Desktop Risk Assessment on the Sustainability of Nunavut's Primary Drinking Water Sources

Prepared for:
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List of Abbreviations

%	Percent
°C	Degree Celsius
AET	Actual Evapotranspiration
A_{hyd}	Watershed Area of Hydrometric Station
BCCAQ	Bias Correction/Constructed Analogues with Quantile Mapping Reordering
CGS	Community and Government Services
CWRS	Centre for Water Resources Studies
d	Day
DEM	Digital Elevation Model
DFO	Department of Fisheries and Oceans
e.g.	Exempli Gratia
et al.	*Et Alia*
ET	Evapotranspiration
etc.	*Et Cetera*
AET_e	Yearly Actual Evapotranspiration
GCM	Global Climate Model
GEV	General Extreme Value
GIS	Geographic Information System
GN	Government of Nunavut
ha	Hectare
i.e.	*Id Est*
IPCC	Intergovernmental Panel on Climate Change
K	Temperature in Kelvin
Kg	Kilogram
KJ	Kilojoule

Km^2	Kilometre Squared
L	Litre
m^2	Metre Squared
m^3	Metre Cubed
MAD	Mean Annual Discharge
Min	Minute
MJ	Megajoule
N	North
NAD	North American Datum
NS	Nova Scotia
NWB	Nunavut Water Board
OECD	Organization for Economic Co-operation and Development
P	Population
P_{14}	Population Projection for 2014
P_{35}	Population Projection for 2035
PCIC	Pacific Climate Impacts Consortium
PET	Potential Evapotranspiration
P_{gr}	Population Growth Rate
pp	Per Person
P_{vol}	Precipitation Volume
Q_{vol}	Runoff Volume
RCP	Representative Concentration Pathway
RWU	Residential Water Use
UTM	Universal Transverse Mercator
W	West
W_a	Water Volume Available After Abstractions

WAI	Water Availability Indicator
W_{us}	Water Used for Residential Purposes
α	alpha

Executive Summary

The Canadian Arctic territory of Nunavut is comprised of 25 small (< 10,000 people) communities distributed throughout an area of approximately 1.9 million km^2. The entire territory is located in the zone of continuous permafrost, and lacks ground based transportation infrastructure (roads or railways) linking the communities to each other, or to southern regions of Canada. These factors result in significant challenges in building and operating community water infrastructure. Every community in Nunavut currently relies on surface water sources for potable water supply. Water is either extracted directly from a lake or river for treatment and delivery to residents, or pumped to reservoirs during the ice-free period in the short arctic summer. The reservoirs are sized to store water required for the entire year. Due to the remote location of many of these communities, it would be extremely challenging to respond to a scenario in which the surface water sources provided inadequate quantities of water for a community during a dry year.

Recent events in Igloolik and Gjoa Haven have illustrated the challenges associated with responding to water supply shortages. The Community and Government Services (CGS) department of the Government of Nunavut recognized a need to conduct a comprehensive assessment of water availability across the territory, which accounted for climate change and population growth. This study was conducted with the objectives to: i) assess the long-term sustainability of water withdrawals from the primary drinking water source locations in all of Nunavut's 24 hamlets; and ii) rank the communities in terms of relative risk levels for water scarcity. Ultimately, the study is intended to be used as a science-based planning tool to inform infrastructure decisions related to drinking water. This will allow for support to be prioritized for communities that are at greatest risk of water scarcity.

The Centre for Water Resources Studies (CWRS) at Dalhousie University has completed a hydrologic analysis of the primary drinking water supply systems in all Nunavut communities, excluding the capital City of Iqaluit. For each community, contributing watershed areas were delineated, and a water balance model was used to predict water availability using historical climate data, and projected future climate data generated from downscaled global circulation model (GCM) output. A water availability indicator (WAI) was computed for each community for both historical and future climate scenarios, which accounted for population growth, and variable per capita water usage rates. The 24 communities were then ranked according to the WAI to provide guidance on prioritizing water supply upgrades.

Based on the water balance analysis, there are some communities which currently have, or may experience, water stress as a result of community demands and climate change. The risk of water shortage was assessed based on median water balance estimates, as well as 50-year return period minimum water availability estimates. The 50-year return period estimates provide a more realistic understanding of which communities may be at risk at some point in the future. A total of 7 communities were classed as high risk for water stress using historical climate records, and 6 were classed as high risk using future climate projections, when the 50-year probability low

precipitation and high evapotranspiration (ET) scenarios are considered, along with no changes in water delivery system. The seven communities where high water stress was observed using historical records included Arctic Bay, Cambridge Bay, Cape Dorset, Clyde River, Igloolik, Rankin Inlet (Nipissar), and Taloyoak. When future conditions were considered, Arctic Bay was downgraded to low risk due to higher precipitation. As a result of this, Arctic Bay was considered to have lower risk overall than the other high water stress ranked communities. Small watershed size (< 1000 ha) was observed to be the primary factor contributing to the level of risk.

Municipal infrastructure planning should take into the consideration the results of this analysis and allocate resources with efforts to reduce risks of high, medium, and moderate source water sites, in sequential order. In some cases, it may be necessary to site alternative back-up source water supplies in communities where the risk of water shortage is particularly high. This assessment provided a high-level desktop methodology with limitations for ranking risk of water scarcity in multiple communities with consideration for changing climate and demographics. This type of planning tool will be useful for managers of territorial drinking water infrastructure and may be translatable to other northern Canadian jurisdictions.

1. Introduction

1.1 Project Scope

This study was initiated to understand drinking water availability challenges, and uncertainty in the sustainability of future withdrawal quantities for community water supplies in the Territory of Nunavut. The study was requested by the Community and Government Services (CGS) Department and the Department of Health within the Government of Nunavut (GN) and conducted by the Centre for Water Resources Studies (CWRS) at Dalhousie University. The territorial government expressed interest in identification of communities that may be susceptible to water shortages in the future with consideration for changing climate and demographics. The need for this study was identified in response to a few cases of water shortages noted in some communities (e.g., Igloolik, Grise Fiord, Gjoa Haven, etc.). As a result, municipal infrastructure managers at the GN initiated the study to develop an understanding of the risk distribution across the Territory associated with drinking water supply. This was conducted to form the basis of a decision making tool for resource allocation on a long term planning horizon (e.g., 25 and 50 years).

This study included analysis of drinking water availability of primary sources in all communities in Nunavut, with the exception of Iqaluit. This type of planning tool will be useful for managers of territorial drinking water infrastructure and may be translatable to other northern Canadian jurisdictions. This report was a deliverable of a broader project conducted by CWRS which provided recommendations to inform the development of new regulations to govern drinking water treatment standards in Nunavut. The scope of this project was limited to a desktop study using readily available datasets from territorial and federal government sources. Ultimately, the study is intended to be used as a science-based planning tool to inform infrastructure decisions related to drinking water. This will allow for support to be prioritized for communities that are at greatest risk of water scarcity.

1.2 Project Background

The territory of Nunavut covers a large expanse of the Canadian Arctic of approximately 1.9 million km^2 (Statistics Canada, 2012). There are twenty-five communities in Nunavut, which are sparsely distributed across the territory (Figure 1). Each community is relatively small with populations of generally less than 2,500 people, with the exception of Iqaluit (6,700) (Government of Nunavut, 2012). Notably, there are no roads connecting communities to each other or to the south; therefore all transport of goods and materials is via aircraft, and cargo ships during the ice-free season. As a result, the construction of drinking water infrastructure is relatively expensive and more challenging compared to southern Canada due to the remote geographic locations of many communities.

Further pressures on the provision of safe and ample drinking water include the extreme climatic conditions characteristic of Nunavut. Source water is extracted solely from surface water rivers and lakes in Nunavut. Typically, the ice-free season on freshwater rivers and lakes spans a short 3 to 4 month period from approximately June until September or October. In some communities, this short season can constrain when drinking water can be collected and stored for the community's supply requirements for an entire year. Drinking water is collected from source locations and in some cases stored in reservoirs before treatment and distribution. Other communities extract raw water from lakes and treat throughout the year on an as-need basis. Another challenge associated with the provision of drinking water in Nunavut includes the presence of continuous permafrost, which hinders the use of buried infrastructure; therefore the majority of communities are reliant of water delivery trucks to convey treated drinking water to each individual household and establishment (Smith & Emde, 1996). Residents in Nunavut's communities typically use much less water than residents in Southern Canada—approximately 100 L per capita per day in comparison to 330 L per capita per day (Daley et al., 2014). This is partly due to the inherent capacity challenges associated with conveyance of drinking water with a trucked distribution system.

In recent years, there has been research focused on drinking water quality in arctic communities (Dudarev et al., 2000; Goldfarb et al, 2013). There has been less focus on the quantity and provisions of adequate drinking water within arctic communities (Daley et al., 2014). However, Daley et al. (2014) identified that recent research frameworks on water security have highlighted the importance of the provision of adequate drinking water quantities, in addition to water quality (Loring et al., 2013; Bakker, 2012; Cook & Bakker, 2012).

In Nunavut specifically, there have been a few recent challenges associated with drinking water supplies. Notably, the hamlet of Igloolik experienced water shortages in 2015 due to a frozen water reservoir and cold spring (Nunatsiaq News, 2015). Residents of Grise Fiord (pop. 150) expressed concern with the long-term sustainability of their source water supply due to their secondary source being a glacier-fed stream (CBC, 2014). To further investigate this risk, Arktis Piusitippaa Inc. (2015) conducted a desktop assessment of the secondary drinking water source in Grise Fiord and concluded that the potential for further glacier melt presents threatens the long-term sustainability of this secondary source of drinking water. In 2005, the community of Gjoa Haven experienced a severe water quantity emergency when the berm in their only water supply breached with winter setting in (Williams Engineering, 2014). Rankin Inlet also has water shortage problems with restrictions placed on when water can be extracted from its primary source location due to Nunavut Water Board (NWB) and Department of Fisheries and Oceans (DFO) requirements. In response, to the challenges associated with water quantity in Rankin Inlet, Golder Associates Ltd. conducted a water balance study for the GN (Golder Associates Ltd., 2015). The findings from their study demonstrated that the primary source is at risk of shortage based usage and climatic projections. However, the tertiary supply (Lower Landing Lake) was estimated to provide sufficient supplementary water as long as extremely high water consumption (5300 m^3/day) is not reached in the future.

In response to the vulnerability of drinking water sources to the extreme conditions in Nunavut and remote nature of the hamlets, the GN commissioned a study which was conducted by Williams Engineering Canada Inc., to locate alternate sources of drinking water for each Nunavut hamlet (Williams Engineering, 2014). This study involved a desktop review and phone interviews to gather available information on the source water details of each community as part of phase I. This was completed to enable identification of potential secondary water sources to use as alternate water supplies. Phase II involved sampling the potential secondary water sources for water quality analysis. The report recommended different secondary water supply options for each community based on the results of the desktop review and water quality analysis. The results of this project are useful for quick action in the event of water shortage emergencies within the hamlets. The study herein differs from the Williams Engineering study because this is focused on the current primary water source locations. Furthermore, a water balance was conducted which provides quantitative details on the actual quantity of water available from the primary sources based on climate factors, topography, and population size. In the case that communities are identified as being at high risk of water scarcity in the coming years, it would advisable to consult the Williams Engineering (2014) report to begin to look for alternate supplies in case of water shortages.

Factors that can affect the hydrology of surface water lakes and rivers in the Arctic, and hence the availability of drinking water include: precipitation, evapotranspiration (ET), air temperatures, permafrost dynamics, and glacial-melt. Climate change poses new uncertainties in the future availability of source water for communities in Nunavut. Some examples of effects of climate change on the hydrology of surface water systems were given in Hinzman et al. (2005). They observed that historical datasets showed a slightly statistically significant increasing trend in precipitation (P) in the winter months at several climate stations around the Arctic; however this may be offset by increased ET in the summer. Furthermore, they observed that the surface water balance (P-ET) declined significantly in Alaska over the past 40 years. On a global scale, the Intergovernmental Panel on Climate Change (IPCC) reports that with consideration for future changes in the climate, the availability of reliable surface freshwater supplies is anticipated to decrease. This decrease in surface water availability is expected due to increased variability in river hydrology, as a result of variability in precipitation, and decreased snow and ice accumulation throughout the winter months (IPCC, 2014). More specifically in high latitude environments characteristic of the Arctic, the precipitation is projected to increase; however, water shortages may still be anticipated due to the increased variability in river hydrology. In addition, higher average ambient air temperatures are projected to increase the rate of evaporation from freshwater lakes and water storage reservoirs and evapotranspiration from the tundra landscape; hence placing further pressures on the water resources in arctic regions (IPCC, 2014).

Additional considerations for sustainable withdrawal of source water includes maintenance flow requirements for fish passage, which are set by the Department of Fisheries and Oceans (DFO). According to the DFO (2013), the maximum amount of water withdrawal from a river cannot exceed 30% of the mean annual discharge (MAD) at any given time, and not more than 10% of the instantaneous river flow at any given time. These minimum requirements for fish passage set further constraints on the availability of source water for communities in Nunavut and should be considered within the assessment of water availability.

1.3 Project Objectives

The objectives of this task of the project were to:

i) assess the long-term sustainability of water withdrawals from the primary drinking water source locations in all of the Nunavut's 24 hamlets; and

ii) rank the communities in terms of relative risk levels for water scarcity.

1.4 Study Limitations and Assumptions

There were a few limitations to this study, and its ultimate accuracy which included that:

- this study was limited to a desktop environment; therefore, many assumptions had to be made to generate the risk ranking;
- the climate datasets were at times sparse and had to be adopted from the nearest weather station to the community; which at times may be distant;
- the statistically down-scaled climate change projections are computer model generated estimates and dependent on assumptions regarding the representative concentration pathway (RCP);
- the residential water usage amounts were assumed as 90 L/pp/d for trucked systems and 225 L/pp/d for piped systems, actual water use in communities may vary from this;
- no consideration was given to permafrost melt and the possible changes to the water balance due to uncertainty in timing and effect of this process;
- the storage term of the water balance equation was assumed to be negligible for the purposes of this study, which was supported by continuous permafrost and the general assumption of a thin soil layer overlying Canadian shield bedrock;
- it was assumed that the effects of sublimation from snow and ice, and undercatch, which is the phenomenon of underestimation of measured precipitation versus actual precipitation, would balance each other due to uncertainties with the effects of these processes on the water balance and lack of data to support an estimation;
- it was assumed that the source water locations in each community were not glacial fed, which was confirmed based on satellite imagery; however, this may not have been the case for the community in Pangnirtung. This was considered to be a conservative assumption;

- this study only assessed the volume of water supplied by the watershed on an annual basis;
- the storage characteristics of the lake and/or reservoirs including loss of capacity due to seasonal ice formation were not considered;
- Iqaluit was not included in the assessment;
- this study did not include assessment of potential alternate water supplies in emergency situations;
- this study did not consider the risk of failure of infrastructure (i.e., reservoir leakage, etc.); and
- the source water extraction locations were specified by the CGS and this formed the basis for the assessments of watershed areas.

2. Methodology

2.1 Study Site Descriptions and Overview of Approach

This study examines 24 communities located in Nunavut. Table 1 below provides location, population, and water supply conveyance type for each community. Community locations are illustrated in Figure 1. For each community, the assessment process first consisted of delineation of the contributing watershed area of the source water extraction point. An annual water balance was then computed for each source watershed using available meteorological data from the nearest Environment Canada Climate Station. The water balance computations were then repeated using statistically downscaled future climate projections. A water availability indicator was used to characterize and rank the risk of water shortage in each community based on the water balance results. Finally, the impact of fisheries maintenance flow requirements on water availability was assessed in a select number of communities where continuous discharge data was available.

Table 1. Community information including current and future populations and source water characteristics.

Community	Coordinates	Population			Water Source	Water Supply
		2011 Census[a]	2040 Projected	2070 Projected		
Arctic Bay	73°02’11”N 085°09’09”W	823	1,111	1,170	Marcil Lake	Trucked
Arviat	61°06’29”N 094°03’25”W	2,318	4,477	9,067	Wolf Creek	Trucked
Baker Lake	64°19’05”N 096°01’03”W	1,872	3,076	4,751	Baker Lake	Trucked
Cambridge Bay	69°07’02”N 105°03’11”W	1,608	2,048	2,578	Water Supply Lake	Trucked
Cape Dorset	64°13’54”N 076°32’25”W	1,363	2,027	2,908	T Lake	Trucked
Chesterfield Inlet	63°20’27”N 090°42’22”W	313	535	798	First Lake	Trucked
Clyde River	70°28’26”N 068°35’10”W	934	1,504	2,385	Water Source Lake	Trucked
Coral Harbour	64°08’13”N 083°09’51”W	834	1,594	3,062	Post River	Trucked
Gjoa Haven	68°37’33”N 095°52’30”W	1,279	1,842	2,643	Swan Lake	Trucked
Grise Fiord	76°25’03”N 082°53’38”W	130	171	201	Snowmelt runoff	Trucked
Hall Beach	68°46’38”N 081°13’27”W	546	1,455	2,722	Water Supply Lake	Trucked
Igloolik	69°22’34”N 081°47’58”W	1,454	2,949	4,775	South Lake	Trucked

Table 1. (Cont'd) Community information including current and future populations and source water characteristics.

Community	Coordinates	Population			Water Source	Water Supply
		2011 Census[a]	2040 Projected	2070 Projected		
Kimmirut	62°50'48"N 069°52'07"W	455	568	690	Fundo Lake	Trucked
Kugaaruk	68°31'59"N 089°49'36"W	771	1,320	1,984	Kugajuk River	Trucked
Kugluktuk	67°49'32"N 115°05'42"W	1,450	1,904	2,355	Coppermine River	Trucked
Naujaat	66°31'19"N 086°14'06"W	945	1,997	4,627	Nuviq Luktujuq Lake	Trucked
Pangnirtung	66°08'52"N 065°41'58"W	1,425	2,144	2,483	Duval River	Trucked
Pond Inlet	72°41'57"N 077°57'33"W	1,549	2,515	4,220	Salmon River	Trucked
Qikiqtarjuaq	67°33'29"N 064°01'29"W	520	597	692	Tulugak River	Trucked
Rankin Inlet	62°48'35"N 092°05'58"W	2,266	4,102	6,545	Char River & Nipissar Lake	Piped
Resolute	74°41'51"N 094°49'56"W	214	287	341	Char Lake	Piped
Sanikiluaq	56°32'34"N 079°13'30"W	812	1,408	2,397	Sanikiliuaq Lake	Trucked
Taloyoak	69°32'13"N 093°31'36"W	899	1,424	2,212	Canso Lake	Trucked
Whale Cove	62°10'22"N 092°34'46"W	407	653	1,021	Fish Lake	Trucked

[a](Government of Nunavut, 2012).

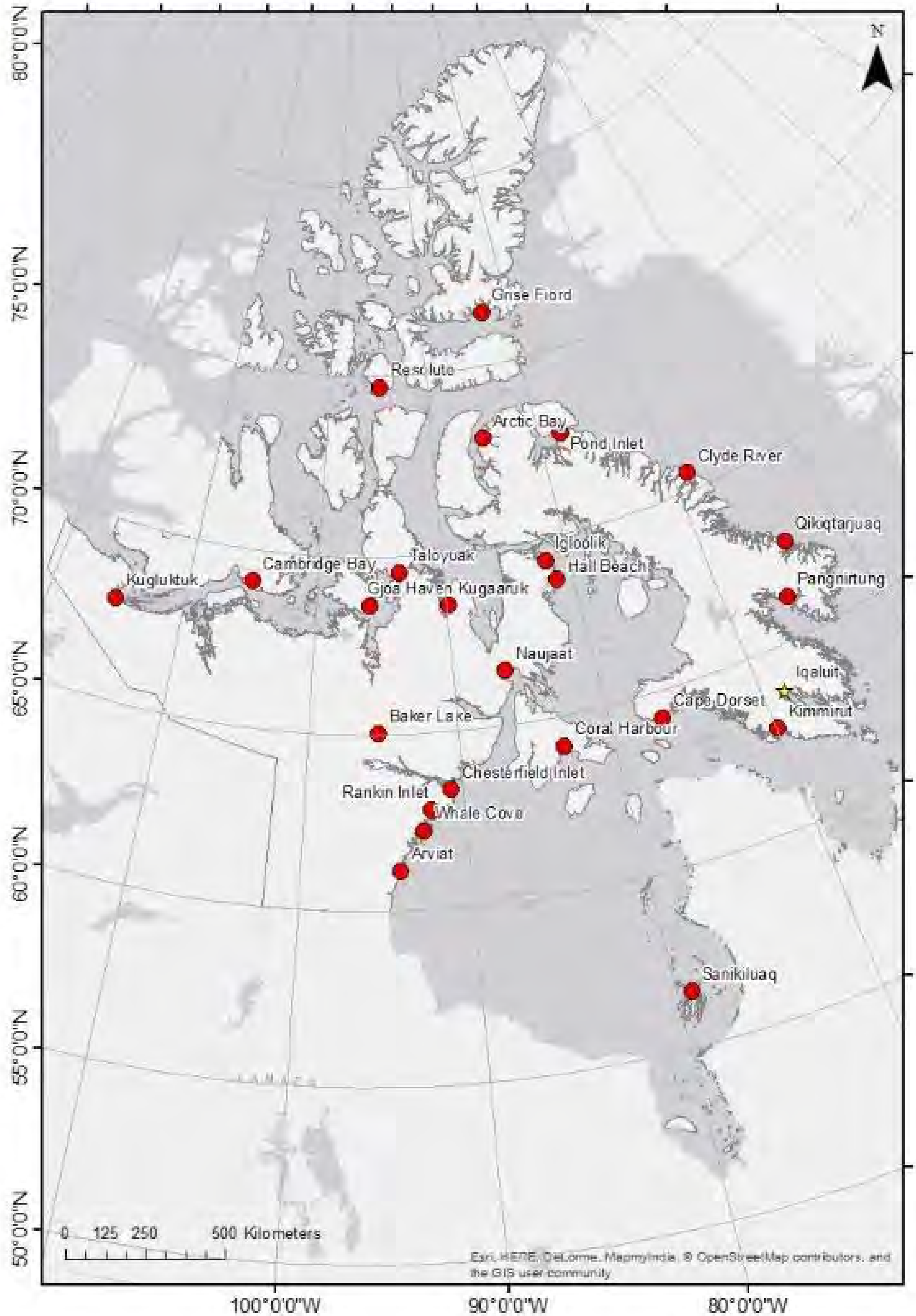

Figure 1. Map of the communities in Nunavut.

2.2 Watershed Delineation

Study site watersheds were delineated using ArcGIS using data obtained from Natural Resources Canada – GeoGratis (Government of Canada, 2016a). The Geospatial Data Extraction tool was used to download digital elevation models (DEMs) and hydro topography with the specifications outlined in Table 2.

Table 2. Specifications for the watershed delineation inputs.

Elevation data		
	Input	**Specification**
	DEM	GeoTiff
	Datum	NAD83-CSR
	Projection	Geographic
	Output format	File Geodatabase (10.1)
Topographic data		
	Input	**Specification**
	Datum	NAD83-CSR
	Projection	Geographic
	Scale	1: 50,000
	Clip data	Yes

To minimize distortion, all data was projected in the UTM zone the community is situated in, (e.g. NAD 1983 UTM Zone 15N, etc.). The Project Raster tool was used to transform the DEM, and the Project tool was used to transform the Hydro data (water_linear_flow_1).

Arc Hydro was used to complete terrain preprocessing steps in the following order (Maidment, 2002):

1. DEM Manipulation > DEM Reconditioning
2. DEM Manipulation > Fill Sinks
3. Flow Direction
4. Flow Accumulation
5. Stream Definition
6. Stream Segmentation
7. Catchment Grid Delineation
8. Catchment Polygon Processing
9. Drainage Line Processing
10. Adjoint Catchment Processing
11. Drainage Point Processing

The Point Delineation feature was used to create the watershed. Flowing watercourses were delineated at the designated intake point, while lakes were delineated using the lake outlet, such that the entire contributing area of the lake was included. The polygon was edited to include any water storage bodies it intersected. Polygon area was available in the attribute table and automatically updated, as Arc Hydro saves the output as a feature class in a file geodatabase.

Due to the nature of the topography and the quality of DEM available, some watersheds could not be delineated using Arc Hydro. Grise Fiord and Sanikiluaq were delineated manually using topographic maps. The Baker Lake watershed was too large to delineate; thus the Thelon River drainage basin was used from the Atlas of Canada. The Atlas of Canada National Frameworks Hydrology data (Natural Resources, 2003) provides shapefiles for drainage area boundaries on a sub-sub-basin level. The Thelon River sub-drainage basin pictured in the Atlas of Canada consists of sub-sub-basins for the Kazan, Dubawnt, and Thelon rivers. These sub-sub-basins were augmented with an additional polygon to include the contributing area immediately surrounding Baker Lake.

2.3 Historical Water Use

The annual historical water values were calculated with consideration for the most recent population according to census data. These water use values were held constant throughout the hindcast water balance calculations to provide a conservative estimate of water availability based on the historical datasets. The census data from the GN was used to obtain the most recent population estimate for each community (Government of Nunavut, 2012). Assumptions of per capita water use of 90 and 225 litres per person per day for trucked and piped water delivery systems based on Smith & Emde (1999) were used. Actual water consumption values are likely to vary from these design values, for instance Golder Associates Ltd. (2016) estimated that an average water consumption rate in Rankin Inlet for 2015 was 720 L/pp/d. It should also be noted that the annual reporting of water use estimates has uncertainties due to in some cases to poor reporting.

2.4 Projected Water Use

The projected water usage from 2014 to 2035 was determined based on population projections available from the Government of Nunavut; which are provided in Appendix A (Government of Nunavut, 2014). The population growth rate from 2014 to 2035 was calculated and used to project the populations to 2070. Equation 1 was used to calculate the population growth rate from 2035 to 2070 for each of the communities.

$$P_{gr} = \frac{P_{35} - P_{14}}{n} \quad \text{[Eq.1]}$$

Where P_{gr} is the population growth rate, P_{35} is the population projection for 2035, P_{14} is the population projection for 2014, and n is the number of years between P_{35} and P_{14}.

The annual projected water usage for each community, based upon the calculated population and residential water use, was then determined using the Equations 2 and 3 from Heinke et al (1991). The residential water use (RWU) was assumed to be 90 litres per person per day for trucked water, and 225 litres per person per day for piped water as provided by Smith & Emde (1999).

