlet of Rankin Inlet Water Supply Capacity, Consumption and Conservation Study

IWA Water Balance Questionnaire

Version 1 – November 27, 2009

Version 1 information gathered shown in BLUE

Information Required shown in RED

OPERATIONS DEPT.

A. Water Supplied

For a minimum period of one year, and upto three to five years, if available, the following. Minimum as monthly data, but daily or weekly if available.

1. Water Produced – from Water Treatment Plant (s), Well (s)
2. Any Water Imported from another water system
3. Any Water Exported to a surrounding municipality

Supplied

Based on Signet paddle wheel meter located at the Nipissar Lake Pump House

There is a relatively new electromagnetic (mag) meter at Nipissar Pump House (Unimag), but the flow totals were not recorded. Joe Strickland was arranging for the daily flow totals to be recorded at the pump house.

Accuracy of Source Meters – list the following for each meter:

- a. Type (differential pressure, mechanical turbine etc, magnetic flow, clamp on ultrasonic, propeller)
- b. Manufacturer
- c. Size
- d. Age
- e. Maintenance / calibration history, and any results

Accuracy information was not available. It is likely that the Unimag meter is recording more accurately than the Signet paddle wheel meter

B. Non-Revenue Water – Unbilled Authorised

1. Flushing of mains and sewers (indicate if data is metered or estimated)

Information required

	MAINS	SEWERS
Avg. # flushed / year		
Avg. flow time		
Avg. flow rate		

2. Cleaning Of Storage Tanks - indicate how data is tracked?

Information required

	STORAGE TANKS
Avg. # cleaned / year	
Avg. size	
Avg. time to clean	

3. Filling Of Water Tankers

Arcene to provide Truck Fill Meter Readings

- For metered stations, what is the annual volume of water used?
- For un-metered stations, what is the estimated number of fills per year and average tanker size?
- Are customers billed on a flat rate or by volume?

4. Water Taken From Hydrants (indicate how data is tracked)

Information required

- What is the average number of flow tests per year?
- What is the average duration of these tests?
- How many areas are tested / year?
- What is the average pressure in the tested areas?
- What is the average main diameter, material and age?

5. Water Used For Street Cleaning (indicate how data is tracked)

None

	WATER USED FOR STREET CLEANING
# of Trucks	
Avg. Volume of Water / Fill	
Avg. # of Truck Fills / Day	
Avg. # of Operation Days / Year	

6. Frost Protection (if applicable)

- What is the average duration of use?

- b. What is the average pipe size and material?

7. Building Water For Metered & Un-metered Sites

Information required

- a. What is the annual volume of water used for metered building sites?
- b. For un-metered building sites, are customers billed on a flat rate or by volume?
- c. Please fill in the following chart with the appropriate information for un-metered building sites:

	UN-METERED SITES
Avg. # of Sites / Year	
Avg. # of Connections / Site	
Avg. Size of Supply / Site	
Estimated Avg. Flow / Site	
Estimated Duration / Site	

8. Blow Offs or Bleeders

Arcene to confirm numbers of bleeders for the Utilidors

- a. What is the total number of blow offs / year?
- b. How many blow offs are permanently running and how many are on a timer?
- c. How many of the blow offs are metered?
- d. What is the average pipe diameter?
- e. What is the estimated flow rate and duration time for the blow offs?

9. Water Main Repairs & Flushing

Information required

- a. What is the average number of water main repairs done per year?
- b. What is the average diameter of the main?
- c. How long are the mains flushed during and after the repairs?
- d. Are the flushed water mains metered; if so, what is the average volume of water used per repair?

10. Unavoidable Annual Real Losses (UARL)
- What is the average water pressure during the day and at night?

Ranges from 30 to 50 psi

- Provide an estimate on the percentage of leaks reported by customers.

11. Potential For Water Loss Reduction

4 leaks in the summer, equivalent to ¾ inch pipe running full bore

	MAIN LEAKS	SERVICE LEAKS
Avg. # of Leaks / Year		
Avg. Size of Leak		
Avg. Duration of Leak		

12. Financial Data

Information required

- What is the annual cost of water production and distribution? Include all operations, maintenance, staff salaries, administration, insurance, overhead etc.
- What is the variable cost of water production? This is normally power for pumping etc and chemicals, but will also include water heating
- What is the annual cost of leak detection?
- Provide a list for the unit cost of repairs on each element of the system.

BILLING DEPARTMENT

A. Revenue Water – Billed Authorised – Water Billing Data

Billing Data was provided for three full years, as follows:

- August 2008 to August 2009**
- August 2007 to August 2008**
- August 2006 to August 2007**

Because the IWA Water Audit and Water Balance is completed for a full year, the most recent years data of August 2008 to August 2009 was chosen for the balance

1. Residential Accounts

- Provide residential billing information for water used in the last 5 years (if possible, show data as bi-monthly, period, or quarterly).

- b. Show any additional information on the residential water use sectors (i.e. how many are multi-residential, single family dwelling).
2. ICI Accounts
 - a. Provide ICI billing information for water used in the last 5 years (if possible, show data as bi-monthly, period, or quarterly).
 - b. Show any additional information on water use in the ICI sectors (i.e. type of industry, institutional use).
3. What are the water rates for residential and ICI accounts (include fixed charges, wastewater charges, and any other associated charges)?
- Information required**
4. Are there any billed un-metered accounts? If so, how many are there?

B. Non Revenue Water – Apparent Losses

1. Theft
 - a. Provide annual water loss estimates for the types of theft listed below.

THEFT TYPE	ESTIMATED ANNUAL VOLUME LOST
Theft From Hydrants	
Not Opening An Account	
Tampering With Meters	
Use of False Names	
Illegal Connections	

2. Customer Meters

Overview of meter stock provided.

 - a. List the manufacturer / size / type, age (number installed by year) and percentage of accuracy for the customer meters.
 - b. Provide any details on maintenance and replacement programs for customer meters.

Maintenance completed not known

- c. Details of meter reading system (direct read, touch pad, walk by radio read, drive by radio read, fixed network radio read)

Generator Remote reading system. Small area of radio read meters (South part of Area 1)

FIRE DEPARTMENT

Non-revenue Water – Unbilled Authorised

Information required

1. What is the average number of fires per year (actual or estimated)?
2. What is average duration of a fire?
3. What is the average number of water hydrants / ports used per fire?
4. Does the Fire Department do any hydrant flow tests? If so, what is the average annual number and duration of these tests?

ENGINEERING / INFRASTRUCTURE DEPARTMENT

Water Distribution System Infrastructure

1. Water Mains (list by diameter, length, material, age if available)

Information required

- a. What are the materials of the main?
 - b. What is the average age and diameter for the water main?
 - c. What is the total length of the water main?
2. Service Mains
- #### **Information required**
- a. What is the total number of active & inactive services?
 - b. What is the average age?
 - c. List the service materials.
 - d. What is the average length of the service to the curb-stop?
 - e. What is the average length of the service from the curb-stop to the house?

50 feet

PARKS DEPARTMENT

Non-Revenue Water – Unbilled Authorised

1. Parks Irrigation

None

a. For metered parks, what is the total volume of water used per year?

b. For un-metered parks:

- What is the total number of irrigation zones?
- What is the number and type of sprinkler heads per zone?
- Average pressure / head?
- Average time that a sprinkler is used per day?
- Average number of days / year that a sprinkler is used?
- Are rain shut offs installed?

3. Public Fountains

None

a. For metered fountains, what is the average volume of water used / year?

b. For un-metered fountains:

- How many are there?
- What's the average size?
- Is the water re-circulated?
- How many days of the year is the fountain operated?

**Government of Nunavut - Hamlet of Rankin Inlet
IWA Spreadsheet**

Rev2 - March, 2010

IWA Water Balance Summary

Utility Government of Nunavut - Hamlet of Rankin Inlet
Year August 2008 to August 2009

Note: Balance is for Full Years Data

No.	Balance Items	Parameter	Total	Units	Comments
1	Water Supplied - Own Sources	volume	427,770	m3	
2	Source Meter Inaccuracy	volume		m3	accuracy not known
3	Water Imported	volume	0		
4	Water Exported	volume	0		
5	Billed Metered	volume	181,143	m3	
6	Billed Unmetered	volume	0	m3	
7	Unbilled Metered	volume	0	m3	
8	Unbilled Unmetered	volume	89,887	m3	
9	Unauthorised Consumption	volume	1,069	m3	IWA default value of 0.25% of supply
10	Customer Meter Inaccuracies	volume	9,057	m3	estimated at 5% under registration
11	Data Handling Errors	volume			Use IWA default
12	Length of Mains	length	40	km	Estimated
13	Number of Services	number	580		Estimated
14	Average Length of Services	length	15.2	m	curb stop to house
15	Average Operating Pressure	pressure	28	m	40 psi
16	Annual Operating Cost	Dollar	\$750,000		Estimated
17	Variable Production Cost	Dollar	\$350.00		/ Megalitre - Estimated
18	Customer Rates	Dollar	\$4.50		/ 1,000 litres - Estimated

Old Unaccounted For Water (UFW)

Total Water Supplied (corrected for accuracy)	427,770
Total Billed Consumption (corrected for accuracy)	190,200
IWA Accounted For Water	90,956
Unaccounted For Water Volume	146,613
Unaccounted For Water Percentage	34.3%

			KB Meter Readings on Mag Meter				
				Date			
17-Aug-09	4-Nov-09			3-Nov-09	4-Nov-09	6-Nov-09	
				10.35 am	9.15 am	10.15 am	
				units - gallons			
4,976,825	5,070,883		Mag at Nipissar PH	8,787,800	9,055,030	9,586,280	
			Difference	267,230	gallons	798,480	Difference
			22 hours, 40 minutes	282,908	gallons per day	267,386	71 hours, 40 minutes
				1,286	m3 per day	1,215	
				469,370	m3 per year	443,617	
				3 to 4 Nov		3 to 6 nov	
			Williamson Lake PH				
			Mag - which includes recirculation flow				
				Date			
				3-Nov-09	4-Nov-09	6-Nov-09	
				8.50 am	9.50 am	10.30 am	
				units - gallons			
				7,223,490	7,969,710	9,431,080	
			Difference	746,220	gallons	2,207,590	Difference
			25 hours	716,371	gallons per day	719,182	73 hours, 40 minutes
				3,256	m3 per day	3,269	
				1,188,525	m3 per year	1,193,189	
				3 to 4 Nov		3 to 6 nov	

Government of Nunavut - Hamlet of Rankin Inlet			
Data not provided			
Accuracy not known			

Government of Nunavut - Hamlet of Rankin Inlet				
None				

Government of Nunavut - Hamlet of Rankin Inlet

None				

Government of Nunavut - Hamlet of Rankin Inlet						
Printed on: Nov 03 2009 @ 5:31:17PM						
Com Gov/Hamlet Shared	10/08	3/09	7/09	Total		
Oomilik Enterprises Acnt:00000280 Unit: 002-71St	85,000.00	33,000.00	58,000.00	176,000.00		
Oomilik Enterprises Acnt:00000281 Unit: 14/16/18-71St	54,000.00	64,000.00	24,000.00	142,000.00		
Oomilik Enterprises Acnt:00000923 Unit: 012-71St	46,500.00	48,500.00	51,500.00	146,500.00		
Total	185,500	145,500	133,500	464,500		
Commercial	10/08	3/09	7/09	Total		
ATUQTUARVIK CORPORATION Acnt:00000847 Unit: 001-12Av	54,000.00	49,000.00	22,000.00	125,000.00		
Aurora Northern Contractors Ltd. Acnt:52200000 Unit: 220-66St	45,000.00	62,000.00	150,000.00	257,000.00		
Aurora Northern Contractors Acnt:00000028 Unit: 234-60St	78,000.00	72,000.00	65,000.00	215,000.00		
Aurora Northern Contractors Acnt:00000865 Unit: 108-11St	61,000.00	48,000.00	26,000.00	135,000.00		
Aurora Northern Contractors Acnt:00000971 Unit: 050-15St	61,000.00	13,500.00	23,500.00	98,000.00		
AURORA NORTHERN CONTRACTORS Acnt:50700000 Unit: 103-	47,500.00	61,000.00	66,000.00	174,500.00		
Aurora Northern Contractors/3 PLEX Acnt:00000834 Unit: 221/225-6	156,000.00	150,000.00	104,000.00	410,000.00		

Aurora Northern Contractors/DUPLEX Acnt:00000831 Unit: 003-63A	72,000.00	75,000.00	100,000.00	247,000.00		
Aurora Northern Contractors/DUPLEX Acnt:00000832 Unit: 001-63A	91,000.00	45,500.00	64,500.00	201,000.00		
B.J.C. Holdings Acnt:00000050 Unit: 050-64Av	80,000.00	40,000.00	50,000.00	170,000.00		
Fotheringham Tootoo, Tara Acnt:00000083 Unit: 106-22St	82,000.00	99,000.00	103,500.00	284,500.00		
Ikajuqtigiit Limited Acnt:00000139 Unit: 022-3Av	232,000.00	694,000.00	296,000.00	1,222,000.00		
Ilagiiktut Limited / 20 UNIT COMPLEX Acnt:00000140 Unit: 111/11	720,000.00	1,280,000.00	720,000.00	2,720,000.00		
Ilagiiktut Limited / OLD APT COMPLEX Acnt:00000142 Unit: 135-2	1,736,000.00	1,507,000.00	1,027,000.00	4,270,000.00		
Ilagiiktut Limited /5 PLEX Acnt:00000144 Unit: 150/158-4Av	270,000.00	258,500.00	162,500.00	691,000.00		
Ilagiiktut Limited Acnt:00000143 Unit: 040-4Av	81,000.00	1,511,000.00	517,000.00	2,109,000.00		
Ilagiiktut Limited Acnt:00000145 Unit: 017-3 AVENUE	41,000.00	95,000.00	240,000.00	376,000.00		
ILAGIHTUT LIMITED Acnt:00000955 Unit: 022-15St	36,000.00	8,000.00	36,000.00	80,000.00		
ILAGIHTUT LIMITED/ DUPLEX Acnt:53900000 Unit: 010- 012- 5	118,000.00	54,000.00	90,000.00	262,000.00		
ILAGIHTUT LIMITED/6 PLEX Acnt:54300003 Unit: 216-226-61 S	324,000.00	324,000.00	262,000.00	910,000.00		
ILAGIHTUT LIMITED/DUPLEX Acnt:00000517 Unit: 016-018-5St	83,000.00	851,000.00	88,000.00	1,022,000.00		
ILAGIHTUT LTD / Ten Plex Acnt:00000509 Unit: 100-118-14TH S	560,000.00	556,000.00	460,000.00	1,576,000.00		
ILAGIHTUT LTD Acnt:00000505 Unit: 014-24St	56,000.00	54,000.00	90,000.00	200,000.00		
ILAGIHTUT LTD Acnt:00000506 Unit: 010-24St	53,000.00	10,000.00	0.00	63,000.00		
ILAGIHTUT LTD Acnt:00000507 Unit: 008-24St	58,000.00	21,000.00	0.00	79,000.00		
ILAGIHTUT LTD Acnt:00000516 Unit: 018-26St	24,000.00	54,000.00	56,000.00	134,000.00		
ILAGIHTUT LTD Acnt:00000624 Unit: 014-5St	31,000.00	28,000.00	19,000.00	78,000.00		
KAKIVAK CONSTRUCTION Acnt:53200000 Unit: 245-61ST	54,000.00	23,500.00	13,000.00	90,500.00		
Kanaaknaq Invenstments ltd Acnt:53500000 Unit: 243-60St	39,000.00	36,000.00	16,000.00	91,000.00		
Kanaaknaq Investment Ltd Acnt:00000171 Unit: 100-21Av	49,000.00	0.00	36,000.00	85,000.00		
Kangiqliniq Developments Ltd Acnt:00000174 Unit: 024-4Av	73,000.00	95,000.00	100,000.00	268,000.00		
Kativik Ltd Acnt:00000179 Unit: 047-4Av	30,500.00	22,000.00	33,000.00	85,500.00		
KEEWATIN AIR LTD /NORMAN GORDON Acnt:00000106 Unit: 1	57,000.00	77,000.00	65,500.00	199,500.00		
Keewatin Air Ltd Acnt:00000181 Unit: 219-63St	48,000.00	12,000.00	29,000.00	89,000.00		
Keewatin Air Ltd Acnt:00000182 Unit: 200/210-24Av	216,000.00	98,000.00	59,500.00	373,500.00		
Keewatin Air Ltd Acnt:00000183 Unit: 108-22Av	47,000.00	37,000.00	35,000.00	119,000.00		
Keewatin Air Ltd Acnt:00000184 Unit: 110-22Av	0.00	103,500.00	46,500.00	150,000.00		
KISSARVIK COOPERATIVES / DUPLEX Acnt:00000510 Unit: 105	54,000.00	0.00	90,000.00	144,000.00		
KISSARVIK COOPERATIVES LTD /4PLEX Acnt:00000512 Unit: 1	121,000.00	726,000.00	542,000.00	1,389,000.00		
KISSARVIK COOPERATIVES LTD Acnt:00000494 Unit: 103-13St	54,000.00	54,000.00	75,000.00	183,000.00		
KISSARVIK CO-OPERATIVES LTD Acnt:00000514 Unit: 003-12Av	39,000.00	63,000.00	59,000.00	161,000.00		

KISSARVIK COOPERATIVES LTD Acnt:00000546 Unit: 002-4St	384,000.00	596,000.00	188,000.00	1,168,000.00		
Kissarvik Co-operatives Ltd. Acnt:00000200 Unit: 109-24Av	77,000.00	52,000.00	29,000.00	158,000.00		
Kissarvik Co-operatives Ltd. Acnt:00000203 Unit: 054-1Av	149,000.00	353,500.00	227,500.00	730,000.00		
Kivalliq Arctic Foods Ltd. Acnt:00000190 Unit: 010-3St	36,000.00	54,000.00	88,000.00	178,000.00		
Kivalliq Property Maintenance KIVALLIQ NEWS Acnt:00000195 Unit: 017-2Av	36,000.00	54,000.00	36,000.00	126,000.00		
Kivalliq Property Maintenance Acnt:00000196 Unit: 017-2Av	0.00	74,000.00	7,000.00	81,000.00		
KIVALLIQ PROPERTY MAINTENANCE Acnt:00000277 Unit: 104-6St	51,000.00	24,000.00	90,000.00	165,000.00		
Kudlik Electric Limited Acnt:00000535 Unit: 002-15St	71,000.00	0.00	6,000.00	77,000.00		
NANUQ LODGE Acnt:00000126 Unit: 001-1St	164,000.00	138,000.00	155,000.00	457,000.00		
NATIK PROJECTS 2007 INC Acnt:00000519 Unit: 206-67St	34,000.00	4,500.00	16,000.00	54,500.00		
Northern Stores Inc. Acnt:00000251 Unit: 039-4Av	163,000.00	89,500.00	46,000.00	298,500.00		
Northern Stores Inc. Acnt:00000252 Unit: 037-4Av	109,000.00	36,000.00	100,000.00	245,000.00		
Northern Stores Inc. Acnt:00000253 Unit: 035-4Av	8,000.00	140,000.00	100,000.00	248,000.00		
Northern Stores Inc./4 PLEX Acnt:00000833 Unit: 063/069-64Av	208,000.00	160,000.00	209,000.00	577,000.00		
NUNAVUT DEVELOPMENT CORPORATION Acnt:00000156 Unit: 001-1St	54,000.00	54,000.00	90,000.00	198,000.00		
Nunnavut Tungavik Inc. Atten. Dept. of Finance Acnt:00000260 Unit: 001-1St	44,000.00	54,000.00	90,000.00	188,000.00		
Oomilik Enterprises Acnt:00000279 Unit: 114-52St	52,000.00	35,500.00	35,000.00	122,500.00		
Pirupsaijit Limited Acnt:00000924 Unit: 219-61St	32,000.00	62,500.00	67,500.00	162,000.00		
PIRUQSAIJIT LIMITED Acnt:00000925 Unit: 221-61St	77,000.00	82,500.00	73,000.00	232,500.00		
Pirupsaijit Limited Acnt:00000927 Unit: 237-61St	61,000.00	58,000.00	25,500.00	144,500.00		
Pirupsaijit Limited Acnt:00000928 Unit: 239-61St	41,000.00	106,000.00	92,000.00	239,000.00		
Pirupsaijit Limited Acnt:00000929 Unit: 251-61St	75,000.00	76,500.00	85,500.00	237,000.00		
Pirupsaijit Limited Acnt:00000930 Unit: 235-61St	84,000.00	53,000.00	72,000.00	209,000.00		
Polar Bear Caves Investments:c/o Nanuq Inn Acnt:00000533 Unit: 025-6St	0.00	7,842,000.00	0.00	7,842,000.00		
Pulaarvik Kablu Friendship Centre Acnt:00000304 Unit: 015-24St	26,000.00	18,500.00	10,000.00	54,500.00		
RBC c/o CBRE GCS Acnt:54200000 Unit: 211-66 St	62,000.00	67,000.00	59,000.00	188,000.00		
RCL Branch 169: c/o Margaret Taylor Acnt:00000938 Unit: 200-64St	54,000.00	85,000.00	80,000.00	219,000.00		
Red Top Variety Shop Acnt:00000476 Unit: 113-23Av	66,000.00	91,000.00	88,000.00	245,000.00		
Sakku Properties Acnt:00000483 Unit: 216-63St	68,000.00	90,000.00	41,000.00	199,000.00		
Sakku Properties Acnt:00000845 Unit: 215-63St	0.00	0.00	63,000.00	63,000.00		
SAKKU PROPERTIES Acnt:52400000 Unit: 220-63St	44,000.00	75,000.00	100,000.00	219,000.00		
Treasures/Tara TooToo-Fotheringham Acnt:00000937 Unit: 116-24Av	154,000.00	202,000.00	176,000.00	532,000.00		
Umingmak Supply Ltd. Acnt:00000584 Unit: 028-12Av	38,000.00	15,000.00	42,000.00	95,000.00		
Umingmak Supply Ltd. Acnt:00000585 Unit: 112-24St	13,500.00	12,500.00	9,000.00	35,000.00		

Total	8,667,500	20,223,000	8,633,500	37,524,000		
FE Gov/Hamlet Shared	10/08	3/09	7/09	Total		
Community & Government Services Sewage Trt. Plt. Acnt:00000093 U	48,000.00	35,000.00	25,000.00	108,000.00		
Total	48,000	35,000	25,000	108,000		
Full Economic	10/08	3/09	7/09	Total		
COMMUNITY & GOVERNMENT SERVICES Arctic College Acnt:	54,000.00	0.00	0.00	54,000.00		
CANADIAN BROADCASTING CORPORATION-LISA POWERS A	39,000.00	36,000.00	38,000.00	113,000.00		
COMMUNITY & GOVERNMENT SERVICES / LEO USSAK Acnt:	316,000.00	1,443,000.00	426,000.00	2,185,000.00		
Community & Government Services /RSO Acnt:00000303 Unit: 013-4	100,000.00	392,000.00	90,000.00	582,000.00		
Community & Government Services CHILD. GRP HOME Acnt:00000	71,000.00	187,000.00	134,500.00	392,500.00		
Community & Government Services DAY CARE Acnt:00000956 Unit	106,000.00	1,181,000.00	100,000.00	1,387,000.00		
COMMUNITY & GOVERNMENT SERVICES KIVALLIQ HALL A	340,000.00	226,000.00	3,672,000.00	4,238,000.00		
COMMUNITY & GOVERNMENT SERVICES MUI Acnt:00000186	271,000.00	215,500.00	106,500.00	593,000.00		
Community & Government Services Acnt:00000094 Unit: 25-71 NUV	478,000.00	0.00	0.00	478,000.00		
Community & Government Services Acnt:00000101 Unit: 008-1St	11,000.00	0.00	0.00	11,000.00		
Community & Government Services Acnt:00000198 Unit: 106/108-52	216,000.00	365,500.00	380,500.00	962,000.00		
Community & Government Services Acnt:00000199 Unit: 011-4St	225,000.00	100,000.00	54,000.00	379,000.00		
COMMUNITY & GOVERNMENT SERVICES/ALAITTUQ Acnt:00	162,000.00	254,000.00	100,000.00	516,000.00		
COMMUNITY AND GOVERNMENT SERVICES Acnt:00000187 U	82,500.00	83,000.00	6,500.00	172,000.00		
COMMUNITY AND GOVERNMENT SERVICES Acnt:00000980 U	303,000.00	672,000.00	50,000.00	1,025,000.00		
D.I.A.N.D. Acnt:00000060 Unit: 107-22St	32,000.00	72,000.00	70,000.00	174,000.00		