For a population size of 0 to 2,000 people, the total water use per capita was estimated using:

$$RWU \times [1.0 + (0.00023 \times P)] \quad \text{[Eq.2]}$$

For a population size of 2,000 to 10,000 people, the total water use per capita was estimated using:

$$RWU \times [-1.0 + (0.323 \times \ln P)] \quad \text{[Eq.3]}$$

where P is population.

2.5 Historical Climate Data

Historical climate data was downloaded from the Environment Canada historical climate data website (Government of Canada, 2016a). Bulk downloads of multi-year datasets were performed according to the directions provided by Government of Canada (2015b). The statistical software package R was used to generate annual amounts of precipitation based on the daily historical climate records at each site. No data was reported when more than 30 consecutive days of data were missing from any given year. In addition, the monthly mean minimum, maximum, and mean temperature for each month were generated for each site with R statistical software. Weather stations are not situated in every community, therefore in these cases, the nearest weather station to the study site was used.

Table 3 indicates which climate station was used for each community, as well as the distance between the station and community, and the years of data available. Figure 2 shows the communities; climate station locations are designated with red pentagons.

Table 3. Study sites and corresponding climate stations.

Community	Climate Station Name	Distance to Community (km)	Number of Years of Historical Data
Arctic Bay	Arctic Bay CS	7	28
Arviat	Arviat A/Climate	1	29
Baker Lake	Baker Lake A/Climate	3	63
Cambridge Bay	Cambridge Bay A/Climate	3	69
Cape Dorset	Cape Dorset A/Climate	1	30
Chesterfield Inlet	Rankin Inlet A	90	34
Clyde River	Clyde River A/Climate	3	55
Coral Harbour	Coral Harbour A	11	68
Gjoa Haven	Gjoa Haven A	1	29
Grise Fiord	Resolute Bay A/CS	385	66
Hall Beach	Hall Beach A/Climate	1	50
Igloolik	Hall Beach A/Climate	70	50
Kimmirut	Iqaluit UA/Climate	120	61
Kugaaruk	Kugaaruk Climate	1	55

Table 3. (cont'd) Study sites and corresponding climate stations.

Community	Climate Station Name	Distance to Community (km)	Number of Years of Historical Data
Kugluktuk	Kugluktuk Climate	2	77
Naujaat	Coral Harbour A	300	68
Pangnirtung	Qikiqtarjuaq A/Climate	173	41
Pond Inlet	Pond Inlet A/Climate	1	38
Qikiqtarjuaq	Qikiqtarjuaq A/Climate	1	41
Rankin Inlet	Rankin Inlet A	1	34
Resolute	Resolute Bay A/CS	5	66
Sanikiluaq	Kuujjuarapik Climate	168	67
Taloyoak	Taloyoak Climate	2	43
Whale Cove	Rankin Inlet A	1	34

Figure 2. Climate station locations in relation to the study sites.

2.6 Evapotranspiration

Potential evapotranspiration (PET) is defined as the total amount of water that can theoretically be released from the landscape into the atmosphere given specific climate conditions. In reality, actual evapotranspiration (AET) is less than PET due to environmental and physical factors which act to limit evapotranspiration. Evapotranspiration was estimated for all the study sites using the Priestley and Taylor (1972) method according to Xu and Singh (2002) and Allen et al (1998). Mendez et al (1998) noted that the Priestley-Taylor method is a favorable method for PET estimation in tundra wetlands when detail on individual physical processes are not required. Radiation data was estimated from temperature data from historical datasets and climate model projections. Assumptions for the Priestley-Taylor calculations are summarized in Table 4.

Table 4. Assumptions for the Priestley-Taylor PET method.

Parameter	Value	Units	Source
Specific heat of moist air	1.013	KJ/kg/°C	Xu and Singh (2002)
Ratio of molecular weight of water vapour/dry air	0.622		Allen et al (1998)
Solar constant	0.082	$MJ/m^2/min$	Xu and Singh (2002)
Albedo	0.155		SNAP (2011)
Stefan-Boltzmann constant	$4.9x10^{-9}$	$MJ/K^4/m^2/d$	Xu and Singh (2002)
Regression constant, a_s	0.25		Allen et al (1998)
Regression constant, b_s	0.5		Allen et al (1998)
Alpha coefficient, α	0.22 – 1.26		Calibrated and Xu and Singh (2002)

2.6.1 Alpha Coefficient Selection in Arctic Environments

The Priestley-Taylor method incorporates an alpha coefficient (α), which represents physical evaporation processes as a lumped term. Commonly, an alpha value (α) is assumed to be 1.26, which is a valid assumption when land conditions are wet or humid (Xu and Singh, 2002). Complications to selection of appropriate alpha coefficients in arctic tundra landscapes include a high degree of inter and intra-site variability (Engstrom et al., 2002). Eugster et al (2000) provided a review of evapotranspiration in arctic tundra environments. The studies summarized within this review show that alpha values ranged widely from 0.23 to 1.51 for tundra and boreal ecosystems. Intersystem variability of ET is attributed to various factors which interact with high complexity including: vegetation cover, regional and micro-climates, permafrost, and soil moisture contents (Liljedahl et al., 2011). Importantly, in an arctic tundra environment permafrost lowers the ground surface temperature and acts to decrease the rate of evapotranspiration from the landscape (Eugster et al., 2000). Therefore the presence of permafrost contributes to AET rates that are substantially lower than PET rates produced from energy-balance estimation methods. Authors Roulet and Woo (1986) emphasized that the alpha coefficient should be treated exclusively as an empirical factor. Due to the variability associated with this coefficient, the approach used in this study treated the alpha coefficient as an empirical factor used to adjust PET to AET with a calibration routine, as per the methodology described in the following section.

2.6.2 Calibration of Alpha Coefficient with Hydrometric Data

The Priestley-Taylor PET calculations for this study were originally computed with the assumption of an alpha coefficient of 1.26. This assumption resulted in PET estimates which were comparatively higher than literature values for actual ET from multiple arctic studies summarized in Kane et al (1990). In order to improve the representation of ET for this study, a calibration routine was performed on the alpha coefficient using measured hydrometric data. Calculation of AET was performed using available historical hydrometric data (HYDAT database) from the

Environment Canada Water Survey of Canada (Government of Canada, 2015b). Historical hydrometric datasets were downloaded for the: Freshwater Creek near Cambridge Bay, Diana River near Rankin Inlet, Kirchoffer River near Coral Harbour, and Apex River in Iqaluit. These hydrometric stations were selected for the analysis because the quantity and quality of discharge data was sufficient for the analysis.

Table 5. Actual evapotranspiration (AET) calculated annually from HYDAT data.

Community	Year	AET Hydat (mm)
Cambridge Bay	2012	53
	2013	49
	2014	48
Rankin Inlet	1991	101
	1992	24
	1993	112
	1994	64
	1995	138
Coral Harbour	1988	24
	1989	70
	1990	39
Apex	2008	104

Annual estimates of AET were determined based on the total annual precipitation over the water year minus the total cumulative flow exiting the watershed. This was completed by summing the daily flows measured at the hydrometric station over a monitoring season (e.g., approximately June to September). The summed daily flows over a season equates to a runoff volume from the watershed area of the hydrometric station. In addition, the daily precipitation for the water year were summed and multiplied by the watershed area of the hydrometric station. The water year spans from October 1 – September 30 for a given year. The total estimated ET was calculated with the following Equation 4:

$$AET_e = \left(\frac{P_{vol} - Q_{vol}}{A_{hyd}}\right) * 0.001 \qquad \text{[Eq.4]}$$

Where: AET_e is the estimated actual annual evapotranspiration (mm/year), P_{vol} is the precipitation volume for a water year, Q_{vol} is the runoff volume for a monitoring season, and A_{hyd} is the watershed area of the hydrometric station.

The calibration procedure was conducted in Microsoft Excel by using the Solver tool. The calibration was conducted by optimizing alpha values so ET calculated from the Priestley-Taylor expression matched the AET estimates calculated from the hydrometric data using Equation 4. The communities of Cambridge Bay, Rankin Inlet, Coral Harbour, and Iqaluit—which were located in closest proximity to each of the four hydrometric stations—were selected for the calibration using the data summarized in Table 5. Only years with sufficient climate and hydrometric data were used for the calibration process. The calibration was performed by toggling the alpha coefficient to minimize the sum of squared errors between the PET calculated from the Priestley-Taylor equation and the AET calculated from the hydrometric data with Equation 4. The calibrated alpha coefficients were averaged to give a value of 0.22.

2.7 Water Balance Calculations

The total annual water available was calculated by determining the volume of precipitation added to the watershed area, then subtracting the total volume of water lost from the watershed through evapotranspiration, and total volume of water extracted for drinking water. Two extraction scenarios were considered which consisted of the trucked and piped water conveyance systems. This was completed to consider the water availability if a community switches to piped drinking water infrastructure in the future. Percolation to groundwater was assumed to be negligible due to permafrost. The water balance calculation is shown in Equation 5:

$$W_a = P - ET - W_{use} \quad \text{[Eq. 5]}$$

Where W_a is the water volume available after abstractions, P is the precipitation volume, ET is the evapotranspiration volume, and W_{use} is the water used for residential purposes.

2.7.1 Water Availability Indicator

The *Water Availability Indicator* (WAI) is used by Environment Canada to assess water resources, and is based on the *Water Stress Indicator* developed by the Organization for Economic Co-operation and Development (OECD) (OECD, 2009). The WAI is the percentage of water used of the total water available from the watershed. Government of Canada (2013) used total water used based on geographic information system (GIS) data from water use surveys and streamflow data from the Water Survey of Canada. Within Government of Canada (2013), it is noted that the methodology used for the WAI was not applicable to the North because they were using river flow data for the water supply calculation; which is challenged due to the extreme climate. In part due to this inadequacy, the study herein applied the WAI concept differently than that used in the Environment Canada assessment. The water demand was calculated based on population and design water use values, and the water supply was calculated based on water calculations, which took into account climate conditions and watershed areas. The watershed areas and precipitation data were used to calculate the total annual amounts of water available. The water used was calculated as the amount needed by the communities based on population growth and for two conveyance types (i.e., piped and trucked). The WAI is determined by calculating the ratio of freshwater demand to freshwater supply as per Equation 6 (Environment Canada, 2011).

$$WAI = \frac{freshwater\ demand}{freshwater\ supply} \times 100 \quad \text{[Eq. 6]}$$

After the WAI was calculated, the threat to water availability was ranked using OECD's scheme shown below in Table 6. This risk ranking distribution is specifically for the OECD scheme adopted by Environment Canada (2011). It was deemed to be most appropriate for the WAI calculation specifically used in this report as well; rather than an arbitrary distribution of WAI percentages.

Table 6. Water availability threat classifications (OECD, 2009).

Risk Level	WAI	Description
High	> 40%	Severe water stress
Medium	20% - 40%	Both water supply and water demand need to be managed; conflicts among competing uses will need to be resolved
Moderate	10% - 19%	Water availability becomes a constraint on development; significant investment is needed to provide for adequate water supply.
Low	< 10%	Low water stress

Freshwater demand includes total municipal, industrial, and agricultural withdrawals (OECD, 2009); predicted trucked/piped community water demands are used in this study.

2.8 Assessment of Maintenance Flow

The hydrometric data was also used to perform an analysis on the maintenance flows required to maintain ecological flow in the rivers. This was performed by proration of the discharge data from the nearest Environment Canada hydrometric station to a select number of study site watersheds where data was available. The discharge datasets from Environment Canada spanned from the spring freshet to the fall freeze-up. During the winter months, precipitation accumulates as snow and ice and does not contribute to flow. The stored precipitation over the winter months is accounted for during the spring freshet in the Environment Canada hydrographs. The 30% MAD was calculated for each year of historical data according to DFO (2013). Periods where the 30% MAD exceeded the instantaneous flow rate were identified as periods when drinking water extraction was not favorable. Flows exceeding the 30% MAD were multiplied by 0.1 to find the permissible withdrawal rate (10% of the instantaneous flow). The mean daily permissible withdrawal rate (m^3/day) was calculated with a 95% confidence interval. Additionally, the minimum, maximum, and average operational days were determined for each community. The annual permissible withdrawal volume was calculated by multiplying the average permissible daily withdrawal by the operational days that year.

The communities and corresponding hydrometric stations are displayed below in Figure 3 and Table 7. Stations were selected on the basis of proximity to the community, Figure 3 shows that all stations are relatively close to the community and should accurately represent the hydrological regime.

Figure 3. Location of study sites in relation to the hydrometric stations.

Table 7. Study sites and corresponding hydrometric stations.

Community	Contributing Area (km^2)	Station Used	ID	Years of Data	Contributing Area (km^2)
Rankin Inlet - Nipissar	2.7	*Diana River*	06NC001	7	1460
Rankin Inlet - Char	68	*Diana River*	06NC001	7	1460
Qikiqtarjuaq	24	*Tulugak River*	10UE001	9	27
Resolute Bay	4.1	*Mecham River*	10VC002	43	87
Cambridge Bay	2.8	*Freshwater Creek*	10TF001	45	1490
Coral Harbour	256	*Kirchoffer River*	06PA001	6	3160

2.9 Future Climate Projections

Assessment of future climate scenarios were performed using precipitation and temperature datasets generated from Global Climate Model (GCM) output. There are numerous GCMs available to generate projections of future climate conditions that are described in detail in IPCC (2014). The GCM datasets were sourced from the Pacific Climate Impacts Consortium (PCIC) based at the University of Victoria (PCIC, 2016). The PCIC provides statistically downscaled climate datasets for Canada.

2.9.1 GCM Selection

Four GCMs were selected to provide a range of possible future climate projections. The GCMs were selected based on the 12 models available through the PCIC portal. The number of GCMs were reduced from 12 to 4 by selecting the GCMs with the lowest observed bias for precipitation and temperature for northern regions presented by Sheffield (2013). The four GCMs selected for the future climate projections were CCSM4-r2, CNRM-CM5-r1, CSIRO-Mk3-6-0-r1, and MRI-CGCM3-r1. The Bias Correction/Constructed Analogues with Quantile mapping reordering (BCCAQ) method was used for statistical downscaling of the GCMs to the sites.

2.9.2 RCP Analysis

Three representative concentration pathways (RCPs) (e.g., 2.6, 4.5 and 8.5) were assessed for generation of future climate projections for one site (Coral Harbour). These represent three different scenarios for future climate change based on carbon concentrations in the atmosphere. Figure 4 demonstrates the difference in the RCPs. For subsequent sites, a middle ground RCP of 4.5 was selected to simplify data analysis, and due to few observed differences in water availability between the RCP scenarios.

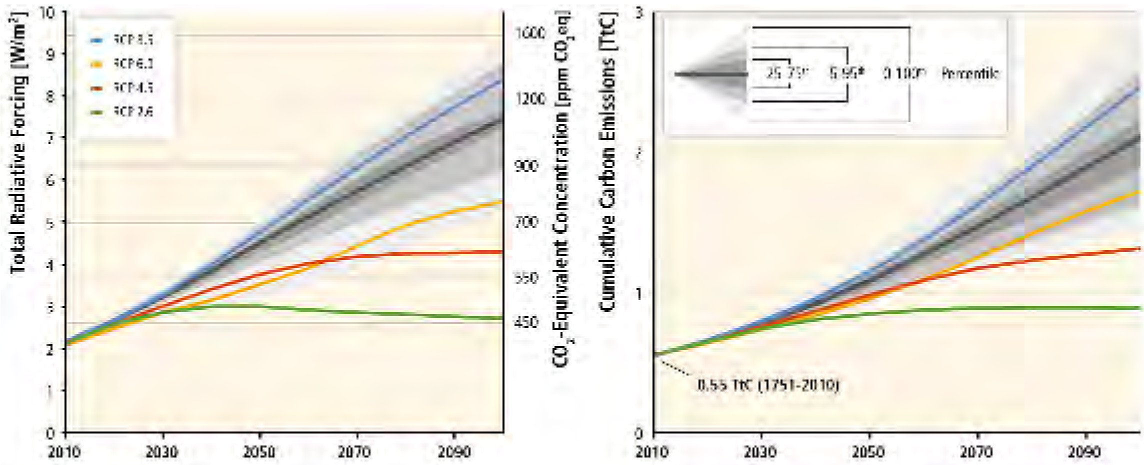

Figure 4. Four RCPs for climate modeling according to IPCC (2014).

The GCM historical and projected datasets generated at three different RCPs were generally similar. There were also no obvious trends in water availability in correlation with RCP for the period ranging from 2016 - 2040. However, there is a slight increase in water availability with RCPs 4.5 and 8.5 later in the century (2040 – 2070). This trend reflects the RCPs trends projected in the IPCC (2014); whereby the RCPs notably diverge in carbon concentrations post 2030 (Figure 4). Since the results between the three RCPs were quite similar this provides justification for selection of only one RCP for subsequent calculations associated with the other communities. Based on this analysis it was concluded that a middle ground RCP of 4.5 is used for subsequent communities.

2.9.3 Selection of Study Periods

Three study periods were selected to run the water balance analysis. These periods consisted of 1950 to 2015 (historical), 2016 – 2040, and 2041 – 2070. Hindcast GCM datasets (i.e., 1950 – 2015) were compared to historical climate data to verify the validity of the future climate projections. These study periods were selected to provide verification of past known climatic conditions at the sites (i.e., past 65 years), to generate projections of near-term water availability for infrastructure planning decisions (i.e., 25-year planning horizon), and to verify far-term projections of water availability (i.e., 25 – 50-year planning horizon).

2.10 Statistical Analysis

2.10.1 Median and 50-Year Return Periods Minimum Computations

The median water availability and 50-year return periods for annual minimum precipitation and annual maximum ET were determined for each of the three study periods, the historical dataset and for each GCM modeled dataset. EasyFit 5.6 Professional statistical software was used to fit the annual time series to chosen probability distributions. The 50-year return period minimum precipitation was calculated by fitting each dataset to a lognormal probability density function. The 50-year return period maximum ET was calculated by fitting each dataset to a general extreme value (GEV) probability density function.

2.10.2 Mann-Kendall Test

A Mann-Kendall statistical test was performed on the historical datasets of precipitation and estimated evapotranspiration, as well as, each of the hindcast climate datasets. The null hypothesis, which assumed a trend, was tested at 95% confidence level for precipitation and evapotranspiration for all communities with complete historical datasets. This test was performed to verify whether the time series trends had statistically significant decreases, increases, or neutrality. This was then compared to the hindcast climate projections from the PCIC datasets to verify for consistency in climate trends. The Mann-Kendall tests were performed with MATLAB R2015b and Microsoft Excel 2013 software packages according to the method described in Gocic and Trajkovic (2013). In order to be used in the statistical assessment, criteria were applied which consisted of: a minimum dataset length of 30 years; no more than 3 consecutive years of data missing, for a maximum of two occurrences; and a dataset which spans until at least the year 2000.

3. Results

3.1 Hydrological Settings

A variety of factors, such as topography, soil type, land use, and climate, can impact water availability. Topography affects water availability because it directly influences the spatial extent of the watersheds which provide water to the source extraction location. The soil type can influence the water availability because it controls the rate of infiltration, and hence the storage term of the water balance equation. However, to maintain simplicity in this desktop study, the soil type was not considered because permafrost was assumed to be continuous and near the surface. Permafrost melt and accumulation would also affect the water availability acting as a storage or production term. Again, for the purposes of this study, permafrost was assumed to negate the storage of water; however release of water from permafrost as a result of climate conditions into the future were uncertain and therefore not addressed under of the scope of this study. Land use can affect the water availability as development can change the permeability of the land surface which affects water infiltration and recharge. This factor was negligible for this study because development is fairly localized near communities and very small in scale in comparison to the watershed areas studied. Climate is an important factor that affects the amount of water available, as it relates to amount of water recharging the watershed through precipitation, and the amount of water removed through ET, which is related to temperature. Sublimation of water from snow and ice can affect the water balance; however for the high-level purpose of this study, this effect was not taken into account.

All these factors affect the water availability; however the driving factor behind water availability in this study was found to be the watershed area. A large contributing area (e.g., Baker Lake watershed) will yield more water than a small contributing area (e.g., Igloolik watershed). The study site watersheds delineated in this study ranged in area from less than 27 to 24 million ha, as shown in Figure 5. Vulnerability of source water availability corresponds largely with watershed area and will increase as the watershed area decreases. The watershed maps for each of the study sites are included in Appendix B.

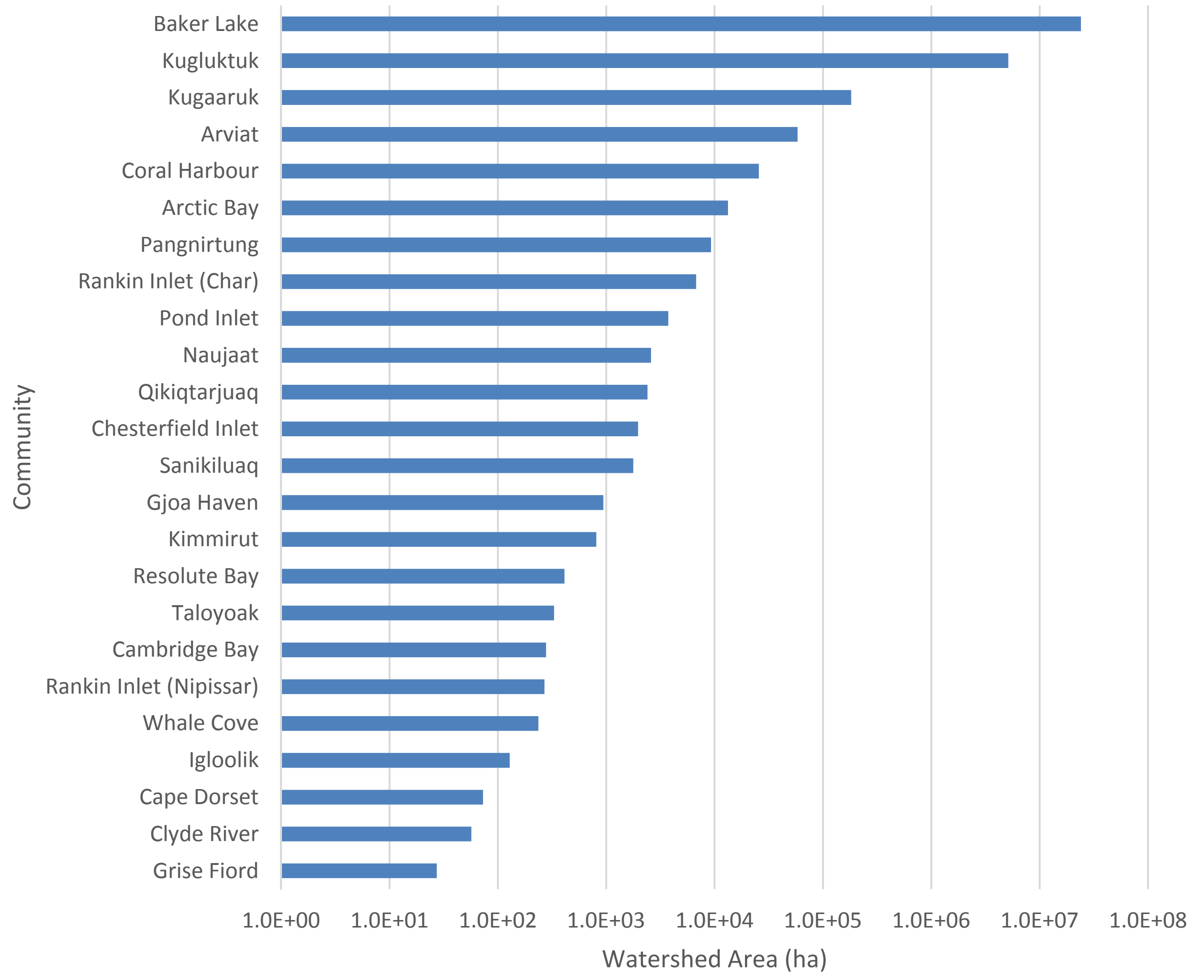

Figure 5: Watershed areas for each of the study sites.

3.2 Water Availability

3.2.1 Summary of Availability Using Median Values

The median water availability indicator, in percentage, was calculated for each scenario and for each community based upon the ratio of water demand to water availability. A risk level was then applied to each GCM scenario and the highest percentage for each of the three study periods was identified in order to remain conservative. The results are displayed in Table 8. The detailed tables describing the median water balance results for each study site are presented in Appendix C.

Table 8. Water shortage threat levels based on median water availability estimates.

Legend						
High		Medium		Moderate		Low

Community	Water Availability Indicator (%)					
	Historical		2016-2040		2041-2070	
	Trucked	Piped	Trucked	Piped	Trucked	Piped
Arctic Bay	<1	1.1	<1	<1	<1	<1
Arviat	<1	<1	<1	<1	<1	1.1
Baker Lake	<1	<1	<1	<1	<1	<1
Cambridge Bay	36	90	30	74	39	98
Cape Dorset	30	75	45	112	67	168
Chesterfield Inlet	<1	<1	<1	1.2	<1	1.9
Clyde River	40	101	61	151	89	223
Coral Harbour	<1	<1	<1	<1	<1	<1
Gjoa Haven	5.5	14	9.5	18	13	29
Grise Fiord	14	34	16	41	17	42
Hall Beach	1.4	3.4	3.6	8.9	7.1	18
Igloolik	27	67	67	167	108	271
Kimmirut	<1	1.6	<1	1.8	1.4	2.1
Kugaaruk	<1	<1	<1	<1	<1	<1
Kugluktuk	<1	<1	<1	<1	<1	<1
Naujaat	<1	1.7	1.6	3.9	5.2	11
Pangnirtung	<1	<1	<1	1.5	<1	1.8
Pond Inlet	1.6	4.1	3.0	7.4	4.3	11
Qikiqtarjuaq	<1	1.1	<1	1.2	<1	1.5
Rankin Inlet – Char	<1	1.9	1.6	3.9	2.7	6.6
Rankin Inlet – Nipissar	19	48	40	99	67	166
Resolute	2.3	5.8	1.8	4.6	2.0	4.9
Sanikiluaq	<1	<1	<1	1.7	1.6	3.0
Taloyoak	10	25	18	46	28	69
Whale Cove	2.8	7.1	4.9	12	7.9	20

Based on the median estimates, 16% of communities will be a high risk of water scarcity before 2070; while 8% are at medium risk, 8% are at moderate risk and 68% are at low risk. The most obvious contributing factor to the risk level was the size of the watershed utilized for source water. The four communities displaying years with a water demand over 40% of the total water available (high risk) were generally determined to be the study sites withdrawing from watersheds with the smallest surface areas. The study sites of highest risk withdrew from watersheds ranging in size from 27 to 330 ha. Contrastingly, Baker Lake utilized less than 1% of the water available and withdrew from the largest watershed at 24,000,000 ha. Climate trends throughout the three study periods generally appeared to show an increase in evapotranspiration with time, and less pronounced increases in precipitation, but this did not appear to have a large impact on water availability.

Table 9: Water shortage threat levels based on 50-year return period minimums.

Legend			
High	Medium	Moderate	Low

Community	Water Availability Indicator (%)					
	Historical		2016-2040		2041-2070	
	Trucked	Piped	Trucked	Piped	Trucked	Piped
Arctic Bay*	100	100	<1	1.7	<1	1.3
Arviat	<1	<1	<1	1.0	<1	1.9
Baker Lake	<1	<1	<1	<1	<1	<1
Cambridge Bay	110	276	91	228	95	236
Cape Dorset	51	128	73	183	114	284
Chesterfield Inlet	1.2	2.9	1.2	3.0	1.6	4.1
Clyde River	250	626	123	308	170	424
Coral Harbour	<1	<1	<1	<1	<1	1
Gjoa Haven	17	43	28	54	30	66
Grise Fiord	39	97	32	80	30	76
Hall Beach	3.8	9.5	7.1	18	12	31
Igloolik	52	130	134	334	191	478
Kimmirut	1.2	2.9	1.1	2.7	2.1	3.0
Kugaaruk	<1	<1	<1	<1	<1	<1
Kugluktuk	<1	<1	<1	<1	<1	<1
Naujaat	1.2	3.1	2.7	6.7	7.5	16
Pangnirtung	<1	1.9	1.3	3.2	1.4	3.5
Pond Inlet	7.0	17	5.2	13	10	25
Qikiqtarjuaq	<1	2.3	1.1	2.7	1.1	2.9
Rankin Inlet – Char	1.4	3.6	3.3	8.2	5.1	13
Rankin Inlet – Nipissar	36	91	82	205	127	318
Resolute	13.1	33	3.7	9.3	3.5	8.7
Sanikiluaq	<1	1.3	1.1	2.7	2.3	4.4
Taloyoak	51	128	48	121	61	152
Whale Cove	5.4	14	10	25	15	38

*Arctic Bay was classed as high risk of water shortage based on one extreme year of low precipitation in combination with high ET. Statistical analysis of historical climate datasets indicated increased precipitation for this community, and therefore the risk level is downgraded in future simulation periods.

3.2.2 Summary of Availability Using 50-Year Return Period Minimum Values

The water availability indicator was also calculated as discussed in Section 3.2.1 while using 50-year low precipitation and 50-year high evapotranspiration values in place of median values. The risk level was applied to the most conservative value of the 4 GCM scenarios for each time period, as shown in Table 9. The detailed tables describing the 50-year return period results for each study site are presented in Appendix D.

The results obtained from the 50-year probability analysis displayed an increase in the number of communities with higher risk levels when compared to the median water availability results. Approximately 24% of the study sites displayed the potential for severe water stress sometime before 2070. The percentage of study sites displaying moderate and medium stress levels were 8% of the communities displaying medium levels and 12% showing moderate risk levels. Finally, 56% of the communities were determined to have a low water stress level throughout the entirety of the study period.

Figures 6, 7, and 8 illustrate the geographic trends in risk levels associate with water availability across the territory for historic conditions, 2016-2040, and 2041-2070, respectively. Generally, the geographic distribution of communities that are high risk do not show obvious spatial trends. As previously discussed in Section 3.2.1, the most influential trend appeared to be the size of the watershed utilized for source water; study sites utilizing watersheds with a smaller surface area appeared to be more frequently subjected to concerning water availability ratios. Arctic Bay displayed an extreme variation in climate during the historical period, where the 50-year low precipitation value was close to that of the 50-year high evapotranspiration, which resulted in a potentially severe water stress level for this type of water year. Therefore, Arctic Bay was considered to have overall lower risk than the other communities that are ranked as at high risk of water stress because into the future it is statistically more likely to be at low risk of water scarcity.Overall, the water availability was observed to decrease overtime, as the water demand increased with population growth and with changing climate projections for all communities.

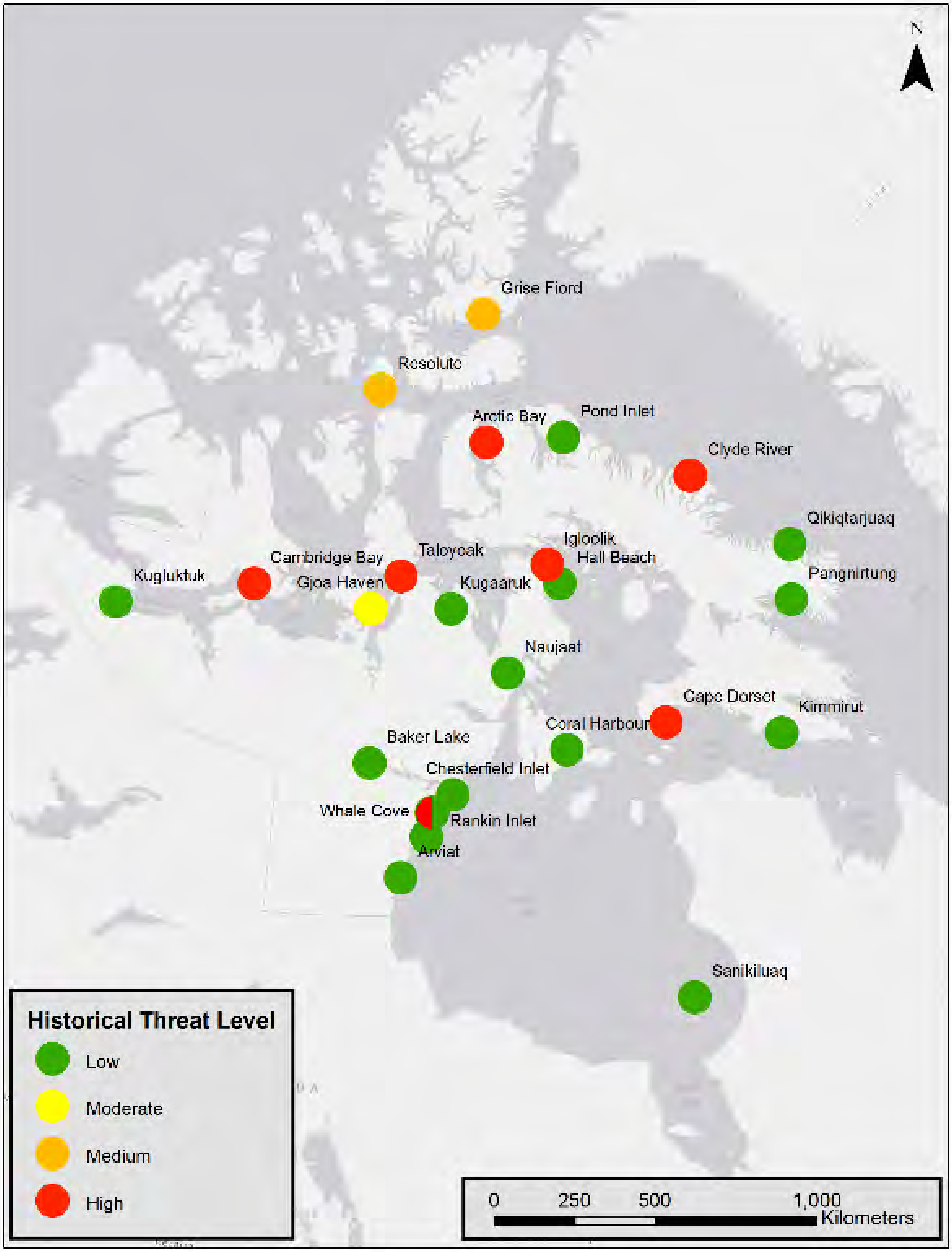

Figure 6. Historic water shortage threat level map based on 50-yr probability estimates.

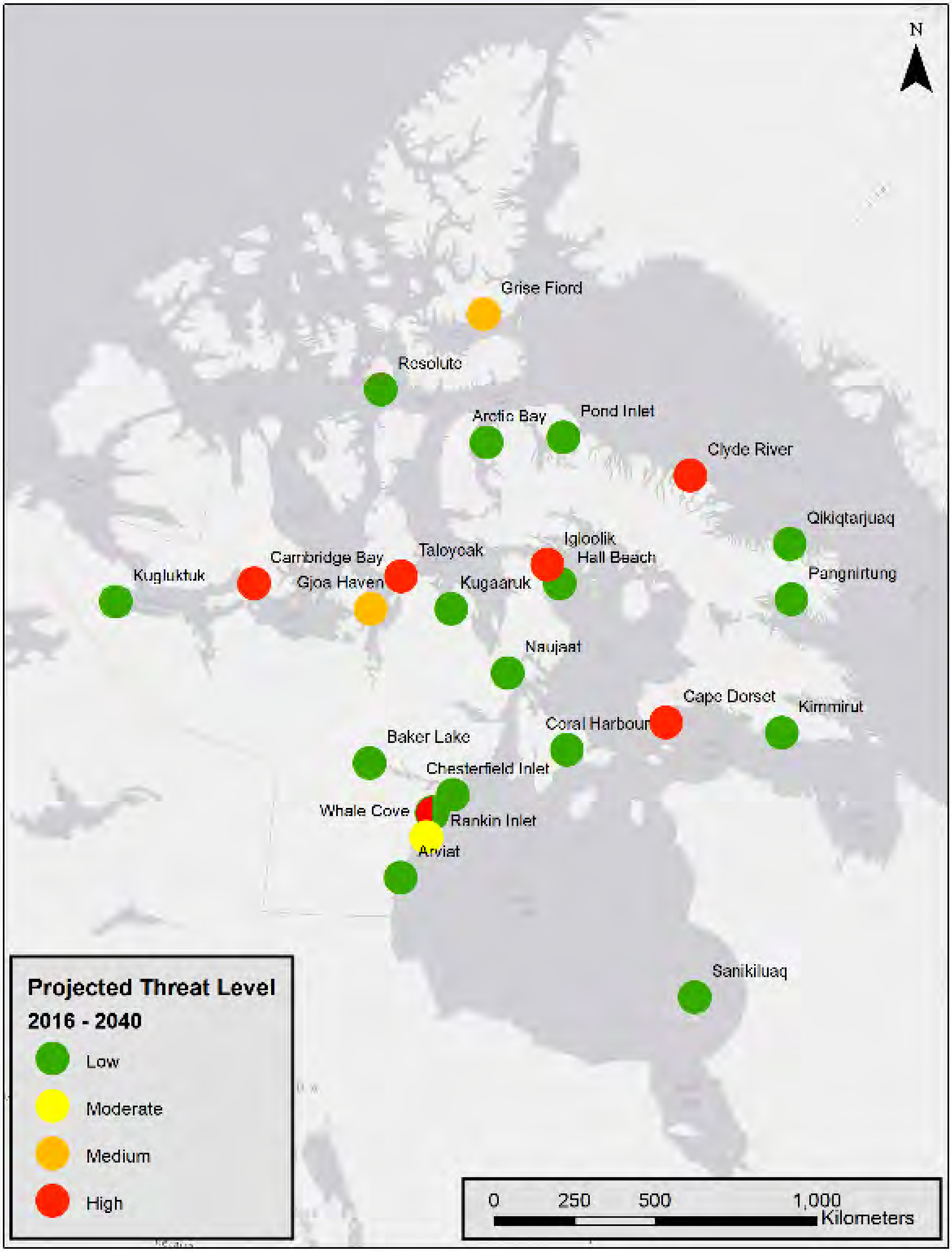

Figure 7. Projected water shortage threat map for 2016 - 2040 based on 50-yr probability estimates.

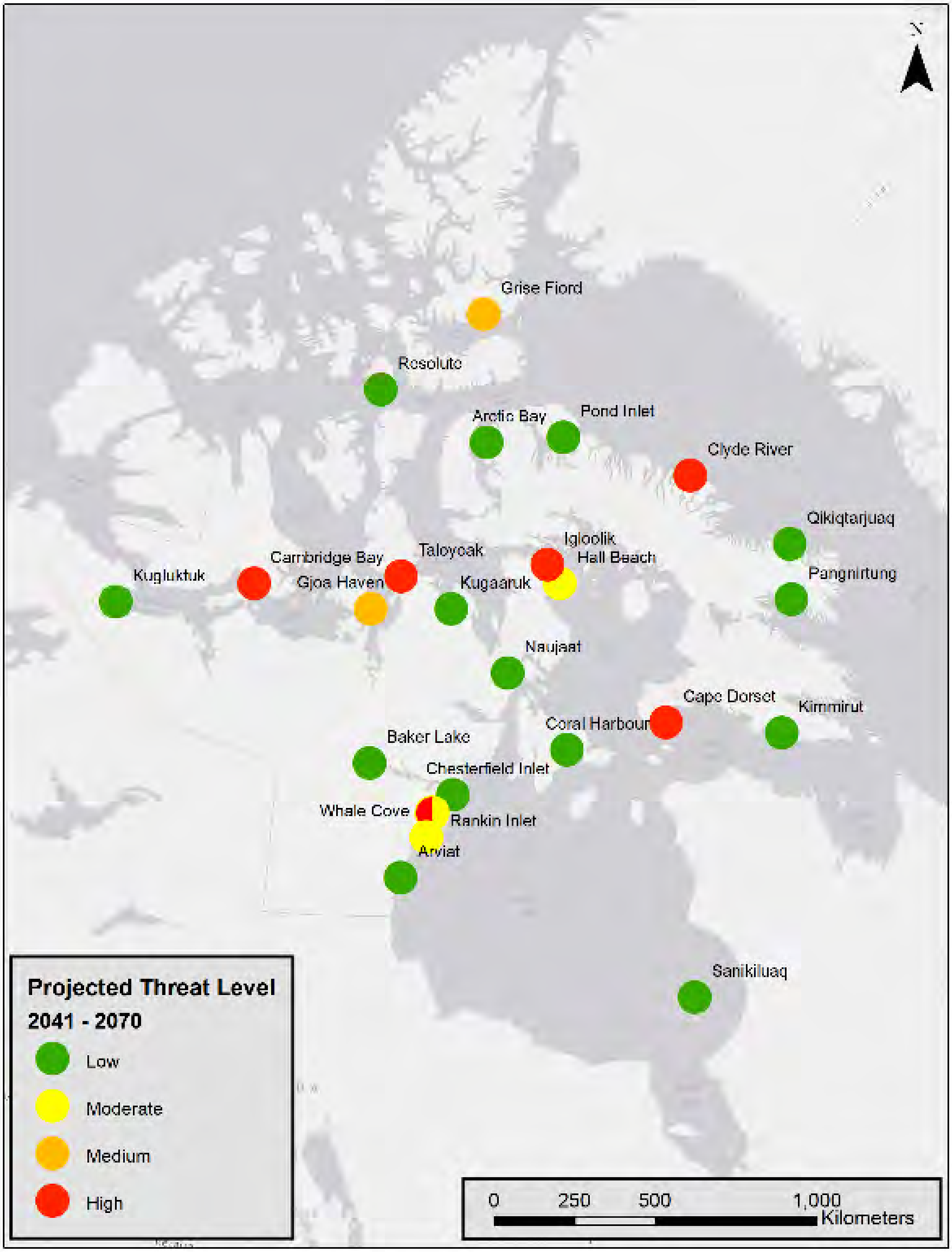

Figure 8. Projected water shortage threat map for 2041 - 2070 based on 50-year probability estimates.

3.3 Climate Projection Verification

3.3.1 Statistical Trends

The Mann Kendall statistical test indicated overall trends of neutrality in precipitation, and increasing trends in evapotranspiration. Figure 9 shows that the historical dataset from Environment Canada largely showed no significant trends in precipitation. Only 3 out of 14 communities showed a statistical increase in historical precipitation, which were Coral Harbour, Naujaat, and Resolute. Only Kimmirut showed a statistical decrease in precipitation. The other communities showed no significant trends in historical precipitation. Based on the PCIC hindcast datasets, 4 out of 24 communities had statistically increasing precipitation, which included: Arctic Bay, Grise Fiord, Kugaaruk, and Resolute. This suggests there are differences at times between the trends observed between the historical and climate model hindcast datasets.

Figure 10 shows that the historical dataset demonstrated that 16 out of 20 communities had statistically increasing trends in evapotranspiration. While, the statistics performed on the PCIC hindcast datasets generally agreed with significant increases in evapotranspiration estimated from historical climate datasets in 22 out of 24 communities. Detailed results of the statistical analysis including the historical and PCIC datasets is presented in Appendix E.

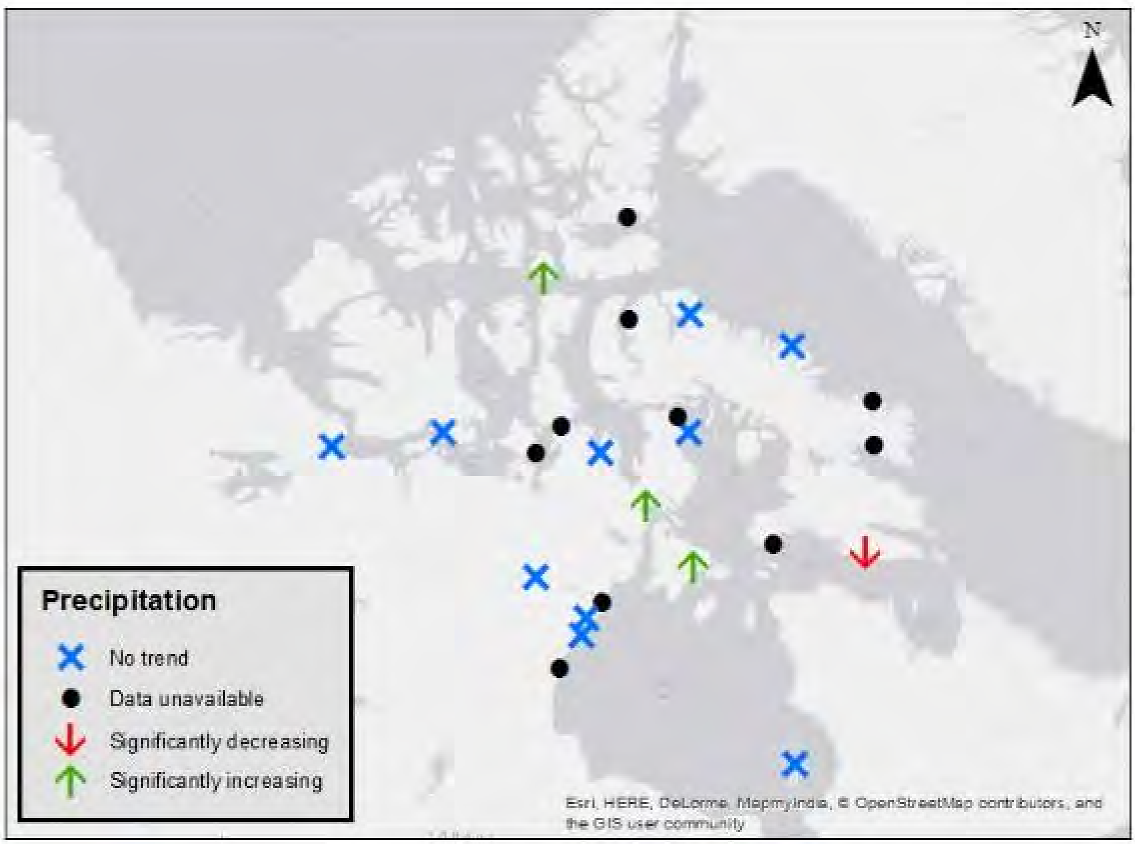

Figure 9. Statistical trends in historical precipitation datasets from Environment Canada.

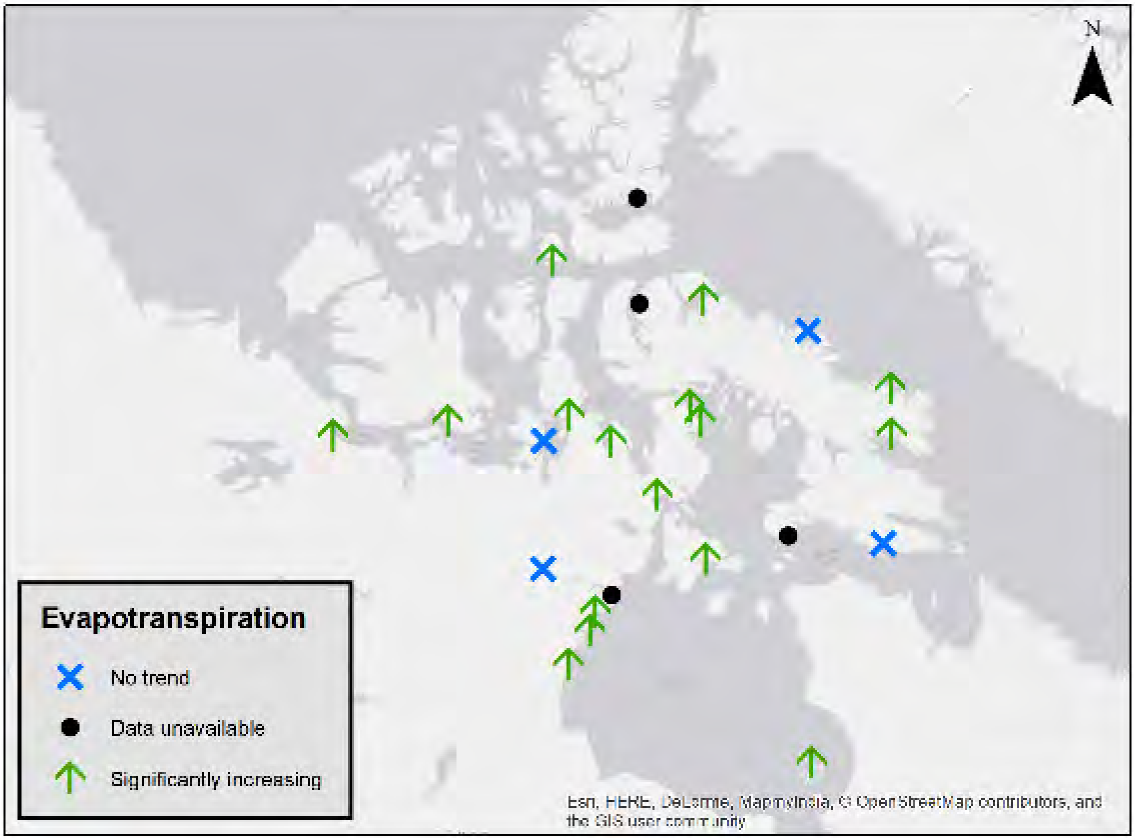

Figure 10. Statistical trends in evapotranspiration based on historical data.

3.3.2 Comparison of GCM and Historical Datasets

Overall, the GCM hindcast statistically downscaled water availability estimates compared well with the water availability calculated from the observed historical climate data. In Coral Harbour for example, the percent differences between the GCM hindcast calculated and historical median water availability consisted of 2% for both CCSM4 and CNRM-CM5, 6% for CSIRO and 9% for MRI. This suggests that the selected models are appropriate to use in calculations for future projections of water availability.

3.4 Hydrometric Station Analysis

3.4.1 Inter-seasonal Variability in River Discharge

Since lakes and rivers freeze during the winter, water availability varies seasonally. The spring freshet usually occurs in June, resulting in peak spring flows that drop off in summer and autumn, as seen in Figure 11. Water must be extracted during this period for use the remainder of the year. During the winter, precipitation is stored as snow and ice and does not contribute to the river discharge until the spring freshet. The Environment Canada hydrographs reflect the release of stored precipitation accumulated over the winter.

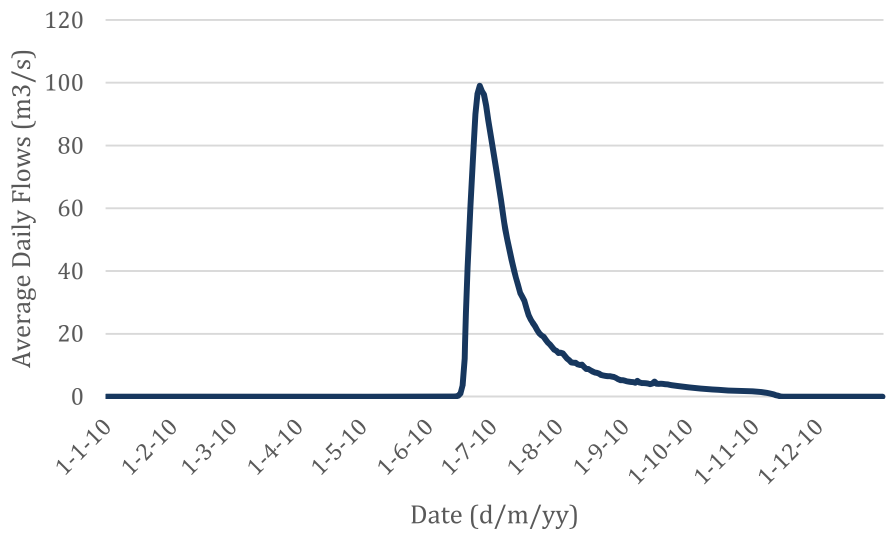

Figure 11: Inter-seasonal variability in discharge values for 2010 used for the Cambridge Bay site (Freshwater Creek 10TF001).

3.4.2 Operational Days Based upon Fisheries Maintenance Flows

In this study, an operational day was defined as a day where the flow exceeds 30% of the MAD, thus water can be withdrawn while meeting DFO's fisheries maintenance flow requirements. The mean, minimum, and maximum number of operational days for the historical dataset are shown in Table 10 for the four communities examined. Notably, the number of operational days in Qikitarjuaq and Resolute Bay were at their minimum only 8 days in length, which suggests that in worst case hydrological scenarios the window for water withdrawal may be very short. It should be noted, Golder Associates Ltd. (2015) conducted a detailed analysis on the maintenance flows for the Char River in Rankin Inlet and therefore this report should be consulted for maintenance flows specific to Rankin Inlet's source water extractions.

Generally, the statistical analysis of the climate data projections showed increasing temperature in most communities as depicted in Figure 10 with ET (directly related to temperature). This may in the future extend the ice-free season when water can be withdrawn from seasonal sources.

Table 10. Number of operational days based on DFO maintenance requirements.