D.I.A.N.D. Acent:00000061 Unit: 103-22St	9,000.00	2,000.00	16,000.00	27,000.00		
Hamlet of Rankin Inlet (Airport) Acent:00000114 Unit: 390	1,813,000.00	150,000.00	111,000.00	2,074,000.00		
IBSL LEASING LTD / ROCKLAND BLDG Acent:00000493 Unit: 04	46,000.00	750,000.00	56,000.00	852,000.00		
IBSL LEASING LTD Acent:00000489 Unit: 110/112-54St	108,000.00	67,000.00	120,000.00	295,000.00		
IBSL LEASING LTD Acent:00000491 Unit: 120-52St	67,000.00	91,000.00	137,000.00	295,000.00		
IBSL LEASING LTD Acent:00000496 Unit: 105-24St	24,000.00	16,000.00	22,500.00	62,500.00		
IBSL LEASING LTD Acent:00000511 Unit: 102-21Av	75,000.00	91,000.00	9,300.00	175,300.00		
IBSL LEASING LTD Acent:00000515 Unit: 018-4Av	16,000.00	84,000.00	56,000.00	156,000.00		
IBSL LEASING LTD Acent:00000966 Unit: 106/108-54St	54,000.00	64,000.00	155,000.00	273,000.00		
IBSL LEASING LTD Acent:53700000 Unit: 43-4Av	0.00	36,000.00	36,000.00	72,000.00		
NUNAVUT HOUSING CORPORATION (4 UNITS) Acent:00000518	108,000.00	91,000.00	88,000.00	287,000.00		
NUNAVUT HOUSING CORPORATION / 10 PLEX Acent:00000556	67,000.00	413,000.00	228,000.00	708,000.00		
NUNAVUT HOUSING CORPORATION /4 UNITS Acent:00000557 U	108,000.00	95,000.00	21,000.00	224,000.00		
NUNAVUT HOUSING CORPORATION /5 Plex Acent:00000558 Uni	35,000.00	25,000.00	25,000.00	85,000.00		
NUNAVUT HOUSING CORPORATION Acent:00000403 Unit: 027-2	30,000.00	54,000.00	97,000.00	181,000.00		
NUNAVUT HOUSING CORPORATION Acent:52700000 Unit: 215-6	73,000.00	1,000.00	0.00	74,000.00		
NUNAVUT HOUSING CORPORATION Acent:53000000 Unit: 229-6	46,000.00	11,000.00	500.00	57,500.00		
NUNAVUT HOUSING CORPORATION Acent:53300000 Unit: 247-6	56,000.00	75,000.00	65,500.00	196,500.00		
Nunavut Housing Corporation/6 PLEX Acent:00000934 Unit: 018/028-	313,000.00	259,000.00	240,000.00	812,000.00		
Nunavut Housing Corporation/6 PLEX Acent:00000935 Unit: 030/040-	324,000.00	193,000.00	218,000.00	735,000.00		
NUNAVUT HOUSING CORPORTATION Acent:00000936 Unit: 223-	53,000.00	40,000.00	500.00	93,500.00		
NUNAVUT HOUSING CORPORTATION Acent:52900000 Unit: 227-	22,000.00	60,000.00	1,000.00	83,000.00		
Nunavut Power Corporation Acent:00000262 Unit: 010-4Av.1	55,000.00	77,000.00	233,000.00	365,000.00		
Nunavut Power Corporation Acent:00000263 Unit: 006-1Av	63,000.00	150,000.00	100,000.00	313,000.00		
Nunavut Power Corporation Acent:00000264 Unit: 007-12St	7,000.00	11,000.00	8,000.00	26,000.00		
Nunavut Power Corporation Acent:00000266 Unit: 003-12St	24,000.00	0.00	0.00	24,000.00		
Nunavut Power Corporation Acent:00000267 Unit: 005-12St	4,000.00	16,000.00	17,000.00	37,000.00		
Nunavut Power Corporation Acent:00000270 Unit: 010-4Av	100,000.00	100,000.00	28,000.00	228,000.00		
R.C.M. Police Acent:00000305 Unit: 007-11	36,000.00	0.00	62,000.00	98,000.00		
R.C.M. Police Acent:00000306 Unit: 116-24St	0.00	2,000.00	0.00	2,000.00		
R.C.M. Police Acent:00000307 Unit: 005-11	40,000.00	27,000.00	23,000.00	90,000.00		
R.C.M. Police Acent:00000308 Unit: 005-15St	51,000.00	31,000.00	41,000.00	123,000.00		
R.C.M. Police Acent:00000309 Unit: 001-11	58,000.00	30,000.00	30,000.00	118,000.00		
R.C.M. Police Acent:00000310 Unit: 007-15St	24,000.00	0.00	0.00	24,000.00		

R.C.M. Police Acnt:00000311 Unit: 003-11	13,000.00	25,000.00	17,000.00	55,000.00		
R.C.M. Police Acnt:00000841 Unit: 009-15St	64,000.00	0.00	36,000.00	100,000.00		
Rankin Inlet Housing Assoc. /4PLEX Acnt:00000416 Unit: 124-24Av	78,000.00	296,500.00	252,500.00	627,000.00		
Rankin Inlet Housing Association (18 UNITS)/DUPLEX Acnt:000004	54,000.00	250,000.00	0.00	304,000.00		
Rankin Inlet Housing Association (9 PLEX) Acnt:00000442 Unit: 147	486,000.00	494,000.00	364,000.00	1,344,000.00		
Rankin Inlet Housing Association (Duplex) Acnt:00000313 Unit: 007-	36,000.00	0.00	0.00	36,000.00		
Rankin Inlet Housing Association (Duplex) Acnt:00000339 Unit: 016-	56,000.00	91,000.00	100,500.00	247,500.00		
Rankin Inlet Housing Association / 4 PLEX Acnt:00000430 Unit: 129-	59,000.00	305,500.00	380,000.00	744,500.00		
Rankin Inlet Housing Association / 4 PLEX Acnt:00000431 Unit: 168/	116,000.00	188,000.00	132,000.00	436,000.00		
Rankin Inlet Housing Association / DUPLEX Acnt:00000432 Unit: 17	93,000.00	851,500.00	1,052,000.00	1,996,500.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000019 Unit: 22	0.00	99,000.00	0.00	99,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000020 Unit: 2	105,000.00	70,000.00	68,000.00	243,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000071 Unit: 2	0.00	81,000.00	0.00	81,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000155 Unit: 20	53,000.00	95,000.00	90,000.00	238,000.00		
Rankin Inlet Housing Association Acnt:00000314 Unit: 005-14St	56,000.00	73,000.00	49,000.00	178,000.00		
Rankin Inlet Housing Association Acnt:00000315 Unit: 006-13St	87,000.00	71,000.00	99,000.00	257,000.00		
Rankin Inlet Housing Association Acnt:00000316 Unit: 008-13St	54,000.00	54,000.00	100,000.00	208,000.00		
Rankin Inlet Housing Association Acnt:00000317 Unit: 010-13St	71,000.00	72,000.00	90,000.00	233,000.00		
Rankin Inlet Housing Association Acnt:00000318 Unit: 009-14St	63,000.00	99,000.00	93,000.00	255,000.00		
Rankin Inlet Housing Association Acnt:00000319 Unit: 012-13St	54,000.00	0.00	0.00	54,000.00		
Rankin Inlet Housing Association Acnt:00000320 Unit: 014-13St	54,000.00	69,000.00	101,000.00	224,000.00		
Rankin Inlet Housing Association Acnt:00000321 Unit: 016-13St	61,000.00	64,500.00	80,300.00	205,800.00		
Rankin Inlet Housing Association Acnt:00000322 Unit: 018-13St	90,000.00	115,000.00	88,000.00	293,000.00		
Rankin Inlet Housing Association Acnt:00000324 Unit: 014-12St	90,000.00	68,000.00	65,000.00	223,000.00		
Rankin Inlet Housing Association Acnt:00000325 Unit: 013-13St	92,000.00	93,000.00	73,000.00	258,000.00		
Rankin Inlet Housing Association Acnt:00000326 Unit: 011-13St	88,000.00	89,000.00	63,500.00	240,500.00		
Rankin Inlet Housing Association Acnt:00000327 Unit: 020-13St	88,000.00	72,000.00	73,000.00	233,000.00		
Rankin Inlet Housing Association Acnt:00000328 Unit: 020-14St	103,000.00	64,500.00	58,500.00	226,000.00		
Rankin Inlet Housing Association Acnt:00000329 Unit: 020-12Av	54,000.00	81,000.00	90,000.00	225,000.00		
Rankin Inlet Housing Association Acnt:00000330 Unit: 006-14Av	89,000.00	81,000.00	76,000.00	246,000.00		
Rankin Inlet Housing Association Acnt:00000331 Unit: 022-12Av	35,000.00	36,000.00	27,000.00	98,000.00		
Rankin Inlet Housing Association Acnt:00000332 Unit: 009-13St	62,000.00	57,000.00	102,000.00	221,000.00		
Rankin Inlet Housing Association Acnt:00000333 Unit: 017-15St	49,000.00	81,000.00	96,000.00	226,000.00		
Rankin Inlet Housing Association Acnt:00000334 Unit: 014-14St	39,000.00	64,000.00	90,000.00	193,000.00		

Rankin Inlet Housing Association	Acnt:00000335 Unit: 100-22St	81,000.00	91,000.00	75,000.00	247,000.00		
Rankin Inlet Housing Association	Acnt:00000336 Unit: 018-14St	82,000.00	48,500.00	70,000.00	200,500.00		
Rankin Inlet Housing Association	Acnt:00000337 Unit: 013-14St	32,000.00	111,000.00	40,000.00	183,000.00		
Rankin Inlet Housing Association	Acnt:00000338 Unit: 022-14St	54,000.00	0.00	0.00	54,000.00		
Rankin Inlet Housing Association	Acnt:00000340 Unit: 012-12Av	53,000.00	54,000.00	72,000.00	179,000.00		
Rankin Inlet Housing Association	Acnt:00000341 Unit: 021-14St	54,000.00	49,000.00	111,000.00	214,000.00		
Rankin Inlet Housing Association	Acnt:00000342 Unit: 019-14St	54,000.00	0.00	0.00	54,000.00		
Rankin Inlet Housing Association	Acnt:00000343 Unit: 015-14St	50,000.00	54,000.00	19,000.00	123,000.00		
Rankin Inlet Housing Association	Acnt:00000344 Unit: 016-14St	75,000.00	41,500.00	18,500.00	135,000.00		
Rankin Inlet Housing Association	Acnt:00000345 Unit: 106-13St	54,000.00	54,000.00	54,000.00	162,000.00		
Rankin Inlet Housing Association	Acnt:00000346 Unit: 017-13Av	96,000.00	24,000.00	45,000.00	165,000.00		
Rankin Inlet Housing Association	Acnt:00000347 Unit: 015-13Av	52,000.00	42,000.00	48,000.00	142,000.00		
Rankin Inlet Housing Association	Acnt:00000348 Unit: 011-13Av	80,000.00	83,000.00	75,000.00	238,000.00		
Rankin Inlet Housing Association	Acnt:00000349 Unit: 006-13Av	96,000.00	45,000.00	100,000.00	241,000.00		
Rankin Inlet Housing Association	Acnt:00000350 Unit: 010-13Av	97,000.00	54,000.00	67,000.00	218,000.00		
Rankin Inlet Housing Association	Acnt:00000351 Unit: 013-13Av	52,000.00	51,000.00	50,000.00	153,000.00		
Rankin Inlet Housing Association	Acnt:00000352 Unit: 018-13Av	54,000.00	32,000.00	24,000.00	110,000.00		
Rankin Inlet Housing Association	Acnt:00000353 Unit: 014-14Av	112,000.00	63,000.00	49,000.00	224,000.00		
Rankin Inlet Housing Association	Acnt:00000355 Unit: 102-13St	85,000.00	45,000.00	49,000.00	179,000.00		
Rankin Inlet Housing Association	Acnt:00000356 Unit: 007-12Av	90,000.00	68,000.00	110,000.00	268,000.00		
Rankin Inlet Housing Association	Acnt:00000357 Unit: 101-22Av	66,000.00	54,000.00	19,000.00	139,000.00		
Rankin Inlet Housing Association	Acnt:00000358 Unit: 017-14St	81,000.00	81,000.00	58,400.00	220,400.00		
Rankin Inlet Housing Association	Acnt:00000359 Unit: 104-22St	77,000.00	58,000.00	38,500.00	173,500.00		
Rankin Inlet Housing Association	Acnt:00000360 Unit: 012-13Av	56,000.00	45,000.00	35,000.00	136,000.00		
Rankin Inlet Housing Association	Acnt:00000361 Unit: 115-14St	75,000.00	46,000.00	36,000.00	157,000.00		
Rankin Inlet Housing Association	Acnt:00000362 Unit: 005-13St	54,000.00	87,000.00	67,500.00	208,500.00		
Rankin Inlet Housing Association	Acnt:00000363 Unit: 002-12St	65,000.00	45,000.00	51,000.00	161,000.00		
Rankin Inlet Housing Association	Acnt:00000364 Unit: 008-12St	54,000.00	0.00	0.00	54,000.00		
Rankin Inlet Housing Association	Acnt:00000365 Unit: 010-12St	68,000.00	37,000.00	27,000.00	132,000.00		
Rankin Inlet Housing Association	Acnt:00000366 Unit: 017-12St	36,000.00	62,000.00	36,000.00	134,000.00		
Rankin Inlet Housing Association	Acnt:00000367 Unit: 009-12Av	54,000.00	28,000.00	120,000.00	202,000.00		
Rankin Inlet Housing Association	Acnt:00000368 Unit: 018-14Av	89,000.00	39,000.00	90,000.00	218,000.00		
Rankin Inlet Housing Association	Acnt:00000369 Unit: 111-14St	80,000.00	92,000.00	72,000.00	244,000.00		
Rankin Inlet Housing Association	Acnt:00000371 Unit: 119-14St	74,000.00	35,000.00	35,000.00	144,000.00		

Rankin Inlet Housing Association	Acnt:00000372 Unit: 021-14Av	84,000.00	54,000.00	45,000.00	183,000.00		
Rankin Inlet Housing Association	Acnt:00000373 Unit: 008-14Av	58,000.00	85,000.00	105,000.00	248,000.00		
Rankin Inlet Housing Association	Acnt:00000374 Unit: 010-14Av	90,000.00	48,000.00	35,000.00	173,000.00		
Rankin Inlet Housing Association	Acnt:00000376 Unit: 007-13St	54,000.00	59,000.00	98,000.00	211,000.00		
Rankin Inlet Housing Association	Acnt:00000384 Unit: 250-61St	79,000.00	91,000.00	100,000.00	270,000.00		
Rankin Inlet Housing Association	Acnt:00000385 Unit: 246-61St	39,000.00	53,000.00	39,000.00	131,000.00		
Rankin Inlet Housing Association	Acnt:00000386 Unit: 118-52St	58,000.00	64,500.00	67,000.00	189,500.00		
Rankin Inlet Housing Association	Acnt:00000387 Unit: 107-23St	59,000.00	51,000.00	93,000.00	203,000.00		
Rankin Inlet Housing Association	Acnt:00000388 Unit: 103-21Av	31,000.00	0.00	0.00	31,000.00		
Rankin Inlet Housing Association	Acnt:00000391 Unit: 103-22Av	45,000.00	66,500.00	55,500.00	167,000.00		
Rankin Inlet Housing Association	Acnt:00000392 Unit: 025-21St	35,500.00	18,000.00	18,000.00	71,500.00		
Rankin Inlet Housing Association	Acnt:00000393 Unit: 023-21St	22,000.00	51,000.00	59,000.00	132,000.00		
Rankin Inlet Housing Association	Acnt:00000394 Unit: 019-21St	66,000.00	14,500.00	55,500.00	136,000.00		
Rankin Inlet Housing Association	Acnt:00000395 Unit: 017-21St	32,000.00	84,500.00	63,000.00	179,500.00		
Rankin Inlet Housing Association	Acnt:00000396 Unit: 015-21St	66,000.00	91,000.00	19,000.00	176,000.00		
Rankin Inlet Housing Association	Acnt:00000397 Unit: 014-21St	82,000.00	106,000.00	91,500.00	279,500.00		
Rankin Inlet Housing Association	Acnt:00000398 Unit: 016-21St	73,000.00	38,000.00	48,000.00	159,000.00		
Rankin Inlet Housing Association	Acnt:00000399 Unit: 018-21St	69,000.00	122,000.00	69,000.00	260,000.00		
Rankin Inlet Housing Association	Acnt:00000400 Unit: 020-21St	90,000.00	0.00	24,000.00	114,000.00		
Rankin Inlet Housing Association	Acnt:00000406 Unit: 104-24St	54,000.00	0.00	0.00	54,000.00		
Rankin Inlet Housing Association	Acnt:00000407 Unit: 103-25St	99,000.00	56,500.00	51,000.00	206,500.00		
Rankin Inlet Housing Association	Acnt:00000411 Unit: 167-24Av	97,000.00	66,000.00	45,000.00	208,000.00		
Rankin Inlet Housing Association	Acnt:00000418 Unit: 136-54St	49,000.00	188,000.00	98,000.00	335,000.00		
Rankin Inlet Housing Association	Acnt:00000422 Unit: 130-54St	74,000.00	86,000.00	88,000.00	248,000.00		
Rankin Inlet Housing Association	Acnt:00000423 Unit: 210-64St	49,000.00	89,000.00	100,000.00	238,000.00		
Rankin Inlet Housing Association	Acnt:00000427 Unit: 169-24Av	81,000.00	54,000.00	0.00	135,000.00		
Rankin Inlet Housing Association	Acnt:00000429 Unit: 162-24Av	64,000.00	67,000.00	51,000.00	182,000.00		
Rankin Inlet Housing Association	Acnt:00000433 Unit: 101-21Av	63,000.00	59,000.00	54,000.00	176,000.00		
Rankin Inlet Housing Association	Acnt:00000434 Unit: 182-24Av	54,000.00	35,000.00	35,000.00	124,000.00		
Rankin Inlet Housing Association	Acnt:00000435 Unit: 186-24Av	54,000.00	64,000.00	56,000.00	174,000.00		
Rankin Inlet Housing Association	Acnt:00000436 Unit: 188-24Av	61,000.00	73,000.00	98,500.00	232,500.00		
Rankin Inlet Housing Association	Acnt:00000437 Unit: 190-24Av	71,000.00	37,000.00	24,000.00	132,000.00		
Rankin Inlet Housing Association	Acnt:00000438 Unit: 011-26St	84,000.00	79,000.00	65,000.00	228,000.00		
Rankin Inlet Housing Association	Acnt:00000439 Unit: 171-24Av	69,000.00	91,000.00	90,000.00	250,000.00		

Rankin Inlet Housing Association	Acnt:00000440 Unit: 180-24Av	83,000.00	53,000.00	42,000.00	178,000.00		
Rankin Inlet Housing Association	Acnt:00000441 Unit: 165-24Av	61,000.00	91,000.00	56,000.00	208,000.00		
Rankin Inlet Housing Association	Acnt:00000443 Unit: 104-24Av	62,000.00	91,000.00	77,500.00	230,500.00		
Rankin Inlet Housing Association	Acnt:00000444 Unit: 106-24Av	73,000.00	73,000.00	43,000.00	189,000.00		
Rankin Inlet Housing Association	Acnt:00000445 Unit: 108-24Av	81,000.00	81,500.00	63,500.00	226,000.00		
Rankin Inlet Housing Association	Acnt:00000446 Unit: 112-24Av	72,000.00	75,000.00	76,000.00	223,000.00		
Rankin Inlet Housing Association	Acnt:00000447 Unit: 115-24Av	92,000.00	54,000.00	90,000.00	236,000.00		
Rankin Inlet Housing Association	Acnt:00000448 Unit: 109-24St	36,000.00	0.00	0.00	36,000.00		
Rankin Inlet Housing Association	Acnt:00000450 Unit: 109-22St	49,000.00	87,000.00	79,000.00	215,000.00		
Rankin Inlet Housing Association	Acnt:00000451 Unit: 108-22St	49,000.00	54,000.00	102,000.00	205,000.00		
Rankin Inlet Housing Association	Acnt:00000452 Unit: 173/189-24Av	472,000.00	331,000.00	336,000.00	1,139,000.00		
Rankin Inlet Housing Association	Acnt:00000453 Unit: 108-23Av	77,000.00	92,500.00	33,000.00	202,500.00		
Rankin Inlet Housing Association	Acnt:00000454 Unit: 014-26St	82,000.00	54,000.00	59,000.00	195,000.00		
Rankin Inlet Housing Association	Acnt:00000455 Unit: 109-22Av	69,000.00	59,500.00	0.00	128,500.00		
Rankin Inlet Housing Association	Acnt:00000456 Unit: 184-24Av	81,000.00	260,000.00	87,000.00	428,000.00		
Rankin Inlet Housing Association	Acnt:00000457 Unit: 105-22Av	41,000.00	56,000.00	56,000.00	153,000.00		
Rankin Inlet Housing Association	Acnt:00000458 Unit: 100-23Av	87,000.00	95,000.00	90,000.00	272,000.00		
Rankin Inlet Housing Association	Acnt:00000459 Unit: 113-22Av	66,000.00	30,000.00	26,000.00	122,000.00		
Rankin Inlet Housing Association	Acnt:00000460 Unit: 106-23Av	74,000.00	91,000.00	90,000.00	255,000.00		
Rankin Inlet Housing Association	Acnt:00000461 Unit: 111-22Av	52,000.00	57,000.00	98,000.00	207,000.00		
Rankin Inlet Housing Association	Acnt:00000462 Unit: 112-23Av	54,000.00	88,500.00	0.00	142,500.00		
Rankin Inlet Housing Association	Acnt:00000463 Unit: 104-22Av	52,000.00	36,000.00	90,000.00	178,000.00		
Rankin Inlet Housing Association	Acnt:00000464 Unit: 102-22Av	69,000.00	60,500.00	72,500.00	202,000.00		
Rankin Inlet Housing Association	Acnt:00000465 Unit: 100-22Av	49,000.00	123,000.00	105,000.00	277,000.00		
Rankin Inlet Housing Association	Acnt:00000466 Unit: 028-21St	63,000.00	42,000.00	55,000.00	160,000.00		
Rankin Inlet Housing Association	Acnt:00000467 Unit: 026-21St	65,000.00	115,000.00	119,500.00	299,500.00		
Rankin Inlet Housing Association	Acnt:00000468 Unit: 104-23Av	66,000.00	36,000.00	88,000.00	190,000.00		
Rankin Inlet Housing Association	Acnt:00000469 Unit: 012-26St	67,000.00	108,000.00	89,000.00	264,000.00		
Rankin Inlet Housing Association	Acnt:00000470 Unit: 010-26St	52,000.00	102,000.00	92,000.00	246,000.00		
Rankin Inlet Housing Association	Acnt:00000472 Unit: 120-22Av	33,000.00	91,000.00	90,000.00	214,000.00		
Rankin Inlet Housing Association	Acnt:00000473 Unit: 117-22Av	56,000.00	54,500.00	78,000.00	188,500.00		
Rankin Inlet Housing Association	Acnt:00000474 Unit: 115-22Av	71,000.00	89,000.00	90,000.00	250,000.00		
RANKIN INLET HOUSING ASSOCIATION	Acnt:00000530 Unit: 20	0.00	89,000.00	83,000.00	172,000.00		
RANKIN INLET HOUSING ASSOCIATION	Acnt:00000559 Unit: 94	165,000.00	120,000.00	127,000.00	412,000.00		

RANKIN INLET HOUSING ASSOCIATION Acnt:00000583 Unit: 2	54,000.00	97,000.00	100,000.00	251,000.00		
Rankin Inlet Housing Association Acnt:00000799 Unit: 213-63St	71,000.00	109,000.00	98,000.00	278,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000903 Unit: 2	75,000.00	31,000.00	27,000.00	133,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:00000967 Unit: 2	78,000.00	49,000.00	46,000.00	173,000.00		
Rankin Inlet Housing Association Acnt:00000978 Unit: 210/214-61St	169,000.00	153,500.00	160,500.00	483,000.00		
RANKIN INLET HOUSING ASSOCIATION Acnt:52000000 Unit: 2	72,000.00	95,000.00	100,000.00	267,000.00		
Rankin Inlet Housing Association Acnt:53600000 Unit: 056-64Av	64,000.00	95,000.00	98,000.00	257,000.00		
Rankin Inlet Housing Association/ 3 PLEX Acnt:00000836 Unit: 209/2	162,000.00	155,500.00	0.00	317,500.00		
Rankin Inlet Housing Association/ 3 PLEX Acnt:00000840 Unit: 210/2	177,000.00	133,500.00	136,500.00	447,000.00		
Rankin Inlet Housing Association/ 4 PLEX Acnt:00000378 Unit: 126/1	200,000.00	417,500.00	433,500.00	1,051,000.00		
Rankin Inlet Housing Association/ 4 PLEX Acnt:00000389 Unit: 134/1	172,000.00	476,500.00	86,500.00	735,000.00		
Rankin Inlet Housing Association/ 4 PLEX Acnt:00000837 Unit: 232/2	224,000.00	229,000.00	326,000.00	779,000.00		
Rankin Inlet Housing Association/ 4 PLEX Acnt:00000839 Unit: 216/2	218,000.00	268,000.00	284,000.00	770,000.00		
Rankin Inlet Housing Association/ DUPLEX Acnt:00000828 Unit: 215	115,000.00	58,000.00	64,500.00	237,500.00		
Rankin Inlet Housing Association/3 PLEX Acnt:00000390 Unit: 115/1	108,000.00	85,000.00	97,500.00	290,500.00		
Rankin Inlet Housing Association/3 PLEX Acnt:00000835 Unit: 215/2	147,000.00	151,500.00	0.00	298,500.00		
Rankin Inlet Housing Association/4 PLEX Acnt:00000420 Unit: 114/1	216,000.00	212,000.00	275,000.00	703,000.00		
Rankin Inlet Housing Association/4 PLEX Acnt:00000425 Unit: 142/1	162,000.00	670,500.00	845,000.00	1,677,500.00		
Rankin Inlet Housing Association/4 PLEX Acnt:00000428 Unit: 124/1	144,000.00	300,000.00	239,000.00	683,000.00		
Rankin Inlet Housing Association/4 PLEX Acnt:00000838 Unit: 224/2	196,000.00	533,000.00	200,000.00	929,000.00		
Rankin Inlet Housing Association/4Plex Acnt:00000471 Unit: 004-26S	68,000.00	90,000.00	124,000.00	282,000.00		
Rankin Inlet Housing Association/DUPLEX Acnt:00000401 Unit: 110	88,000.00	337,000.00	203,000.00	628,000.00		
Rankin Inlet Housing Association/DUPLEX Acnt:00000415 Unit: 132	45,000.00	187,000.00	90,000.00	322,000.00		
Rankin Inlet Housing Association/DUPLEX Acnt:00000421 Unit: 126	123,000.00	121,500.00	120,500.00	365,000.00		
Rankin Inlet Housing Association/DUPLEX Acnt:00000826 Unit: 223	149,500.00	64,000.00	68,500.00	282,000.00		
Rankin Inlet Housing Association/DUPLEX Acnt:00000827 Unit: 219	118,500.00	310,500.00	143,500.00	572,500.00		
Total	19,832,000	24,819,500	22,231,000	66,882,500		
No Charge	10/08	3/09	7/09	Total		
Hamlet of Rankin Inlet Acnt:00000115 Unit: 018-4St	0.00	62,000.00	0.00	62,000.00		
Hamlet of Rankin Inlet Acnt:00000116 Unit: 122-4Av	232,000.00	146,000.00	157,000.00	535,000.00		
Hamlet of Rankin Inlet Acnt:00000122 Unit: 127-53St	49,000.00	189,000.00	56,000.00	294,000.00		
Hamlet of Rankin Inlet Acnt:50200000 Unit: 020-11Av	90,000.00	89,000.00	42,000.00	221,000.00		

Total	371,000	486,000	255,000	1,112,000		
Residential	10/08	3/09	7/09	Total		
NOKKITOK, MARGARET FOR Nokkitok, Emilia Acnt:00000249 U	72,000.00	107,000.00	127,500.00	306,500.00		
ABUAN, CYNTHIA E. Acnt:00000073 Unit: 010-11Av	47,000.00	33,000.00	25,000.00	105,000.00		
Adams, Sandy Acnt:00000002 Unit: 203-66St	39,000.00	59,000.00	37,000.00	135,000.00		
ADAMS, STEPHANIE Acnt:52600000 Unit: 213-61St	54,000.00	78,500.00	90,000.00	222,500.00		
Adams, Tommy Acnt:00000003 Unit: 113-51St	59,000.00	88,000.00	98,000.00	245,000.00		
Adams, Willie Jr. and Donna Acnt:00000004 Unit: 002-11St	67,000.00	38,000.00	49,000.00	154,000.00		
Airut, Oscar&Lisa Acnt:00000007 Unit: 053-62Av	84,000.00	57,000.00	54,000.00	195,000.00		
AJAJA PAIRIVIK SOCIETY Acnt:00000164 Unit: 213-64St	69,000.00	69,000.00	102,500.00	240,500.00		
Akerolik, Andrew Acnt:00000010 Unit: 004-12Av	51,000.00	29,000.00	54,000.00	134,000.00		
Akerolik, Ernest & Nancy Acnt:00000631 Unit: 216-65St	82,000.00	62,000.00	70,000.00	214,000.00		
Akerolik, Timothy Acnt:00000011 Unit: 113-24St	61,000.00	54,000.00	129,000.00	244,000.00		
AKSALNIK, INUKSHUK & KYLE SHEPPARD Acnt:00000968 Uni	37,000.00	54,000.00	88,000.00	179,000.00		
Aksalnik, Margo Acnt:00000012 Unit: 016-15St	61,000.00	49,000.00	37,000.00	147,000.00		
Aliyak, Mariah Acnt:00000013 Unit: 206-64St	31,000.00	26,000.00	32,000.00	89,000.00		
Aliyak, Samson Acnt:00000014 Unit: 209-63St	50,000.00	27,000.00	36,500.00	113,500.00		
AMAROK, TONY AND LINSDEY Acnt:00000550 Unit: 102-21St	1,000.00	13,000.00	26,000.00	40,000.00		
ANAWAK, GERALD/JENNIFER FLUEGAR Acnt:00000983 Unit: 2	54,000.00	54,000.00	56,000.00	164,000.00		
ANAWAK, STACY Acnt:00000206 Unit: 233-60St	75,000.00	86,000.00	89,000.00	250,000.00		
Anderson, Stan / DUPLEX/SM Acnt:00000921 Unit: 142-24Av	108,000.00	50,000.00	32,000.00	190,000.00		
Angalik, Emelia Acnt:00000021 Unit: 208-64St	48,000.00	67,000.00	58,000.00	173,000.00		
Angidlik, Kerry & Simon Acnt:00000022 Unit: 057-62Av	86,000.00	73,000.00	87,000.00	246,000.00		
Angidlik, Luke & Mary Acnt:00000023 Unit: 015-12St	56,000.00	67,000.00	80,000.00	203,000.00		
Angoshadluk, Moses & MaryRose Acnt:00000816 Unit: 062-64Av	78,000.00	80,500.00	87,000.00	245,500.00		
Aupaluktuq, Jane Acnt:00000027 Unit: 006-12Av	54,000.00	51,000.00	43,000.00	148,000.00		

AUTUT, ALIISA & CEDRIC Acnt:54300004 Unit: 91-65 AVENUE	54,000.00	54,000.00	54,000.00	162,000.00		
Autut, Cecilia Acnt:00000029 Unit: 110-22St	37,000.00	0.00	36,000.00	73,000.00		
Autut, Danny Acnt:00000030 Unit: 036-15St	39,000.00	34,000.00	30,000.00	103,000.00		
Autut, Marcel Acnt:00000031 Unit: 213-66St	43,000.00	28,000.00	39,000.00	110,000.00		
Ayaruak, Sarah Acnt:00000035 Unit: 105-25St	66,000.00	54,000.00	88,000.00	208,000.00		
BALAJI, RAMAMANI Acnt:51100000 Unit: 150-24Av	37,000.00	36,000.00	24,000.00	97,000.00		
BEARDSALL, KEN Acnt:00000904 Unit: 235-60St	62,000.00	66,000.00	54,000.00	182,000.00		
BEATON, RYAN Acnt:00000289 Unit: 054-62Av	47,000.00	54,000.00	90,000.00	191,000.00		
Benoit, Anne-Hannah Acnt:00000037 Unit: 052-64Av	82,000.00	0.00	100,000.00	182,000.00		
Berry, Leonie Acnt:00000038 Unit: 003-24St	79,000.00	52,000.00	50,000.00	181,000.00		
BOUTHILLIER, JOCELYN Acnt:51400000 Unit: 016-24ST	54,000.00	90,000.00	80,000.00	224,000.00		
BRIGHAM, DAWN Acnt:05230000 Unit: 214-65St	40,000.00	23,000.00	15,000.00	78,000.00		
BROWN, ARNIE Acnt:00000811 Unit: 217-66St	84,000.00	85,000.00	77,000.00	246,000.00		
Brown, Jake & Edith Acnt:00000822 Unit: 084-64Av	76,000.00	67,000.00	66,000.00	209,000.00		
Brown, Levinia Acnt:00000041 Unit: 201-51St	80,000.00	43,000.00	94,000.00	217,000.00		
Brown, Rosemary Acnt:00000042 Unit: 101-22St	35,000.00	19,000.00	12,000.00	66,000.00		
BRUCE, HERMAN/DUPLEX/SM Acnt:51200000 Unit: 138-24AV	49,000.00	75,000.00	90,000.00	214,000.00		
Bruce, Tommy Acnt:00000879 Unit: 121-53St	59,000.00	41,000.00	15,000.00	115,000.00		
Chislett, Jerry Acnt:00000051 Unit: 016-26St	64,000.00	75,000.00	76,000.00	215,000.00		
Clark, Donald Acnt:00000052 Unit: 102-24St	51,000.00	54,000.00	56,000.00	161,000.00		
CLARK, KELLY Acnt:00000541 Unit: 214-67St	36,000.00	31,500.00	30,500.00	98,000.00		
CONNELLY, Richard Acnt:00000084 Unit: 109-21Av	62,000.00	114,000.00	92,000.00	268,000.00		
CONNELLY, RICHARD Acnt:00000551 Unit: 152-24Av	45,000.00	0.00	94,000.00	139,000.00		
Connelly, Robert Acnt:00000056 Unit: 028-11Av	33,000.00	23,000.00	20,000.00	76,000.00		
COOPER, YVONNE Acnt:51000000 Unit: 207-24Av	56,000.00	40,000.00	24,000.00	120,000.00		
CURLEY, JACQUELINE Acnt:00000564 Unit: 112-23 St.	24,000.00	28,000.00	21,000.00	73,000.00		
Curley, Sebastian Acnt:00000058 Unit: 104-21Av	78,000.00	56,500.00	42,500.00	177,000.00		
Curley, Tagak Acnt:00000948 Unit: 051-62Av	70,000.00	35,000.00	39,000.00	144,000.00		
David, Teresita Acnt:00000062 Unit: 026-15St	61,000.00	53,500.00	45,000.00	159,500.00		
Dean, Bert & Bernadette Acnt:00000063 Unit: 103-24St	56,000.00	37,000.00	33,000.00	126,000.00		
DIAS, SHAWNA Acnt:52800000 Unit: 225-61ST	47,000.00	126,000.00	88,000.00	261,000.00		
DUGUAY, BRIAN Acnt:50000000 Unit: 104-21St	14,000.00	11,000.00	8,000.00	33,000.00		
Eccles, Selma Acnt:00000066 Unit: 113-53St	62,000.00	51,500.00	35,500.00	149,000.00		
EECHERK, ANDY Acnt:00000069 Unit: 118-22Av	50,000.00	43,000.00	38,000.00	131,000.00		

FAULKNER, STEVEN & KIMBERLEY Acnt:00000544 Unit: 219-67	73,000.00	40,000.00	19,000.00	132,000.00		
Fitzpatrick, Bob Acnt:00000074 Unit: 202-64St	77,000.00	63,000.00	29,000.00	169,000.00		
Fleischhacker, Larry Acnt:00000075 Unit: 109-13St	41,000.00	24,000.00	40,000.00	105,000.00		
Flynn, Darren Acnt:05380000 Unit: 105-13StA	54,000.00	56,000.00	80,000.00	190,000.00		
FORBES, AARON Acnt:00000076 Unit: 014-11Av	46,000.00	18,000.00	15,000.00	79,000.00		
Ford, Beverly Acnt:00000077 Unit: 109-23St	59,000.00	102,000.00	90,000.00	251,000.00		
FORD, PALLULAAQ Acnt:00000299 Unit: 249-61St	66,000.00	40,000.00	36,500.00	142,500.00		
FREDLUND, BENJI Acnt:00000477 Unit: 049-62Av	75,000.00	89,000.00	57,000.00	221,000.00		
FREDLUND, DAVID Acnt:54300002 Unit: 240-60th Street	50,000.00	111,500.00	50,500.00	212,000.00		
Gamble, John Acnt:00000087 Unit: 019-15St	39,000.00	0.00	54,000.00	93,000.00		
Gawor, Bill Acnt:00000089 Unit: 028-15St	57,000.00	22,000.00	4,000.00	83,000.00		
Glad Tidings Arctic Mission: Kay Gordon Acnt:00000090 Unit: 121-2	41,000.00	54,000.00	7,500.00	102,500.00		
Glad Tidings Fellowship /RON DEWER Acnt:00000053 Unit: 008-13	39,000.00	45,000.00	66,000.00	150,000.00		
Gordon, Mark & Irene Acnt:00000817 Unit: 064-64Av	70,000.00	49,000.00	46,000.00	165,000.00		
GORDON, NANCY Acnt:00000124 Unit: 214-63St	0.00	72,000.00	42,000.00	114,000.00		
Gordon, Tommy Acnt:00000107 Unit: 003-26St	84,000.00	59,000.00	66,000.00	209,000.00		
Graham, Mary Acnt:00000108 Unit: 038-15St	56,000.00	71,000.00	72,000.00	199,000.00		
Graves, Alma Acnt:00000866 Unit: 010-15St	45,000.00	29,000.00	18,000.00	92,000.00		
GREEN, JOYCE Acnt:54300000 Unit: 105-13StB	36,000.00	36,000.00	50,000.00	122,000.00		
GREEN, STEPHEN Acnt:00000230 Unit: 024-11Av	61,000.00	25,000.00	26,000.00	112,000.00		
HAPANAK, DICK Acnt:50400000 Unit: 018-15St	24,000.00	0.00	0.00	24,000.00		
HICKES, MARTHA Acnt:00000128 Unit: 004-11St	36,000.00	24,000.00	36,000.00	96,000.00		
HICKES, LOUISE Acnt:00000658 Unit: 020-15St	29,000.00	61,000.00	41,900.00	131,900.00		
HIDALGO JOSE D Acnt:00000130 Unit: 006-15St	81,000.00	38,000.00	53,000.00	172,000.00		
HIDALGO, CAROLINA AND JOEY Acnt:00000250 Unit: 021-4St	165,000.00	190,500.00	54,000.00	409,500.00		
Hidalgo, Carolina Acnt:00000129 Unit: 107-24St	58,000.00	35,000.00	12,000.00	105,000.00		
Hill, Beverly Acnt:00000131 Unit: 112-21St	28,000.00	56,000.00	89,000.00	173,000.00		
I.N.P.H.C. / (5 PLEX) Acnt:00000137 Unit: 130/138-14St	195,000.00	270,000.00	72,000.00	537,000.00		
I.N.P.H.C. Acnt:00000136 Unit: 128-14St	54,000.00	24,000.00	88,000.00	166,000.00		
IGNERDJUK MOSES & SABINA Acnt:00000224 Unit: 014-11St	48,000.00	48,000.00	48,000.00	144,000.00		
Iguptak, Jackie Acnt:00000138 Unit: 009-26St	70,000.00	56,500.00	76,500.00	203,000.00		
IKAKHIK, DARREN Acnt:54000000 Unit: 006-11St	61,000.00	57,000.00	49,500.00	167,500.00		
Irwin, Kathleen Acnt:00000149 Unit: 217-64St	69,000.00	36,000.00	100,000.00	205,000.00		
ISMAIL, AHMED Acnt:51500000 Unit: 021-21St	12,000.00	24,000.00	45,500.00	81,500.00		

Issaluk, Mrs. Acnt:00000910 Unit: 040-15St	50,000.00	36,000.00	90,000.00	176,000.00		
Ittinuar, David Acnt:00000152 Unit: 004-12St	90,000.00	82,000.00	67,000.00	239,000.00		
Ittinuar, Harry Acnt:00000153 Unit: 016-11St	39,000.00	47,000.00	56,000.00	142,000.00		
Ittinuar, Johnny Acnt:00000154 Unit: 022-13St	63,000.00	54,000.00	40,000.00	157,000.00		
JACKIE UGJUK/DUPLEX/SM Acnt:00000874 Unit: 140-24Av	54,000.00	65,000.00	56,000.00	175,000.00		
Janes, Robert Acnt:00000157 Unit: 040-21St	51,000.00	50,000.00	38,500.00	139,500.00		
Jones, Les Acnt:00000159 Unit: 208-63St	50,000.00	25,000.00	26,500.00	101,500.00		
K.R. Manson Ltd Acnt:00000160 Unit: 017-24St	32,500.00	21,000.00	17,000.00	70,500.00		
Kabluitok, Patrick Acnt:00000161 Unit: 199-24Av	92,000.00	91,000.00	69,000.00	252,000.00		
KAKUKTINNINQ, FAITH Acnt:00000939 Unit: 217-61St	24,000.00	36,000.00	0.00	60,000.00		
KALASERK, CRYSTAL Acnt:00000913 Unit: 032-15St	25,000.00	54,000.00	98,000.00	177,000.00		
Kalaserk, Joan Acnt:00000165 Unit: 029-21St	43,000.00	35,000.00	30,000.00	108,000.00		
Kaludjak, Joeffrey Acnt:00000977 Unit: 223-67St	40,000.00	36,000.00	0.00	76,000.00		
Kaludjak, Pasha Acnt:00000169 Unit: 003-14Av	39,000.00	48,000.00	41,000.00	128,000.00		
KALUDJAK, PATRICK & MADELINE Acnt:00000001 Unit: 107-25	71,500.00	47,500.00	43,500.00	162,500.00		
KANGIQLINIQ DEVELOPMENT LTD Acnt:00000147 Unit: 020-4A	0.00	24,000.00	0.00	24,000.00		
Kappi, Leonie Acnt:00000175 Unit: 008-15St	28,000.00	20,500.00	17,500.00	66,000.00		
KARLIK, GABRIAL & KATHY Acnt:50300000 Unit: 014-15St	36,000.00	34,000.00	20,000.00	90,000.00		
Kasaluak, Johnny Acnt:00000864 Unit: 114-24Av	41,000.00	132,000.00	99,000.00	272,000.00		
Kataujaq Society Acnt:00000178 Unit: 107-51St	50,500.00	67,500.00	27,500.00	145,500.00		
Komaksiutiksak, Lisa-Ann & Titaq Acnt:00000209 Unit: 048-64Av	65,000.00	73,000.00	61,000.00	199,000.00		
Kowmuk, Simeon Acnt:00000211 Unit: 010-11St	59,000.00	36,000.00	57,000.00	152,000.00		
KOWTAK, GLORIA Acnt:51300000 Unit: 103-23Av	24,000.00	24,000.00	24,000.00	72,000.00		
KRESKY, LISA Acnt:00000902 Unit: 114-21St	36,000.00	36,000.00	56,000.00	128,000.00		
KUSUGAK JODY & WARREN Acnt:00000528 Unit: 023-15St	54,000.00	49,000.00	44,000.00	147,000.00		
KUSUGAK, GEOFF AND DENISE Acnt:00000168 Unit: 126-52St	44,000.00	63,000.00	53,000.00	160,000.00		
Kusugak, Jean Acnt:00000214 Unit: 008-11St	49,000.00	36,000.00	54,000.00	139,000.00		
KUSUGAK, JOHNNY Acnt:00000975 Unit: 082-64Av	59,000.00	45,000.00	47,000.00	151,000.00		
Kusugak, Jose Acnt:00000215 Unit: 125-53St	64,000.00	52,000.00	56,500.00	172,500.00		
Kusugak, Lorne Acnt:00000216 Unit: 141-24Av	76,000.00	57,500.00	51,000.00	184,500.00		
KUSUGAK, PUJJUUT AND ADRIANA Acnt:00000239 Unit: 015-26	3,000.00	27,500.00	27,500.00	58,000.00		
Kusugak, Sandra Acnt:00000217 Unit: 017-14Av	44,000.00	36,000.00	90,000.00	170,000.00		
KWEDZO, FORSON Acnt:00000979 Unit: 60-64Av	74,000.00	48,500.00	48,500.00	171,000.00		
LEGERE, JOY & FELIKS GAWOR Acnt:00000191 Unit: 048-15St	49,000.00	26,000.00	18,000.00	93,000.00		

LINDELL, JACKSON Acnt:00000210 Unit: 106-11St	61,000.00	54,000.00	56,000.00	171,000.00		
MACCALLUM, JEREMIAH Acnt:00000151 Unit: 034-15St	31,000.00	41,000.00	36,500.00	108,500.00		
MacCallum, Cecilia Acnt:00000793 Unit: 215-66St	54,000.00	28,500.00	25,000.00	107,500.00		
MacCallum, Naomi Acnt:53400000 Unit: 231-60St	80,000.00	69,000.00	68,000.00	217,000.00		
MACKENZIE, RICHARD AND LAURA Acnt:00000772 Unit: 083-6	74,000.00	89,000.00	84,000.00	247,000.00		
Makayak, Noah Acnt:00000218 Unit: 117-25St	39,000.00	70,000.00	50,000.00	159,000.00		
Makkigak, LUCY Acnt:00000219 Unit: 212-63St	0.00	0.00	10,500.00	10,500.00		
Makpah, Celestino Acnt:00000220 Unit: 055-62Av	43,000.00	31,000.00	34,000.00	108,000.00		
Makpah, Raymond&Hilarie Acnt:00000882 Unit: 122-14St	40,000.00	54,000.00	90,000.00	184,000.00		
Makpah, Susan Acnt:00000221 Unit: 076-64Av	43,000.00	42,000.00	56,500.00	141,500.00		
MAKPAH, TRISHA Acnt:00000562 Unit: 215-67 STREET	55,000.00	39,500.00	37,500.00	132,000.00		
MAKTAR, RACHEL JENNIFER Acnt:00000970 Unit: 244-61St	61,000.00	80,000.00	59,000.00	200,000.00		
Maley, Shawn Acnt:00000222 Unit: 006-12St	61,000.00	46,500.00	37,500.00	145,000.00		
MANCHUR, SHELDON Acnt:53100000 Unit: 231-61ST	12,000.00	23,000.00	19,500.00	54,500.00		
Manitok, Paul Acnt:00000223 Unit: 205-24Av	69,000.00	72,500.00	53,500.00	195,000.00		
Manson, Kenneth Acnt:00000225 Unit: 102-23St	52,000.00	24,000.00	21,000.00	97,000.00		
Manson, Kenneth Acnt:00000226 Unit: 111-24St	56,000.00	40,000.00	27,000.00	123,000.00		
MARSHMAN AMANDA Acnt:00000788 Unit: 218-66St	24,000.00	36,000.00	36,000.00	96,000.00		
Mercer, Holly Acnt:00000829 Unit: 213-65St	75,000.00	40,000.00	36,000.00	151,000.00		
Mercer, Raymond & Charmaine Acnt:00000843 Unit: 105-53St	44,000.00	80,000.00	47,000.00	171,000.00		
Merritt, Dorothy Acnt:00000232 Unit: 106-23St	59,000.00	54,000.00	92,000.00	205,000.00		
MILLER, RANDY Acnt:00000047 Unit: 241-60St	29,000.00	6,000.00	14,000.00	49,000.00		
Misherlak, Moses&Linda Acnt:00000237 Unit: 232-60St	81,000.00	56,000.00	56,000.00	193,000.00		
MOORE, LESLIE Acnt:00000878 Unit: 100-21St	46,000.00	58,000.00	37,000.00	141,000.00		
MOREY, WALTER/KISSARVIK COOP Acnt:00000212 Unit: 034-4	66,000.00	117,000.00	39,000.00	222,000.00		
NAKOOLAK, GORDON Acnt:00000870 Unit: 248-61St	75,000.00	68,000.00	65,000.00	208,000.00		
Nauya, Vital Acnt:00000244 Unit: 105-21Av	42,000.00	7,500.00	2,500.00	52,000.00		
NICHOL, DARRIN Acnt:00000213 Unit: 205-51St	64,000.00	64,000.00	54,000.00	182,000.00		
Ningeogan, David & Anne Acnt:00000247 Unit: 208-67St	79,000.00	50,000.00	61,000.00	190,000.00		
Nukapiak, Christine & Eric Acnt:00000256 Unit: 109-53St	56,000.00	69,000.00	66,000.00	191,000.00		
NUNA M & T Acnt:51900000 Unit: 124-54St	54,000.00	171,000.00	110,000.00	335,000.00		
Oingonn, Manasie & Julie Acnt:00000271 Unit: 111-53St	61,000.00	35,000.00	18,000.00	114,000.00		
Okpatauyak, Joe & Clara Acnt:00000272 Unit: 223-63St	59,000.00	75,000.00	58,000.00	192,000.00		
Okpatauyak, Simon Acnt:00000273 Unit: 101-25St	77,000.00	89,000.00	76,000.00	242,000.00		

Onalik, Janet Acnt:00000274 Unit: 012-11Av	39,000.00	80,000.00	44,000.00	163,000.00		
Onalik, Naanasee Acnt:00000275 Unit: 106-24St	50,000.00	13,000.00	3,000.00	66,000.00		
Oolooyuk, Bobby Acnt:00000276 Unit: 144-54St	81,000.00	91,000.00	100,000.00	272,000.00		
OOLOOYUK, DAVID Acnt:50800000 Unit: 115-25ST	51,000.00	31,000.00	22,000.00	104,000.00		
OOLOOYUK, LISA Acnt:00000278 Unit: 210-63St	38,000.00	33,000.00	31,000.00	102,000.00		
OUTCHIKAT, SHAWNEE Acnt:00000110 Unit: 241-61St	45,000.00	89,500.00	47,500.00	182,000.00		
PANIGONIAK, CHARLIE Acnt:00000285 Unit: 056-62Av	85,000.00	55,000.00	57,500.00	197,500.00		
Panika, RICHARD Acnt:00000286 Unit: 225-63St	54,000.00	0.00	36,000.00	90,000.00		
PANIYUK, NOAH & LYNDA Acnt:00000587 Unit: 127-14St	57,000.00	53,000.00	49,000.00	159,000.00		
Papik, Cecelia Acnt:00000287 Unit: 054-64Av	90,000.00	44,000.00	56,000.00	190,000.00		
Patterk, John Acnt:50900000 Unit: 109-25St	62,000.00	38,000.00	40,000.00	140,000.00		
PETRYSHEN, DAVE Acnt:50600000 Unit: 032-12AV	71,000.00	55,000.00	47,000.00	173,000.00		
PFLUGER, GERRY Acnt:00000193 Unit: 124-52St	43,000.00	34,500.00	31,500.00	109,000.00		
Pilakapsi, Aaron & Tootoo, Corrine Acnt:00000290 Unit: 210-67St	63,000.00	32,500.00	31,500.00	127,000.00		
Pilakapsi, Catherine Acnt:00000291 Unit: 102-24Av	54,000.00	23,000.00	17,500.00	94,500.00		
PILAKAPSI, DEBBIE Acnt:00000292 Unit: 207-63St	61,000.00	54,000.00	63,000.00	178,000.00		
Pilakapsi, Hannah Acnt:00000294 Unit: 212-67St	54,000.00	14,000.00	60,000.00	128,000.00		
Pimentel, Emerlinda C. Acnt:50500000 Unit: 030-15St	31,000.00	56,000.00	24,500.00	111,500.00		
PORTER, BRENTON Acnt:00000065 Unit: 104-23ST	48,000.00	29,000.00	18,000.00	95,000.00		
POWELL, ESTHER Acnt:00000645 Unit: 088-64Av	65,000.00	77,000.00	87,000.00	229,000.00		
RBC c/o CBRE GCS Acnt:00000931 Unit: 100-24Av	36,000.00	54,000.00	90,000.00	180,000.00		
Roach, Ron & Goretti Acnt:00000478 Unit: 004-13Av	80,000.00	42,000.00	90,000.00	212,000.00		
Roman Catholic Mission Acnt:00000085 Unit: 102-4Av	31,000.00	20,000.00	16,000.00	67,000.00		
Roman Catholic Mission Acnt:00000086 Unit: 104-4Av	22,000.00	11,500.00	7,000.00	40,500.00		
ROY, PETER Acnt:00000176 Unit: 012-15St	88,000.00	54,000.00	47,000.00	189,000.00		
Rudd, Chris Acnt:00000480 Unit: 107-21Av	49,000.00	57,000.00	61,000.00	167,000.00		
Ruediger, Ralph Acnt:00000481 Unit: 215-64St	40,000.00	29,000.00	34,000.00	103,000.00		
SABOURIN, DONNA Acnt:00000261 Unit: 216-66St	54,000.00	91,000.00	53,000.00	198,000.00		
SABOURIN, PAULINE Acnt:00000684 Unit: 203-51St	51,000.00	50,000.00	56,000.00	157,000.00		
SACULLES MELANIE & MAX MCDONALD Acnt:51600000 Unit:	12,000.00	7,500.00	12,500.00	32,000.00		
SACULLES, CAMILLO & IMELDA DAVID Acnt:00000118 Unit: 10	48,000.00	31,000.00	25,000.00	104,000.00		
SADIWA, WINILDA Acnt:00000078 Unit: 018-11Av	81,000.00	47,000.00	43,000.00	171,000.00		
Sammurtok, Alex Acnt:00000485 Unit: 145-24Av	64,000.00	123,000.00	93,000.00	280,000.00		
SAMMURTOK, KARYNA & MINGERIAK KOLOLA Acnt:0000056	90,000.00	45,000.00	51,000.00	186,000.00		