Community	Mean	Minimum	Maximum
Qikiqtarjuaq	34	8	61
Resolute Bay	33	8	59
Cambridge Bay	82	40	133
Coral Harbour	65	34	93

3.4.3 Permissible Withdrawals

In addition to the increased risk associated with flow alterations resulting in instantaneous flows less than 30% of the MAD, DFO states that cumulative flow alterations less than 10% of the instantaneous flow have a low likelihood of impacting fisheries (DFO, 2013). Thus, withdrawals on operational days cannot exceed 10% of the instantaneous flow. Considering this constraint, Table 11 shows the permissible average daily withdrawals (m^3/day), with a 95% confidence interval.

Table 11. Permissible average daily withdrawal rates based on DFO requirements.

Community	Source	Mean (m^3/day)	95% Confidence Limit	
			Lower Bound	Upper Bound
Qikiqtarjuaq	*Tulugak River*	11677	10274	13079
Resolute Bay	*Char Lake*	2192	1933	2451
Cambridge Bay	*Lake*	276	268	284
Coral Harbour	*River*	87161	76679	97642

The permissible daily withdrawal can vary significantly from year to year; an example of this is shown in Figure 12, where Cambridge Bay's permissible withdrawals fluctuate widely between the years 1970 and 2014.

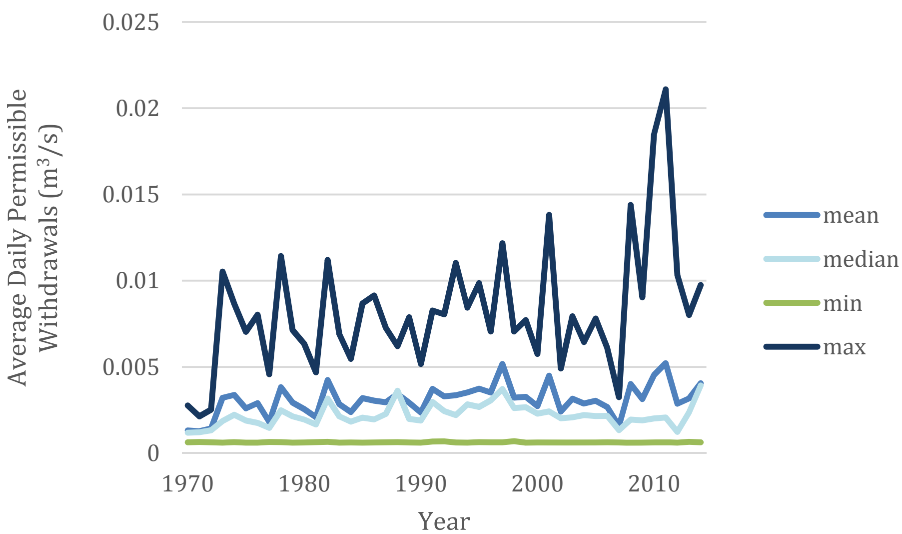

Figure 12: Inter-Annual Variability in Average Daily Permissible Withdrawal Rates for Cambridge Bay.

3.4.4 Water Use versus Permissible Withdrawals

For a select number of communities where data was available, permissible withdrawals were compared against community water use, to determine if communities could feasibly meet DFO Ecological Flow requirements. These constraints would only be applicable to communities withdrawing water directly from a flowing, fish bearing watercourse. The results for three sample communities withdrawing from a flowing watercourse are shown in Figure 13 and Figure 14. Both the trucked and piped water scenarios are shown to assess the difference in water demand based on the type of distribution infrastructure. All three of the communities were able to meet their demand while adhering to DFO requirements. Coral Harbour has the largest watershed, resulting in the largest permissible annual withdrawal volume.

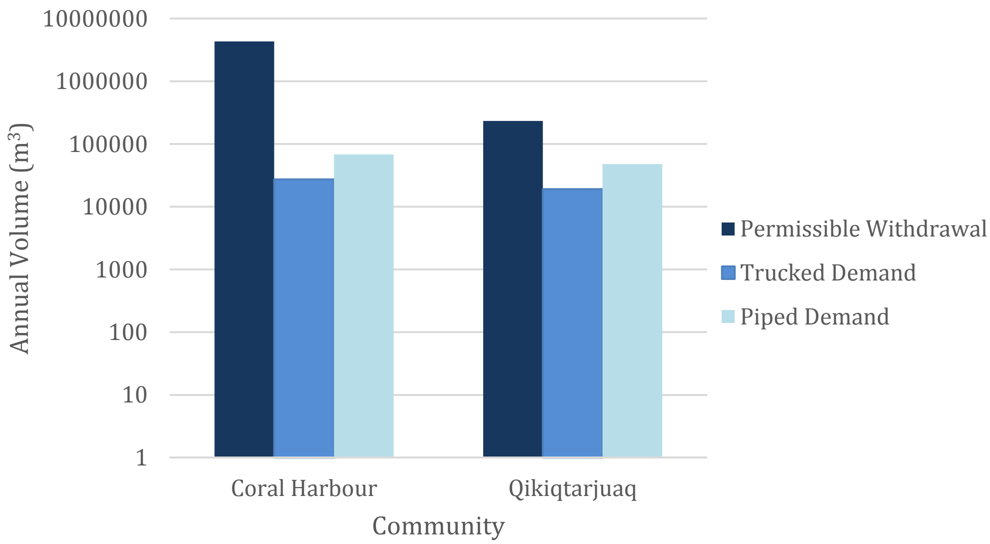

Figure 13: Water demand versus worst case permissible withdrawal considering fisheries maintenance flow constraints.

Figure 13 shows the permissible withdrawal and water use for the driest year in the historical dataset for each community. Figure 14 shows the permissible withdrawal for the driest year in the historical dataset and the projected 2070 water use.

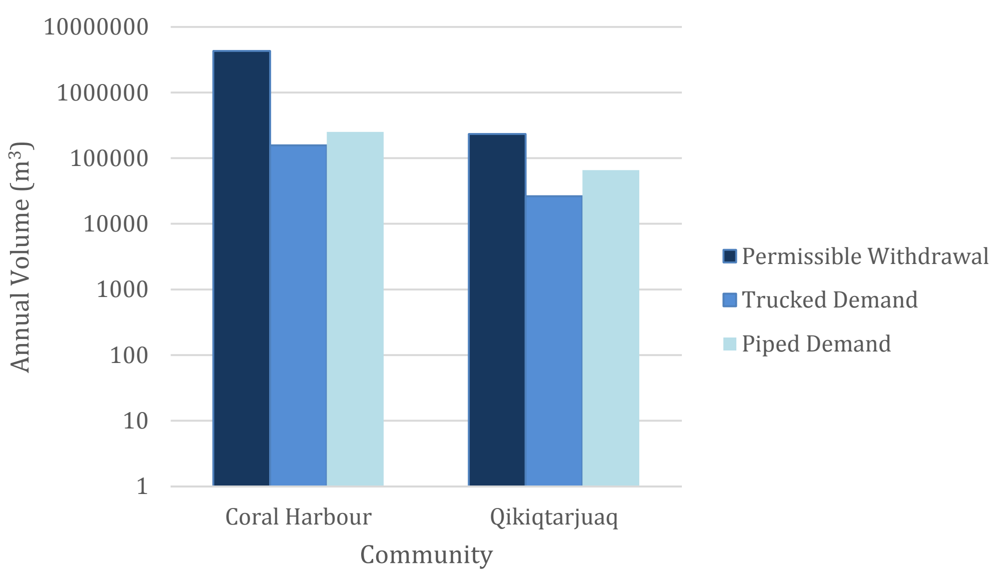

Figure 14: Projected 2070 water use versus worst case permissible withdrawal considering fisheries maintenance flow requirements.

3.5 Overall Risk Assessment

Based on the water balance analysis there are some communities which currently have, or may experience, water stress as a result of community demands and climate change. The results of the median water balance analysis demonstrated that 2 communities historically have had high risk of water stress, and in the future scenarios there is anticipated to be an increase to 4 communities vulnerable to high water stress by 2070 (Figure 15). The number of communities classed as high risk for water stress increases to 7 historically and 6 for future climate projections, when the 50-year return period low precipitation and high ET scenarios are considered (Figure 16).

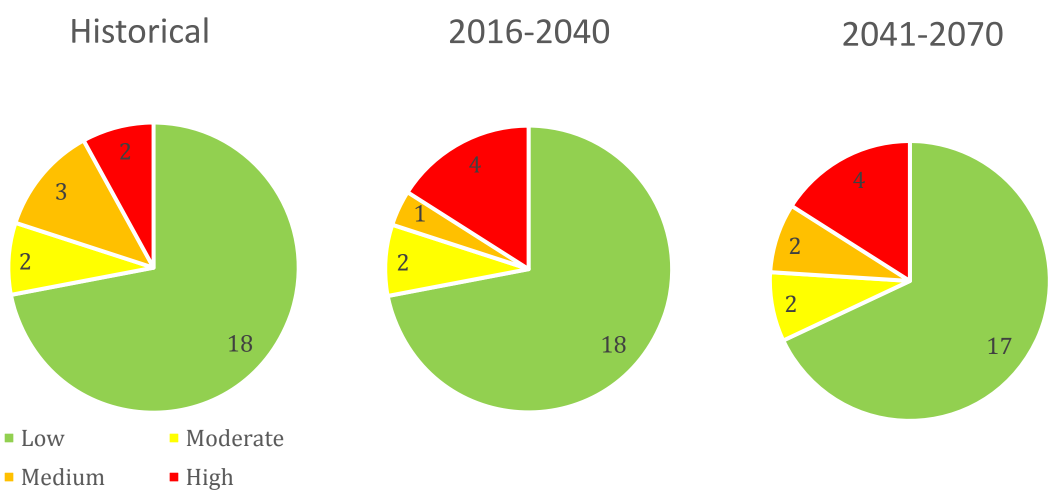

Figure 15. Pie-charts showing the distribution of risk levels for the 25 source water locations according to median water balance values (all are trucked except Rankin Inlet and Resolute).

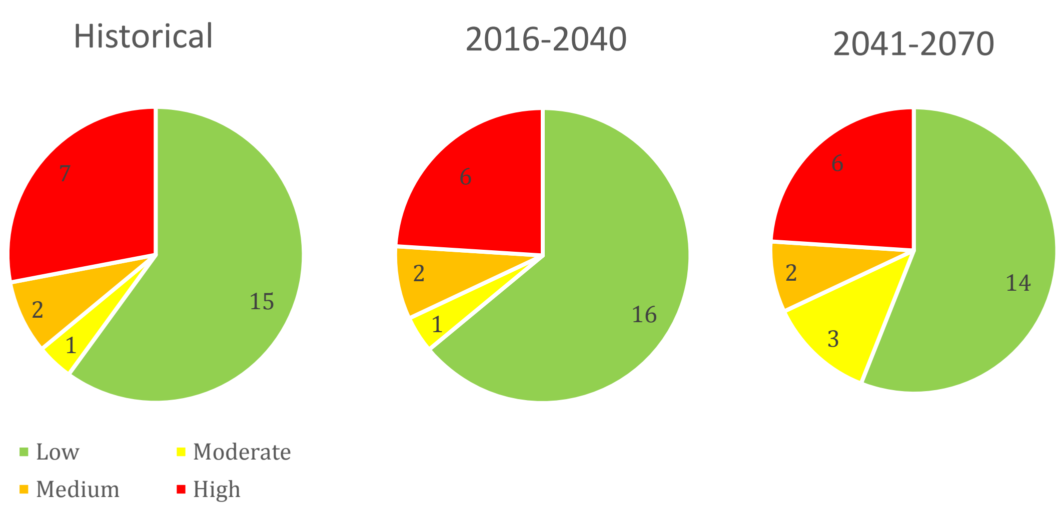

Figure 16. Pie-charts showing the distribution of risk levels for the 25 source water locations according to the 50-year return periods (all are trucked except Rankin Inlet and Resolute).

Table 12 summarizes the communities where elevated levels of risk of water stress based on the water availability index were observed. Based on historical data, there were a total of seven communities where high water stress was observed when the 50-year return periods which were: Arctic Bay, Cambridge Bay, Cape Dorset, Clyde River, Igloolik, Rankin Inlet (Nipissar), and Taloyoak. The same communities are at high risk into the future with climate projections except Arctic Bay because precipitation is anticipated to increase in this community.

Grise Fiord and Resolute were identified as being medium risk of water scarcity based on the 50-year return periods from the historical datasets. Gjoa Haven was elevated to medium risk levels for future climate projections. Gjoa Haven was at moderate risk of water scarcity based on historical datasets. In future climate projections, Gjoa Haven's risk level is increased to medium and Resolute is anticipated to decrease in risk due to increased precipitation. Whale Cove is anticipated to have moderate risk level for water scarcity by 2040. While, further into the future (i.e., 2041 -2070) Hall Beach, Rankin Inlet (Char) are anticipated to be elevated to moderate risk of water scarcity.

Table 12. Summary of communities which have risk of water stress based on water availability indicator.

Period	Median estimates			50 year probability worst case		
	High	Medium	Moderate	High	Medium	Moderate
Historical	• Clyde River • Rankin Inlet (Nipissar)	• Cambridge Bay • Cape Dorset • Igloolik	• Grise Fiord • Taloyoak	• Arctic Bay • Cambridge Bay • Cape Dorset • Clyde River • Igloolik • Rankin Inlet (Nipissar) • Taloyoak	• Grise Fiord • Resolute	• Gjoa Haven
2016 - 2040	• Cape Dorset • Clyde River • Igloolik • Rankin Inlet (Nipissar)	• Cambridge Bay	• Grise Fiord • Taloyoak	• Cambridge Bay • Cape Dorset • Clyde River • Igloolik • Rankin Inlet (Nipissar) • Taloyoak	• Gjoa Haven • Grise Fiord	• Whale Cove
2041-2070	• Cape Dorset • Clyde River • Igloolik • Rankin Inlet (Nipissar)	• Cambridge Bay • Taloyoak	• Grise Fiord • Gjoa Haven	• Cambridge Bay • Cape Dorset • Clyde River • Igloolik • Rankin Inlet (Nipissar) • Taloyoak	• Gjoa Haven • Grise Fiord	• Hall Beach • Rankin Inlet (Char) • Whale Cove

4. Conclusions

In conclusion, this desktop risk assessment of the sustainability of water withdrawal from the source drinking water locations for Nunavut's hamlets demonstrated that there are several communities that are at high risk of water shortages both now and in the future. Generally, the degree of risk was directly related to the size of the watershed contributing to source water intake location.

Based on the water balance analysis there are some communities which currently have, or may experience, water stress as a result of community demands and climate change. The risk of water shortage was assessed based on median water balance estimates, as well as 50-year return period minimum water availability estimates. The 50-year return period estimates provide a more realistic understanding of which communities may be at risk at some point in the future. A total of 7 communities were classed as high risk for water stress using historical climate records, when the 50-year probability low precipitation and high ET scenarios are considered, along with no changes in water delivery system. The seven communities where high water stress was observed using historical records included: Arctic Bay, Cambridge Bay, Cape Dorset, Clyde River, Igloolik, Rankin Inlet (Nipissar), and Taloyoak. When future conditions were considered, six communities were classed as high risk of water shortages. Arctic Bay was downgraded to low risk and the rest remained as high risk of water scarcity.

Based on the 50-year return period historical data, the two communities of Grise Fiord and Resolute were ranked at medium risk of water scarcity. The future projections until 2070 ranked Grise Fiord and Gjoa Haven as having medium risk of water scarcity. In terms of moderate risk, Gjoa Haven was ranked accordingly for the historical analysis. The three communities of Hall Beach, Rankin Inlet (Char), and Whale Cove were all ranked as having moderate risk of water shortages before 2070.

Minimal change was observed in risk levels of water shortages when comparing historical and future climate scenarios. However, a few communities changed from low to moderate risk levels for the worst case (50-year probabilities) for future climate scenarios. These communities included: Whale Cove, Rankin Inlet (Char), and Hall Beach. Resolute was at low risk of water scarcity for future scenarios.

Based on this desktop analysis, it is recommended that efforts are focused on mitigation of risks of high, medium, and moderate source water sites, in sequential order. This may entail siting alternate back-up source water supplies in some communities where the risk is particularly high. Overall, this assessment has provided a high-level desktop methodology for ranking risk in multiple communities to identify potential scarcity problems with consideration for changing climate and demographics. This type of planning tool will be useful for managers of territorial drinking water infrastructure and may be translatable to other northern Canadian jurisdictions.

5. Recommendations

Based on the findings from this desktop study the following items are recommended:

- Infrastructure managers should consult the risk ranking scheme developed in this study to help make science-based decisions in regards to where to prioritize allocation of resources in hamlets where it is most needed to reduce overall risk of water scarcity.
- Communities that would be good candidates for immediate or near-term (e.g., within the next 5 to 10 years) allocation of resources to develop alternate sources or emergency water supplies are as follows in order of highest priority:
  - Clyde River, Cambridge Bay, Rankin Inlet (Nipissar), Igloolik, Cape Dorset, and Taloyoak.
- Communities that would be good candidates for subsequent allocation of resources to develop alternate or emergency water supplies are as follows in order of priority:
  - Grise Fiord and Gjoa Haven.
- Arctic Bay and Resolute should be monitored only to confirm that the anticipated increase in precipitation is an actuality to prevent the possibility of a water stress year.

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Appendix A:

Population Projections (2014 – 2035)

Table A - 1 Population projections for Nunavut communities (2014-2024) (Government of Nunavut, 2014).

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Arctic Bay	875	885	895	904	913	922	930	938	947	956	966
Arviat	2,611	2,671	2,737	2,804	2,870	2,937	3,006	3,075	3,143	3,210	3,275
Baker Lake	2,164	2,194	2,229	2,264	2,299	2,333	2,369	2,404	2,435	2,468	2,499
Cambridge Bay	1,684	1,700	1,718	1,737	1,757	1,778	1,799	1,819	1,835	1,853	1,869
Cape Dorset	1,508	1,530	1,555	1,578	1,600	1,622	1,643	1,663	1,682	1,700	1,717
Chesterfield Inlet	387	392	398	402	407	413	418	423	428	433	438
Clyde River	1,039	1,058	1,077	1,095	1,114	1,131	1,149	1,165	1,181	1,196	1,213
Coral Harbour	961	979	998	1,016	1,034	1,053	1,073	1,093	1,112	1,131	1,150
Gjoa Haven	1,370	1,385	1,404	1,422	1,441	1,460	1,477	1,494	1,512	1,530	1,547
Grise Fiord	163	163	164	165	166	167	168	169	171	171	172
Hall Beach	895	913	936	958	980	1,003	1,025	1,044	1,063	1,084	1,103
Igloolik	2,007	2,039	2,075	2,110	2,145	2,179	2,214	2,248	2,282	2,314	2,346
Iqaluit	7,542	7,614	7,697	7,785	7,881	7,980	8,090	8,205	8,318	8,427	8,524
Kimmirut	481	485	489	495	500	506	510	514	518	521	525
Kugaaruk	953	965	979	992	1,006	1,020	1,033	1,046	1,060	1,073	1,085
Kugluktuk	1,591	1,606	1,623	1,638	1,652	1,666	1,677	1,689	1,700	1,712	1,723
Naujaat	1,068	1,091	1,118	1,144	1,170	1,195	1,220	1,244	1,272	1,302	1,334
Pangnirtung	1,613	1,638	1,664	1,691	1,718	1,744	1,768	1,789	1,810	1,829	1,847
Pond Inlet	1,673	1,698	1,727	1,756	1,784	1,809	1,835	1,862	1,891	1,919	1,946
Qikiqtarjuaq	526	530	535	539	544	549	555	560	564	568	572
Rankin Inlet	2,820	2,864	2,908	2,953	2,998	3,046	3,093	3,139	3,185	3,228	3,274
Resolute	247	250	254	257	260	262	265	267	268	269	270
Sanikiluaq	924	942	962	980	999	1,016	1,032	1,049	1,065	1,082	1,098
Taloyoak	998	1,014	1,030	1,045	1,059	1,072	1,086	1,100	1,114	1,126	1,140
Whale Cove	456	461	468	474	481	488	494	502	509	515	522

Table A - 2 Population projections for Nunavut communities (2025-2035) (Government of Nunavut, 2014).

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Arctic Bay	976	989	1,001	1,018	1,030	1,042	1,055	1,068	1,081	1,094	1,106
Arviat	3,340	3,405	3,467	3,528	3,590	3,652	3,715	3,780	3,845	3,912	3,980
Baker Lake	2,532	2,565	2,597	2,632	2,667	2,700	2,736	2,767	2,800	2,829	2,861
Cambridge Bay	1,883	1,895	1,906	1,917	1,927	1,937	1,946	1,954	1,961	1,967	1,971
Cape Dorset	1,735	1,752	1,768	1,785	1,802	1,819	1,838	1,855	1,874	1,893	1,909
Chesterfield Inlet	442	447	452	460	465	471	477	483	489	495	501
Clyde River	1,230	1,247	1,263	1,286	1,302	1,317	1,332	1,345	1,360	1,377	1,392
Coral Harbour	1,174	1,197	1,220	1,247	1,274	1,300	1,326	1,353	1,379	1,405	1,429
Gjoa Haven	1,563	1,578	1,592	1,608	1,625	1,643	1,661	1,679	1,698	1,716	1,735
Grise Fiord	173	173	173	173	173	172	171	170	169	167	166
Hall Beach	1,122	1,140	1,157	1,181	1,197	1,215	1,233	1,251	1,269	1,290	1,311
Igloolik	2,377	2,409	2,441	2,477	2,511	2,545	2,580	2,616	2,651	2,686	2,721
Iqaluit	8,615	8,694	8,767	8,859	8,925	8,993	9,062	9,132	9,202	9,265	9,329
Kimmirut	528	531	534	538	540	541	543	544	545	548	550
Kugaaruk	1,099	1,111	1,124	1,136	1,149	1,163	1,177	1,191	1,204	1,218	1,233
Kugluktuk	1,733	1,743	1,753	1,764	1,774	1,787	1,797	1,809	1,820	1,829	1,838
Naujaat	1,364	1,396	1,430	1,470	1,507	1,544	1,581	1,620	1,658	1,696	1,736
Pangnirtung	1,866	1,885	1,906	1,934	1,953	1,973	1,992	2,012	2,034	2,055	2,075
Pond Inlet	1,976	2,006	2,038	2,079	2,110	2,144	2,179	2,213	2,245	2,276	2,307
Qikiqtarjuaq	575	578	580	585	586	586	586	585	585	584	583
Rankin Inlet	3,318	3,365	3,411	3,470	3,520	3,566	3,615	3,664	3,710	3,754	3,794
Resolute	271	272	274	275	276	277	277	277	277	278	278
Sanikiluaq	1,114	1,130	1,147	1,169	1,186	1,203	1,218	1,235	1,253	1,270	1,288
Taloyoak	1,155	1,171	1,187	1,203	1,220	1,238	1,255	1,271	1,288	1,307	1,323
Whale Cove	529	538	546	555	563	571	578	585	592	600	606

Appendix B:

Watershed Areas

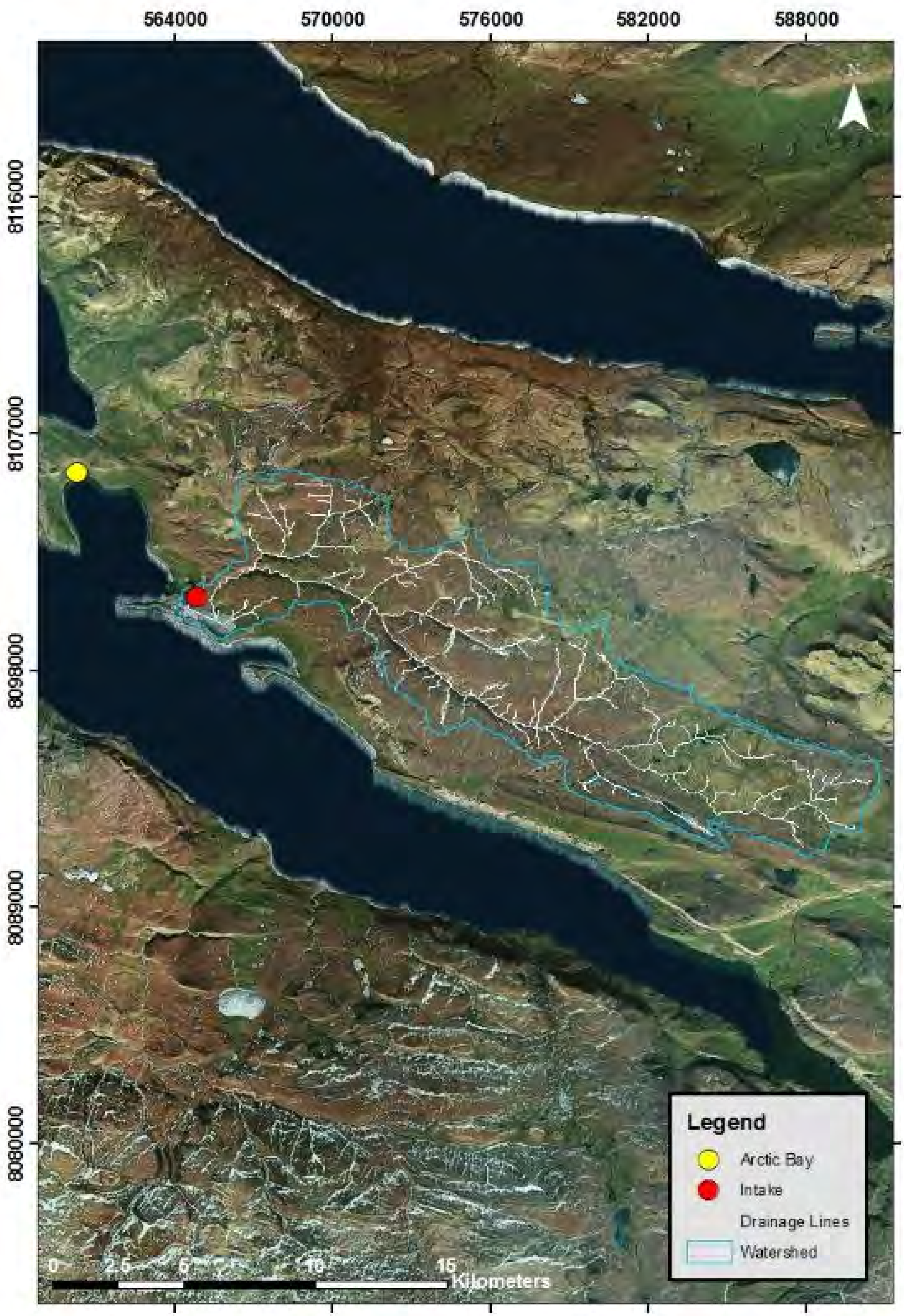

Figure B - 1 Arctic Bay located at 73°02'11"N, 085°09'09"W has a lake source water with a total watershed area of 132 km^2.