SAMMURTOK, MELODIE Acnt:00000632 Unit: 068-64Av	37,000.00	54,000.00	56,000.00	147,000.00		
SAMMURTOK, TOM Acnt:00000039 Unit: 009-12St	51,000.00	23,000.00	28,000.00	102,000.00		
San Leasing Ltd / DUPLEX Acnt:00000487 Unit: 105-23St.1	61,000.00	0.00	0.00	61,000.00		
Sandy, Eddie Acnt:00000521 Unit: 212-64St	37,000.00	27,000.00	32,000.00	96,000.00		
Sandy, James Acnt:00000522 Unit: 122-52St	57,000.00	64,000.00	90,000.00	211,000.00		
SANERTANUT, FRANCES Acnt:00000127 Unit: 022-11Av	52,000.00	89,000.00	84,000.00	225,000.00		
Sanertanut, Paul & Lucy Acnt:00000524 Unit: 197-24Av	64,000.00	59,000.00	41,000.00	164,000.00		
SANGUIN, KEVIN Acnt:00000954 Unit: 239-60St	54,000.00	45,000.00	36,000.00	135,000.00		
Sateana, Danny Acnt:00000526 Unit: 236-60St	57,000.00	31,000.00	34,000.00	122,000.00		
Sateana, James Acnt:00000527 Unit: 030-12Av	44,000.00	81,000.00	62,000.00	187,000.00		
Sateana, Steven & Roxanne Acnt:00000529 Unit: 237-60St	69,000.00	124,500.00	136,000.00	329,500.00		
SAYLES, STEVE Acnt:00000972 Unit: 042-15St	49,000.00	7,500.00	8,500.00	65,000.00		
Schindel, Brian & Vivian Acnt:00000900 Unit: 217-63St	75,000.00	59,000.00	39,000.00	173,000.00		
Sharp, Keith Acnt:00000537 Unit: 002-24St	64,000.00	43,500.00	29,500.00	137,000.00		
SHARP, PELAGIE Acnt:00000539 Unit: 117-21Av	53,000.00	93,000.00	90,000.00	236,000.00		
SHEARMAN, RALPH Acnt:00000049 Unit: 108-21St	34,000.00	20,000.00	15,000.00	69,000.00		
Shirley, Susan Acnt:00000540 Unit: 111-25St	49,000.00	35,000.00	20,000.00	104,000.00		
Shouldice, Michael Acnt:00000943 Unit: 113-25St	51,000.00	46,000.00	51,000.00	148,000.00		
SIGURDSON, MRS Acnt:00000868 Unit: 115-21Av	47,000.00	77,000.00	41,000.00	165,000.00		
SIGURDSON, PAKAK Acnt:00000166 Unit: 126-14St	47,000.00	53,000.00	35,000.00	135,000.00		
Siksik, Steven & Nancy Acnt:00000957 Unit: 013-12St	52,000.00	36,000.00	53,000.00	141,000.00		
SMITH CIELO Acnt:00000235 Unit: 214-66St	47,000.00	22,000.00	38,000.00	107,000.00		
SMITH, ALLAN Acnt:00000132 Unit: 024-15St	54,000.00	75,000.00	72,000.00	201,000.00		
SMITH, PATRICK Acnt:50100000 Unit: 016-11AV	0.00	0.00	24,000.00	24,000.00		
Smith, Tammy Acnt:00000553 Unit: 026-11Av	36,000.00	0.00	0.00	36,000.00		
Smutylo, Dale Acnt:00000554 Unit: 102-23Av	47,000.00	21,000.00	8,000.00	76,000.00		
SOLOMON, MARY-ANN Acnt:00000555 Unit: 108-23St	36,000.00	35,000.00	13,500.00	84,500.00		
Strickland, Joe Acnt:51700000 Unit: 116-52St	58,000.00	44,500.00	34,000.00	136,500.00		
Strickland, Rick Acnt:00000556 Unit: 111-51St	16,000.00	9,000.00	9,000.00	34,000.00		
SUBGUT, GIBSON Acnt:00000248 Unit: 012-11St	54,000.00	39,000.00	36,000.00	129,000.00		
TAGOONA, PATRICK Acnt:52100000 Unit: 209-66ST	8,000.00	6,000.00	35,000.00	49,000.00		
Taipana, John & Cecilia Acnt:00000820 Unit: 080-64Av	71,000.00	51,000.00	92,000.00	214,000.00		
Taparti, Louis / DUPLEX /SM Acnt:00000560 Unit: 144-24Av	87,000.00	64,000.00	32,000.00	183,000.00		
Tartak, Joe Acnt:00000561 Unit: 105-51St	69,000.00	29,000.00	59,000.00	157,000.00		

Tattuinee, Jerome & Marianne Acnt:00000562 Unit: 216-64St	54,000.00	33,000.00	46,000.00	133,000.00		
TATTUINEE, KONO Acnt:00000896 Unit: 243-61St	54,000.00	65,000.00	76,000.00	195,000.00		
TATTUINEE, KYLE Acnt:05550000 Unit: 090-64 Av	95,000.00	67,000.00	69,000.00	231,000.00		
Tattuinee, Louie Acnt:00000563 Unit: 116-22Av	40,000.00	24,000.00	28,000.00	92,000.00		
Tatty, Bill & Mary Acnt:00000710 Unit: 208-62St	49,000.00	79,000.00	90,000.00	218,000.00		
TATTY, CHARLENE Acnt:00000818 Unit: 066-64Av	51,000.00	54,000.00	54,000.00	159,000.00		
Tatty, Elsa Acnt:00000564 Unit: 204-64St	61,000.00	95,000.00	109,000.00	265,000.00		
Tatty, Eric Acnt:00000965 Unit: 086-64Av	36,000.00	54,000.00	56,000.00	146,000.00		
TATTY, HAMISH Acnt:00000567 Unit: 013-14Av	58,000.00	61,000.00	46,000.00	165,000.00		
Tatty, John Acnt:00000566 Unit: 011-14Av	42,000.00	28,000.00	27,000.00	97,000.00		
TATTY, ROSS Acnt:00000563 Unit: 140-14 STREET	54,000.00	36,000.00	60,000.00	150,000.00		
Tatty, Simeoni Acnt:00000568 Unit: 125-24Av	39,000.00	25,000.00	23,000.00	87,000.00		
Tatty, Toota Acnt:00000571 Unit: 148-24Av	64,000.00	54,000.00	56,000.00	174,000.00		
THORNE, TEENA / STEVEN HARTMAN Acnt:00000538 Unit: 114	64,000.00	90,000.00	57,000.00	211,000.00		
Tiktak, Noah & Okatsiak, Margaret Acnt:00000570 Unit: 100-23St	70,500.00	42,000.00	35,000.00	147,500.00		
TODD, JASON /DUPLEX Acnt:51800000 Unit: 140/142-54St	84,000.00	83,000.00	69,000.00	236,000.00		
Tongola, Sandy Acnt:00000523 Unit: 120-14St	45,000.00	24,000.00	56,000.00	125,000.00		
Tootoo, Barney Acnt:00000572 Unit: 119-21Av	77,000.00	52,000.00	56,500.00	185,500.00		
TOOTOO, DOROTHY Acnt:00000245 Unit: 046-15St	43,000.00	27,000.00	21,000.00	91,000.00		
TOROMONT ARCTIC LTD Acnt:01071489 Unit: 107-13ST	54,000.00	24,000.00	44,000.00	122,000.00		
TOWTONGIE, HARRY Acnt:00000561 Unit: 47-62 AVENUE	8,000.00	18,000.00	21,500.00	47,500.00		
TOWTONGIE, HARRY Acnt:00000573 Unit: 230-60St	54,000.00	54,000.00	100,000.00	208,000.00		
Towtongie, Harry Acnt:00000919 Unit: 114-24St	66,000.00	54,000.00	56,000.00	176,000.00		
TOWTONGNIE, NECO Acnt:00000559 Unit: 110-24St	71,000.00	60,000.00	47,000.00	178,000.00		
TUCKTOO, DALLAS Acnt:52500000 Unit: 211-61ST	54,000.00	53,000.00	46,500.00	153,500.00		
TULUGAK, DAVID & MARLENE Acnt:00000576 Unit: 122-54St	65,000.00	64,000.00	120,000.00	249,000.00		
TULUGAK, SANDRA Acnt:00000579 Unit: 192-24Av	81,000.00	54,000.00	1,500.00	136,500.00		
Tulugak, Jeff Acnt:00000578 Unit: 203-24Av	67,000.00	121,000.00	36,000.00	224,000.00		
Tungilik, Theresie Acnt:00000581 Unit: 021-15St	39,000.00	20,000.00	23,000.00	82,000.00		
TUTANUAK, RONNIE & RITA Acnt:00000914 Unit: 146-24Av	54,000.00	91,000.00	100,000.00	245,000.00		
Tutanuak, Samson Acnt:00000582 Unit: 011-12St	54,000.00	35,000.00	100,000.00	189,000.00		
ULUADLUAK, MANDY Acnt:00000513 Unit: 107-22Av	80,000.00	74,000.00	76,000.00	230,000.00		
USSAK, JOSEPHINE Acnt:00000984 Unit: 044-15St	32,000.00	80,000.00	83,000.00	195,000.00		
Wallace, John Acnt:00000618 Unit: 102-22St	52,000.00	47,000.00	31,000.00	130,000.00		

Wallace, Tracy Acnt:00000619 Unit: 106-22Av	41,000.00	72,000.00	75,000.00	188,000.00		
White, Boyd Acnt:00000620 Unit: 106-21St	7,000.00	4,000.00	21,000.00	32,000.00		
White, Larry Acnt:00000621 Unit: 026-12Av	61,000.00	66,000.00	67,000.00	194,000.00		
WHITE, MELANIE Acnt:00000819 Unit: 070-64Av	54,000.00	54,000.00	36,000.00	144,000.00		
Wiebe, Lyle Acnt:00000622 Unit: 129-53St	48,000.00	30,000.00	36,500.00	114,500.00		
WILKERSON, STUART Acnt:00000812 Unit: 012-12St	23,000.00	16,000.00	21,000.00	60,000.00		
Williams, Paul & Nowyah Acnt:00000623 Unit: 221-63St	61,000.00	26,000.00	50,000.00	137,000.00		
YAREMA, MARGARET & MIKE Acnt:00000231 Unit: 015-14Av	56,000.00	50,000.00	52,000.00	158,000.00		
Zawadski, Brian & Putulik, Maggie Acnt:00000630 Unit: 207-66St	70,000.00	47,000.00	71,000.00	188,000.00		
Total	14,604,000	13,626,500	13,462,400	41,692,900		
						OnTap - Wa

Water Usage Report By Month								
Community & Government Services Department								
From: AUG-15-2008 To: AUG-15-2009								
					Page: 1			
TOTAL FOR YEAR (Aug 2008 to Aug 2009)								
	litres				Check			
Com Gov/Hamlet Shared	464,500				176,000.00			
Commercial	37,524,000				142,000.00			
FE Gov/Hamlet Shared	108,000				146,500.00			
Full Economic	66,882,500							
No Charge	1,112,000							
Residential	41,692,900							
TOTAL FOR YEAR (Aug 2008 to Aug 2009)	147,783,900	litres						
	147,784	m3						
population	2,500							
water use per person per day	162	lcd						
					125,000.00			
					257,000.00			
					215,000.00			
					135,000.00			
					98,000.00			
					174,500.00			
					410,000.00			

					247,000.00			
					201,000.00			
					170,000.00			
					284,500.00			
					1,222,000.00			
					2,720,000.00			
					4,270,000.00			
					691,000.00			
					2,109,000.00			
					376,000.00			
					80,000.00			
					262,000.00			
					910,000.00			
					1,022,000.00			
					1,576,000.00			
					200,000.00			
					63,000.00			
					79,000.00			
					134,000.00			
					78,000.00			
					90,500.00			
					91,000.00			
					85,000.00			
					268,000.00			
					85,500.00			
					199,500.00			
					89,000.00			
					373,500.00			
					119,000.00			
					150,000.00			
					144,000.00			
					1,389,000.00			
					183,000.00			
					161,000.00			

					1,168,000.00			
					158,000.00			
					730,000.00			
					178,000.00			
					126,000.00			
					81,000.00			
					165,000.00			
					77,000.00			
					457,000.00			
					54,500.00			
					298,500.00			
					245,000.00			
					248,000.00			
					577,000.00			
					198,000.00			
					188,000.00			
					122,500.00			
					162,000.00			
					232,500.00			
					144,500.00			
					239,000.00			
					237,000.00			
					209,000.00			
					7,842,000.00			
					54,500.00			
					188,000.00			
					219,000.00			
					245,000.00			
					199,000.00			
					63,000.00			
					219,000.00			
					532,000.00			
					95,000.00			
					35,000.00			

					108,000.00			
					54,000.00			
					113,000.00			
					2,185,000.00			
					582,000.00			
					392,500.00			
					1,387,000.00			
					4,238,000.00			
					593,000.00			
					478,000.00			
					11,000.00			
					962,000.00			
					379,000.00			
					516,000.00			
					172,000.00			
					1,025,000.00			
					174,000.00			

					27,000.00			
					2,074,000.00			
					852,000.00			
					295,000.00			
					295,000.00			
					62,500.00			
					175,300.00			
					156,000.00			
					273,000.00			
					72,000.00			
					287,000.00			
					708,000.00			
					224,000.00			
					85,000.00			
					181,000.00			
					74,000.00			
					57,500.00			
					196,500.00			
					812,000.00			
					735,000.00			
					93,500.00			
					83,000.00			
					365,000.00			
					313,000.00			
					26,000.00			
					24,000.00			
					37,000.00			
					228,000.00			
					98,000.00			
					2,000.00			
					90,000.00			
					123,000.00			
					118,000.00			
					24,000.00			

					55,000.00			
					100,000.00			
					627,000.00			
					304,000.00			
					1,344,000.00			
					36,000.00			
					247,500.00			
					744,500.00			
					436,000.00			
					1,996,500.00			
					99,000.00			
					243,000.00			
					81,000.00			
					238,000.00			
					178,000.00			
					257,000.00			
					208,000.00			
					233,000.00			
					255,000.00			
					54,000.00			
					224,000.00			
					205,800.00			
					293,000.00			
					223,000.00			
					258,000.00			
					240,500.00			
					233,000.00			
					226,000.00			
					225,000.00			
					246,000.00			
					98,000.00			
					221,000.00			
					226,000.00			
					193,000.00			

					247,000.00			
					200,500.00			
					183,000.00			
					54,000.00			
					179,000.00			
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					54,000.00			
					123,000.00			
					135,000.00			
					162,000.00			
					165,000.00			
					142,000.00			
					238,000.00			
					241,000.00			
					218,000.00			
					153,000.00			
					110,000.00			
					224,000.00			
					179,000.00			
					268,000.00			
					139,000.00			
					220,400.00			
					173,500.00			
					136,000.00			
					157,000.00			
					208,500.00			
					161,000.00			
					54,000.00			
					132,000.00			
					134,000.00			
					202,000.00			
					218,000.00			
					244,000.00			
					144,000.00			

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Government of Nunavut - Hamlet of Rankin Inlet				
None				

Government of Nunavut - Hamlet of Rankin Inlet				
None				

<u>Government of Nunavut - Hamlet of Rankin Inlet</u>		
Area of Use	Volume	Units
Bleeders on dead end of Utilidors	17,280,000	gallons
Bleeders at customer homes	2,430,000	gallons
Flushing of watermain		gallons
Fighting fires		gallons
Total	19,710,000	gallons
Total	89,877	m3
conversion 219.3 gallons per m3		

[illegible]

Government of Nunavut - Hamlet of Rankin Inlet				
Theft				
Use IWA default of 0.25%				
	1,069	m3		

Government of Nunavut - Hamlet of Rankin Inlet				
<u>Typical customer water meter under-registration</u>				
Customer Meter Age	Estimated Under-			
Years	Percentage			
5 to 10	1% to 2%			
10 to 15	2% to 4%			
15 to 20	3% to 5%			
20 to 25	5% to 8%			
25+	6% to 10%+			
Assume meters 15 to 25 years old - estimated under-registration of 5%				

Government of Nunavut - Hamlet of Rankin Inlet				
Use IWA Default				

Government of Nunavut - Hamlet of Rankin Inlet				
Data not provided				
Population	2358			
Number of properties	580	approximate		
Assume	40 km	For flow and return mains		

Government of Nunavut - Hamlet of Rankin Inlet		
Data not provided		
Number of Customer Accounts		
Number of services	580	Estimate

Government of Nunavut - Hamlet of Rankin Inlet			
Main to curb stop			
Curb stop to house	50 ft	15.24	m

Government of Nunavut - Hamlet of Rankin Inlet		
Average	psi	m
From	30	21
To	50	35
Average	40	28
conversion 1 psi is 0.7 m		

Government of Nunavut - Hamlet of Rankin Inlet		
Data not provided		
Canadian example for municipality of 600 services is \$250,000		
Assume	\$750,000.00	Three times average
Item	Cost	Comment
Total	\$0	
Operation and Maintenance		
Salaries, benefits, insurance, administration, overhead		
Total	\$0	

Government of Nunavut - Hamlet of Rankin Inlet	
Data not provided	
Cost per m3	Assumptions
0.20	Power and chemicals - typical Canadian \$0.10, so double for Rankin Inlet
0.15	Heating water added to produce tempered water - estimate
0.35	total
Cost per ML	
\$350.00	

Government of Nunavut - Hamlet of Rankin Inlet						
Data not provided						
Not Known						
Canadian rates, on average \$1.50 per m3 - water and sewer						
Assume	\$4.50	per m3	Three times Canadian average rate			

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

[Back to Instructions](#)

[?](#) Click to access definition

Water Audit Report for: **Regional Municipality of Peel**

Reporting Year: **2008** **1/2008 - 12/2008**

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	?	7	213,977.000	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	?	4	0.000	ML/Yr
Water imported:	?	n/a	0.000	ML/Yr
Water exported:	?	7	26,457.500	ML/Yr

WATER SUPPLIED: [?](#) 187,519.500 ML/Yr

AUTHORIZED CONSUMPTION

Billed metered:	?	7	163,665.000	ML/Yr
Billed unmetered:	?	2	433.900	ML/Yr
Unbilled metered:	?	8	1,768.400	ML/Yr
Unbilled unmetered:	?	5	230.100	ML/Yr

Click here: [?](#)
for help using option
buttons below

Pcnt: ☐ Value: ☐ 230.100

Use buttons to select
percentage of water supplied
OR
value

AUTHORIZED CONSUMPTION: [?](#) 166,097.400 ML/Yr

WATER LOSSES (Water Supplied - Authorized Consumption) 21,422.100 ML/Yr

Apparent Losses

Unauthorized consumption: [?](#) 5 886.800 ML/Yr

Pcnt: ☐ Value: ☐ 886.800

Customer metering inaccuracies: [?](#) 7 2,851.000 ML/Yr

Systematic data handling errors: [?](#) 0.000 ML/Yr

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses: [?](#) 3,737.800 ML/Yr

Choose this option to
enter a percentage of
billed metered
consumption. This is
NOT a default value

Real Losses

Real Losses = Water Losses - Apparent Losses: [?](#) 17,684.300 ML/Yr

WATER LOSSES: 21,422.100 ML/Yr

NON-REVENUE WATER

NON-REVENUE WATER: [?](#) 23,420.600 ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	?	8	4,161.0	kilometers
Number of active AND inactive service connections:	?	9	287,905	
Connection density:			69	conn./km main
Average length of customer service line:	?	5	16.0	metres (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	?	6	58.4	metres (head)

COST DATA

Total annual cost of operating water system:	?	3	\$100,000,000	\$/Year
Customer retail unit cost (applied to Apparent Losses):	?	10	\$0.64	\$/1000 litres
Variable production cost (applied to Real Losses):	?	10	\$642.00	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	12.5%
Non-revenue water as percent by cost of operating system:	15.0%
Annual cost of Apparent Losses:	\$2,399,668
Annual cost of Real Losses:	\$11,353,321

Operational Efficiency Indicators

Apparent Losses per service connection per day:	35.57	litres/connection/day
Real Losses per service connection per day*:	168.29	litres/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per meter (head) pressure:	2.88	litres/connection/day/m
? Unavoidable Annual Real Losses (UARL):	8,960.91	cubic meters/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	1.97	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 64 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources

2: Master meter error adjustment

3: Billed unmetered

[For more information, click here to see the Grading Matrix worksheet](#)

APPENDIX C

Residential

Toilet Replacement (HET)

	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants	776			
Number of Participants	698	138.75		
Number of Toilets/Participant	1.1			
Equipment and Installation	\$ 918.63		\$	641,572.59
Marketing	\$ 15.00		\$	10,476.00
Program Management	\$ 60.00		\$	41,904.00
Project Management	\$ 20.00		\$	13,968.00
Total per Participant	\$ 1,013.63			
Total for Program	\$ 707,920.59	96,903	\$ 7.31	\$ 707,920.59

Toilet Replacement (Dual Flush)

	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants	776			
Number of Participants	78	138.75		
Number of Toilets/Participant	1.1			
Equipment and Installation	\$ 918.63		\$	71,285.84
Marketing	\$ 15.00		\$	1,164.00
Program Management	\$ 70.00		\$	5,432.00
Project Management	\$ 20.00		\$	1,552.00
Total per Participant	\$ 1,023.63			
Total for Program	\$ 79,433.84	10,767	\$ 7.38	\$ 79,433.84

Showerhead Replacement

	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants	776	54		
Number of Participants	776			
Number of Showerheads/Participant	1.1			
Equipment	\$ 33.00		\$	25,608.00
Installation	\$ 50.00		\$	38,800.00
Marketing	\$ 10.00		\$	7,760.00
Program Management	\$ 30.00		\$	23,280.00
Project Management	\$ 10.00		\$	7,760.00
Total per Participant	\$ 133.00			
Total for Program	\$ 103,208.00	42,246	\$ 2.44	\$ 103,208.00

Kitchen Faucet Aerator Replacement

	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants	776	20		
Number of Participants	776			
Number of Faucets/Participant	1.0			
Equipment	\$ 13.00		\$	10,088.00
Installation	\$ 20.00		\$	15,520.00
Marketing	\$ 10.00		\$	7,760.00
Program Management	\$ 20.00		\$	15,520.00
Project Management	\$ 8.00		\$	6,208.00
Total per Participant	\$ 71.00			
Total for Program	\$ 55,096.00	15,644	\$ 3.52	\$ 55,096.00

Bathroom Faucet Aerator Replacement

	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants	776	24		
Number of Participants	776			
Number of Faucets/Participant	1.1			
Equipment	\$ 6.00		\$	4,656.00
Installation	\$ 20.00		\$	15,520.00
Marketing	\$ 10.00		\$	7,760.00
Program Management	\$ 20.00		\$	15,520.00
Project Management	\$ 8.00		\$	6,208.00
Total per Participant	\$ 64.00			
Total for Program	\$ 49,664.00	18,376	\$ 2.70	\$ 49,664.00

Leakage Repair

		Per Participant	Water Savings (lpd)	Cost per litre/day	
Single Family					
Potential Number of Participants		776	56		
Number of Participants		776			
Number of Leak/Participant		1.1			
Equipment	assume flapperless HET toilets	\$ -		\$ -	
Installation	installed at no extra cost	\$ -		\$ -	
Marketing		\$ -		\$ -	
Program Management		\$ -		\$ -	
Project Management		\$ -		\$ -	
Total per Participant		\$ -			
Total for Program		\$ -	43,068	\$ -	\$ -

Water Efficient Clothes Washing

		Per Participant	Water Savings (lpd)	Cost per litre/day	
Single Family					
Potential Number of Participants		776			
Number of Participants		776	19		
Equipment and Delivery		\$ 1,200.00		\$ 931,200.00	
Marketing		\$ 10.00		\$ 7,760.00	
Program Management		\$ 30.00		\$ 23,280.00	
Project Management		\$ 10.00		\$ 7,760.00	
Total per Participant		\$ 1,250.00			
Total for Program		\$ 970,000.00	14,356	\$ 67.57	\$ 970,000.00

Industrial/Commerical/Institutional**Toilet Replacement (HET)**

		Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants		62	375		
Number of Participants		44.64			
Number of Toilets/Participant		8.0			
Equipment and Installation		\$ 6,680.96		\$ 298,238.05	
Marketing		\$ 200.00		\$ 8,928.00	
Program Management		\$ 400.00		\$ 17,856.00	
Project Management		\$ 100.00		\$ 4,464.00	
Total per Participant		\$ 7,380.96			
Total for Program		\$ 329,486.05	16,740	\$ 19.68	\$ 329,486.05

Toilet Replacement (Dual Flush)

		Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants		62	375		
Number of Participants		4.96			
Number of Toilets/Participant		8.0			
Equipment and Installation		\$ 6,680.96		\$ 33,137.56	
Marketing		\$ 300.00		\$ 1,488.00	
Program Management		\$ 500.00		\$ 2,480.00	
Project Management		\$ 150.00		\$ 744.00	
Total per Participant		\$ 7,630.96			
Total for Program		\$ 37,849.56	1,860	\$ 20.35	\$ 37,849.56

Pre-Rinse Spray Nozzle

		Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of Participants		10	368		
Number of Participants		10			
Number of Nozzles/Participant		1.5			
Equipment		\$ 225.00		\$ 2,250.00	
Installation		\$ 150.00		\$ 1,500.00	
Marketing		\$ 300.00		\$ 3,000.00	
Program Management		\$ 700.00		\$ 7,000.00	
Project Management		\$ 75.00		\$ 750.00	
Total per Participant		\$ 1,450.00			
Total for Program		\$ 14,500.00	3,680	\$ 3.94	\$ 14,500.00

ICI Audit and Capacity Buy-Back	Per Participant	Water Savings (lpd)	Cost per litre/day	
Number of Participants (Audits)		5		5
Implementation Rate		0.15		
Number of Implementation Participants		0.75		
Average Savings Per Implementation		20,000 litres per day		
Average Cost of Audit	\$	5,500.00		\$ 27,500.00
Monitoring and Verification	\$	3,000.00		\$ 3,000.00
Capacity Buy-back	\$	2.00 per litre per day savings		\$ 30,000.00
Program Management	\$	1,500.00		\$ 7,500.00
Project Management	\$	1,000.00		\$ 4,250.00
Total Cost Audit Participant	\$	34,000.00		\$ 72,250.00
Total for Audit/Implementation Participant	\$	38,250.00		
Total	\$	72,250.00		\$ 4.82
Cost per Participant	\$	96,333.33	15,000	\$ 4.82

Distribution Leakage Reduction

Leakage Reduction	Per Participant	Water Savings (lpd)	Cost per litre/day	
Potential Number of DMAs		5		
Number of DMAs per year		5		
Field Work Cost	\$	30,000.00		\$ 150,000.00
Cost to repair leak per DMA	\$	20,000.00		\$ 100,000.00
Program Management	\$	3,000.00		\$ 15,000.00
Project Management	\$	2,000.00		\$ 10,000.00
Total per Participant	\$	55,000.00		
Total for Program	\$	275,000.00	287,500	\$ 0.96 \$ 275,000.00

Per Participant Costing

		Equipment & Installation	Marketing	Program Management & Administration	Project Management	Cost per Participant	Savings per Participant (L/d)	Cost per litre
Residential								
Installation	HET Toilets	\$ 918.63	\$ 15.00	\$ 60.00	\$ 20.00	\$ 1,013.63	138.75	\$ 7.31
Installation	Dual Flush Toilets	\$ 918.63	\$ 15.00	\$ 70.00	\$ 20.00	\$ 1,023.63	138.75	\$ 7.38
Installation	Low Flow Showerheads	\$ 83.00	\$ 10.00	\$ 30.00	\$ 10.00	\$ 133.00	54	\$ 2.44
Installation	Kitchen Faucets	\$ 33.00	\$ 10.00	\$ 20.00	\$ 8.00	\$ 71.00	20	\$ 3.52
Installation	Bathroom Faucets	\$ 26.00	\$ 10.00	\$ 20.00	\$ 8.00	\$ 64.00	24	\$ 2.70
Installation	Leakage Repair	\$ -	\$ -	\$ -	\$ -	\$ -	56	\$ -
Installation	Clotheswashers	\$ 1,200.00	\$ 10.00	\$ 30.00	\$ 10.00	\$ 1,250.00	19	\$ 67.57
Industrial, Commercial, Institutional								
Installation	HET Toilets	\$ 6,680.96	\$ 200.00	\$ 400.00	\$ 100.00	\$ 7,380.96	375	\$ 19.68
Installation	Dual Flush Toilets	\$ 6,680.96	\$ 300.00	\$ 500.00	\$ 150.00	\$ 7,630.96	375	\$ 20.35
Installation	Pre-Rinse Spray Valves	\$ 375.00	\$ 300.00	\$ 700.00	\$ 75.00	\$ 1,450.00	368	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	\$ -	\$ -	\$ -	\$ -	\$ 72,250.00	15,000	\$ 4.82
Municipal								
Installation	Leakage Reduction	\$ 50,000.00	\$ -	\$ 3,000.00	\$ 2,000.00	\$ 55,000.00	57,500	\$ 0.96

Total Program Costing

		Number Product Installed	Equipment & Installation	Marketing	Program Management & Administration	Project Management	Total Cost	Total Program Savings (L/d)	Cost per litre	Utility Electrical Savings (KWh/yr)	Utility Electric Bill Savings (\$/yr)	CO2 Reductions (tonnes/yr)
Residential												
Installation	HET Toilets	768	\$ 641,572.59	\$ 10,476.00	\$ 41,904.00	\$ 13,968.00	\$ 707,920.59	96,903	\$ 7.31	24,051	\$ 8,482.90	14.4
Installation	Dual Flush Toilets	85	\$ 71,285.84	\$ 1,164.00	\$ 5,432.00	\$ 1,552.00	\$ 79,433.84	10,767	\$ 7.38	2,672	\$ 942.54	1.6
Installation	Low Flow Showerheads	854	\$ 64,408.00	\$ 7,760.00	\$ 23,280.00	\$ 7,760.00	\$ 103,208.00	42,246	\$ 2.44	10,485	\$ 3,698.19	6.3
Installation	Kitchen Faucets	776	\$ 25,608.00	\$ 7,760.00	\$ 15,520.00	\$ 6,208.00	\$ 55,096.00	15,644	\$ 3.52	3,883	\$ 1,369.49	2.3
Installation	Bathroom Faucets	854	\$ 20,176.00	\$ 7,760.00	\$ 15,520.00	\$ 6,208.00	\$ 49,664.00	18,376	\$ 2.70	4,561	\$ 1,608.61	2.7
Installation	Leakage Repair	854	\$ -	\$ -	\$ -	\$ -	\$ -	43,068	\$ -	10,689	\$ 3,770.18	6.4
Installation	Clotheswashers	776	\$ 931,200.00	\$ 7,760.00	\$ 23,280.00	\$ 7,760.00	\$ 970,000.00	14,356	\$ 67.57	3,563	\$ 1,256.73	2.1
Industrial, Commercial, Institutional												
Installation	HET Toilets	357	\$ 298,238.05	\$ 8,928.00	\$ 17,856.00	\$ 4,464.00	\$ 329,486.05	16,740	\$ 19.68	4,155	\$ 1,465.42	2.5
Installation	Dual Flush Toilets	40	\$ 33,137.56	\$ 1,488.00	\$ 2,480.00	\$ 744.00	\$ 37,849.56	1,860	\$ 20.35	462	\$ 162.82	0.3
Installation	Pre-Rinse Spray Valves	15	\$ 3,750.00	\$ 3,000.00	\$ 7,000.00	\$ 750.00	\$ 14,500.00	3,680	\$ 3.94	913	\$ 322.15	0.5
Installation	ICI Audits and Capacity Buy-back	5	\$ 60,500.00	\$ -	\$ 7,500.00	\$ 4,250.00	\$ 72,250.00	15,000	\$ 4.82	3,723	\$ 1,313.10	2.2
Municipal												
Installation	Leakage Reduction	5	\$ 250,000.00	\$ -	\$ 15,000.00	\$ 10,000.00	\$ 275,000.00	287,500	\$ 0.96	60,864	\$ 21,466.64	36.5
Education												
Public Education (5 years)							\$ 150,000.00					
Youth Education (5 years)							\$ 180,000.00					

Equipment/Installation	Marketing	Prog. Mngmt	Proj. Mngmt.	Total Cost	Total Savings							
\$ 2,399,876.05	\$ 13,416.00	\$ 174,772.00	\$ 63,664.00	\$ 3,024,408.05	566,140	\$ 5.34	130,022	\$ 45,858.79				78.0

Residential	Water Efficiency Measure	Cost per Participant	Savings per Participant (L/d)	Cost per litre
Installation	HET Toilets	\$ 1,014	139	\$ 7.31
Installation	Dual Flush Toilets	\$ 1,024	139	\$ 7.38
Installation	Low Flow Showerheads	\$ 133	54	\$ 2.44
Installation	Kitchen Faucets	\$ 71	20	\$ 3.52
Installation	Bathroom Faucets	\$ 64	24	\$ 2.70
Installation	Leakage Repair	\$ -	56	\$ -
Installation	Clotheswashers	\$ 1,250	19	\$ 67.57
ICI				
Installation	HET Toilets	\$ 7,381	375	\$ 19.68
Installation	Dual Flush Toilets	\$ 7,631	375	\$ 20.35
Installation	Pre-Rinse Spray Valves	\$ 1,450	368	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	\$ 72,250	15,000	\$ 4.82
Municipal				
Installation	Leakage Reduction	\$ 55,000	57,500	\$ 0.96

Residential	Water Saving Measure	Number of Product Installed	Total Cost	Total Program Savings (L/d)	Cost per litre
Installation	HET Toilets	768	\$ 707,921	96,903	\$ 7.31
Installation	Dual Flush Toilets	85	\$ 79,434	10,767	\$ 7.38
Installation	Low Flow Showerheads	854	\$ 103,208	42,246	\$ 2.44
Installation	Kitchen Faucets	776	\$ 55,096	15,644	\$ 3.52
Installation	Bathroom Faucets	854	\$ 49,664	18,376	\$ 2.70
Installation	Leakage Repair	854	\$ -	43,068	\$ -
Installation	Clotheswashers	776	\$ 970,000	14,356	\$ 67.57
Industrial, Commercial, Institutional					
Installation	HET Toilets	357	\$ 329,486	16,740	\$ 19.68
Installation	Dual Flush Toilets	40	\$ 37,850	1,860	\$ 20.35
Installation	Pre-Rinse Spray Valves	15	\$ 14,500	3,680	\$ 3.94
Installation	ICI Audits and Capacity Buy-back	5	\$ 72,250	15,000	\$ 4.82
Municipal					
Installation	Leakage Reduction	5	\$ 275,000	287,500	\$ 0.96
Education					
Public Education (5 years)			\$ 150,000		
Youth Education (5 years)			\$ 180,000		
TOTAL			\$ 3,024,408	566,140	\$ 5.34

RESIDENTIAL - Maintenance

		Cost per Participant	Participants (Capital)	Year 1 Maintenance (1%)	Year 1 Cost	Year 2 Annual Maintenance (2%)	Year 2 Annual Cost	Year 3 Maintenance (3%)	Year 3 Annual Cost	Year 4 Maintenance (3%)	Year 4 Annual Cost	Year 5 Maintenance (3%)	Year 5 Annual Cost	Total
Residential														
Indoor	Showerheads	\$ 33.00	854	8.54	\$ 281.82	17.1	\$ 563.64	51.24	\$ 1,690.92	76.86	\$ 2,536.38	102.48	\$ 3,381.84	
	Kitchen Faucet Aerators	\$ 13.00	776	7.76	\$ 100.88	15.5	\$ 201.76	46.56	\$ 605.28	69.84	\$ 907.92	93.12	\$ 1,210.56	
	Bathroom Aerators	\$ 6.00	854	8.54	\$ 51.24	17.1	\$ 102.48	51.24	\$ 307.44	76.86	\$ 461.16	102.48	\$ 614.88	
	Clotheswashers	\$ 35.00	779											
	Program Mngmt/Admin				\$ 8,000.00		\$ 8,000.00		\$ 8,000.00		\$ 8,000.00		\$ 8,000.00	
Total					\$ 8,433.94		\$ 8,867.88		\$ 10,603.64		\$ 11,905.46		\$ 13,207.28	\$ 53,018.20
Toilet Flappers	HET Toilets	\$ 75.00	768	7.68	\$ 576.00	15.4	\$ 1,152.00	46.08	\$ 3,456.00	69.12	\$ 5,184.00	92.16	\$ 6,912.00	
	Dual Flush Toilets	\$ 115.00	85	0.85	\$ 97.75	1.7	\$ 195.50	5.1	\$ 586.50	7.65	\$ 879.75	10.2	\$ 1,173.00	
	Program Mngmt/Admin				\$ 8,000.00		\$ 8,000.00		\$ 8,000.00		\$ 8,000.00		\$ 8,000.00	
					\$ 8,673.75		\$ 9,347.50		\$ 12,042.50		\$ 14,063.75		\$ 16,085.00	\$ 60,212.50
Total														
TOTAL RESIDENTIAL					\$ 17,107.69		\$ 18,215.38		\$ 22,646.14		\$ 25,969.21		\$ 29,292.28	\$ 113,230.70

INDUSTRIAL/COMMERCIAL/INSTITUTIONAL

		Cost per Participant	Participants (Capital)	Year 1 Maintenance (1%)	Year 1 Cost	Year 2 Annual Maintenance (2%)	Year 2 Annual Cost	Year 3 Maintenance (3%)	Year 3 Annual Cost	Year 4 Maintenance (3%)	Year 4 Annual Cost	Year 5 Maintenance (3%)	Year 5 Annual Cost	Total
Large Volume Industrial/Commercial/Institutional														
	Pre-Rinse Spray Valves	\$ 150.00	30	0.3	\$ 45.00	0.6	\$ 90.00	1.8	\$ 270.00	2.7	\$ 405.00	10	\$ 1,500.00	
	Program Mngmt/Admin				\$ 6,000.00		\$ 6,000.00		\$ 6,000.00		\$ 6,000.00		\$ 8,000.00	
					\$ 6,045.00		\$ 6,090.00		\$ 6,270.00		\$ 6,405.00		\$ 9,500.00	\$ 34,310.00
Total														
Toilet Flappers	HET Toilets	\$ 75.00	446	4.46	\$ 334.50	8.9	\$ 669.00	26.76	\$ 2,007.00	40.14	\$ 3,010.50	53.52	\$ 4,014.00	
	Dual Flush Toilets	\$ 115.00	50	0.5	\$ 57.50	1.0	\$ 115.00	3	\$ 345.00	4.5	\$ 517.50	6	\$ 690.00	
	Program Mngmt/Admin				\$ 6,000.00		\$ 6,000.00		\$ 6,000.00		\$ 6,000.00		\$ 6,000.00	
					\$ 6,392.00		\$ 6,784.00		\$ 8,352.00		\$ 9,528.00		\$ 10,704.00	\$ 41,760.00
Total														
ICI Audit and Capacity Buyback	Program Mngmt/Admin	\$ 1,500.00	1		\$ -		\$ -	1	\$ 1,500.00	1	\$ 1,500.00	1	\$ 1,500.00	
					\$ -		\$ -		\$ 6,000.00		\$ 6,000.00		\$ 6,000.00	
Total									\$ 7,500.00		\$ 7,500.00		\$ 7,500.00	\$ 22,500.00
TOTAL INDUSTRIAL/COMMERCIAL/INSTITUTIONAL					\$ 12,437.00		\$ 12,874.00		\$ 22,122.00		\$ 23,433.00		\$ 27,704.00	\$ 98,570.00

Five Year Maintenance Plan		Year 1	Year 2	Year 3	Year 4	Year 5	Total
		Costs	Costs	Costs	Costs	Costs	
Residential		\$ 17,107.69	\$ 18,215.38	\$ 22,646.14	\$ 25,969.21	\$ 29,292.28	\$ 113,230.70
Industrial/Commercial/Institutional		\$ 12,437.00	\$ 12,874.00	\$ 22,122.00	\$ 23,433.00	\$ 27,704.00	\$ 98,570.00
Distribution Leakage Reduction				\$ 60,000.00	\$ 90,000.00		\$ 150,000.00
Total		\$ 29,544.69	\$ 31,089.38	\$ 44,768.14	\$ 109,402.21	\$ 146,996.28	\$ 361,800.70

Residential	End-Use Monitoring	End-use Monitoring one month pre, one post	Persistence Audits	Persistence Audits	Total
	Sample Size		Sample Size	Year 5 150 sample	
HET Toilets	30	\$ 45,000.00	125	\$ 8,750.00	
Dual Flush Toilets	15	\$ 22,500.00	25	\$ 1,750.00	
Clothes Washer	30	\$ 45,000.00	150	\$ 10,500.00	
Showers,Faucets,	30	\$ 45,000.00	150	\$ 9,000.00	
TOTAL RESIDENTIAL INDOOR		\$ 157,500.00		\$ 30,000.00	\$ 187,500.00

Industrial/Commercial/Institutional

Pre-rinse spray valves	10	\$ 15,000.00	10	\$ 800.00	
HET Toilets	20	\$ 42,000.00	60	\$ 4,800.00	
Dual Flush Toilets	10	\$ 21,000.00	20	\$ 1,600.00	
TOTAL INDUSTRIAL/COMMERCIAL/INSTITUTIONAL		\$ 78,000.00		\$ 7,200.00	\$ 85,200.00
		\$ 235,500.00		\$ 37,200.00	

Five Year Monitoring and Evaluation Plan	
	Costs
Residential	\$ 187,500.00
Industrial, Commercial and Institutional	\$ 85,200.00
Total	\$ 272,700.00

Five Year Monitoring and Evaluation Plan		Year 1	Year 2	Year 3	Year 4	Year 5	Total
		Costs	Costs	Costs	Costs	Costs	Costs
Residential		\$ 157,500				\$ 30,000	\$ 187,500
Industrial, Commercial and Institutional		\$ 78,000				\$ 7,200	\$ 85,200
Total		\$ 235,500	\$ -	\$ -	\$ -	\$ 37,200	\$ 272,700

APPENDIX D

Program Descriptions

Table of Contents

Residential – Toilet Replacement - HET.....	1
Residential – Toilet Replacement - DF.....	3
Residential – Efficient Clothes Washers.....	5
Residential – Low Flow Showerheads.....	7
Residential – Kitchen Faucet Aerators.....	9
Residential – Bathroom Aerators.....	11
Residential – Leakage.....	13
Industrial, Commercial, Institutional – Toilet Replacement – HET.....	14
Industrial, Commercial, Institutional – Toilet Replacement – DF.....	16
Industrial, Commercial, Institutional – Pre-Rinse Spray Valves.....	18
Industrial, Commercial, Institutional – Audit and Capacity Buyback.....	19
Municipal – Distribution Leakage Reduction.....	20
Broadscale Public Education.....	22
Youth Education.....	23

Toilet Replacement - HET**Residential**

Incentive	Free Supply and Installation
Savings Per Participant	139 litres per average day
Cost Per Participant	\$1,014.00
Number of Participants	698
Number of Toilets	768
Program Costs	\$707,920
Program Savings (litres per average day)	96,903
Cost per Litre per Average Day Saved	\$7.31
Monitoring Cost	\$53,750

Program Description

Through a mass campaign, all residential toilets would be replaced with High Efficiency toilets (HETs) or Dual Flush toilets. A contractor, selected through a tendering process would go door to door replacing the existing toilets with the new HET toilets. It is assumed that 90% of the participant would select an HET toilet while 10% would select the dual flush models. Toilets would be purchased and shipped in bulk ensuring the lowest cost possible. Existing toilets would be removed and scrapped.

It is recommended that the toilets selected for this campaign be EPA WaterSense approved to ensure sustained water savings and a high level of customer satisfaction amongst program participants.

Assumptions**Savings**

- Current housing stock is 776 units¹
- Assume 90% of the participants would select an HET toilet model and 10% would select a dual flush model²
- 698 participants
- 3.7 persons per household¹
- 1.1 toilets per household³
- 5 flushes per person per day⁴
- Average flush volume per existing toilet is 12.3 litres⁵
- Average flush volume per replaced toilet is 4.8 litres⁶

Savings per Participant = (Existing toilet flush volume – Replaced toilet flush volume)
x number of flushes per person per day
x number of persons per household

Savings per Participant = (12.3 – 4.8) x 5.0 x 3.7 = 139 litres per average day

Costs per Participant

- Assume 1.1 toilets per participant
- Equipment cost is \$535.12
- Installation cost is \$300.00
- Marketing cost is \$15.00
- Program management cost is \$60.00
- Project management cost is \$20.00

References

- 1 Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- 2 Assumption.
- 3 Rankin Inlet, Customer Survey, RMSi, October 2009.
- 4 American Water Works Association, Research Foundation. Residential End Uses of Water Study. 1999.
- 5 Rankin Inlet, Household Audits, RMSi, October 2009.
- 6 US Environmental Protection Agency, WaterSense Program, 2009.

Toilet Replacement – Dual Flush**Residential**

Incentive	Free Supply and Installation
Savings Per Participant	139 litres per average day
Cost Per Participant	\$1,023.00
Number of Participants	78
Number of Toilets	85
Program Costs	\$79,434
Program Savings (litres per average day)	10,767
Cost per Litre per Average Day Saved	\$7.38
Monitoring Cost	\$24,250

Program Description

Through a mass campaign, all residential toilets would be replaced with High Efficiency toilets (HETs) or Dual Flush toilets. A contractor, selected through a tendering process would go door to door replacing the existing toilets with the new HET toilets. It is assumed that 90% of the participant would select a HET toilet while 10% would select the dual flush models. Toilets would be purchased and shipped in bulk ensuring the lowest cost possible. Existing toilets would be removed and scrapped.

It is recommended that the toilets selected for this campaign be EPA WaterSense approved to ensure sustained water savings and a high level of customer satisfaction amongst program participants.

Assumptions**Savings**

- Current housing stock is 776 units¹
- Assume 10% of the participants would select a dual flush toilet model and 10%²
- 78 participants
- 3.7 persons per household¹
- 1.1 toilets per household³
- 5 flushes per person per day⁴
- Average flush volume per existing toilet is 12.3 litres⁵
- Average flush volume per replaced toilet is 4.8 litres⁶

Savings per Participant = (Existing toilet flush volume – Replaced toilet flush volume)
x number of flushes per person per day
x number of persons per household

Savings per Participant = (12.3 – 4.8) x 5.0 x 3.7 = 139 litres per average day

Costs per Participant

- Assume 1.1 toilets per participant
- Equipment cost is \$535.12
- Installation cost is \$300.00
- Marketing cost is \$15.00
- Program management cost is \$70.00
- Project management cost is \$20.00

References

- 1 Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- 2 Assumption.
- 3 Rankin Inlet, Customer Survey, RMSi, October 2009.
- 4 American Water Works Association, Research Foundation. Residential End Uses of Water Study. 1999.
- 5 Rankin Inlet, Household Audits, RMSi, October 2009.
- 6 US Environmental Protection Agency, WaterSense Program, 2009.

Clothes Washer Replacement**Residential**

Incentive	Free Supply and Delivery	
Savings Per Participant	19 litres per average day	
Cost Per Participant	\$1,250.00	
Number of Participants		776
Number of Clothes Washers		776
Program Costs		\$970,000
Program Savings (litres per average day)		14,356
Cost per Litre per Average Day Saved		\$67.57
Monitoring Cost		\$55,500

Program Description

Through a mass campaign, all residential clothes washers would be replaced with water efficient front loading models. Water efficient clothes washers would be purchased and shipped in bulk ensuring the lowest cost possible. Washers would be delivered to each home and the existing machines removed for scrap.

It is recommended that the clothes washers selected for this campaign be Energy Star rated to ensure sustained water savings and a high level of customer satisfaction amongst program participants. Significant energy savings can be attributed to water efficient clothes washers. Not only do they use less hot water, the machines themselves are inherently energy efficient. Energy providers may be interested in partnering in this program.

Assumptions**Savings**

- Current housing stock is 776 units¹
- 3.7 persons per household¹
- 0.204 wash cycles per person per day²
- Average consumption per cycle of existing clothes washer is 79 litres³
- Average consumption per cycle of replaced clothes washer is 55.5 litres⁴

Savings per Participant = (Existing clothes washer volume – Replaced clothes washer volume)
x number of cycles per person per day x number of persons per household

$$\text{Savings per Participant} = (80 - 55.5) \times 0.204 \times 3.7 = 19 \text{ litres per average day}$$

Costs per Participant

- Equipment cost is \$1,200.00
- Marketing cost is \$10.00
- Program management cost is \$30.00
- Project management cost is \$10.00

References

- ¹ Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- ² Rankin Inlet, Customer Survey, RMSi, October 2009.
- ³ Rankin Inlet, Household Audits, RMSi, October 2009.
- ⁴ Based on analysis of Energy Star Canada listing, 2008.

Low Flow Showerheads**Residential**

Incentive	Free Supply and Installation	
Savings Per Participant	54 litres per average day	
Cost Per Participant	\$133	
Number of Participants		776
Number of Showerheads		854
Program Costs		\$103,208
Program Savings (litres per average day)		42,246
Cost per Litre per Average Day Saved		\$2.44
Monitoring Cost		\$18,000

Program Description

Low flow showerheads would be installed in all homes in Rankin Inlet through a mass campaign. Low flow showerheads save approximately 60% of the water during a shower while maintaining good shower performance. In addition to reducing water bills, low flow showers contribute to lower energy bills due to the less hot water used. Through a mass campaign, all showerheads would be replaced with water efficient low flow models. Water efficient showerheads would be purchased and shipped in bulk ensuring the lowest cost possible. An installing contractor would be selected by a tendering process. Existing showerheads would be removed for scrap.

Due to the inherit energy savings attributed to low flow showerheads, energy providers may be interested in partnering in this program.

Assumptions**Savings**

- Current housing stock is 776 units¹
- 3.7 persons per household¹
- 1.1 showerheads per household²
- 0.44 showers per person per day²
- Average length of shower is 7.6 minutes³
- Average flow rate per existing showerhead is 12.0 litres per minute⁴
- Average flow rate per replaced showerhead is 7.6 litres per minute⁵

Savings per Participant = (Existing shower flow rate – Replaced shower flow rate)
x number of showers per person per day x average length of shower
x number of persons per household

$$\text{Savings per Participant} = (12.0 - 7.6) \times 0.44 \times 7.6 \times 3.7 = 54 \text{ litres per average day}$$

Costs per Participant

- Assume 1.1 showerheads per participant
- Equipment cost is \$33.00
- Installation cost is \$50.00
- Marketing cost is \$10.10
- Program management cost is \$30.00
- Project management cost is \$10.00

References

- ¹ Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- ² Rankin Inlet, Customer Survey, RMSi, October 2009.
- ³ American Water Works Association, Research Foundation. Residential End Uses of Water Study. 1999.
- ⁴ Rankin Inlet, Household Audits, RMSi, October 2009.
- ⁵ Showerhead manufacturer data, 2009.

Kitchen Faucet Aerators**Residential**

Incentive	Free Supply and Installation	
Savings Per Participant	20 litres per average day	
Cost Per Participant	\$71.00	
Number of Participants		776
Number of Kitchen Faucets		776
Program Costs		\$55,096
Program Savings (litres per average day)		15,644
Cost per Litre per Average Day Saved		\$3.52
Monitoring Cost		\$18,000

Program Description

Low flow kitchen faucet aerators would be installed in all homes in Rankin Inlet through a mass campaign. Through a mass campaign, low flow aerators would be installed on all kitchen faucets. Water efficient aerators would be purchased and shipped in bulk ensuring the lowest cost possible. An installing contractor would be selected by a tendering process. Existing aerators would be removed for scrap.

In addition to reducing water bills, low flow faucet aerators contribute to lower energy bills due to the less hot water used. Energy providers may be interested in partnering in this program.

Assumptions**Savings**

- Current housing stock is 776 units¹
- 3.7 persons per household¹
- 1 kitchen faucet per household²
- Average length of use is 8.4 minutes per day³
- Average flow rate per existing kitchen faucet is 11.8 litres per minute⁴
- Average flow rate per replaced faucet is 5.7 litres per minute⁵

Savings per Participant = (Existing faucet flow rate – Replaced faucet flow rate)
x average length of use per day

Savings per Participant = (8.1 – 5.7) x 8.4 = 20 litres per average day

Costs per Participant

- Equipment cost is \$13.00
- Installation cost is \$20.00
- Marketing cost is \$10.00
- Program management cost is \$20.00
- Project management cost is \$8.00

References

- ¹ Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- ² Rankin Inlet, Customer Survey, RMSi, October 2009.
- ³ Regional Municipality of Waterloo. Water Efficiency Master Plan Update Research Study, May 24, 2006.
- ⁴ Rankin Inlet, Household Audits, RMSi, October 2009.
- ⁵ Faucet aerator manufacturer data, 2009.

Bathroom Aerators**Residential**

Incentive	Free Supply and Installation
Savings Per Participant	24 litres per average day
Cost Per Participant	\$64.00
Number of Participants	776
Number of Bathroom Aerators	854
Program Costs	\$49,664
Program Savings (litres per average day)	18,376
Cost per Litre per Average Day Saved	\$2.70
Monitoring Cost	\$18,000

Program Description

Low flow bathroom faucet aerators would be installed in all homes in Rankin Inlet through a mass campaign. Through a mass campaign, low flow aerators would be installed on all bathroom faucets. Water efficient aerators would be purchased and shipped in bulk ensuring the lowest cost possible. An installing contractor would be selected by a tendering process. Existing aerators would be removed for scrap.