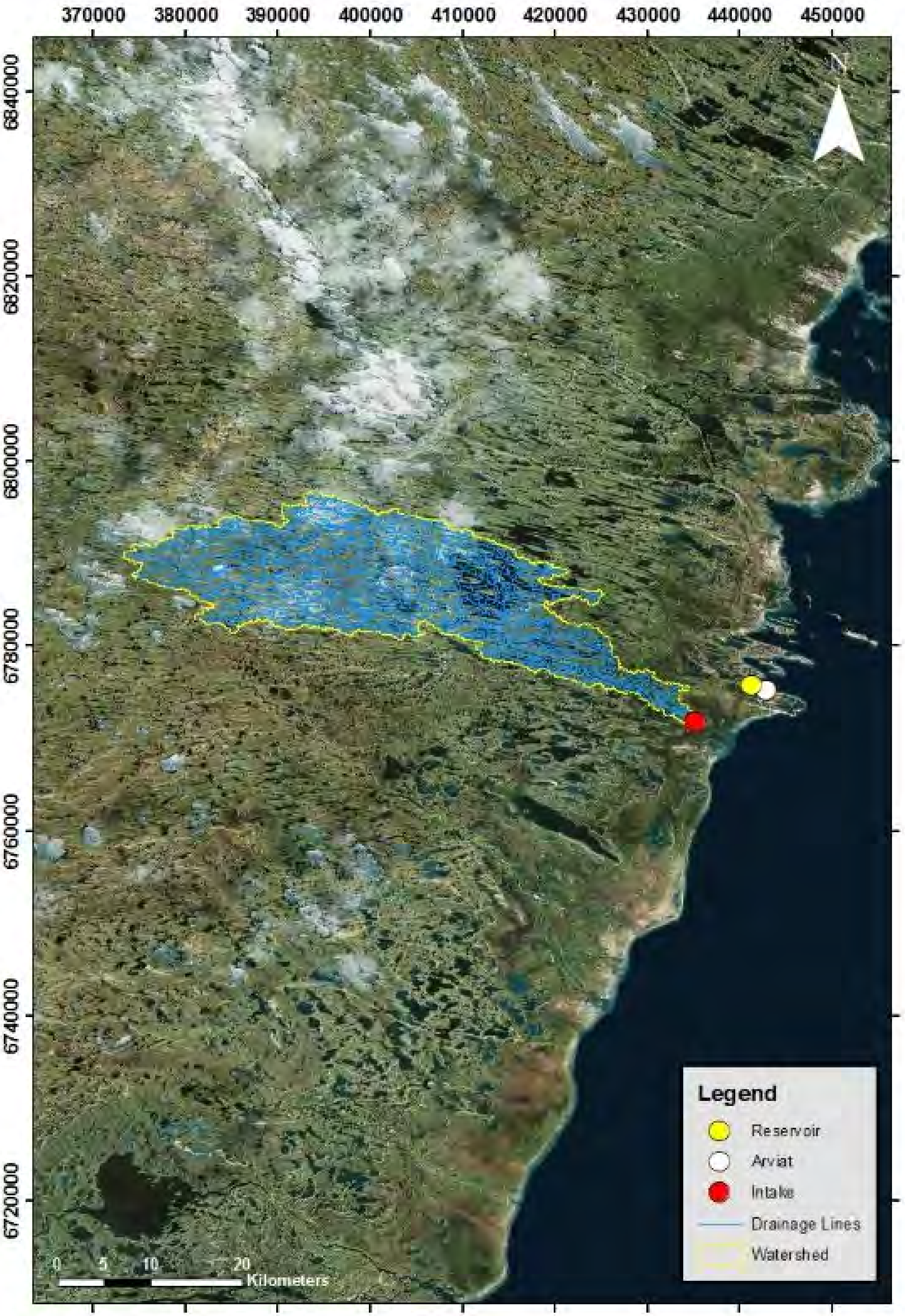

Figure B - 2 Arviat located at 61°06'29"N, 094°03'25"W has a river source water with a total watershed area of 582 km².

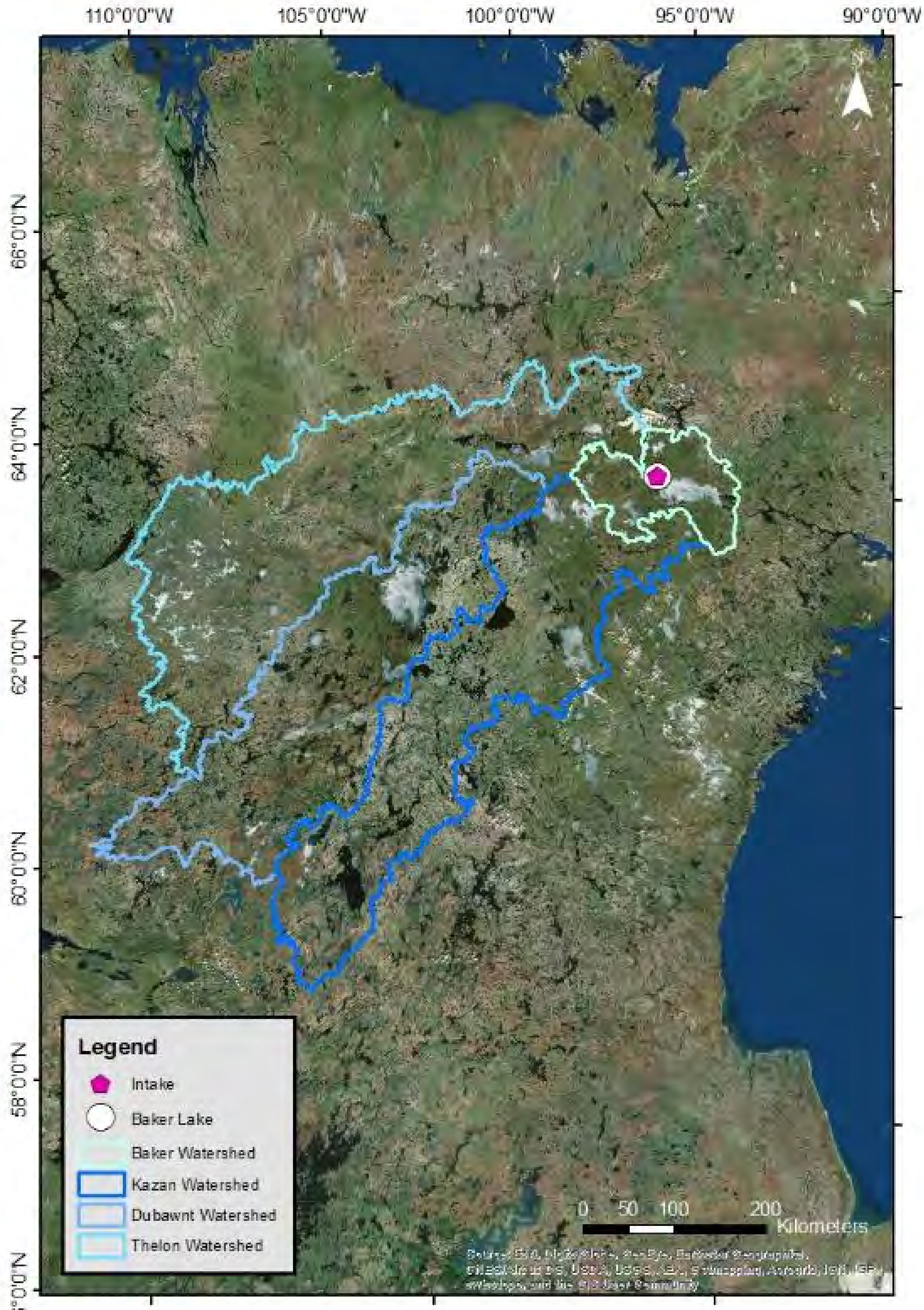

Figure B - 3 Baker Lake located at 64°19'05"N, 096°01'03"W has a lake source water with a total watershed area of 240,000 km².

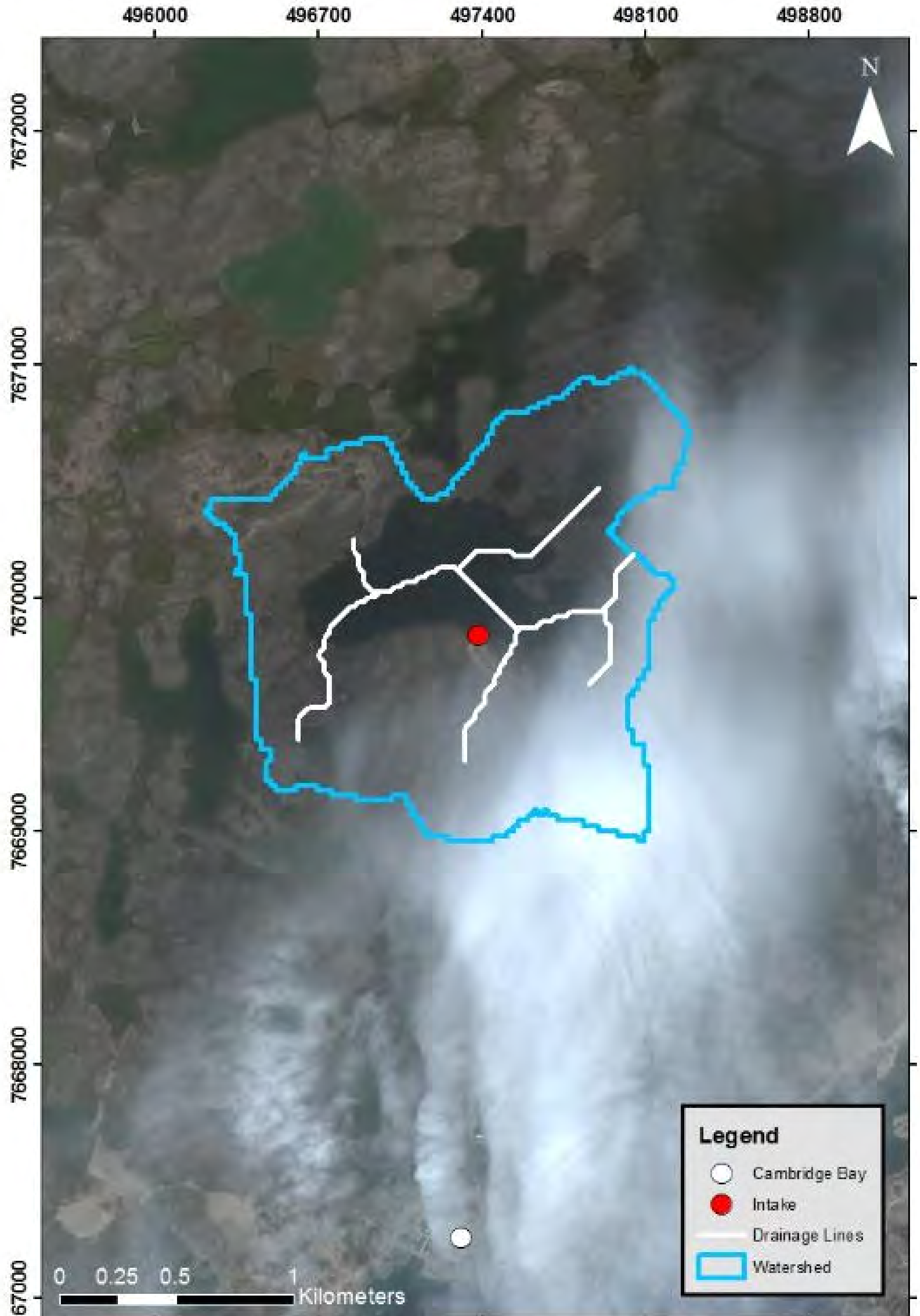

Figure B - 4 Cambridge Bay located at 69°07'02"N, 105°03'11"W has a lake source water with a total watershed area of 2.78 km^2.

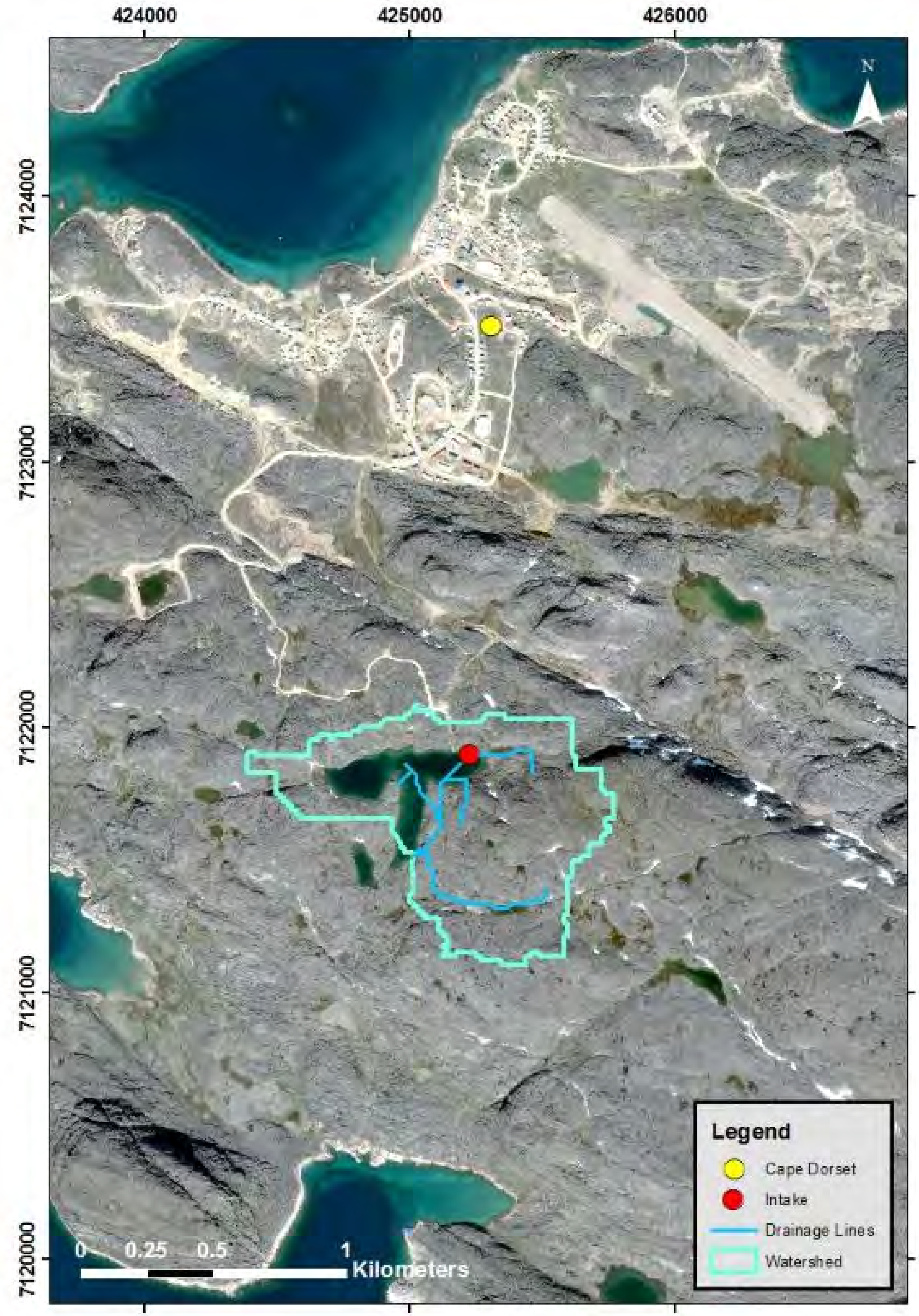

Figure B - 5 Cape Dorset located at 64°13’54”N, 076°32’25”W has a lake source water with a total watershed area of 0.73 km².

Figure B - 6 Chesterfield Inlet located at 63°20'27"N, 090°42'22"W has a lake source water with a total watershed area of 19.7 km².

Figure B - 7 Clyde River located at 70°28'26"N, 068°35'10"W has a lake source water with a total watershed area of 0.57 km^2.

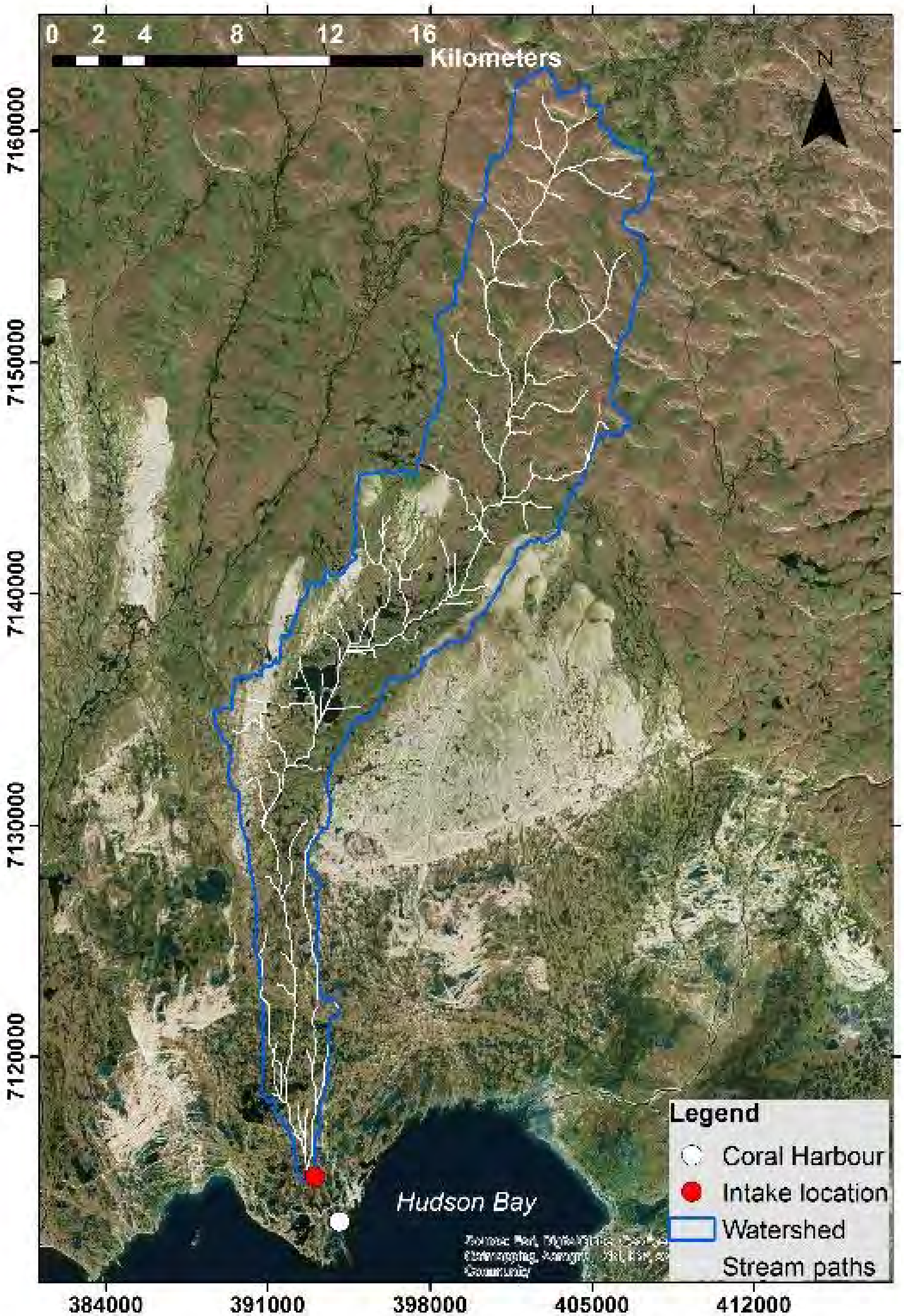

Figure B - 8 Coral Harbour located at 64°08’13”N, 083°09’51”W has a river source water with a total watershed area of 256 km^2.

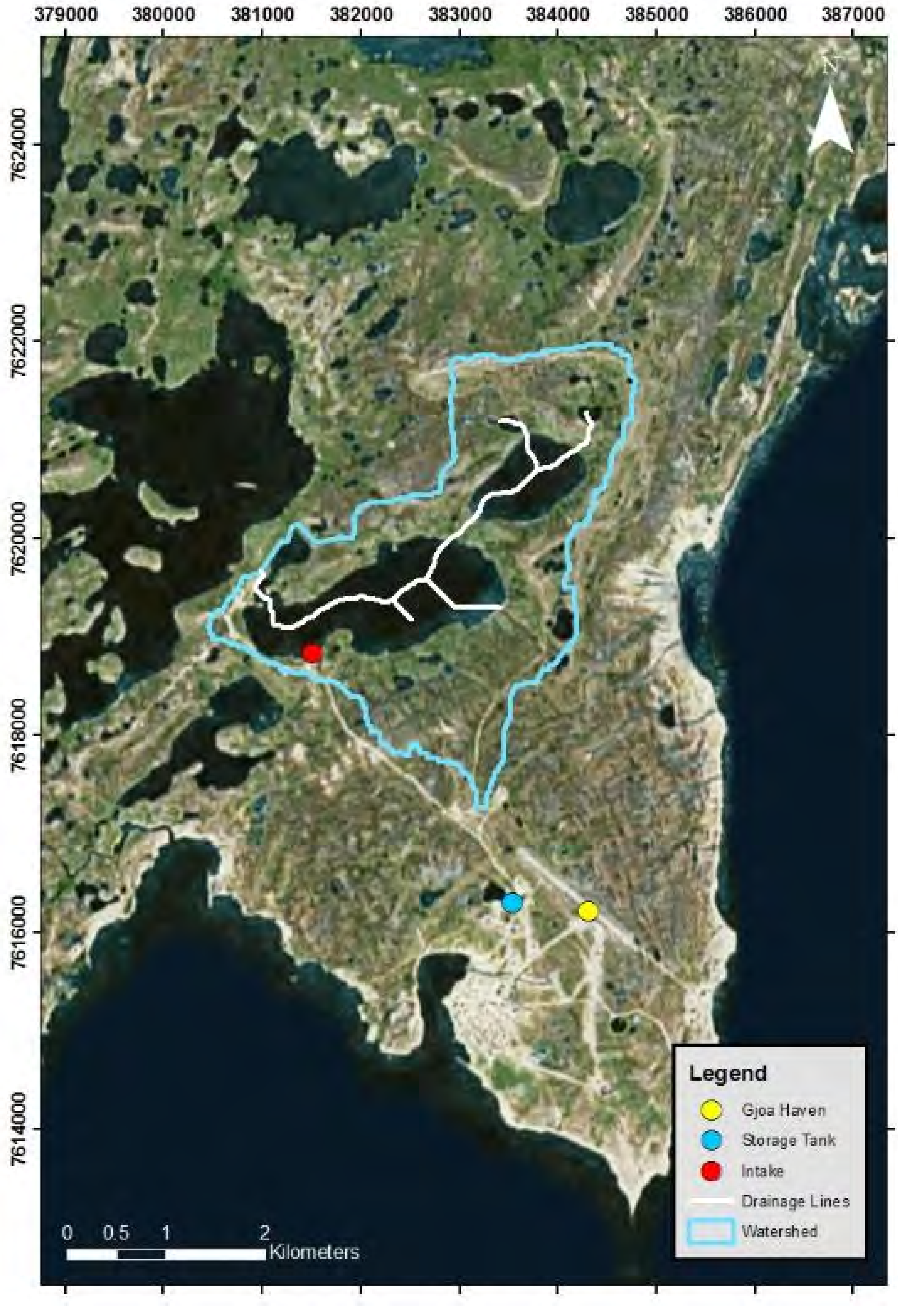

Figure B - 9 Gjoa Haven located at 68°37'33"N, 095°52'30"W has a lake source water with a total watershed area of 9.4 km².

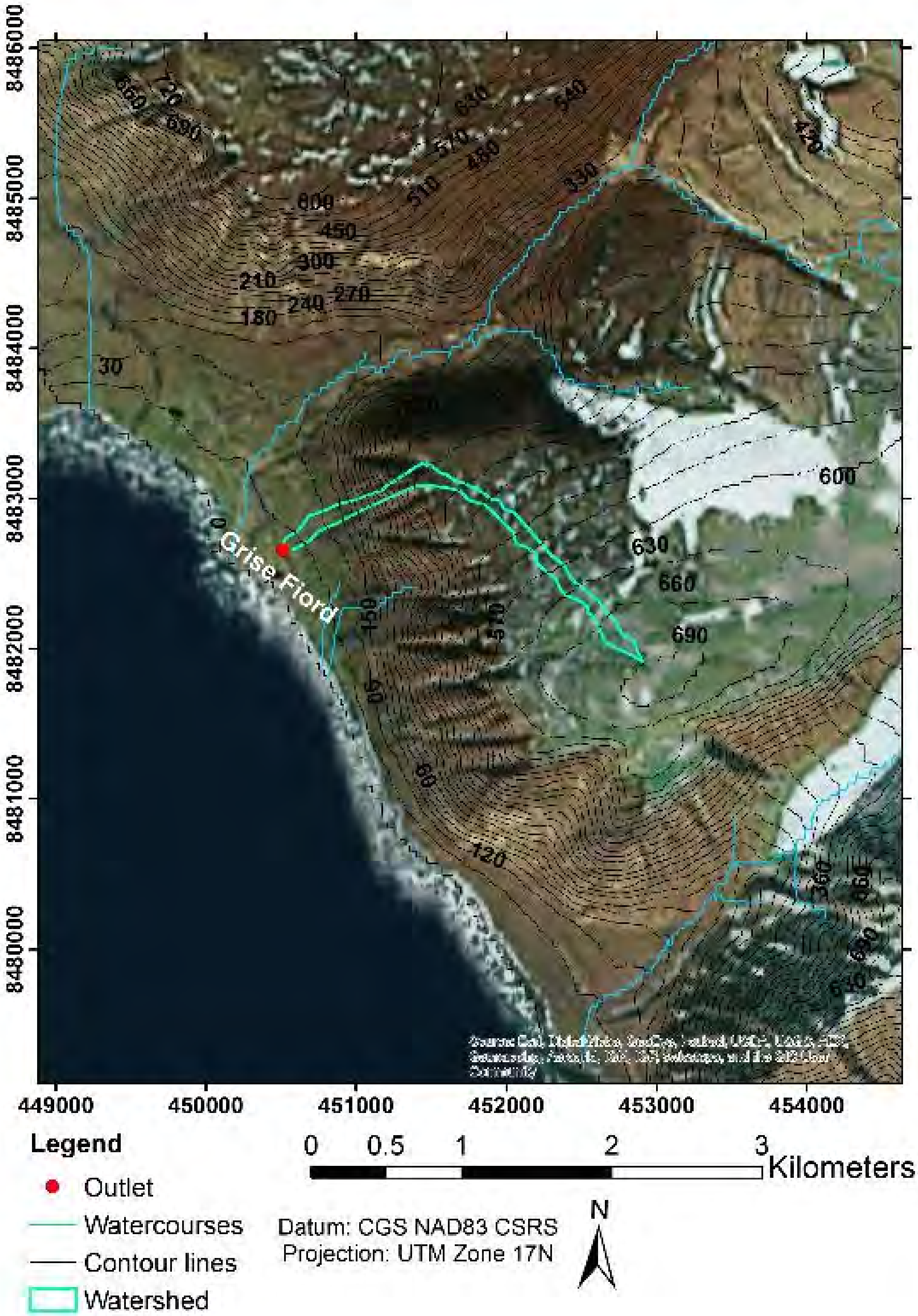

Figure B - 10 Grise Fiord located at 76°25’03”N, 082°53’38”W has a snowmelt runoff source water with a total watershed area of 0.27 km².