In addition to reducing water bills, low flow faucet aerators contribute to lower energy bills due to the less hot water used. Energy providers may be interested in partnering in this program.

Assumptions**Savings**

- Current housing stock is 776 units¹
- 3.7 persons per household¹
- 1.1 bathroom faucets per household²
- Average length of use is 2.0 minutes per person per day³
- Average flow rate per existing bathroom faucet is 7.0 litres per minute⁴
- Average flow rate per replaced faucet is 3.8 litres per minute⁵

Savings per Participant = (Existing faucet flow rate – Replaced faucet flow rate)
x average length of use per day

Savings per Participant = (7.0 – 3.8) x 2.0 x 3.7 = 24 litres per average day

Costs per Participant

- Equipment cost is \$6.00
- Installation cost is \$20.00
- Marketing cost is \$10.00
- Program management cost is \$20.00
- Project management cost is \$8.00

References

- ¹ Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.
- ² Rankin Inlet, Customer Survey, RMSi, October 2009.
- ³ Assumption.
- ⁴ Rankin Inlet, Household Audits, RMSi, October 2009.
- ⁵ Faucet aerator manufacturer data, 2009.

Leakage Repair

Residential

Incentive	None Required
Savings Per Participant	56 litres per average day
Cost Per Participant	Included in toilet program
Number of Participants	776
Number of Leaks	776
Program Costs	\$0
Program Savings (litres per average day)	43,068
Cost per Litre per Average Day Saved	\$0.00
Monitoring Cost	Included in toilet program

Program Description

Leaks in homes can account for up to 13.7%² of the total household usage. It has been assumed that toilet flapper leakage is equivalent to 10% of the total household usage. Flappers wear out or deteriorate over time causing water from the cistern to leak down the toilet drain. In many cases these leaks are silent and as such undetected. It is suggested that the Municipality selects a flapperless toilet model for its toilet replacement program. This approach will eliminate existing and future flapper leakage. Flapperless toilets, which cost no more than other toilets, are available in HET models and are EPA WaterSense approved.

Assumptions

Savings

- Current housing stock is 776 units¹
- 3.7 persons per household¹
- 15.0 litres per day per person of leakage²

Savings per Participant = Existing leakage rate per person per day x number of persons per household

$$\text{Savings per Participant} = 15.0 \times 3.7 = 56 \text{ litres per average day}$$

Costs per Participant

- No additional costs incurred. Need only to specify flapperless toilets when purchasing for the toilet replacement program.

References

¹ Statistics Canada, 2006 Census, Community Profile, Rankin Inlet.

² Assume toilet flapper leakage is equivalent to approximately 10% of household use or 15.0 lpd.

Toilet Replacement - HET**Industrial, Commercial, Institutional**

Incentive	Free Supply and Installation	
Savings Per Participant	375 litres per average day	
Cost Per Participant	\$7,381.00	
Number of Participants		45
Number of Toilets		357
Program Costs		\$329,486
Program Savings (litres per average day)		16,740
Cost per Litre per Average Day Saved		\$19.68
Monitoring Cost		\$46,800

Program Description

Through a mass campaign, all toilets in the Industrial, Commercial and Institutional sector would be replaced with High Efficiency toilets (HETs) or Dual Flush toilets. A contractor, selected through a tendering process would go door to door replacing the existing toilets with the new HET toilets. It is assumed that 90% of the participant would select and HET toilet while 10% would select the dual flush models. Toilets would be purchased and shipped in bulk ensuring the lowest cost possible. Existing toilets would be removed and scrapped.

It is recommended that the toilets selected for this campaign be EPA WaterSense approved to ensure sustained water savings and a high level of customer satisfaction amongst program participants.

Assumptions**Savings**

- 62 business units¹
- 80% of businesses would qualify and 90% would select the HET models²
- 8 toilets per building²
- 5 flushes per person per day³
- 10 persons on premise per day assumed²
- Average flush volume per existing toilet is 12.3 litres⁴
- Average flush volume per replaced toilet is 4.8 litres⁵

$$\begin{aligned} \text{Savings per Participant} &= (\text{Existing toilet flush volume} - \text{Replaced toilet flush volume}) \\ &\quad \times \text{number of flushes per person per day} \\ &\quad \times \text{number of persons on premise per day} \end{aligned}$$

$$\text{Savings per Participant} = (12.3 - 4.8) \times 5.0 \times 10 = 375 \text{ litres per average day}$$

Costs per Participant

- Assume 8 toilets per participant
- Equipment cost is \$4,280.96
- Installation cost is \$2,400.00
- Marketing cost is \$200.00
- Program management cost is \$400.00
- Project management cost is \$100.00

References

- 1 Water Billing Data, Rankin Inlet, 2009.
- 2 Assumption.
- 3 American Water Works Association, Research Foundation. Residential End Uses of Water Study. 1999.
- 4 Rankin Inlet, Household Audits, RMSi, October 2009.
- 5 US Environmental Protection Agency, WaterSense Program, 2009.

Toilet Replacement – Dual Flush**Industrial, Commercial, Institutional**

Incentive	Free Supply and Installation	
Savings Per Participant	375 litres per average day	
Cost Per Participant	\$7,631.00	
Number of Participants		5
Number of Toilets		40
Program Costs		\$37,850
Program Savings (litres per average day)		1,860
Cost per Litre per Average Day Saved		\$20.35
Monitoring Cost		\$22,600

Program Description

Through a mass campaign, all toilets in the Industrial, Commercial and Institutional sector would be replaced with High Efficiency toilets (HETs) or Dual Flush toilets. A contractor, selected through a tendering process would go door to door replacing the existing toilets with the new HET toilets. It is assumed that 90% of the participant would select and HET toilet while 10% would select the dual flush models. Toilets would be purchased and shipped in bulk ensuring the lowest cost possible. Existing toilets would be removed and scrapped.

It is recommended that the toilets selected for this campaign be EPA WaterSense approved to ensure sustained water savings and a high level of customer satisfaction amongst program participants.

Assumptions**Savings**

- 62 business units¹
- 80% of business would qualify and 10% would select the Dual Flush models²
- 8 toilets per building²
- 5 flushes per person per day³
- 10 persons on premise per day assumed²
- Average flush volume per existing toilet is 12.3 litres⁴
- Average flush volume per replaced toilet is 4.8 litres⁵
-

$$\begin{aligned} \text{Savings per Participant} &= (\text{Existing toilet flush volume} - \text{Replaced toilet flush volume}) \\ &\quad \times \text{number of flushes per person per day} \\ &\quad \times \text{number of persons on premise per day} \end{aligned}$$

$$\text{Savings per Participant} = (12.3 - 4.8) \times 5.0 \times 10 = 375 \text{ litres per average day}$$

Costs per Participant

- Assume 8 toilets per participant
- Equipment cost is \$4,280.96
- Installation cost is \$2,400.00
- Marketing cost is \$300.00
- Program management cost is \$500.00
- Project management cost is \$150.00

References

- 1 Water Billing Data, Rankin Inlet, 2009.
- 2 Assumption.
- 3 American Water Works Association, Research Foundation. Residential End Uses of Water Study. 1999.
- 4 Rankin Inlet, Household Audits, RMSi, October 2009.
- 5 US Environmental Protection Agency, WaterSense Program, 2009.

Pre-Rinse Spray Valves

Industrial, Commercial, Institutional

Incentive	Free Supply and Installation
Savings Per Participant	368 litres per average day
Cost Per Participant	\$1,450
Number of Participants	10
Number of Nozzles	15
Program Costs	\$14,500
Program Savings (litres per average day)	3,680
Cost per Litre per Average Day Saved	\$3.94
Monitoring Cost	\$15,800

Program Description

Pre-rinse spray valves would be provided and installed free of charge in approximately 10 businesses with cafeterias and commercial kitchens. Low flow pre-rinse spray valves have a flow rate of 6 litres per minute while maintaining good cleaning performance. In addition to reducing water bills, low flow pre-rinse spray valves contribute to lower energy bills due to the less hot water used.

Assumptions

Savings

- 10 potential units¹
- 1.5 valves per business²
- 245 litres per valve per day savings³

Savings per Participant = savings per valve x number of valves replaced

Savings per Participant = 245 x 1.5 = 368 litres per average day

Costs per Participant

- Assume 1.5 valves per participant
- Equipment cost is \$225.00
- Installation cost is \$150.00
- Marketing cost is \$300.00
- Program management cost is \$700.00
- Project management cost is \$75.00

References

- ¹ Potential developed from Rankin Inlet Business Directory, Canada-Nunavut Business Service Centre, 2009.
- ² Assumption.
- ⁴ Regional Municipality of Waterloo. Pre-rinse Spray Valve Research Study. January 2005.

Audit and Capacity Buyback**Industrial, Commercial, Institutional**

Incentive	\$2.00 per litre per average day saved	
Savings Per Participant	15,000 litres per day	
Cost Per Participant	\$72,250	
Number of Participants		1.0
Program Costs		\$72,250
Program Savings (litres per average day)		15,000
Cost per Litre per Average Day Saved		\$4.82
Monitoring Cost		Included above

Program Description

A rebate or capacity-buyback of \$2.00 per litre per average day would be provided to large volume industrial clients who replace inefficient processes with water efficient processes. The capacity buyback would be available to any client who participated in the ICI Water Audit program. Five audits would be completed and it is anticipated that 1.0 of the audited clients will implement water saving measures. Savings would have to be verified before the capacity-buyback is paid.

Assumptions**Savings**

- Target 5 facilities¹
- Average 15,000 litres per day savings per participant²

Savings per Participant = Savings per participant as referenced above

Savings per Participant = 15,000 litres per day

Costs per Participant

- 5 audits to be completed
- 1.0 of those audited clients will implement water savings
- Average savings per participant per day is 15,000 litres
- Capacity buyback is \$2.00 per litre per average day saved
- Average cost of an audit is \$5,500.00
- Average cost for monitoring and verification is \$3,000.00
- Program management cost is \$1,500.00
- Project management cost is \$1,000.00

References

¹ Based on Rankin Inlet billing data, 2009.

² Based on results from York Region's Industrial Audit Program from 1998 to 2004.

Distribution Leakage Reduction

Municipal

Incentive	
Savings Per District Meter Area	57,500 litres per average day
Cost Per District Meter Area	\$55,000
Number of District Meter Areas	5
Program Costs	\$275,000
Program Savings (litres per average day)	287,500
Cost per Litre per Average Day Saved	\$0.96
Monitoring Cost	included

Program Description

Active Leak Detection Overview

Over the last 10 years, there has been considerable progress in the development of practices and techniques to identify and reduce losses in water distribution systems. There are in essence three types of leaks associated with a water distribution system, which are:

1. Reported leaks, which come to the surface, and are repaired
2. Unreported leaks, which do not surface, but are economic to repair (larger leaks). These leaks are best found using District Meter Areas (DMAs)
3. Background leakage, which do not surface, and are not economic to repair (very small leaks). These leaks can be reduced by flow modulation, using Permanent DMAs

The methods of leak detection fall into two main categories, namely “passive” and “active” leak detection, which can conveniently be defined as follows:

Passive leak detection

Repair of reported leaks

Active leak detection

Traditional leak detection sounding survey and leak pinpointing

Temporary flow monitoring, using the District Meter Area (DMA) methodology

Permanent flow monitoring, using permanent DMAs

District Meter Area Approach

The approach used to complete leak detection using District Meter Areas is as follows:

1. Conduct initial meetings and site inspections with Hamlet staff.
2. Design of DMAs based on meetings with Hamlet staff and review of water distribution system map
3. Identification of associated valve closures and potential flow metering locations.
4. The Hamlet completes the tapings for the temporary flow meters, including installing any chambers.
5. Set up DMAs and data log the flows for 7 days.
6. Identify the recorded Night Flow, establish Legitimate Night Flow (or Background Leakage), and Identify Potential Leakage.
7. Identify DMAs where leakage is evident and complete methods to find the general area of the leak (step-testing) within the DMA.

8. Pinpoint the leaks using acoustic leak detection and correlation methods and report on the locations for a directed repair program.
9. The Hamlet repairs the identified leaks
10. Repeat DMA operation after the identified leaks have been repaired, to confirm leakage reduction.
11. Report on the findings of the program with procedures for an ongoing Water Loss Management Program to be undertaken by the Hamlet staff.

Assumptions

Savings

- 5 Temporary District Meter Areas (DMAs) to be completed
- Average 57,500 litres per day savings per DMA
- 287,500 litres per day in saving from the completion of 5 DMAs

Costs per Participant

- 5 Temporary DMAs to be completed
- Average cost for implementing a temporary DMA is \$30,000 which includes design, installation of temporary flowmeter and data logging for 7 days, step testing and leak pinpointing, and verifying savings after the leak repair
- Estimated average cost for repairing leaks in each DMA is \$20,000 per DMA
- Note, providing insertion points, operation of all valves, repairing leaks would be the responsibility of the Hamlet
- Program management cost is \$3,000 per DMA
- Project management cost is \$2,000 per DMA

Broad-scale Public Education

Annual Cost	\$30,000
Total 5 Year Cost	\$150,000

Program Description

Technical solutions can only go so far in achieving overall water savings. Education that changes habits and attitudes towards water use is needed to finish the job. An important element of the Hamlet's water efficiency program has been public outreach and education. These activities are intended to educate and change the water-use attitudes of Rankin Inlet's residents. Activities that could be undertaken include:

- Literature including booklets, leaflets and flyers
- Two water efficiency bulletins distributed in the water bills annually
- Display booths at community events
- Displays at the Hamlet Administration Office
- Presentations at service clubs, community and youth groups
- Hamlet of Rankin Inlet Water Efficiency website

In addition to traditional education and communication strategies, it is recommended that the City develop and pursue a community based social marketing (CBSM) approach to education. Highly effective in the solid waste education programs during the past decade, CBSM techniques are being introduced more and more into water conservation and efficiency programs across North America.

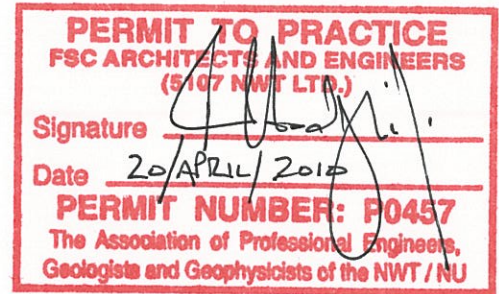
Youth Education

Annual Cost	\$36,000
Total 5 Year Cost	\$180,000

Program Description

It is intended that the Hamlet develops an educational program that meets current Curriculum standards and can be delivered by the Hamlet's elementary school teachers. The program and supporting materials would be developed to support the current curriculum at the Grade 7 and 8 levels - specifically targeting Geography and Science expectations, but incorporating language, art and mathematics activities. An interactive website could be developed where teachers can direct their students for assistance on projects or to have fun completing a water quiz. A poster drawing contest resulting in an annual calendar could be held every year.

In addition to the Grade 7 & 8 program, it is suggested that the Hamlet considers hosting a Children's Water Festival. Students will learn about water and the environment in the out-of-doors at an annual Children's Water Festival. The festival can be held over one day where Grade 3 to 5 students learn by participating in over 40 curriculum based activities about water and the environment. Children's Water Festivals are held around the world. For more information about this opportunity please visit the Children's Water Education Council website at www.cwec.ca.



Nipissar Lake Volume Study and Environmental Variable Study

Rankin Inlet, NU

GN Project # 09-3009

FSC Project # 2009-1310

April 20, 2010

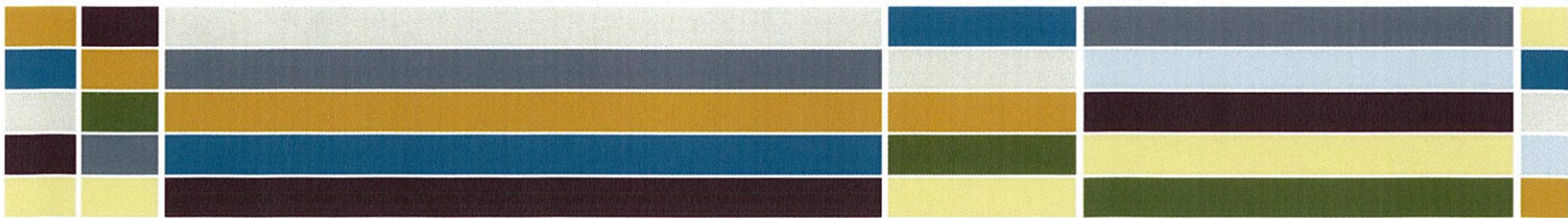
Prepared for:

The Office of the Regional Director
Kivalliq Region
Dept. of Community and Government Services
Government of Nunavut
Delivered to Project Management/O&M Building
P.O. Bag #002, Rankin Inlet, Nunavut X0C 0G0
Attn: Dawn Brigham, Project Officer

Prepared by:

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LISTEN. DESIGN. MANAGE.



FSC File: 2009-1310
April 20, 2010

Government of Nunavut
Dept. of Community & Government Services
Public Works Building, PO Bag 002
Rankin Inlet, Nunavut X0C 0G0

Attn: Dawn Brigham, Project Officer

Re: Water Supply Capacity, Consumption & Conservation Study

Dear Ms. Brigham,

Please find attached our Final Report on the volume calculation of Nipissar Lake and the affecting climatic variables.

You asked the following questions of an earlier draft; our answers follow your questions.

When will Nipissar Lake fail to be an adequate water source for Rankin Inlet? *Ans: As early as 2015*

What is the maximum consumption rate per day Nipissar Lake can provide? *Ans: 854,000 litres/day*

When do you estimate Rankin will reach the maximum consumption rate? *Ans: It has been reached now.*

Please contact us should you have any questions regarding this report.

Sincerely,

FSC ARCHITECTS & ENGINEERS



Kevin Hodgins, P. Eng., Principal
Civil Engineering



Table of Contents

1	Definitions	1
2	Understanding of Project.....	2
3	Volume Calculations	3
4	Climate Variables.....	4
4.1	Precipitation	5
4.2	Evapotranspiration.....	7
5	AWWA - IWA Water Audit	8
6	Results and Discussion	9
6.1	Comparison with AWWA - IWA Water Audit	9
6.2	Comparison to MACA Planning Standards	14
7	Conclusions	15
 Appendix A: Drawings		16
Appendix B: Spreadsheet Data & Calculations		17



1 Definitions

LCPD	Litres per capita per day, the total daily volume of water supplied to the community divided by the population of the community.
Evapotranspiration	Discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces and by transpiration from plants.
ILI	Infrastructure Leakage Index, ratio of CARL/UARL.
Apparent Losses	Volume of water from unauthorised consumption (theft) and metering inaccuracies (calibration and accounting errors).
CARL	Current Annual Real Losses, the water supplied and deducting the calculated authorized consumption and apparent losses.
UARL	Unavoidable Annual Real Losses, volume of leakage within the CARL that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair.
Minimum Pumping Volume	Volume of Nipissar Lake required to submerge pumping equipment for withdrawal.
Maximum Annual Withdrawal Rate	Estimated recharge rate to Nipissar Lake from inputs such as precipitation, and is therefore the restricting volume of water that can be withdrawn without forcing the overall annual Lake volume to decrease.



2 Understanding of Project

In this report FSC has three important tasks that were asked for in the RFP. These were:

1. Determine the volume of Nipissar Lake and calculate any losses compared to the Bathymetry and Topographical survey that was completed in 1995 by Vista Engineering.
2. Complete an environmental assessment of climate variables affecting the Nipissar Lake watershed capacity and report on how these might be affecting the long-term storage potential of the reserve.
3. Complete a review of historical precipitation and evapo-transpiration rates to establish if the current volume reduction of Nipissar Lake is a result of climatic variables or municipal consumption/wastage.



3 Volume Calculations

To accurately calculate the current volume of Nipissar Lake, a survey was completed of the water level on September 26, 2009. This information was used to determine the volume of Nipissar Lake.

To make sure that the volume calculation in 2009 was consistent with the Vista survey done in 1995, the two drawings were compared to each other. Vista's original reference point could not be located at the time of FSC's 2009 survey. FSC's reference point (TBM 1) was generated from Canada Control Markers (CCMs) established for the fuel project.

A scan of the mapping from the Vista 1995 survey was inserted into the current base drawing as provided by the Government of Nunavut and scaled to match existing features such as roadways and lake outlines. However, Vista's mapping is from 1994 and this older technology now shows as very pixilated, rather than as smooth line.

The shoreline from the FSC 2009 survey fit neatly into the outline of the lake from the earlier Vista mapping. The reference point (TBM 1) established in the FSC 2009 survey was noted to fall slightly above a contour line from the Vista survey mapping.

The elevation of the reference point was 12.72 m and the contour line from the Vista survey map was approximately 15.00 m.

As the elevations did not match exactly, a correction factor of 2.36 m (i.e. + 0.08 m) was selected to consider the pixilated nature of the mapping and the slightly elevated location of FSC TBM 1.

The correction factor was then applied to the bathymetric survey elevations and several major contours were traced from the scanned mapping. These major contours were used to estimate the total volume of the lake.

The current volume of the Lake is 2,809,259.60 cubic meters. Appendix A contains drawings for more detail.

Table 3.1: Nipissar Lake Volume

Survey	Volume
1995 survey	3,469,780.00 m ³
2009 survey	2,809,259.60 m ³
Difference	- 660,520.40 m ³



4 Climate Variables

Rankin Inlet is located in the continuous permafrost mid-Arctic region of the Canadian Shield, on the west coast of Hudson Bay. Topographic relief is low. The regional terrain consists of a high proportion of bedrock, glacial till, clay, outwash gravels and peat forming the scattered soil in the region. Vegetation is of the tundra type.

Climatic data in the Rankin Inlet area is characterized, in the terms of long-term normals, by the published data from Environment Canada between the year of 1981 and 2008. A summary of this data as well as information from the 1996 Stanley Report is provided below.

Table 4.1: Climatic Data

Climatic Parameter	Average Value	
	2009 Report	1996 Report
Annual Rainfall	180.39643 mm	146 mm
Annual Snowfall	128.7393 cm	113 cm
Annual Precipitation	305.425 mm	259 mm ¹
Days with Snow	77.8	66
Days with Rain	46.9	36
Daily Average Temperature	-11 C °C	- 11.6 °C
Daily Maximum Temperature	-7.3 °C	- 7.9 °C
Daily Minimum Temperature	-14.7 °C	- 15.2 °C°C
Start Date of Snowcover	mid October	mid October
Finish Date of Snowcover	mid June	mid June
Average Snow Depth	16 cm	No data
Lake freeze over Date	mid October	mid October
Lake Ice-Free Date	mid July	mid July
Lake Ice Thickness	Approx 200 cm	200 cm

Based on the comparison between the climatic parameters of the 1996 report and the 2009 report, there is a slight difference between the two sets of data. The 2009 data shows an 18 % increase in days with snow. This same data shows an increase of 30 % of days with rain. This information is constant with the annual rainfall and snowfall being greater then in the 1996 Report. Because the rainfall and snowfall have increased from the earlier report, an increase into the potential input into Nipissar Lake may occur.

The temperature difference between the 2009 report and the 1996 report vary on an average of 5% between the Daily Average, Daily Maximum and the Daily Minimum. The 2009 report temperatures are

¹ The Stanley report of 1996 used mean annual precipitation from Chesterfield Inlet for their data. This report used mean annual precipitation from Rankin Inlet. Rankin inlet and Chesterfield Inlet are only 80 km apart and for the basis for this report the geographic difference will be considered irrelevant. The 1996 Report chose Chesterfield Inlet because of the similarity to Rankin Inlet.



all warmer than the 1996 report temperatures. The slight increase could lead to more evaporation in the warmer months and thus more water loss.

Because of the short time span that this report looks at temperature, the difference could be based on the lack of data for the area. To see a 5% increase in temperature in 27 years appears to be very dramatic. Global climate change has seen only a fraction of a degree increase over the last century.

The start and finish dates of snowcover are the same from the 2009 report to the 1996 report. Although this date varies from year to year, snowcover can be generally expected in mid October. This has not changed from the earlier Stanley report. The same can be said about the lake freezing dates.

4.1 PRECIPITATION

Based on the information shown below in Table 4.2, and the Original Stanley data from 1996, the average precipitation shows an increase from the 1996 numbers. The percentage of increase is shown in the table below.

Table 4.2: Precipitation Increases

Item	Percent Increase
Rainfall	+ 24 %
Snowfall	+ 14%
Precipitation	+ 18 %

The amount of rainfall in Rankin Inlet has increased from an average of 146 mm annually to an average of 180 mm annually. This average would mean an increase of available input into Nipissar Lake. The amount of snowfall has also increased 14%, which would mean more snow to be deposited into the watershed area and into the lake in the spring when it melts.

The Stanley Report acquired their parameters for Rankin Inlet from Weather data from 1981 to 1994, a period of only 14 years. For this report, Environment Canada provided information from 1981 to 2008, a period of 28 years. Because of the increased amount of weather data the 2009 parameters will be more historically accurate. Having twice the data set may help to explain why there is such an apparent increase in Rainfall, Snowfall and Precipitation. Additionally, if data from Environment Canada was chosen for years 1981–1994, and compared to that for years 1995-2008, very little difference would be noticed. This is summarized in the table 4.3 below.

Table 4.3: Overall Precipitation Amounts

Years	1981-1994	1995-2008
Rainfall	181.5 mm	179.2 mm
Snowfall	126.6 cm	130.8 cm
Precipitation	302.7 mm	308.1 mm



Table 4.4: Ranking Inlet Annual Precipitation

Year	Total Rain (mm)	Total Snow (cm)	Total Precip. (mm)
1981	199	101.1	297.8
1982	171	108.7	277.3
1983	233.9	97.2	323.4
1984	174.9	102.5	262.2
1985	255.7	209.5	449.2
1986	168.8	103.5	270.1
1987	161.4	189.4	352.5
1988	110.3	117.4	221.4
1989	133.4	68.5	198.1
1990	253.4	162.6	399.9
1991	228.6	165.8	387.8
1992	139.8	113.7	253.2
1993	191.4	121.8	313.2
1994	120	111.1	231.5
1995	197.8	73.6	271.2
1996	159.2	96.2	254.6
1997	139.9	99.6	240.6
1998	189.8	102.6	289.8
1999	268.4	120.6	388
2000	133.3	108	241.7
2001	230.4	145.8	371.8
2002	174.2	115	287.8
2003	158.4	146.8	303.6
2004	156.8	180.4	337.2
2005	163	257.8	417
2006	222.6	152.6	373.6
2007	161.9	92.5	243.2
2008	153.8	140.4	294.2
Average	180.4	128.7	305.4

Looking at the historical precipitation rates from 1981 to 2008 we see dry years and wet years with an average of 180 mm. There are no obvious trends that state historical precipitation is on the increase or decrease. So we must conclude that it is relatively stable. The increased percentage from the 1996 Stanley Report can be explained by the lack of climatic data and the fact that the 1996 report.



4.2 EVAPOTRANSPIRATION

Evapotranspiration is based on evaporation and vegetation. The vegetation in the watershed area has remained constant since 1996 so there would be no difference between then and now.

The rate of evaporation is primarily a function of temperature, pressure, wind speed and direction, relative humidity and surface area. All of these factors interplay.

For the purpose of this study, we will assume that for now and in the future, inflow to the lake and losses from the lake remains stable and evapotranspiration is not a factor in the analysis.



5 AWWA - IWA Water Audit

The Government of Nunavut completed an American Water Works Association (AWWA) / International Water Association (IWA) Water Audit and Water Balance for the Hamlet of Rankin Inlet Water System.

The information determined from the audit was previously used in the Rankin Inlet, Water Consumption and Conservation Study, Draft Report, December 4, 2009 completed by FSC Architects & Engineers and Resource Management Strategies Inc.

The study explained that the World Bank Target Matrix provides performance categories according to a Infrastructure Leakage Index (ILI) shown in Table 5.1. The ILI is based on the ratio of Unavoidable Annual Real Losses (UARL) and Current Annual Real Losses (CARL).²

The CARL is the volume of water remaining after the calculated authorized consumption and apparent losses are subtracted from the total water supplied to the community.

An apparent loss is any volume of water from unauthorized consumption (ex. theft) and metering inaccuracies (ex. calibration and accounting errors).

The UARL is volume of leakage within the CARL that includes small leaks and weeps that is either undetectable in practice, or not economic to find and repair.

Table 5.1: ILI Performance Categories

ILI Range	Performance Category	Real Loss Management
1 – 2	A	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost effective improvement
2 – 4	B	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network management
4 – 8	C	Poor leakage record, tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
>8	D	Very inefficient use of resources; leakage reduction programs imperative and high priority.

² Rankin Inlet, Water Consumption and Conservation Study, Draft Report, December 4, 2009, FSC Architects & Engineers, Resource Management Strategies Inc.



6 Results and Discussion

6.1 COMPARISON WITH AWWA - IWA WATER AUDIT

The volume of Nipissar Lake has approximately decreased by 660,520 cubic meters over the past 15 years. As we are not considering climate to be a factor in this exercise, then an increase in population and water usage is the primary cause for the drop in Nipissar Lake.

The Town of Rankin Inlet is currently drawing more water from Nipissar Lake than water is recharged through natural precipitation and other sources. Using the two known water volumes of Nipissar Lake for 1994 and 2009, an average lake decrease of 44,035 m³/year of water was determined. The same procedure was completed in determining an annual water usage of 355,824 m³/year for Rankin Inlet.

The difference between the annual lake decrease and annual water usage is the estimated annual volume of water from recharge to the lake. This volume of water is approximately 311,789 m³/year, and is therefore the maximum rate Rankin Inlet can withdrawal without forcing the lake to continue to deplete.

The second column in Table 6.1 represents the total water supplied to Rankin Inlet, which corresponds to an ILI of 12.62, placing them in performance D category. As stated in the RMSi/FSC Study, being in this category means the Hamlet of Rankin Inlet water system is operating with a very inefficient use of resources; making leakage reduction programs imperative and a high priority.²

Table 6.1 also shows the required management and reduction of the Unaccounted for Water in order to meet performance categories A, B, and C. The reduction of the Unaccounted for Water is not simply the reassigning of the water volume to a different water use sector; rather it is the elimination of that loss. Determining how to eliminate the Unaccounted for Water in Rankin Inlet's water system is beyond the scope of this project.

Table 6.1: Water Consumption Data for 2009 Population of 2499

Item	Current Water Use Sector ³ (m ³)	Category C Performance (m ³)	Category B Performance (m ³)	Category A Performance (m ³)
Total Billed Consumption	155,173	155,173	155,173	155,173
IWA Accounted For Water	90,956	90,956	90,956	90,956
Unaccounted for Water	181,640	112,000	56,000	28,000
Total Water Supplied	427,770	358,129	302,129	274,129
LCPD	469	393	331	301

Table 6.1 further shows that Rankin Inlet has already surpassed the maximum withdrawal rate Nipissar Lake can provide without continuing to decrease in volume. If the Unaccounted for Water were reduced to meet category B performance or better, Rankin Inlet could meet the maximum withdrawal rate of Nipissar Lake with its current population in 2009.

³ Rankin Inlet, Water Consumption and Conservation Study, Draft Report, December 4, 2009, FSC Architects & Engineers, Resource Management Strategies Inc.



However, as the population increases, water use increases correspondingly. Therefore, there will come a point where the Unaccounted for Water cannot be decreased any further and Rankin Inlet's water consumption rate will once again be greater than the Nipissar Lake maximum annual withdrawal rate of 311,789 m³/year.

Figures 6.1 to 6.3 depict the projected water volume decrease in Nipissar Lake corresponding to population increases and the management of the Unaccounted for Water. All data and calculations are found in spreadsheets in Appendix B.

The objective of this exercise was to portray visually the effect of:

- Managing the Unaccounted for Water loss;
- When the lake would continue to be depleted; and
- When it will fail completely.

The projected year when Nipissar Lake will fall below the current volume can be estimated when each line intersects the Current Lake Volume line. The years at which this occurs is summarized in Table 6.2.

Table 6.2: Projected Year of Lake Depletion Below Current Volume

Population Increase	Category D Performance (Current)	Category C Performance	Category B Performance	Category A Performance
2.04%	Immediate	Immediate	2011	2019
2.5%	Immediate	Immediate	2011	2017
3.0%	Immediate	Immediate	2011	2016

The projected year when Nipissar Lake will completely fail to be an adequate source of water for Rankin Inlet can be estimated as the location when each line intersects the Minimum Pumping Volume line. The years at which this occurs is summarized in Table 6.3.

Table 6.3: Projected Year of Failure of Nipissar Lake as Adequate Water Source

Population Increase	Category D Performance (Current)	Category C Performance	Category B Performance	Category A Performance
2.04%	2022	2027	2033	2038
2.5%	2021	2025	2031	2033
3.0%	2020	2024	2028	2031

For example, if the current consumption of water continues as is (Category D), and a population increase of 2.04% is realized, Figure 6.1 suggests that Nipissar Lake will fail to be an adequate source of water as early as 2022. However, water quality and the ability to pump water from under the ice will have impacted production at least 5 years before that in 2017.



Figure 6.1: Lake Volume with 2.04% Population Increase

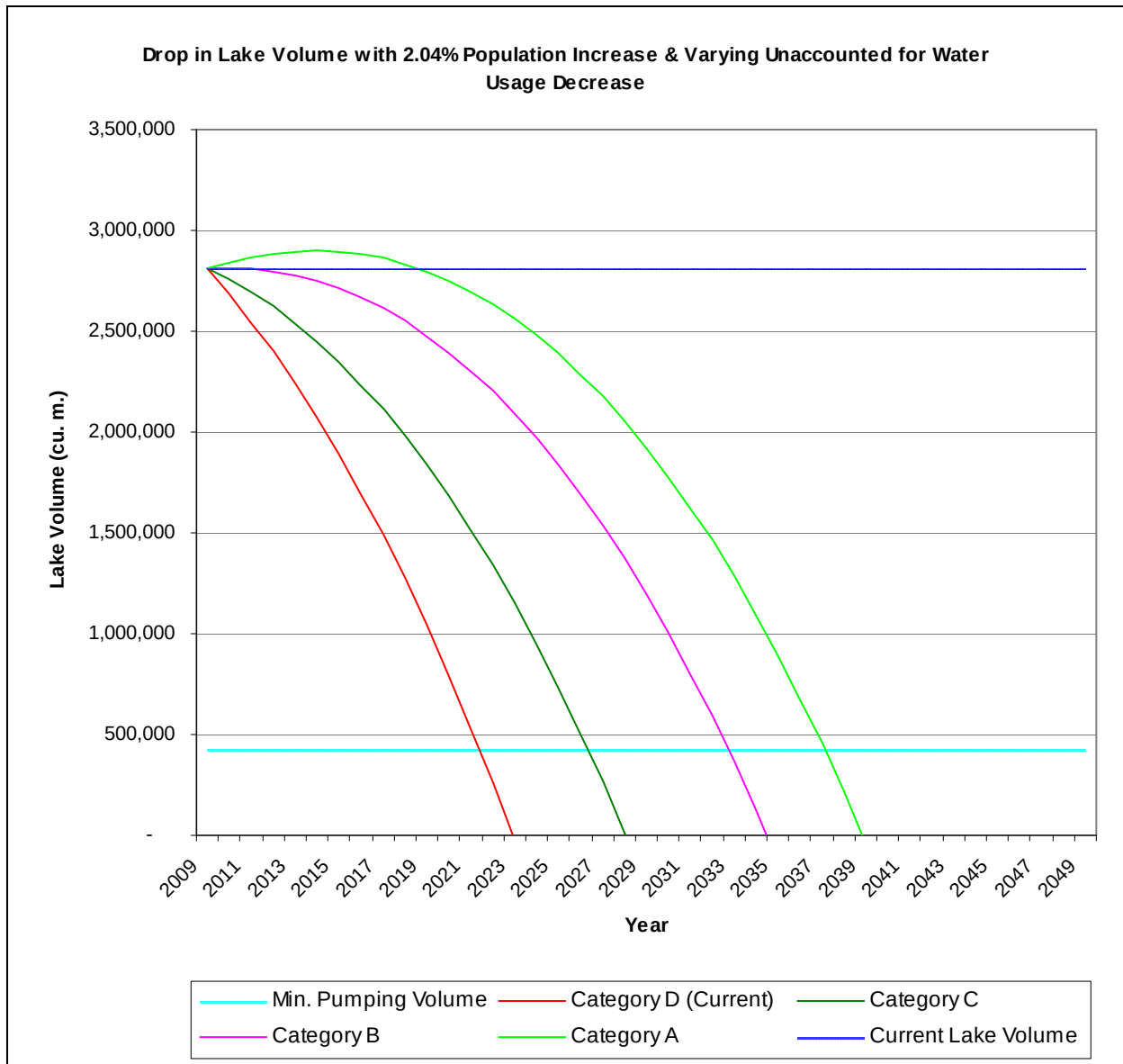




Figure 6.2: Lake Volume with 2.5% Population Increase

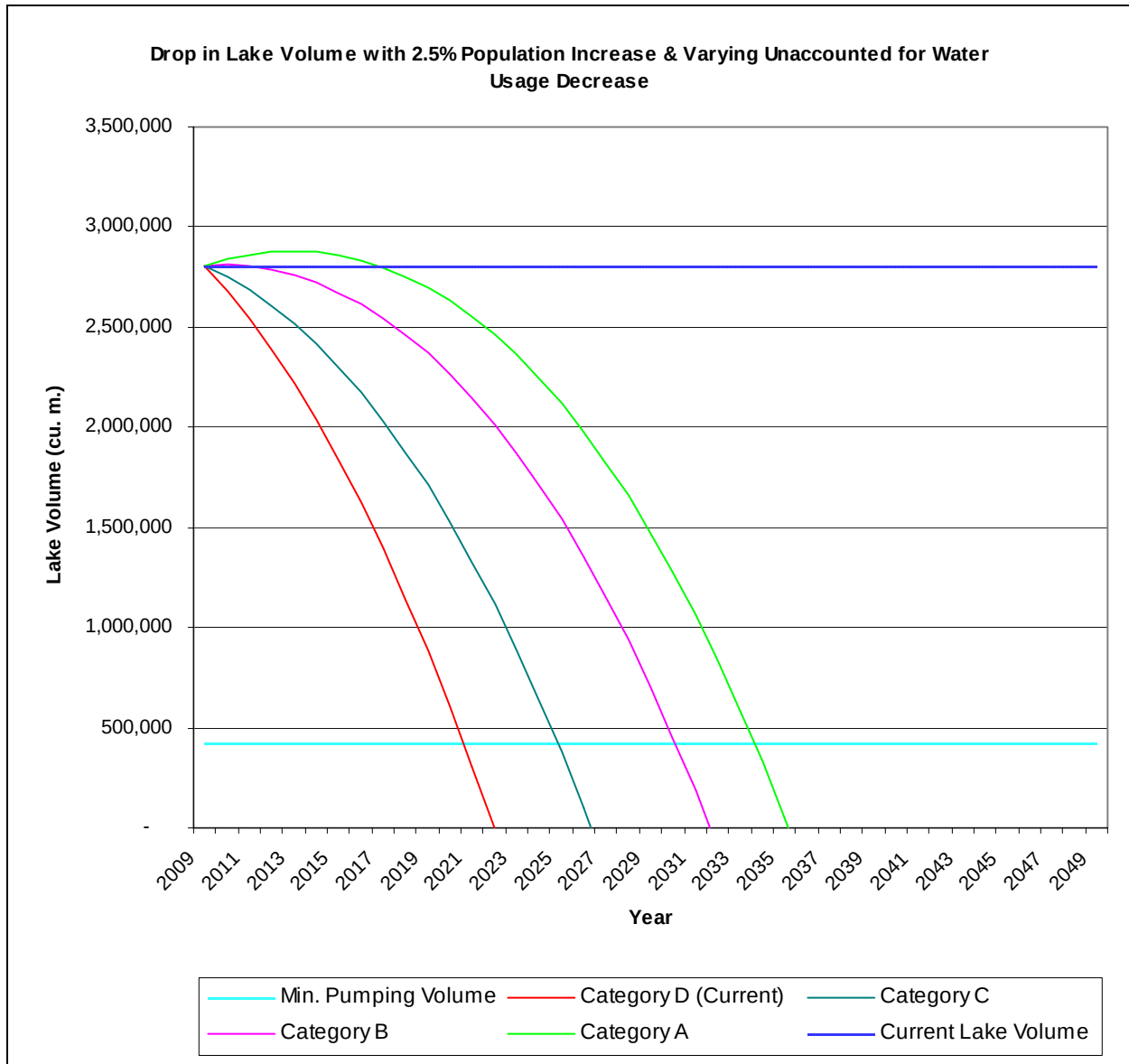
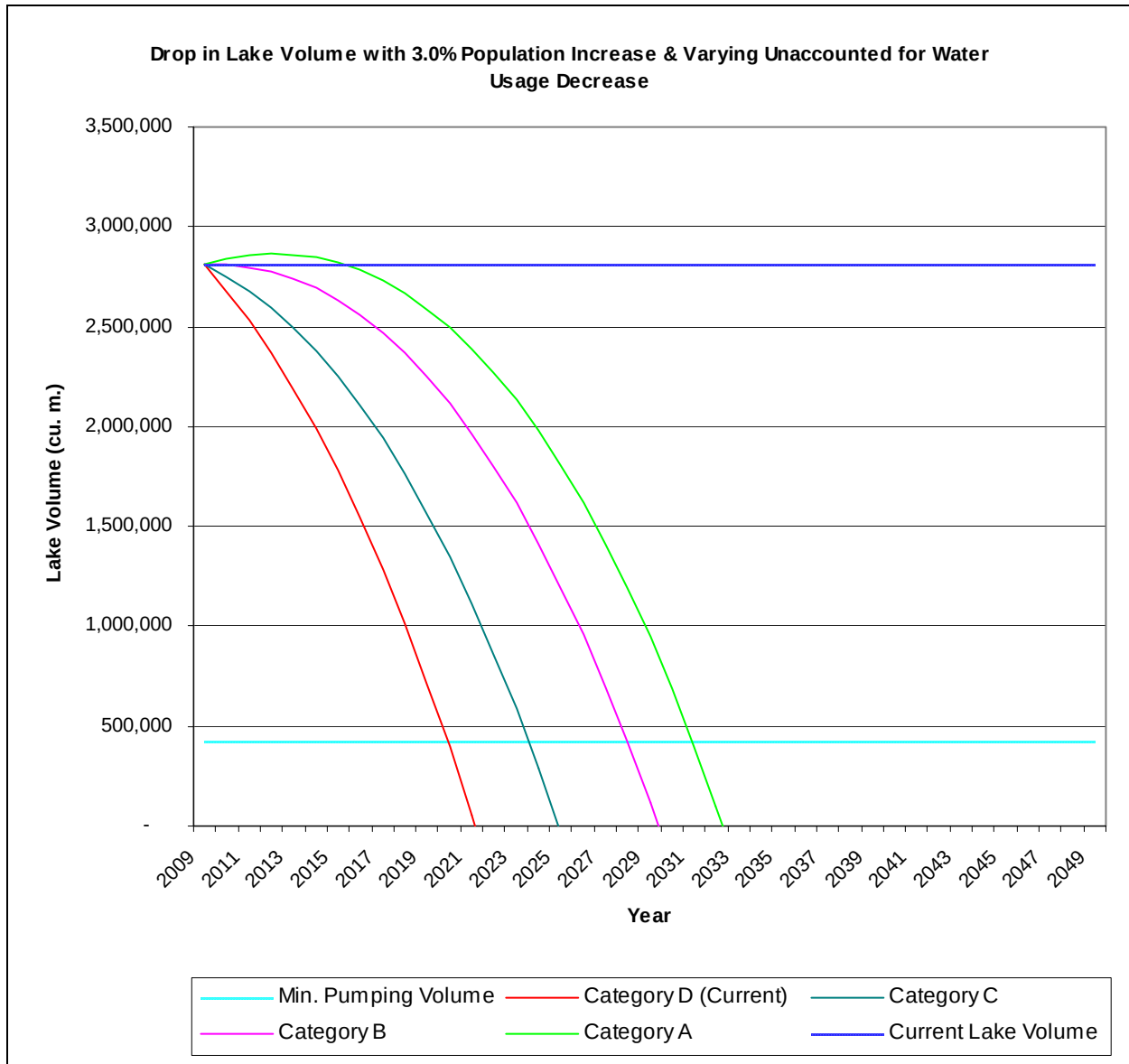




Figure 6.3: Lake Volume with 3.0% Population Increase





6.2 COMPARISON TO MACA PLANNING STANDARDS

MACA developed design usage rates for specific populations that have stood the test of time for planning purposes; the MACA usage rate for Rankin Inlet at its current 2009 population is found to be 344 LCPD.

Comparing the MACA planning rate (344 LCPD) to the proposed Category B Performance usage rate (331 LCPD) for the year 2009 suggests that continuing population increases will continue to deplete the water storage in Nipissar Lake regardless of conservation and the further elimination of the Unaccounted for Water.

This then suggests that meeting the Category B Performance or better will delay but not eliminate the need to recharge Nipissar Lake artificially.



7 Conclusions

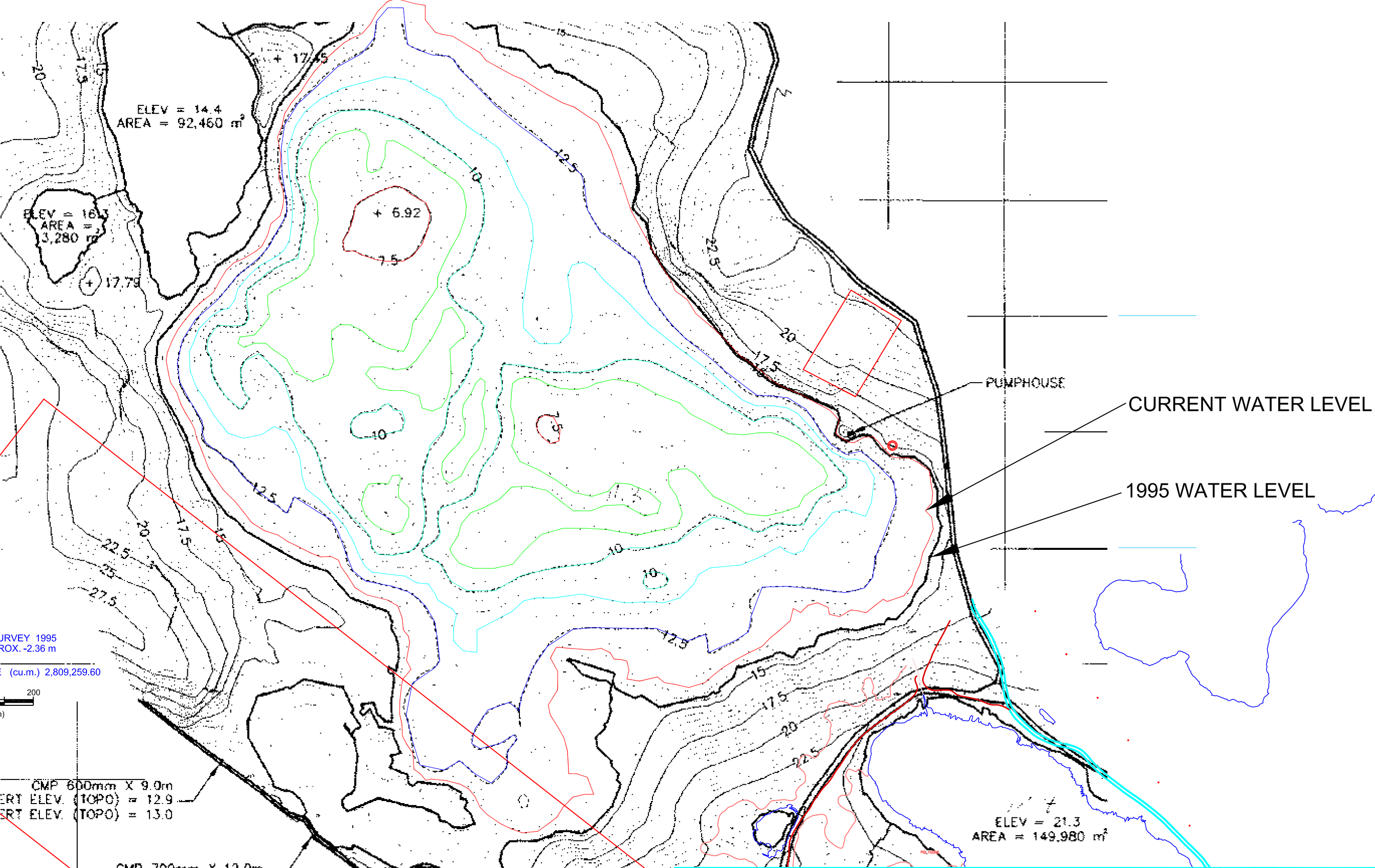
1. The maximum rate that Nipissar Lake can provide without forcing the Lake to continue to deplete is estimated to be 311,789 m³/year (854,000 litres/day).
2. Rankin Inlet has already surpassed the maximum withdrawal rate Nipissar Lake can provide without forcing the Lake to continue to deplete. The following table summarizes the projected year Nipissar Lake will begin to decrease from its current volume:

Population Increase	Category D Performance (Current)	Category C Performance	Category B Performance	Category A Performance
2.04%	Immediate	Immediate	2011	2019
2.5%	Immediate	Immediate	2011	2017
3.0%	Immediate	Immediate	2011	2016

3. The projected year when Nipissar Lake will fail completely can be estimated as the location when each line intersects the Minimum Pumping Volume line in Figures 6.1 to 6.3.
4. With the current consumption of water, and with a population increase of 2.04% realized, Figure 6.1 suggests that Nipissar Lake will fail completely as early as 2022. However, water quality and the ability to pump water from under the ice will have impacted production at least 5 years before that in 2017. The worst-case scenario for a 3.0% population increase is the year 2015, at which time water quality is expected to degrade.
5. If the Unaccounted for Water were reduced to meet Category B performance or better (≤ 331 LCPD), Rankin Inlet could meet the maximum withdrawal rate of Nipissar Lake with its current 2009 population.
6. According to MACA design usage rates, Rankin Inlet requires 344 LCPD using its current 2009 population. This is a higher usage rate than that of Category B Performance, and therefore suggests that reducing the Unaccounted for Water to meet Category B Performance may be moot.
7. Continuing population increases will continue to deplete the water storage in Nipissar Lake regardless of conservation and the further elimination of unaccounted water. This then suggests that meeting the Category B Performance or better will delay but not eliminate the need to recharge Nipissar Lake artificially within the next five years.