Figure B - 11 Hall Beach located at 68°46’38”N, 081°13’27”W has a lake source water with a total watershed area of 10.1 km².

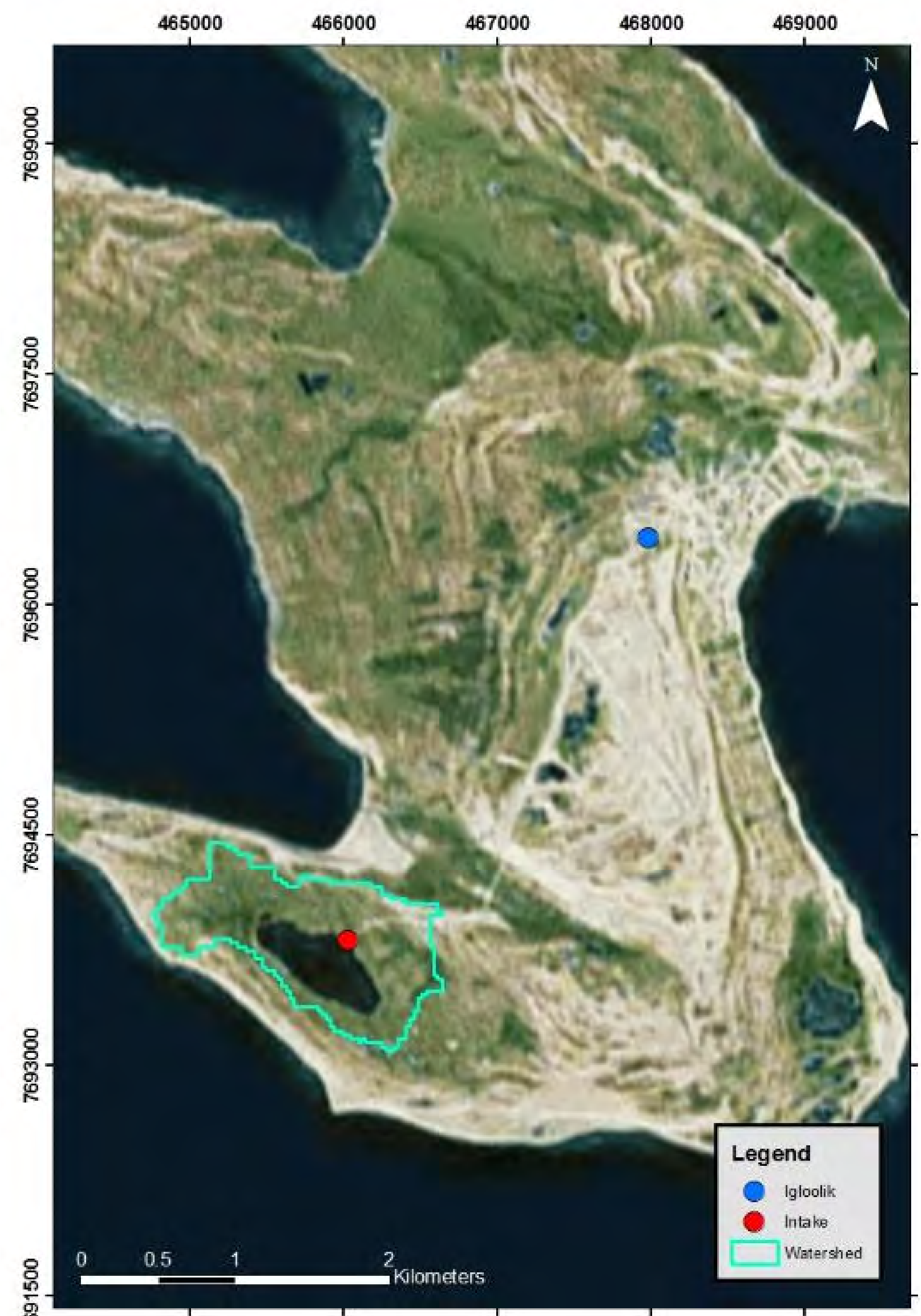

Figure B - 12 Igloolik located at 69°22'34"N, 081°47'58"W has a lake source water with a total watershed area of 1.3 km².

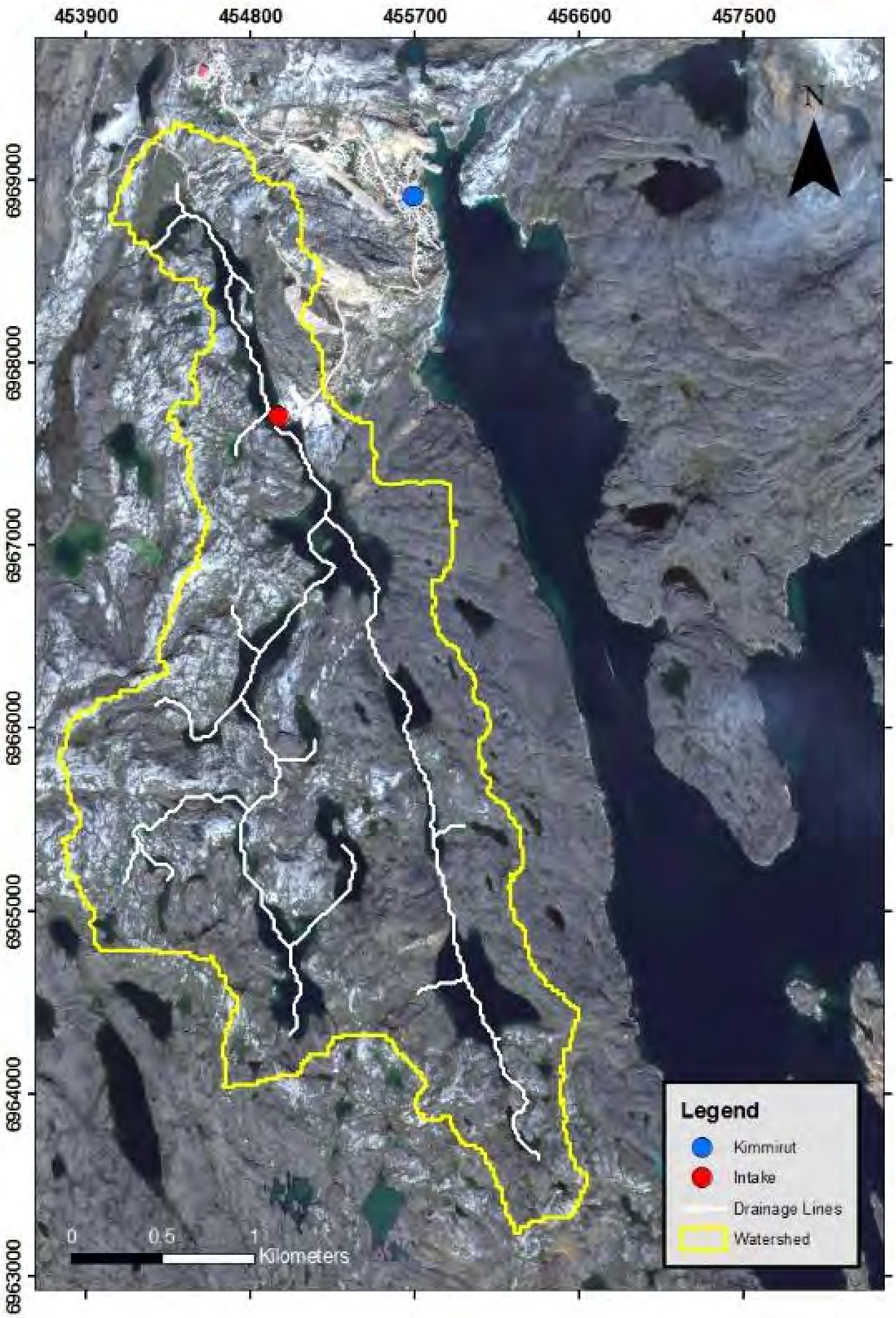

Figure B - 13 Kimmirut located at 62°50'48"N, 069°52'07"W has a lake source water with a total watershed area of 8.1 km^2.

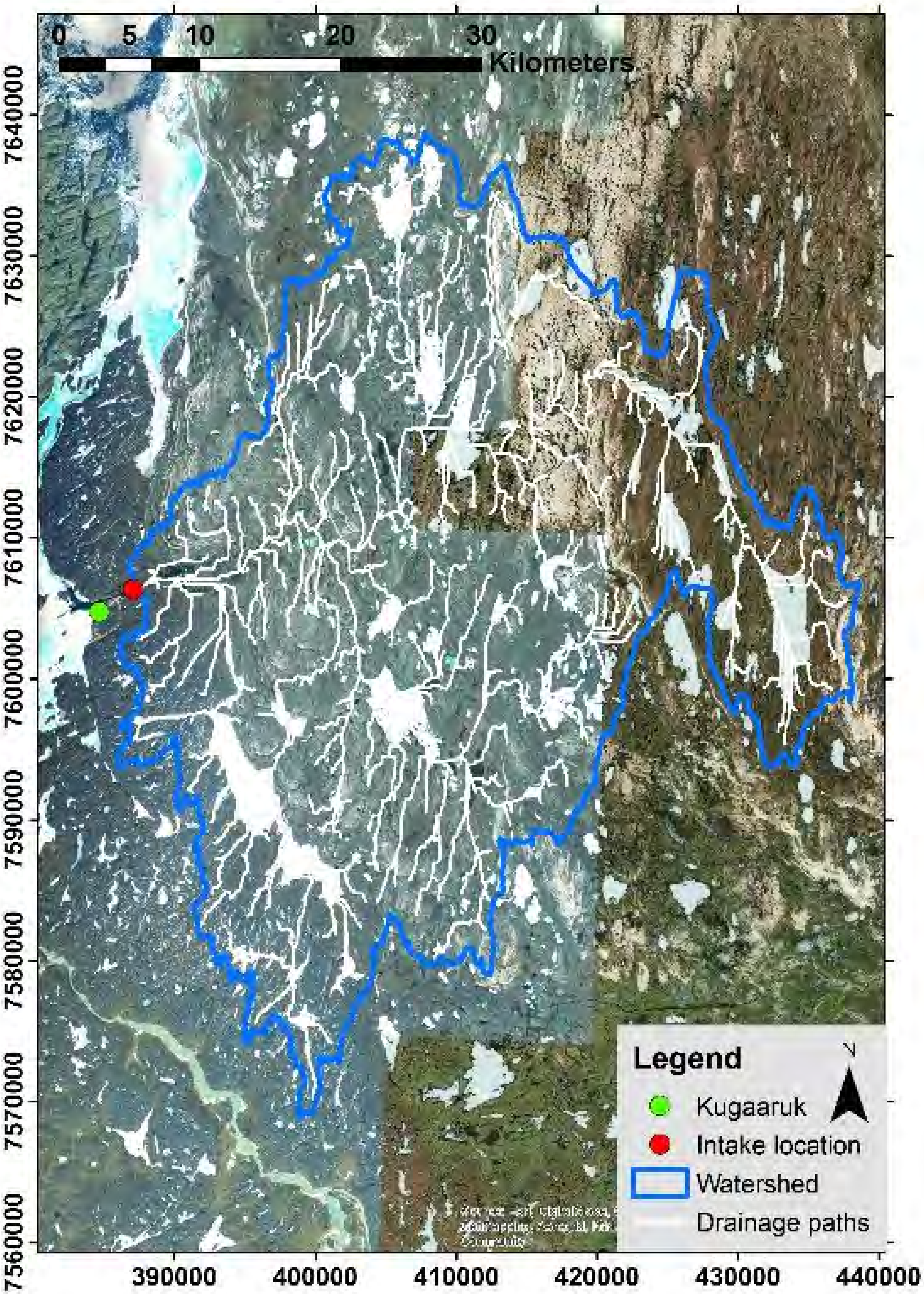

Figure B - 14 Kugaaruk located at 68°31’59”N, 089°49’36”W has a river source water with a total watershed area of 1,819 km².

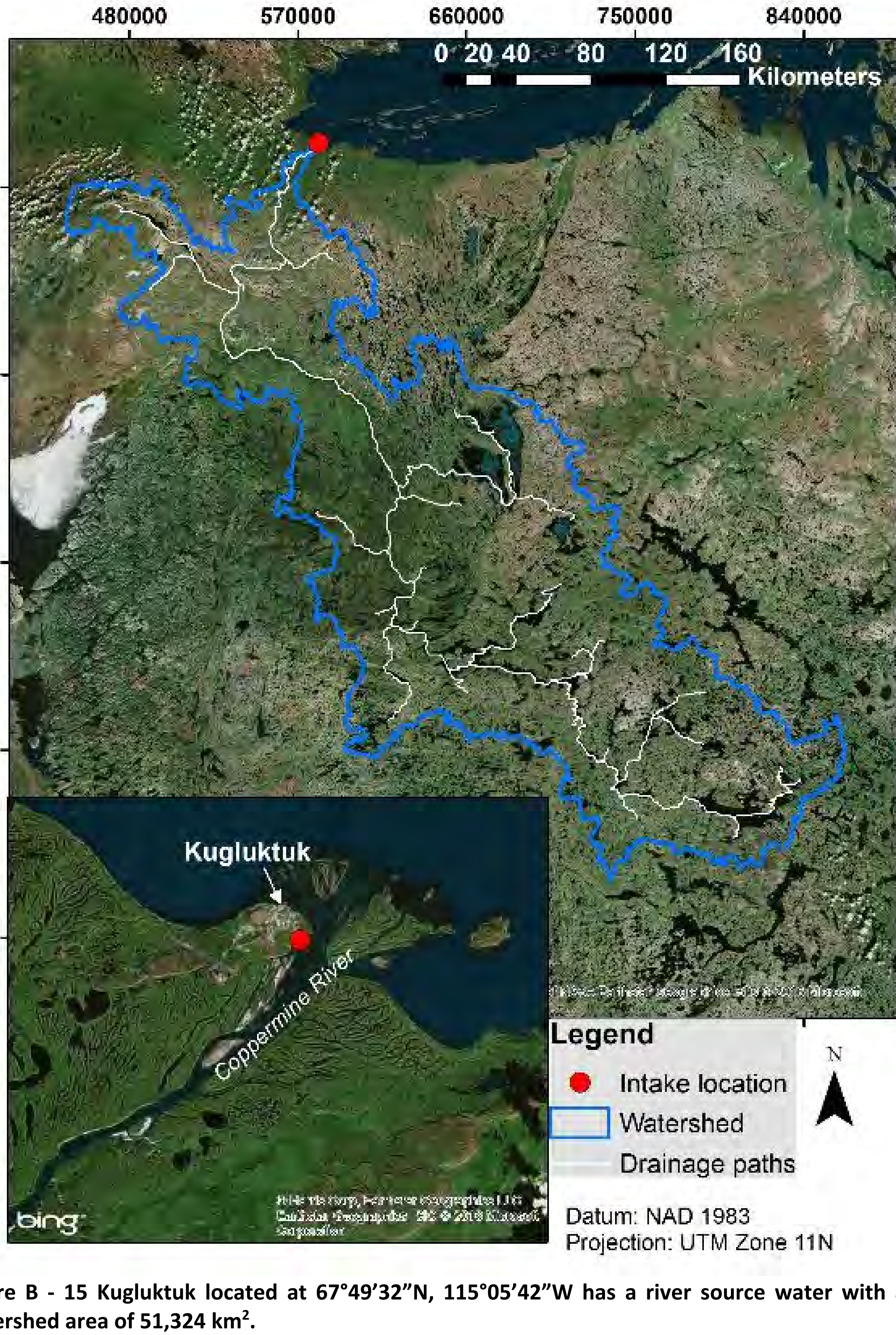

Figure B - 15 Kugluktuk located at 67°49’32”N, 115°05’42”W has a river source water with a total watershed area of 51,324 km^2.

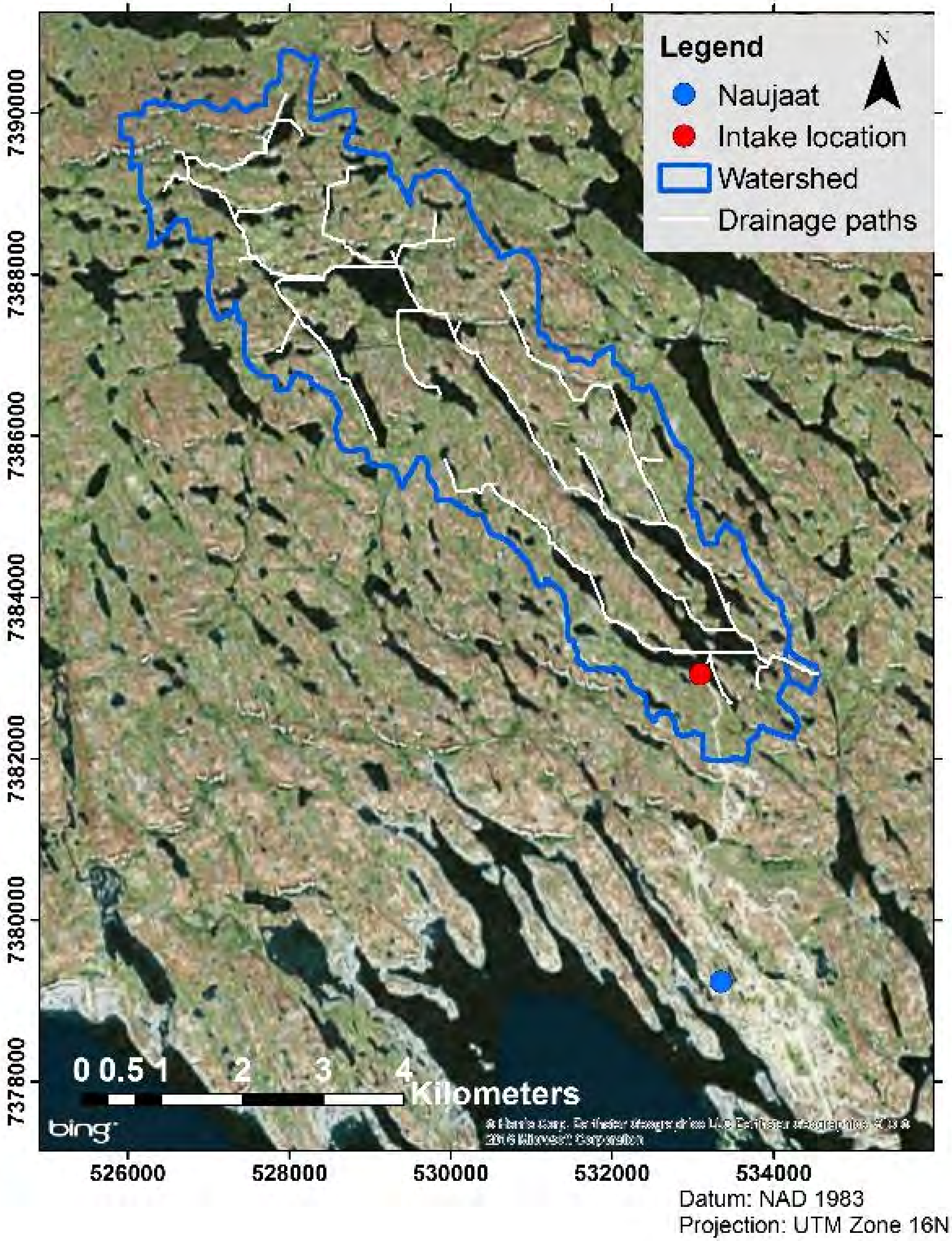

Figure B - 16 Naujaat located at 66°31'19"N, 086°14'06"W has a lake source water with a total watershed area of 25.9 km^2.

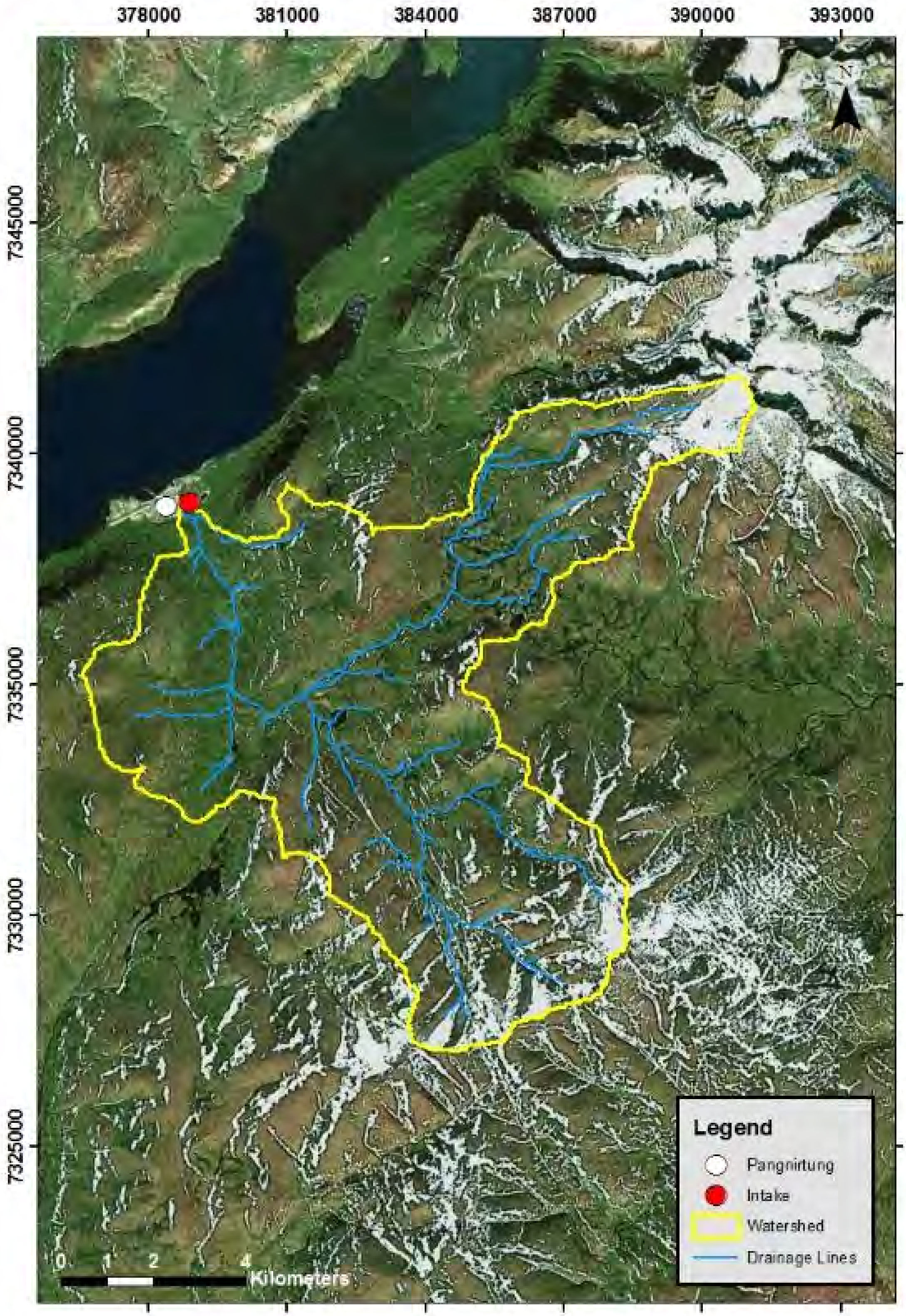

Figure B - 17 Pangnirtung located at 66°08'52"N, 065°41'58"W has a river source water with a total watershed area of 92.7 km².

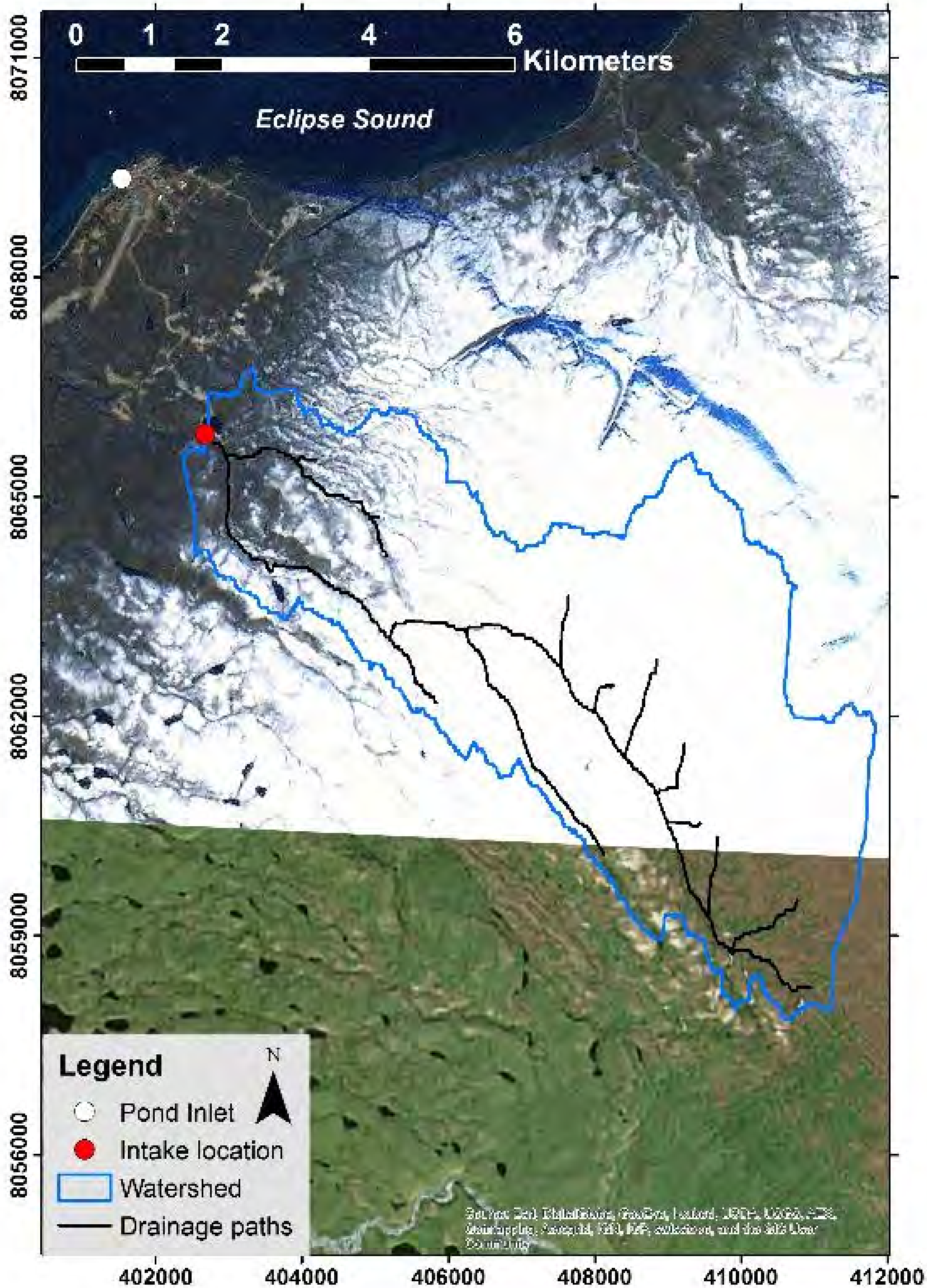

Figure B - 18 Pond Inlet located at 72°41'57"N, 077°57'33"W has a river source water with a total watershed area of 37.4 km².

Figure B - 19 Qikiqtarjuaq located at 67°33'29"N, 064°01'29"W has a river source water with a total watershed area of 24 km².

Figure B - 20 Rankin Inlet located at 62°48'35"N, 092°05'58"W has both lake and river sources with total watershed areas of 67.6 km^2 (Char) and 2.7 km^2 (Nipissar).

Figure B - 21 Resolute Bay located at 74°41’51”N, 094°49’56”W has a lake source water with a total watershed area of 4.1 km².

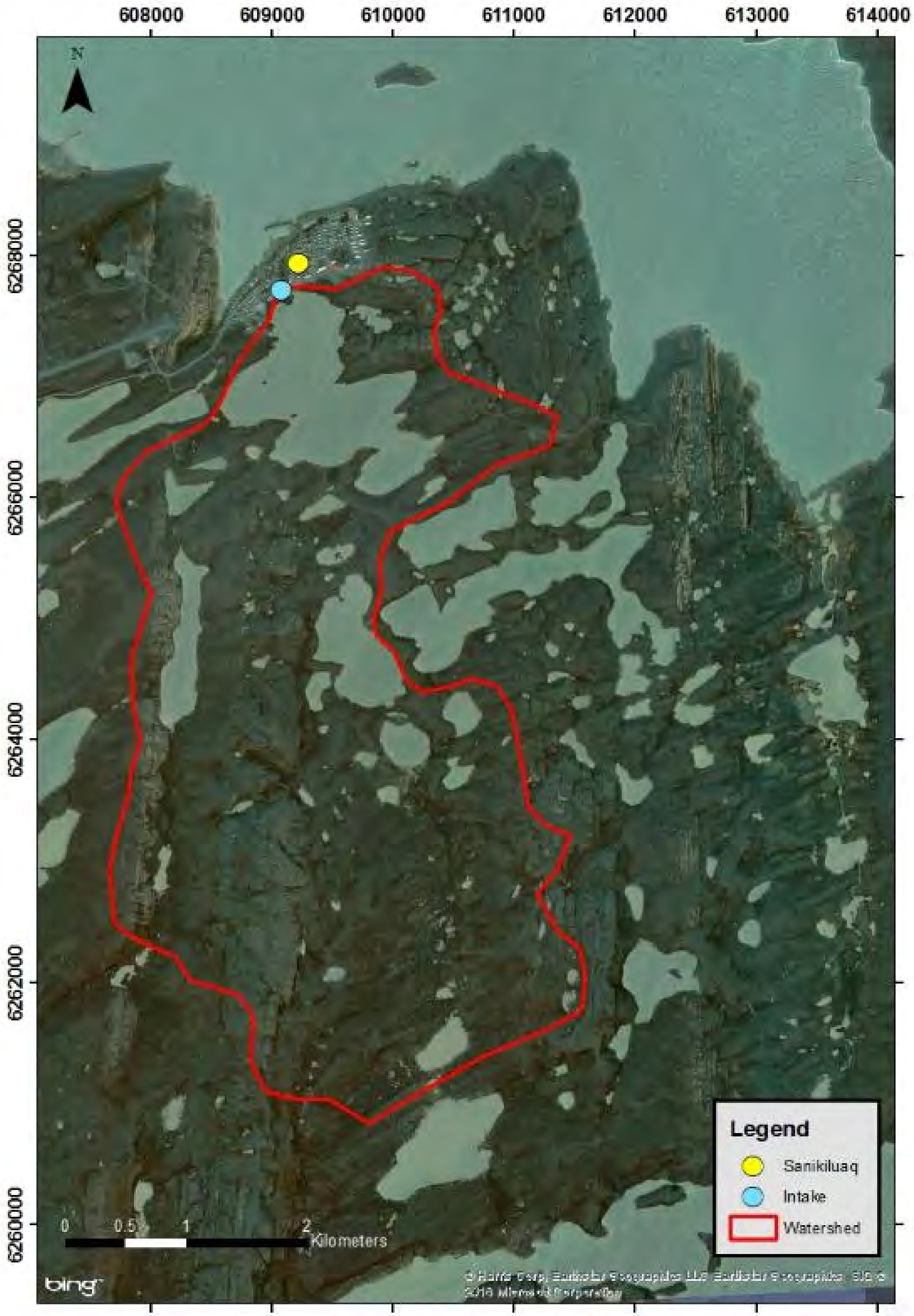

Figure B - 22 Sanikiluaq located at 56°32'34"N, 079°13'30"W has a lake source water with a total watershed area of 17.8 km².

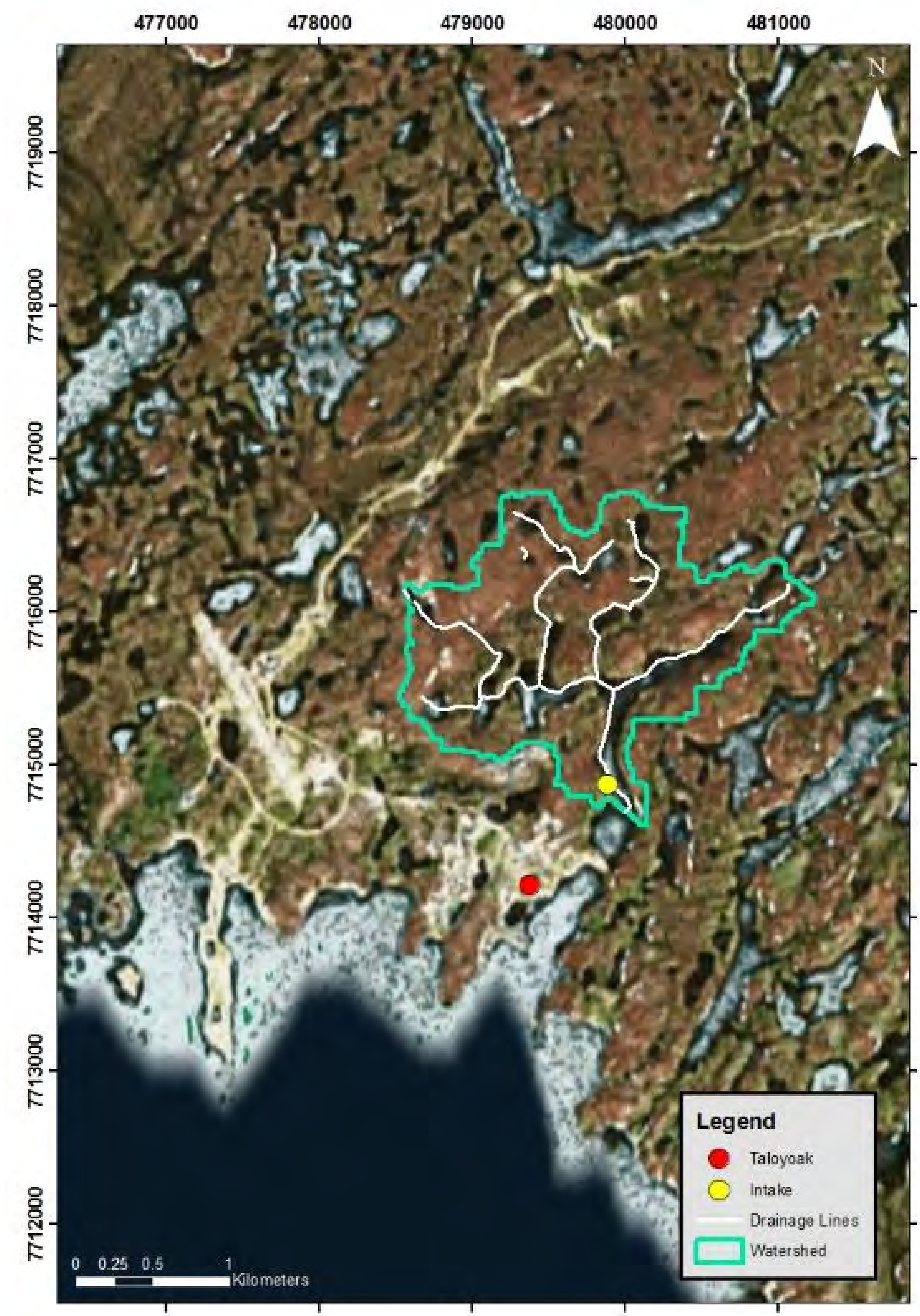

Figure B - 23 Taloyoak located at 69°32'13"N, 093°31'36"W has a lake source water with a total watershed area of 3.3 km².

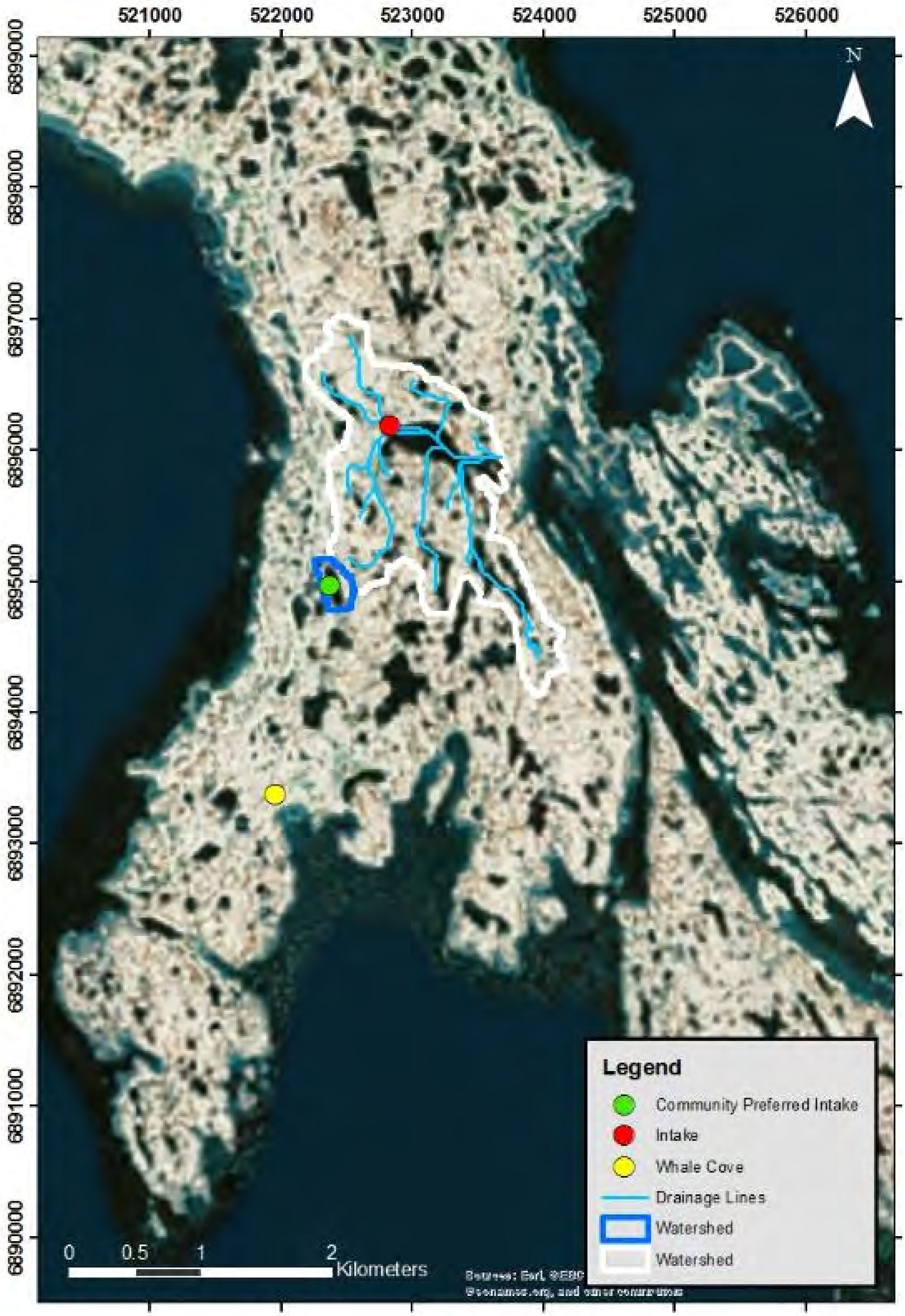

Figure B - 24 Whale cove located at 62°10’22”N, 092°34’46”W has two lake source water locations with total watershed areas of 0.08km² (Preferred) and 2.3 km² (Main) .

Appendix C:

Median Water Availability Tables

Table C - 1 Arctic Bay.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	114	61	7.0E+03	7.0E+03	0.5	1.1
	CCSM4	185	58	1.7E+04	1.7E+04	0.2	0.5
	CNRM-CM5	185	58	1.6E+04	1.6E+04	0.2	0.5
	CSIRO	179	57	1.6E+04	1.6E+04	0.2	0.5
	MRI	179	62	2.2E+04	2.2E+04	0.2	0.6
2016-2040	CCSM4	218	71	2.0E+04	2.0E+04	0.2	0.6
	CNRM-CM5	191	58	1.7E+04	1.7E+04	0.2	0.5
	CSIRO	205	60	1.9E+04	1.9E+04	0.2	0.6
	MRI	184	59	1.7E+04	1.7E+04	0.3	0.7
2041-2070	CCSM4	249	73	2.3E+04	2.3E+04	0.2	0.5
	CNRM-CM5	226	60	1.7E+04	1.7E+04	0.3	0.7
	CSIRO	215	71	1.9E+04	1.9E+04	0.3	0.6
	MRI	213	60	2.0E+04	2.0E+04	0.2	0.6

[a]Trucked water use was estimated to be 32 ML in 2015; 46 ML in 2040; and 49 ML in 2070.
[b]Piped water use was estimated to be 80 ML in 2015; 115 ML in 2040; and 122 ML in 2070.

Table C - 2 Arviat.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	277	76	1.2E+05	1.2E+05	0.1	0.2
	CCSM4	310	88	1.3E+05	1.3E+05	0.1	0.2
	CNRM-CM5	302	82	1.3E+05	1.3E+05	0.1	0.2
	CSIRO	300	81	1.3E+05	1.3E+05	0.1	0.2
	MRI	302	81	1.3E+05	1.3E+05	0.1	0.2
2016-2040	CCSM4	327	93	1.4E+05	1.4E+05	0.2	0.5
	CNRM-CM5	309	85	1.3E+05	1.3E+05	0.2	0.5
	CSIRO	315	84	1.3E+05	1.3E+05	0.2	0.5
	MRI	308	79	1.3E+05	1.3E+05	0.2	0.5
2041-2070	CCSM4	312	93	1.3E+05	1.3E+05	0.5	1.1
	CNRM-CM5	334	93	1.4E+05	1.4E+05	0.4	1.0
	CSIRO	362	85	1.6E+05	1.6E+05	0.4	0.9
	MRI	344	87	1.5E+05	1.5E+05	0.4	1.0

[a]Trucked water use was estimated to be 114 ML in 2015; 252 ML in 2040; and 579 ML in 2070.
[b]Piped water use was estimated to be 286 ML in 2015; 631 ML in 2040; and 1447 ML in 2070.

Table C - 3 Baker Lake.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	241	71	4.1E+07	4.1E+07	0.0	0.0
	CCSM4	262	81	4.4E+07	4.4E+07	0.0	0.0
	CNRM-CM5	271	77	4.6E+07	4.6E+07	0.0	0.0
	CSIRO	270	82	4.5E+07	4.5E+07	0.0	0.0
	MRI	274	73	4.8E+07	4.8E+07	0.0	0.0
2016-2040	CCSM4	311	89	5.3E+07	5.3E+07	0.0	0.0
	CNRM-CM5	274	83	4.6E+07	4.6E+07	0.0	0.0
	CSIRO	293	85	5.0E+07	5.0E+07	0.0	0.0
	MRI	288	74	5.1E+07	5.1E+07	0.0	0.0
2041-2070	CCSM4	301	89	5.1E+07	5.1E+07	0.0	0.0
	CNRM-CM5	303	87	5.2E+07	5.2E+07	0.0	0.0
	CSIRO	301	84	5.2E+07	5.2E+07	0.0	0.0
	MRI	253	76	4.2E+07	4.2E+07	0.0	0.0

[a]Trucked water use was estimated to be 88 ML in 2015; 161 ML in 2040; and 271 ML in 2070.
[b]Piped water use was estimated to be 220 ML in 2015; 403 ML in 2040; and 677 ML in 2070.

Table C - 4 Cambridge Bay.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	136	64	1.3E+02	2.0E+01	36	90
	CCSM4	180	65	2.5E+02	1.4E+02	22	56
	CNRM-CM5	174	65	2.3E+02	1.2E+02	24	59
	CSIRO	180	66	2.5E+02	1.4E+02	23	57
	MRI	178	64	2.4E+02	1.4E+02	23	57
2016-2040	CCSM4	206	75	2.7E+02	1.2E+02	27	67
	CNRM-CM5	199	67	2.7E+02	1.2E+02	27	67
	CSIRO	195	72	2.4E+02	9.5E+01	29	72
	MRI	184	66	2.3E+02	8.5E+01	30	74
2041-2070	CCSM4	230	78	2.9E+02	9.7E+01	31	77
	CNRM-CM5	188	69	2.0E+02	6.2E+00	39	98
	CSIRO	216	73	2.7E+02	7.3E+01	33	82
	MRI	194	67	2.2E+02	2.9E+01	37	92

[a]Trucked water use was estimated to be 72 ML in 2015; 98 ML in 2040; and 130 ML in 2070.
[b]Piped water use was estimated to be 181 ML in 2015; 246 ML in 2040; and 325 ML in 2070.

Table C - 5 Cape Dorset.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	372	64	1.7E+02	7.8E+01	26	65
	CCSM4	340	71	1.4E+02	4.9E+01	30	75
	CNRM-CM5	339	67	1.4E+02	5.1E+01	30	74
	CSIRO	343	71	1.4E+02	5.1E+01	30	74
	MRI	343	66	1.4E+02	5.5E+01	29	73
2016-2040	CCSM4	377	77	1.2E+02	-2.4E+01	44	111
	CNRM-CM5	400	70	1.4E+02	-2.0E+00	40	101
	CSIRO	377	76	1.2E+02	-2.3E+01	44	110
	MRI	364	66	1.2E+02	-2.6E+01	45	112
2041-2070	CCSM4	395	79	7.9E+01	-1.5E+02	65	164
	CNRM-CM5	429	70	1.1E+02	-1.2E+02	58	144
	CSIRO	401	75	8.7E+01	-1.4E+02	63	158
	MRI	375	68	7.3E+01	-1.5E+02	67	168

[a]Trucked water use was estimated to be 59 ML in 2015; 97 ML in 2040; and 151 ML in 2070.
[b]Piped water use was estimated to be 147 ML in 2015; 243 ML in 2040; and 376 ML in 2070.

Table C - 6 Chesterfield Inlet.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	245	71	3.4E+03	3.4E+03	0.3	0.8
	CCSM4	281	83	3.9E+03	3.9E+03	0.3	0.7
	CNRM-CM5	286	72	4.2E+03	4.2E+03	0.3	0.7
	CSIRO	284	81	4.0E+03	4.0E+03	0.3	0.7
	MRI	280	72	4.1E+03	4.1E+03	0.3	0.7
2016-2040	CCSM4	296	88	4.1E+03	4.0E+03	0.5	1.2
	CNRM-CM5	309	75	4.6E+03	4.6E+03	0.4	1.1
	CSIRO	316	85	4.5E+03	4.5E+03	0.4	1.1
	MRI	277	73	4.0E+03	4.0E+03	0.5	1.2
2041-2070	CCSM4	296	88	4.1E+03	4.0E+03	0.8	1.9
	CNRM-CM5	330	80	4.9E+03	4.8E+03	0.6	1.6
	CSIRO	327	87	4.7E+03	4.6E+03	0.7	1.6
	MRI	302	76	4.4E+03	4.4E+03	0.7	1.7

[a]Trucked water use was estimated to be 11 ML in 2015; 20 ML in 2040; and 31 ML in 2070.
[b]Piped water use was estimated to be 28 ML in 2015; 49 ML in 2040; and 78 ML in 2070.

Table C - 7 Clyde River.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	219	59	5.5E+01	-1.1E+00	40	101
	CCSM4	268	59	8.3E+01	2.7E+01	31	78
	CNRM-CM5	267	59	8.2E+01	2.6E+01	31	78
	CSIRO	255	59	7.5E+01	1.9E+01	33	83
	MRI	262	59	7.9E+01	2.4E+01	32	80
2016-2040	CCSM4	284	70	5.7E+01	-4.3E+01	54	135
	CNRM-CM5	281	60	6.0E+01	-4.0E+01	53	132
	CSIRO	259	68	4.3E+01	-5.7E+01	61	151
	MRI	283	59	6.2E+01	-3.8E+01	52	130
2041-2070	CCSM4	310	73	1.8E+01	-1.6E+02	87	218
	CNRM-CM5	300	61	1.9E+01	-1.6E+02	87	216
	CSIRO	301	70	1.4E+01	-1.6E+02	89	223
	MRI	333	60	3.8E+01	-1.4E+02	76	189

[a]Trucked water use was estimated to be 37 ML in 2015; 66 ML in 2040; and 118 ML in 2070.
[b]Piped water use was estimated to be 93 ML in 2015; 166 ML in 2040; and 296 ML in 2070.

Table C - 8 Coral Harbour.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	283	65	5.6E+04	5.6E+04	0.0	0.1
	CCSM4	295	76	5.6E+04	5.6E+04	0.0	0.1
	CNRM-CM5	289	69	5.6E+04	5.6E+04	0.0	0.1
	CSIRO	302	75	5.8E+04	5.8E+04	0.0	0.1
	MRI	304	68	6.0E+04	6.0E+04	0.0	0.1
2016-2040	CCSM4	320	83	6.0E+04	6.0E+04	0.1	0.2
	CNRM-CM5	331	73	6.6E+04	6.6E+04	0.1	0.2
	CSIRO	317	81	6.1E+04	6.1E+04	0.1	0.2
	MRI	329	70	6.6E+04	6.6E+04	0.1	0.2
2041-2070	CCSM4	337	86	6.4E+04	6.4E+04	0.2	0.4
	CNRM-CM5	382	77	7.8E+04	7.8E+04	0.2	0.3
	CSIRO	375	80	7.5E+04	7.5E+04	0.2	0.3
	MRI	354	71	7.2E+04	7.2E+04	0.2	0.3

[a]Trucked water use was estimated to be 27 ML in 2015; 81 ML in 2040; and 156 ML in 2070.
[b]Piped water use was estimated to be 68 ML in 2015; 131 ML in 2040; and 251 ML in 2070.

Table C - 9 Gjoa Haven.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	171	62	9.6E+02	8.8E+02	5.4	13
	CCSM4	167	62	9.3E+02	8.5E+02	5.5	14
	CNRM-CM5	171	63	9.6E+02	8.8E+02	5.4	13
	CSIRO	169	62	9.4E+02	8.6E+02	5.5	14
	MRI	167	63	9.3E+02	8.4E+02	5.5	14
2016-2040	CCSM4	219	73	1.3E+03	1.2E+03	6.3	12
	CNRM-CM5	170	66	8.9E+02	8.1E+02	8.8	17
	CSIRO	176	70	9.1E+02	8.3E+02	8.6	17
	MRI	160	64	8.2E+02	7.4E+02	9.5	18
2041-2070	CCSM4	212	75	1.1E+03	9.8E+02	10	23
	CNRM-CM5	190	68	1.0E+03	8.4E+02	12	26
	CSIRO	193	75	9.7E+02	8.1E+02	12	27
	MRI	172	65	8.7E+02	7.1E+02	13	29

[a]Trucked water use was estimated to be 54 ML in 2015; 86 ML in 2040; and 134 ML in 2070.
[b]Piped water use was estimated to be 136 ML in 2015; 166 ML in 2040; and 296 ML in 2070.

Table C - 10 Grise Fiord.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	154	35	2.8E+01	2.1E+01	14	34
	CCSM4	181	57	2.9E+01	2.3E+01	13	33
	CNRM-CM5	190	56	3.2E+01	2.6E+01	12	30
	CSIRO	179	56	2.9E+01	2.2E+01	13	33
	MRI	177	56	2.9E+01	2.2E+01	13	33
2016-2040	CCSM4	205	59	3.4E+01	2.5E+01	15	37
	CNRM-CM5	212	57	3.6E+01	2.8E+01	14	35
	CSIRO	203	58	3.4E+01	2.5E+01	15	37
	MRI	188	57	3.0E+01	2.1E+01	16	41
2041-2070	CCSM4	230	69	3.7E+01	2.7E+01	16	39
	CNRM-CM5	217	60	3.6E+01	2.6E+01	16	40
	CSIRO	227	68	3.6E+01	2.6E+01	16	40
	MRI	206	57	3.4E+01	2.3E+01	17	42

[a]Trucked water use was estimated to be 4 ML in 2015; 6 ML in 2040; and 7 ML in 2070.
[b]Piped water use was estimated to be 11 ML in 2015; 15 ML in 2040; and 17 ML in 2070.