Appendix A: Drawings



PROJECT TITLE NIPISSAR LAKE VOLUME STUDY		CLIENT PROJECT NO. -	FSC PROJECT NO. 2009--1310
FSC ARCHITECTS & ENGINEERS 4910 - 53rd Street, P.O. Box 1777 Yellowknife, NT, X1A 2P4, Canada T 867.920.2882 F 867.920.4319		DRAWN BY IGM	CHECKED BY CP
LOCATION RANKIN INLET, NU		SCALE 2009--1310	DATE 2010 JAN
DRAWING TITLE NIPISSAR LAKE BATHYMETRIC AND VOLUME		DRAWING NO. OF --	



Appendix B: Spreadsheet Data & Calculations

Population Increase Rate 2.04%
Water Management Category A
Water Use (LPCD) 196

Year	Population	LCPD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,749	2,809,260
2010	2550	301	279,716	2,841,333
2011	2602	302	286,685	2,866,437
2012	2655	303	293,783	2,884,443
2013	2709	304	301,051	2,895,181
2014	2765	306	308,494	2,898,476
2015	2821	307	316,115	2,894,151
2016	2879	308	323,918	2,882,022
2017	2938	310	331,909	2,861,902
2018	2998	311	340,091	2,833,600
2019	3059	312	348,468	2,796,921
2020	3121	313	357,046	2,751,664
2021	3185	315	365,829	2,697,624
2022	3250	316	374,822	2,634,591
2023	3317	317	384,030	2,562,351
2024	3384	319	393,457	2,480,683
2025	3454	320	403,109	2,389,363
2026	3524	321	412,992	2,288,160
2027	3596	322	423,110	2,176,839
2028	3670	324	433,469	2,055,160
2029	3745	325	444,074	1,922,874
2030	3821	326	454,933	1,779,730
2031	3899	327	466,049	1,625,470
2032	3979	329	477,430	1,459,829
2033	4060	330	489,081	1,282,537
2034	4143	331	501,009	1,093,317
2035	4228	333	513,221	891,885
2036	4314	334	525,722	677,952
2037	4402	335	538,520	451,221
2038	4492	336	551,621	211,389
2039	4584	338	565,033 -	41,855
2040	4678	339	578,762 -	308,828

2041	4773	340	592,817 -	589,856
2042	4871	342	607,205 -	885,272
2043	4970	343	621,933 -	1,195,415
2044	5072	344	637,009 -	1,520,635
2045	5175	345	652,441 -	1,861,287
2046	5281	347	668,239 -	2,217,737
2047	5389	348	684,409 -	2,590,358
2048	5499	349	700,962 -	2,979,530
2049	5611	351	717,905 -	3,385,646

Population Increase Rate 2.04%
Water Management Category B
Water Use (LPCD) 216

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,749	2,809,260
2010	2550	331	308,286	2,812,762
2011	2602	333	315,939	2,808,613
2012	2655	334	323,761	2,796,641
2013	2709	335	331,771	2,776,660
2014	2765	337	339,973	2,748,476
2015	2821	338	348,371	2,711,894
2016	2879	340	356,971	2,666,712
2017	2938	341	365,777	2,612,724
2018	2998	343	374,794	2,549,719
2019	3059	344	384,026	2,477,482
2020	3121	345	393,479	2,395,792
2021	3185	347	403,159	2,304,422
2022	3250	348	413,069	2,203,142
2023	3317	350	423,216	2,091,715
2024	3384	351	433,606	1,969,898
2025	3454	352	444,243	1,837,445
2026	3524	354	455,134	1,694,100
2027	3596	355	466,284	1,539,605
2028	3670	357	477,700	1,373,693
2029	3745	358	489,388	1,196,094
2030	3821	359	501,354	1,006,529
2031	3899	361	513,605	804,713
2032	3979	362	526,147	590,354
2033	4060	364	538,988	363,156
2034	4143	365	552,133	122,812
2035	4228	367	565,590 -	130,989
2036	4314	368	579,367 -	398,567
2037	4402	369	593,471 -	680,249
2038	4492	371	607,909 -	976,369
2039	4584	372	622,689 -	1,287,269
2040	4678	374	637,820 -	1,613,300

2041	4773	375	653,309 -	1,954,819
2042	4871	376	669,164 -	2,312,195
2043	4970	378	685,395 -	2,685,801
2044	5072	379	702,010 -	3,076,021
2045	5175	381	719,017 -	3,483,249
2046	5281	382	736,426 -	3,907,887
2047	5389	383	754,247 -	4,350,345
2048	5499	385	772,488 -	4,811,044
2049	5611	386	791,160 -	5,290,416

Population Increase Rate 2.04%
Water Management Category C
Water Use (LPCD) 256

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,749	2,809,260
2010	2550	393	365,427	2,755,621
2011	2602	394	374,446	2,692,964
2012	2655	396	383,716	2,621,037
2013	2709	398	393,210	2,539,616
2014	2765	399	402,930	2,448,475
2015	2821	401	412,884	2,347,380
2016	2879	403	423,077	2,236,092
2017	2938	404	433,513	2,114,367
2018	2998	406	444,200	1,981,957
2019	3059	408	455,142	1,838,604
2020	3121	409	466,346	1,684,047
2021	3185	411	477,818	1,518,018
2022	3250	413	489,563	1,340,244
2023	3317	414	501,590	1,150,443
2024	3384	416	513,903	948,329
2025	3454	418	526,510	733,608
2026	3524	419	539,418	505,980
2027	3596	421	552,633	265,136
2028	3670	423	566,163	10,761
2029	3745	424	580,016 -	257,465
2030	3821	426	594,198 -	539,874
2031	3899	428	608,717 -	836,802
2032	3979	429	623,582 -	1,148,595
2033	4060	431	638,800 -	1,475,606
2034	4143	433	654,380 -	1,818,197
2035	4228	434	670,329 -	2,176,737
2036	4314	436	686,657 -	2,551,605
2037	4402	438	703,373 -	2,943,189
2038	4492	439	720,485 -	3,351,885
2039	4584	441	738,002 -	3,778,098
2040	4678	443	755,935 -	4,222,243

2041	4773	444	774,292 -	4,684,746
2042	4871	446	793,084 -	5,166,041
2043	4970	448	812,320 -	5,666,572
2044	5072	449	832,011 -	6,186,794
2045	5175	451	852,168 -	6,727,173
2046	5281	453	872,802 -	7,288,186
2047	5389	454	893,922 -	7,870,320
2048	5499	456	915,542 -	8,474,072
2049	5611	458	937,671 -	9,099,955

Population Increase Rate 2.04%

Water Management Category D (Current)

Water Use (LPCD) 306

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,749	2,809,260
2010	2550	469	436,488	2,684,561
2011	2602	471	447,580	2,548,770
2012	2655	473	458,661	2,401,898
2013	2709	475	470,008	2,243,679
2014	2765	477	481,628	2,073,840
2015	2821	479	493,526	1,892,103
2016	2879	481	505,709	1,698,183
2017	2938	483	518,184	1,491,788
2018	2998	485	530,958	1,272,620
2019	3059	487	544,037	1,040,372
2020	3121	489	557,429	794,732
2021	3185	491	571,141	535,379
2022	3250	493	585,181	261,987
2023	3317	495	599,556 -	25,780
2024	3384	497	614,275 -	328,266
2025	3454	499	629,344 -	645,821
2026	3524	501	644,773 -	978,804
2027	3596	503	660,569 -	1,327,585
2028	3670	505	676,742 -	1,692,538
2029	3745	507	693,300 -	2,074,049
2030	3821	509	710,252 -	2,472,512
2031	3899	511	727,607 -	2,888,330
2032	3979	513	745,375 -	3,321,916
2033	4060	515	763,566 -	3,773,693
2034	4143	517	782,188 -	4,244,092
2035	4228	519	801,253 -	4,733,556
2036	4314	521	820,770 -	5,242,537
2037	4402	523	840,750 -	5,771,498
2038	4492	525	861,204 -	6,320,913
2039	4584	527	882,143 -	6,891,267
2040	4678	529	903,578 -	7,483,056

2041	4773	531	925,521 -	8,096,788
2042	4871	533	947,983 -	8,732,982
2043	4970	535	970,976 -	9,392,169
2044	5072	537	994,514 -	10,074,894
2045	5175	539	1,018,608 -	10,781,712
2046	5281	541	1,043,271 -	11,513,194
2047	5389	543	1,068,517 -	12,269,922
2048	5499	545	1,094,359 -	13,052,491
2049	5611	547	1,120,810 -	13,861,513

Population Increase Rate 2.50%
Water Management Category A
Water Use (LPCD) 196

Year	Population	LCPD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2561	301	280,982	2,840,066
2011	2626	302	289,818	2,862,037
2012	2691	304	298,599	2,875,227
2013	2758	306	307,638	2,879,378
2014	2827	307	316,942	2,874,224
2015	2898	309	326,520	2,859,494
2016	2971	310	336,377	2,834,905
2017	3045	312	346,524	2,800,170
2018	3121	313	356,968	2,754,991
2019	3199	315	367,717	2,699,063
2020	3279	316	378,781	2,632,070
2021	3361	318	390,168	2,553,691
2022	3445	320	401,888	2,463,592
2023	3531	321	413,950	2,361,430
2024	3619	323	426,364	2,246,855
2025	3710	324	439,140	2,119,504
2026	3803	326	452,288	1,979,005
2027	3898	327	465,819	1,824,975
2028	3995	329	479,744	1,657,020
2029	4095	331	494,074	1,474,735
2030	4197	332	508,821	1,277,703
2031	4302	334	523,996	1,065,495
2032	4410	335	539,612	837,672
2033	4520	337	555,682	593,779
2034	4633	338	572,217	333,351
2035	4749	340	589,232	55,908
2036	4868	342	606,740 -	239,043
2037	4989	343	624,756 -	552,010
2038	5114	345	643,293 -	883,514
2039	5242	346	662,366 -	1,234,090
2040	5373	348	681,991 -	1,604,292

2041	5507	349	702,183 -	1,994,685
2042	5645	351	722,958 -	2,405,854
2043	5786	352	744,333 -	2,838,399
2044	5931	354	766,326 -	3,292,935
2045	6079	356	788,952 -	3,770,099
2046	6231	357	812,231 -	4,270,541
2047	6387	359	836,181 -	4,794,933
2048	6546	360	860,821 -	5,343,965
2049	6710	362	886,170 -	5,918,346

Population Increase Rate 2.50%
Water Management Category B
Water Use (LPCD) 216

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2561	331	309,682	2,811,366
2011	2626	333	319,392	2,803,764
2012	2691	335	329,069	2,786,484
2013	2758	337	339,030	2,759,243
2014	2827	338	349,283	2,721,749
2015	2898	340	359,838	2,673,700
2016	2971	342	370,702	2,614,788
2017	3045	344	381,884	2,544,693
2018	3121	345	393,393	2,463,088
2019	3199	347	405,240	2,369,638
2020	3279	349	417,432	2,263,994
2021	3361	351	429,982	2,145,802
2022	3445	352	442,897	2,014,693
2023	3531	354	456,190	1,870,292
2024	3619	356	469,871	1,712,211
2025	3710	357	483,950	1,540,050
2026	3803	359	498,440	1,353,399
2027	3898	361	513,352	1,151,836
2028	3995	363	528,698	934,927
2029	4095	364	544,490	702,226
2030	4197	366	560,741	453,274
2031	4302	368	577,465	187,598
2032	4410	369	594,675 -	95,288
2033	4520	371	612,384 -	395,883
2034	4633	373	630,607 -	714,701
2035	4749	375	649,358 -	1,052,270
2036	4868	376	668,653 -	1,409,134
2037	4989	378	688,506 -	1,785,851
2038	5114	380	708,935 -	2,182,996
2039	5242	382	729,954 -	2,601,161
2040	5373	383	751,581 -	3,040,954

2041	5507	385	773,834 -	3,502,999
2042	5645	387	796,729 -	3,987,939
2043	5786	388	820,286 -	4,496,436
2044	5931	390	844,522 -	5,029,169
2045	6079	392	869,458 -	5,586,837
2046	6231	394	895,112 -	6,170,161
2047	6387	395	921,506 -	6,779,877
2048	6546	397	948,660 -	7,416,748
2049	6710	399	976,596 -	8,081,555

Population Increase Rate 2.50%
Water Management Category C
Water Use (LPCD) 256

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2561	393	367,082	2,753,966
2011	2626	395	378,538	2,687,217
2012	2691	397	390,007	2,608,999
2013	2758	399	401,813	2,518,975
2014	2827	401	413,966	2,416,798
2015	2898	403	426,474	2,302,113
2016	2971	405	439,350	2,174,552
2017	3045	407	452,603	2,033,738
2018	3121	409	466,244	1,879,283
2019	3199	411	480,284	1,710,788
2020	3279	413	494,735	1,527,842
2021	3361	415	509,608	1,330,023
2022	3445	417	524,915	1,116,897
2023	3531	420	540,670	888,016
2024	3619	422	556,884	642,922
2025	3710	424	573,571	381,140
2026	3803	426	590,744	102,185
2027	3898	428	608,417 -	194,442
2028	3995	430	626,605 -	509,258
2029	4095	432	645,321 -	842,791
2030	4197	434	664,583 -	1,195,584
2031	4302	436	684,403 -	1,568,198
2032	4410	438	704,800 -	1,961,209
2033	4520	440	725,788 -	2,375,208
2034	4633	442	747,386 -	2,810,805
2035	4749	444	769,609 -	3,268,626
2036	4868	446	792,477 -	3,749,314
2037	4989	448	816,007 -	4,253,532
2038	5114	450	840,219 -	4,781,962
2039	5242	452	865,131 -	5,335,304
2040	5373	454	890,763 -	5,914,278

2041	5507	456	917,136 -	6,519,625
2042	5645	458	944,272 -	7,152,108
2043	5786	460	972,191 -	7,812,510
2044	5931	462	1,000,915 -	8,501,636
2045	6079	464	1,030,468 -	9,220,315
2046	6231	466	1,060,874 -	9,969,400
2047	6387	469	1,092,155 -	10,749,766
2048	6546	471	1,124,338 -	11,562,314
2049	6710	473	1,157,447 -	12,407,972

Population Increase Rate 2.50%
Water Management Category D (Current)
Water Use (LPCD) 306

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2561	469	438,464	2,682,584
2011	2626	472	452,471	2,541,902
2012	2691	475	466,180	2,387,511
2013	2758	477	480,292	2,219,007
2014	2827	479	494,818	2,035,978
2015	2898	482	509,770	1,837,997
2016	2971	484	525,161	1,624,625
2017	3045	487	541,002	1,395,412
2018	3121	489	557,307	1,149,894
2019	3199	492	574,090	887,593
2020	3279	494	591,363	608,020
2021	3361	497	609,141	310,668
2022	3445	499	627,438 -	4,981
2023	3531	501	646,269 -	339,461
2024	3619	504	665,650 -	693,322
2025	3710	506	685,596 -	1,067,129
2026	3803	509	706,123 -	1,461,463
2027	3898	511	727,248 -	1,876,922
2028	3995	514	748,988 -	2,314,122
2029	4095	516	771,361 -	2,773,694
2030	4197	519	794,384 -	3,256,288
2031	4302	521	818,076 -	3,762,575
2032	4410	523	842,456 -	4,293,242
2033	4520	526	867,544 -	4,848,997
2034	4633	528	893,360 -	5,430,568
2035	4749	531	919,924 -	6,038,702
2036	4868	533	947,258 -	6,674,171
2037	4989	536	975,384 -	7,337,766
2038	5114	538	1,004,324 -	8,030,301
2039	5242	540	1,034,102 -	8,752,614
2040	5373	543	1,064,740 -	9,505,565

2041	5507	545	1,096,265 -	10,290,041
2042	5645	548	1,128,700 -	11,106,952
2043	5786	550	1,162,071 -	11,957,234
2044	5931	553	1,196,406 -	12,841,851
2045	6079	555	1,231,732 -	13,761,794
2046	6231	558	1,268,075 -	14,718,080
2047	6387	560	1,305,467 -	15,711,758
2048	6546	562	1,343,935 -	16,743,904
2049	6710	565	1,383,510 -	17,815,625

Population Increase Rate 3.00%
 Water Management Category A
 Water Use (LPCD) 196

Year	Population	LCPD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2574	301	282,353	2,838,696
2011	2651	303	293,249	2,857,236
2012	2731	305	303,912	2,865,113
2013	2813	307	314,950	2,861,952
2014	2897	309	326,377	2,847,364
2015	2984	311	338,207	2,820,946
2016	3073	312	350,452	2,782,283
2017	3166	314	363,128	2,730,944
2018	3261	316	376,249	2,666,485
2019	3358	318	389,830	2,588,443
2020	3459	320	403,888	2,496,344
2021	3563	322	418,438	2,389,695
2022	3670	324	433,498	2,267,986
2023	3780	325	449,085	2,130,691
2024	3893	327	465,216	1,977,263
2025	4010	329	481,912	1,807,140
2026	4130	331	499,191	1,619,739
2027	4254	333	517,072	1,414,456
2028	4382	335	535,577	1,190,667
2029	4513	337	554,727	947,729
2030	4649	339	574,545	684,973
2031	4788	340	595,052	401,711
2032	4932	342	616,272	97,228
2033	5080	344	638,230 -	229,213
2034	5232	346	660,950 -	578,374
2035	5389	348	684,460 -	951,045
2036	5551	350	708,785 -	1,348,041
2037	5718	352	733,954 -	1,770,206
2038	5889	354	759,995 -	2,218,412
2039	6066	355	786,938 -	2,693,561
2040	6248	357	814,813 -	3,196,586

2041	6435	359	843,653 -	3,728,450
2042	6628	361	873,490 -	4,290,151
2043	6827	363	904,358 -	4,882,720
2044	7032	365	936,291 -	5,507,222
2045	7243	367	969,327 -	6,164,761
2046	7460	369	1,003,503 -	6,856,474
2047	7684	370	1,038,856 -	7,583,541
2048	7914	372	1,075,427 -	8,347,179
2049	8152	374	1,113,258 -	9,148,648

Population Increase Rate 3.00%
 Water Management Category B
 Water Use (LPCD) 216

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2574	331	311,193	2,809,856
2011	2651	334	323,172	2,798,472
2012	2731	336	334,923	2,775,339
2013	2813	338	347,088	2,740,040
2014	2897	340	359,681	2,692,148
2015	2984	342	372,718	2,631,219
2016	3073	344	386,213	2,556,796
2017	3166	346	400,182	2,468,403
2018	3261	348	414,642	2,365,550
2019	3358	350	429,609	2,247,731
2020	3459	353	445,101	2,114,419
2021	3563	355	461,136	1,965,072
2022	3670	357	477,732	1,799,128
2023	3780	359	494,910	1,616,008
2024	3893	361	512,688	1,415,109
2025	4010	363	531,087	1,195,812
2026	4130	365	550,128	957,472
2027	4254	367	569,835	699,427
2028	4382	369	590,228	420,988
2029	4513	371	611,332	121,444
2030	4649	373	633,172 -	199,938
2031	4788	375	655,771 -	543,920
2032	4932	377	679,157 -	911,288
2033	5080	379	703,355 -	1,302,854
2034	5232	381	728,394 -	1,719,460
2035	5389	383	754,303 -	2,161,973
2036	5551	386	781,110 -	2,631,295
2037	5718	388	808,847 -	3,128,353
2038	5889	390	837,546 -	3,654,110
2039	6066	392	867,238 -	4,209,558
2040	6248	394	897,958 -	4,795,727

2041	6435	396	929,740 -	5,413,678
2042	6628	398	962,622 -	6,064,511
2043	6827	400	996,639 -	6,749,361
2044	7032	402	1,031,831 -	7,469,404
2045	7243	404	1,068,238 -	8,225,853
2046	7460	406	1,105,901 -	9,019,965
2047	7684	408	1,144,862 -	9,853,037
2048	7914	410	1,185,165 -	10,726,413
2049	8152	412	1,226,856 -	11,641,480

Population Increase Rate 3.00%
 Water Management Category C
 Water Use (LPCD) 256

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2574	393	368,873	2,752,176
2011	2651	396	383,019	2,680,946
2012	2731	398	396,946	2,595,789
2013	2813	401	411,363	2,496,215
2014	2897	403	426,289	2,381,715
2015	2984	406	441,739	2,251,765
2016	3073	408	457,733	2,105,821
2017	3166	410	474,290	1,943,320
2018	3261	413	491,427	1,763,682
2019	3358	415	509,166	1,566,305
2020	3459	418	527,527	1,350,567
2021	3563	420	546,531	1,115,825
2022	3670	423	566,201	861,412
2023	3780	425	586,560	586,642
2024	3893	428	607,630	290,801
2025	4010	430	629,436 -	26,846
2026	4130	432	652,004 -	367,061
2027	4254	435	675,360 -	730,631
2028	4382	437	699,530 -	1,118,372
2029	4513	440	724,542 -	1,531,125
2030	4649	442	750,426 -	1,969,762
2031	4788	445	777,210 -	2,435,183
2032	4932	447	804,926 -	2,928,320
2033	5080	450	833,606 -	3,450,137
2034	5232	452	863,282 -	4,001,631
2035	5389	454	893,989 -	4,583,830
2036	5551	457	925,760 -	5,197,801
2037	5718	459	958,634 -	5,844,646
2038	5889	462	992,647 -	6,525,504
2039	6066	464	1,027,837 -	7,241,552
2040	6248	467	1,064,246 -	7,994,009

2041	6435	469	1,101,914 -	8,784,135
2042	6628	472	1,140,885 -	9,613,231
2043	6827	474	1,181,202 -	10,482,644
2044	7032	476	1,222,911 -	11,393,766
2045	7243	479	1,266,060 -	12,348,037
2046	7460	481	1,310,697 -	13,346,945
2047	7684	484	1,356,873 -	14,392,029
2048	7914	486	1,404,640 -	15,484,880
2049	8152	489	1,454,051 -	16,627,143

Population Increase Rate 3.00%
 Water Management Category D (Current)
 Water Use (LPCD) 306

Year	Population	LPCD	Cu. M./ Year	Volume of Lake
1994	1845	450	303,041	3,469,780
1995	1883	450	309,232	3,464,452
1996	1921	450	315,550	3,453,688
1997	1960	450	321,997	3,437,376
1998	2000	450	328,575	3,415,403
1999	2041	450	335,288	3,387,653
2000	2083	450	342,138	3,354,008
2001	2126	450	349,128	3,314,349
2002	2169	450	356,260	3,268,551
2003	2213	450	363,539	3,216,490
2004	2259	450	370,966	3,158,037
2005	2305	450	378,545	3,093,063
2006	2352	450	386,278	3,021,433
2007	2400	450	394,170	2,943,012
2008	2449	459	410,704	2,857,661
2009	2499	469	427,770	2,809,260
2010	2574	469	440,603	2,680,446
2011	2651	473	457,827	2,534,407
2012	2731	476	474,474	2,371,722
2013	2813	479	491,708	2,191,803
2014	2897	482	509,548	1,994,044
2015	2984	485	528,017	1,777,817
2016	3073	488	547,134	1,542,471
2017	3166	491	566,924	1,287,336
2018	3261	494	587,409	1,011,716
2019	3358	496	608,612	714,893
2020	3459	499	630,560	396,122
2021	3563	502	653,276	54,635
2022	3670	505	676,787 -	310,363
2023	3780	508	701,122 -	699,696
2024	3893	511	726,307 -	1,114,214
2025	4010	514	752,373 -	1,554,798
2026	4130	517	779,349 -	2,022,358
2027	4254	520	807,266 -	2,517,834
2028	4382	523	836,156 -	3,042,202
2029	4513	526	866,054 -	3,596,467
2030	4649	529	896,993 -	4,181,671
2031	4788	532	929,009 -	4,798,891
2032	4932	534	962,139 -	5,449,241
2033	5080	537	996,420 -	6,133,871
2034	5232	540	1,031,892 -	6,853,974
2035	5389	543	1,068,596 -	7,610,781
2036	5551	546	1,106,573 -	8,405,565
2037	5718	549	1,145,867 -	9,239,643
2038	5889	552	1,186,523 -	10,114,377
2039	6066	555	1,228,587 -	11,031,175
2040	6248	558	1,272,107 -	11,991,492

2041	6435	561	1,317,132 -	12,996,835
2042	6628	564	1,363,714 -	14,048,761
2043	6827	567	1,411,906 -	15,148,877
2044	7032	570	1,461,761 -	16,298,849
2045	7243	572	1,513,337 -	17,500,398
2046	7460	575	1,566,693 -	18,755,302
2047	7684	578	1,621,887 -	20,065,400
2048	7914	581	1,678,983 -	21,432,594
2049	8152	584	1,738,046 -	22,858,851



NWB Tools

Robin Ikkutisluk <robin.ikkutisluk@nwb-oen.ca>

131119 3AM-GRA1015 Hamlet of Rankin Inlet - Amendment - Notice of Application - Kivalliq Region

1 message

Christopher Tickner <ctickner@nunavut.ca>

Wed, Dec 11, 2013 at 8:37 AM

To: Robin Ikkutisluk <robin.ikkutisluk@nunavutwaterboard.org>

Cc: Info at NIRB <info@nirb.ca>, licensing@nunavutwaterboard.org, phyllis.beaulieu@nwb-oen.ca, Brian Aglukark <aglukark@nunavut.ca>

Good morning Ms. Ikkutisluk,

RE: 131119 3AM-GRA1015 Hamlet of Rankin Inlet

Thank you for your email.

The Nunavut Planning Commission reviewed the above noted project as part of NPC File reference NWB – NWB File #3AM GRA0207 – Hamlet of Rankin Inlet Water/Sewage/Solid Waste/Land Farm and determined that it conformed to the Keewatin Regional Land Use Plan. I have attached the NPC's conformity determination with this email for your records.

The NPC has reviewed the amendment request and supporting materials found on the NWB Ftp Site for this project and has determined that it does not change the scope of the originally reviewed project to an extent that would warrant a further review by the NPC at this time. The original terms agreed to as part of the conformity determination must form part of any authorisation or permit issued for this project proposal.

Should the scope of the project change, NPC would respectfully request that the project proposal be forwarded to our office for further review.

I have cc'd the Nunavut Impact Review Board (NIRB) with this email for their information.

Please contact me should you have any questions.

Sincerely,

Christopher

Christopher Tickner MCIP, RPP

Senior Planner

Nunavut Planning Commission

P.O. Box 2101 Cambridge Bay, NU X0B 0C0

Phone: (867) 983-4634

Fax: (867) 983-4626

Website: www.nunavut.ca

From: Robin Ikkutisluk [<mailto:robin.ikkutisluk@nunavutwaterboard.org>]

Sent: November-19-13 2:29 PM

To: jtologanak@gov.nu.ca; arlen.foster@stantec.com

Cc: Phyllis Beaulieu; Megan Porter

Subject: 131119 3AM-GRA1015 Hamlet of Rankin Inlet - Amendment - Notice of Application - Kivalliq Region

Hello,

Please see attached letter giving notice of Application for an amendment to water licence 3AM-GRA1015 Hamlet of Rankin Inlet.

Regards,

Robin Ikkutisluk



Robin Ikkutisluk- ᑭᐱᑦ ᐃᑖᑎᑦᑭᑦ

Licence Administrator Assistant- Administratrice des permis

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NUNAVUT WATER BOARD - OFFICE DES EAUX DU NUNAVUT

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Merci de penser à l'environnement avant d'imprimer ce courriel / Thank you for thinking of the environment before printing this email



NWB - NWB File #3AM GRA0207 - Hamlet of Rankin Inlet WaterSewageSolid WasteLand Farm

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Nunavunmi Parnaiyit
Nunavut Planning Commission
Commission d'Aménagement du Nunavut

March 19, 2010

Ms. Phyllis Beaulieu
Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU., X0B 1J0
Fax # 867 360 6369

Dear Ms Beaulieu

**Re: INWB – NWB File # 3AM GRA0207 – Hamlet of Rankin Inlet
Water/Sewage/Solid Waste/Land Farm Activities]**

The NPC has completed its review of the above noted project proposal. It conforms to the Keewatin Regional Land Use Plan (KRLUP), subject to the attached.

The applicant has undertaken to comply with the attached requirements. The authorizing agencies to which this letter is addressed are responsible under the *Nunavut Land Claims Agreement* to implement any of the attached requirements by incorporating the requirements directly, or otherwise ensuring that they must be met, in the terms and conditions of any authorizations issued.

My office would be pleased to discuss with these agencies how best to implement these requirements and to review any draft authorizations that the agencies wish to provide for that purpose.

This conformity determination applies only to the above noted applications as submitted. Therefore, the proponent must ensure other applications for a permit under this project proposal not listed above are forwarded to NPC for a conformity

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