Table C - 11 Hall Beach.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	206	60	1.5E+03	1.4E+03	1.4	3.4
	CCSM4	260	60	2.0E+03	2.0E+03	1.0	2.5
	CNRM-CM5	245	61	1.8E+03	1.8E+03	1.1	2.7
	CSIRO	253	62	1.9E+03	1.9E+03	1.0	2.6
	MRI	251	61	1.9E+03	1.9E+03	1.1	2.6
2016-2040	CCSM4	285	70	2.1E+03	2.0E+03	2.9	7.3
	CNRM-CM5	242	65	1.7E+03	1.6E+03	3.6	8.9
	CSIRO	291	69	2.2E+03	2.1E+03	2.8	7.1
	MRI	256	62	1.9E+03	1.8E+03	3.2	8.1
2041-2070	CCSM4	297	75	2.1E+03	1.9E+03	6.2	15
	CNRM-CM5	296	65	2.2E+03	2.0E+03	6.0	15
	CSIRO	323	70	2.4E+03	2.2E+03	5.4	14
	MRI	258	64	1.8E+03	1.6E+03	7.1	18

[a]Trucked water use was estimated to be 20 ML in 2015; 64 ML in 2040; and 139 ML in 2070.
[b]Piped water use was estimated to be 50 ML in 2015; 160 ML in 2040; and 348 ML in 2070.

Table C - 12 Igloolik.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	264	62	2.0E+02	1.0E+02	25	61
	CCSM4	260	60	1.9E+02	9.8E+01	25	62
	CNRM-CM5	245	61	1.7E+02	7.8E+01	27	67
	CSIRO	253	62	1.8E+02	8.8E+01	26	65
	MRI	251	61	1.8E+02	8.6E+01	26	65
2016-2040	CCSM4	285	70	1.3E+02	-1.1E+02	55	138
	CNRM-CM5	242	65	7.6E+01	-1.5E+02	67	167
	CSIRO	291	69	1.3E+02	-9.6E+01	53	133
	MRI	256	62	9.7E+01	-1.3E+02	61	153
2041-2070	CCSM4	297	75	1.5E+01	-3.9E+02	95	237
	CNRM-CM5	296	65	2.6E+01	-3.8E+02	91	228
	CSIRO	323	70	5.4E+01	-3.5E+02	83	209
	MRI	258	64	-2.2E+01	-4.3E+02	108	271

[a]Trucked water use was estimated to be 64 ML in 2015; 153 ML in 2040; and 272 ML in 2070.
[b]Piped water use was estimated to be 159 ML in 2015; 383 ML in 2040; and 681 ML in 2070.

Table C - 13 Kimmirut.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	391	69	2.6E+03	2.6E+03	0.6	1.6
	CCSM4	437	74	2.9E+03	2.9E+03	0.6	1.4
	CNRM-CM5	422	68	2.9E+03	2.8E+03	0.6	1.4
	CSIRO	419	74	2.8E+03	2.8E+03	0.6	1.5
	MRI	435	68	3.0E+03	2.9E+03	0.6	1.4
2016-2040	CCSM4	452	79	3.0E+03	3.0E+03	0.7	1.7
	CNRM-CM5	468	69	3.2E+03	3.2E+03	0.7	1.6
	CSIRO	441	76	2.9E+03	2.9E+03	0.7	1.8
	MRI	475	73	3.2E+03	3.2E+03	0.6	1.6
2041-2070	CCSM4	472	80	3.1E+03	3.1E+03	1.4	2.1
	CNRM-CM5	492	74	3.3E+03	3.3E+03	1.3	1.9
	CSIRO	500	76	3.4E+03	3.4E+03	1.3	1.9
	MRI	504	71	3.5E+03	3.4E+03	1.3	1.9

[a]Trucked water use was estimated to be 17 ML in 2015; 21 ML in 2040; and 45 ML in 2070.
[b]Piped water use was estimated to be 41 ML in 2015; 53 ML in 2040; and 66 ML in 2070.

Table C - 14 Kugaaruk.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	224	61	3.0E+05	3.0E+05	0.0	0.0
	CCSM4	224	62	3.0E+05	3.0E+05	0.0	0.0
	CNRM-CM5	221	62	2.9E+05	2.9E+05	0.0	0.0
	CSIRO	223	63	2.9E+05	2.9E+05	0.0	0.0
	MRI	224	63	2.9E+05	2.9E+05	0.0	0.0
2016-2040	CCSM4	278	72	3.8E+05	3.8E+05	0.0	0.0
	CNRM-CM5	226	66	2.9E+05	2.9E+05	0.0	0.0
	CSIRO	251	72	3.3E+05	3.3E+05	0.0	0.0
	MRI	227	64	3.0E+05	3.0E+05	0.0	0.0
2041-2070	CCSM4	283	73	3.8E+05	3.8E+05	0.0	0.1
	CNRM-CM5	267	68	3.6E+05	3.6E+05	0.0	0.1
	CSIRO	283	75	3.8E+05	3.8E+05	0.0	0.1
	MRI	235	66	3.1E+05	3.1E+05	0.0	0.1

[a]Trucked water use was estimated to be 30 ML in 2015; 57 ML in 2040; and 95 ML in 2070.
[b]Piped water use was estimated to be 75 ML in 2015; 141 ML in 2040; and 237 ML in 2070.

Table C - 15 Kugluktuk.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	224	70	7.9E+06	7.9E+06	0.0	0.0
	CCSM4	234	79	7.9E+06	7.9E+06	0.0	0.0
	CNRM-CM5	238	71	8.6E+06	8.6E+06	0.0	0.0
	CSIRO	241	80	8.2E+06	8.2E+06	0.0	0.0
	MRI	227	71	8.0E+06	8.0E+06	0.0	0.0
2016-2040	CCSM4	257	86	8.8E+06	8.8E+06	0.0	0.0
	CNRM-CM5	256	77	9.2E+06	9.2E+06	0.0	0.0
	CSIRO	285	83	1.0E+07	1.0E+07	0.0	0.0
	MRI	255	73	9.4E+06	9.4E+06	0.0	0.0
2041-2070	CCSM4	286	89	1.0E+07	1.0E+07	0.0	0.0
	CNRM-CM5	241	82	8.2E+06	8.2E+06	0.0	0.0
	CSIRO	300	84	1.1E+07	1.1E+07	0.0	0.0
	MRI	295	75	1.1E+07	1.1E+07	0.0	0.0

[a]Trucked water use was estimated to be 64 ML in 2015; 90 ML in 2040; and 117 ML in 2070.
[b]Piped water use was estimated to be 159 ML in 2015; 225 ML in 2040; and 292 ML in 2070.

Table C - 16 Naujaat.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	281	68	5.5E+03	5.4E+03	0.7	1.7
	CCSM4	293	75	5.6E+03	5.6E+03	0.7	1.7
	CNRM-CM5	293	69	5.8E+03	5.7E+03	0.7	1.6
	CSIRO	303	75	5.9E+03	5.8E+03	0.6	1.6
	MRI	302	68	6.0E+03	6.0E+03	0.6	1.6
2016-2040	CCSM4	320	83	6.0E+03	5.9E+03	1.6	3.9
	CNRM-CM5	326	73	6.5E+03	6.3E+03	1.5	3.7
	CSIRO	318	79	6.1E+03	5.9E+03	1.6	3.9
	MRI	318	70	6.3E+03	6.2E+03	1.5	3.7
2041-2070	CCSM4	336	85	6.2E+03	5.8E+03	4.7	10
	CNRM-CM5	382	80	7.5E+03	7.2E+03	3.9	8.4
	CSIRO	375	78	7.4E+03	7.0E+03	4.0	8.5
	MRI	297	72	5.5E+03	5.2E+03	5.2	11

[a]Trucked water use was estimated to be 38 ML in 2015; 96 ML in 2040; and 304 ML in 2070.
[b]Piped water use was estimated to be 94 ML in 2015; 239 ML in 2040; and 656 ML in 2070.

Table C - 17 Pangnirtung.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	264	54	1.9E+04	1.9E+04	0.3	0.8
	CCSM4	256	66	1.8E+04	1.7E+04	0.4	0.9
	CNRM-CM5	256	62	1.8E+04	1.8E+04	0.3	0.9
	CSIRO	252	66	1.7E+04	1.7E+04	0.4	0.9
	MRI	261	61	1.9E+04	1.9E+04	0.3	0.8
2016-2040	CCSM4	262	73	1.7E+04	1.7E+04	0.6	1.5
	CNRM-CM5	284	62	2.1E+04	2.0E+04	0.5	1.3
	CSIRO	272	72	1.9E+04	1.8E+04	0.6	1.4
	MRI	279	61	2.0E+04	2.0E+04	0.5	1.3
2041-2070	CCSM4	286	77	1.9E+04	1.9E+04	0.6	1.6
	CNRM-CM5	316	64	2.3E+04	2.3E+04	0.5	1.3
	CSIRO	263	74	1.7E+04	1.7E+04	0.7	1.8
	MRI	312	63	2.3E+04	2.3E+04	0.5	1.3

[a]Trucked water use was estimated to be 62 ML in 2015; 104 ML in 2040; and 124 ML in 2070.
[b]Piped water use was estimated to be 155 ML in 2015; 260 ML in 2040; and 311 ML in 2070.

Table C - 18 Pond Inlet.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	181	62	4.4E+03	4.3E+03	1.5	3.9
	CCSM4	184	61	4.5E+03	4.4E+03	1.5	3.8
	CNRM-CM5	183	70	4.1E+03	4.0E+03	1.6	4.1
	CSIRO	180	61	4.4E+03	4.3E+03	1.6	3.9
	MRI	178	61	4.3E+03	4.2E+03	1.6	3.9
2016-2040	CCSM4	224	72	5.6E+03	5.4E+03	2.2	5.6
	CNRM-CM5	194	72	4.5E+03	4.3E+03	2.8	6.9
	CSIRO	211	70	5.1E+03	5.0E+03	2.4	6.0
	MRI	177	62	4.2E+03	4.0E+03	3.0	7.4
2041-2070	CCSM4	247	75	6.2E+03	5.9E+03	3.6	9.1
	CNRM-CM5	230	74	5.6E+03	5.2E+03	4.0	10.1
	CSIRO	217	72	5.2E+03	4.8E+03	4.3	11
	MRI	208	63	5.2E+03	4.8E+03	4.3	11

[a]Trucked water use was estimated to be 69 ML in 2015; 126 ML in 2040; and 235 ML in 2070.
[b]Piped water use was estimated to be 173 ML in 2015; 316 ML in 2040; and 588 ML in 2070.

Table C - 19 Qikiqtarjuaq.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	264	54	5.0E+03	5.0E+03	0.4	0.9
	CCSM4	256	66	4.5E+03	4.5E+03	0.4	1.0
	CNRM-CM5	256	62	4.7E+03	4.6E+03	0.4	1.0
	CSIRO	252	66	4.5E+03	4.4E+03	0.4	1.1
	MRI	261	61	4.8E+03	4.8E+03	0.4	1.0
2016-2040	CCSM4	262	73	4.5E+03	4.5E+03	0.5	1.2
	CNRM-CM5	284	62	5.3E+03	5.3E+03	0.4	1.0
	CSIRO	272	72	4.8E+03	4.8E+03	0.5	1.2
	MRI	279	61	5.2E+03	5.2E+03	0.4	1.1
2041-2070	CCSM4	286	77	5.0E+03	5.0E+03	0.5	1.3
	CNRM-CM5	316	64	6.0E+03	6.0E+03	0.4	1.1
	CSIRO	263	74	4.5E+03	4.5E+03	0.6	1.5
	MRI	312	63	6.0E+03	5.9E+03	0.4	1.1

[a]Trucked water use was estimated to be 19 ML in 2015; 22 ML in 2040; and 26 ML in 2070.
[b]Piped water use was estimated to be 48 ML in 2015; 56 ML in 2040; and 66 ML in 2070.

Table C - 20 Rankin Inlet (Char).

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	295	73	1.5E+04	1.5E+04	0.7	1.9
	CCSM4	281	66	1.5E+04	1.4E+04	0.8	1.9
	CNRM-CM5	286	64	1.5E+04	1.5E+04	0.7	1.8
	CSIRO	284	64	1.5E+04	1.5E+04	0.7	1.9
	MRI	280	63	1.5E+04	1.4E+04	0.8	1.9
2016-2040	CCSM4	296	73	1.5E+04	1.5E+04	1.5	3.8
	CNRM-CM5	309	64	1.6E+04	1.6E+04	1.4	3.4
	CSIRO	316	71	1.6E+04	1.6E+04	1.4	3.5
	MRI	277	63	1.4E+04	1.4E+04	1.6	3.9
2041-2070	CCSM4	296	75	1.5E+04	1.4E+04	2.7	6.6
	CNRM-CM5	330	66	1.7E+04	1.7E+04	2.2	5.5
	CSIRO	327	72	1.7E+04	1.6E+04	2.3	5.7
	MRI	302	66	1.6E+04	1.5E+04	2.5	6.2

[a]Trucked water use was estimated to be 111 ML in 2015; 227 ML in 2040; and 395 ML in 2070.
[b]Piped water use was estimated to be 278 ML in 2015; 568 ML in 2040; and 988 ML in 2070.

Table C - 21 Rankin Inlet (Nipissar).

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	295	73	4.9E+02	3.2E+02	19	47
	CCSM4	281	66	4.7E+02	3.0E+02	19	48
	CNRM-CM5	286	64	4.9E+02	3.2E+02	19	46
	CSIRO	284	64	4.8E+02	3.1E+02	19	47
	MRI	280	63	4.7E+02	3.1E+02	19	48
2016-2040	CCSM4	296	73	3.7E+02	3.1E+01	38	95
	CNRM-CM5	309	64	4.3E+02	9.1E+01	34	86
	CSIRO	316	71	4.3E+02	8.9E+01	35	86
	MRI	277	63	3.5E+02	6.8E+00	40	99
2041-2070	CCSM4	296	75	2.0E+02	-3.9E+02	67	166
	CNRM-CM5	330	66	3.1E+02	-2.8E+02	56	139
	CSIRO	327	72	2.9E+02	-3.0E+02	58	144
	MRI	302	66	2.4E+02	-3.5E+02	62	155

[a]Trucked water use was estimated to be 111 ML in 2015; 227 ML in 2040; and 395 ML in 2070.
[b]Piped water use was estimated to be 278 ML in 2015; 568 ML in 2040; and 988 ML in 2070.

Table C - 22 Resolute.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	142	64	3.1E+02	3.0E+02	2.3	5.8
	CCSM4	181	56	5.1E+02	5.0E+02	1.4	3.6
	CNRM-CM5	190	55	5.5E+02	5.4E+02	1.3	3.3
	CSIRO	179	56	5.0E+02	4.9E+02	1.5	3.6
	MRI	177	55	5.0E+02	4.8E+02	1.5	3.7
2016-2040	CCSM4	205	58	6.0E+02	5.8E+02	1.7	4.1
	CNRM-CM5	212	56	6.3E+02	6.2E+02	1.6	3.9
	CSIRO	203	57	5.9E+02	5.8E+02	1.7	4.2
	MRI	188	56	5.3E+02	5.2E+02	1.8	4.6
2041-2070	CCSM4	230	68	6.6E+02	6.4E+02	1.8	4.5
	CNRM-CM5	217	59	6.4E+02	6.2E+02	1.9	4.6
	CSIRO	227	67	6.5E+02	6.3E+02	1.8	4.6
	MRI	206	56	6.1E+02	5.9E+02	2.0	4.9

[a]Trucked water use was estimated to be 7 ML in 2015; 10 ML in 2040; and 12 ML in 2070.
[b]Piped water use was estimated to be 18 ML in 2015; 25 ML in 2040; and 30 ML in 2070.

Table C - 23 Sanikiluaq.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	642	95	9.7E+03	9.6E+03	0.3	0.8
	CCSM4	627	99	9.3E+03	9.3E+03	0.3	0.8
	CNRM-CM5	598	98	8.8E+03	8.8E+03	0.4	0.9
	CSIRO	602	98	8.9E+03	8.9E+03	0.4	0.9
	MRI	629	100	9.4E+03	9.3E+03	0.3	0.8
2016-2040	CCSM4	680	103	1.0E+04	1.0E+04	0.6	1.5
	CNRM-CM5	628	101	9.3E+03	9.2E+03	0.7	1.6
	CSIRO	613	98	9.1E+03	9.0E+03	0.7	1.7
	MRI	665	101	9.9E+03	9.9E+03	0.6	1.5
2041-2070	CCSM4	657	103	9.7E+03	9.5E+03	1.6	3.0
	CNRM-CM5	665	104	9.8E+03	9.7E+03	1.6	3.0
	CSIRO	696	99	1.0E+04	1.0E+04	1.5	2.8
	MRI	708	102	1.1E+04	1.1E+04	1.5	2.8

[a]Trucked water use was estimated to be 32 ML in 2015; 61 ML in 2040; and 158 ML in 2070.
[b]Piped water use was estimated to be 79 ML in 2015; 153 ML in 2040; and 298 ML in 2070.

Table C - 24 Taloyoak.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	169	63	3.2E+02	2.6E+02	10	25
	CCSM4	176	61	3.4E+02	2.9E+02	9.4	24
	CNRM-CM5	173	62	3.3E+02	2.8E+02	10	24
	CSIRO	176	61	3.4E+02	2.9E+02	9.5	24
	MRI	176	62	3.4E+02	2.9E+02	9.5	24
2016-2040	CCSM4	213	72	4.0E+02	3.1E+02	13	33
	CNRM-CM5	175	66	3.0E+02	2.0E+02	17	43
	CSIRO	179	71	2.9E+02	2.0E+02	17	44
	MRI	167	64	2.8E+02	1.9E+02	18	46
2041-2070	CCSM4	221	75	3.7E+02	2.1E+02	22	56
	CNRM-CM5	189	67	3.0E+02	1.3E+02	27	67
	CSIRO	196	75	2.9E+02	1.3E+02	27	68
	MRI	183	65	2.8E+02	1.2E+02	28	69

[a]Trucked water use was estimated to be 36 ML in 2015; 62 ML in 2040; and 108 ML in 2070.
[b]Piped water use was estimated to be 89 ML in 2015; 155 ML in 2040; and 270 ML in 2070.

Table C - 25 Whale Cove.

Simulation Period	Climate Model	Median Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	304	73	5.3E+02	5.1E+02	2.7	6.7
	CCSM4	281	66	5.0E+02	4.7E+02	2.9	7.2
	CNRM-CM5	286	64	5.1E+02	4.9E+02	2.8	6.9
	CSIRO	284	64	5.1E+02	4.8E+02	2.8	7.0
	MRI	280	63	5.0E+02	4.8E+02	2.9	7.1
2016-2040	CCSM4	296	73	5.0E+02	4.7E+02	4.7	12
	CNRM-CM5	309	64	5.6E+02	5.2E+02	4.3	11
	CSIRO	316	71	5.5E+02	5.2E+02	4.3	11
	MRI	277	63	4.8E+02	4.4E+02	4.9	12
2041-2070	CCSM4	296	75	4.8E+02	4.2E+02	7.9	20
	CNRM-CM5	330	66	5.8E+02	5.2E+02	6.6	17
	CSIRO	327	72	5.6E+02	5.0E+02	6.9	17
	MRI	302	66	5.2E+02	4.6E+02	7.4	19

[a]Trucked water use was estimated to be 15 ML in 2015; 25 ML in 2040; and 41 ML in 2070.
[b]Piped water use was estimated to be 37 ML in 2015; 62 ML in 2040; and 104 ML in 2070.

Appendix D:

50-Year Low Water Availability Tables

Table D - 1 Arctic Bay.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	Median ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	64	65	-1.6E+02	-2.0E+02	-26	-65
	CCSM4	115	76	5.1E+03	5.0E+03	0.6	1.6
	CNRM-CM5	121	64	7.6E+03	7.5E+03	0.4	1.1
	CSIRO	118	66	6.9E+03	6.8E+03	0.5	1.2
	MRI	124	64	7.9E+03	7.8E+03	0.4	1.0
2016-2040	CCSM4	140	76	8.4E+03	8.4E+03	0.5	1.3
	CNRM-CM5	118	68	6.7E+03	6.6E+03	0.7	1.7
	CSIRO	134	74	7.9E+03	7.8E+03	0.6	1.4
	MRI	126	67	7.7E+03	7.7E+03	0.6	1.5
2041-2070	CCSM4	165	80	1.1E+04	1.1E+04	0.4	1.1
	CNRM-CM5	141	72	9.0E+03	9.0E+03	0.5	1.3
	CSIRO	152	74	1.0E+04	1.0E+04	0.5	1.2
	MRI	139	66	9.7E+03	9.6E+03	0.5	1.3

[a]Trucked water use was estimated to be 32 ML in 2015; 46 ML in 2040; and 49 ML in 2070.
[b]Piped water use was estimated to be 80 ML in 2015; 115 ML in 2040; and 122 ML in 2070.

Table D - 2 Arviat.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	148	89	3.4E+04	3.4E+04	0.3	0.8
	CCSM4	220	95	7.3E+04	7.2E+04	0.2	0.4
	CNRM-CM5	213	101	6.5E+04	6.5E+04	0.2	0.4
	CSIRO	213	85	7.5E+04	7.4E+04	0.2	0.4
	MRI	209	94	6.7E+04	6.7E+04	0.2	0.4
2016-2040	CCSM4	217	101	6.7E+04	6.7E+04	0.4	0.9
	CNRM-CM5	211	103	6.2E+04	6.2E+04	0.4	1.0
	CSIRO	226	89	8.0E+04	7.9E+04	0.3	0.8
	MRI	221	99	7.1E+04	7.1E+04	0.4	0.9
2041-2070	CCSM4	234	102	7.6E+04	7.5E+04	0.8	1.9
	CNRM-CM5	241	102	8.1E+04	8.0E+04	0.7	1.8
	CSIRO	265	92	1.0E+05	1.0E+05	0.6	1.4
	MRI	239	98	8.1E+04	8.0E+04	0.7	1.8

[a]Trucked water use was estimated to be 114 ML in 2015; 252 ML in 2040; and 579 ML in 2070.
[b]Piped water use was estimated to be 286 ML in 2015; 631 ML in 2040; and 1447 ML in 2070.

Table D - 3 Baker Lake.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	152	81	1.7E+07	1.7E+07	0.0	0.0
	CCSM4	182	96	2.1E+07	2.1E+07	0.0	0.0
	CNRM-CM5	182	95	2.1E+07	2.1E+07	0.0	0.0
	CSIRO	190	89	2.4E+07	2.4E+07	0.0	0.0
	MRI	186	91	2.3E+07	2.3E+07	0.0	0.0
2016-2040	CCSM4	220	97	2.9E+07	2.9E+07	0.0	0.0
	CNRM-CM5	178	98	1.9E+07	1.9E+07	0.0	0.0
	CSIRO	196	92	2.5E+07	2.5E+07	0.0	0.0
	MRI	171	95	1.8E+07	1.8E+07	0.0	0.0
2041-2070	CCSM4	216	97	2.9E+07	2.9E+07	0.0	0.0
	CNRM-CM5	224	97	3.1E+07	3.1E+07	0.0	0.0
	CSIRO	229	93	3.3E+07	3.3E+07	0.0	0.0
	MRI	173	98	1.8E+07	1.8E+07	0.0	0.0

[a]Trucked water use was estimated to be 88 ML in 2015; 161 ML in 2040; and 271 ML in 2070.

[b]Piped water use was estimated to be 220 ML in 2015; 403 ML in 2040; and 677 ML in 2070.

Table D - 4 Cambridge Bay.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	94	71	-6.8E+00	-1.2E+02	110	276
	CCSM4	122	81	4.0E+01	-6.8E+01	64	160
	CNRM-CM5	127	71	8.2E+01	-2.7E+01	47	117
	CSIRO	128	75	7.7E+01	-3.1E+01	48	121
	MRI	115	70	5.2E+01	-5.7E+01	58	146
2016-2040	CCSM4	125	86	9.4E+00	-1.4E+02	91	228
	CNRM-CM5	147	80	9.0E+01	-5.7E+01	52	130
	CSIRO	135	80	5.4E+01	-9.3E+01	64	161
	MRI	128	71	5.8E+01	-9.0E+01	63	158
2041-2070	CCSM4	152	84	5.8E+01	-1.4E+02	69	173
	CNRM-CM5	133	83	7.6E+00	-1.9E+02	95	236
	CSIRO	142	79	4.4E+01	-1.5E+02	75	186
	MRI	136	76	3.8E+01	-1.6E+02	77	194

[a]Trucked water use was estimated to be 72 ML in 2015; 98 ML in 2040; and 130 ML in 2070.

[b]Piped water use was estimated to be 181 ML in 2015; 246 ML in 2040; and 325 ML in 2070.

Table D - 5 Cape Dorset.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	269	70	8.6E+01	-2.0E+00	41	101
	CCSM4	243	84	5.7E+01	-3.1E+01	51	127
	CNRM-CM5	256	78	7.1E+01	-1.7E+01	45	113
	CSIRO	263	79	7.5E+01	-1.3E+01	44	110
	MRI	235	77	5.6E+01	-3.2E+01	51	128
2016-2040	CCSM4	267	85	3.6E+01	-1.1E+02	73	183
	CNRM-CM5	285	76	5.5E+01	-9.1E+01	64	160
	CSIRO	297	78	6.2E+01	-8.3E+01	61	152
	MRI	262	79	3.6E+01	-1.1E+02	73	183
2041-2070	CCSM4	299	87	4.3E+00	-2.2E+02	97	243
	CNRM-CM5	300	84	6.6E+00	-2.2E+02	96	239
	CSIRO	321	81	2.4E+01	-2.0E+02	86	215
	MRI	265	84	-1.8E+01	-2.4E+02	114	284

[a]Trucked water use was estimated to be 59 ML in 2015; 97 ML in 2040; and 151 ML in 2070.
[b]Piped water use was estimated to be 147 ML in 2015; 243 ML in 2040; and 376 ML in 2070.

Table D - 6 Chesterfield Inlet.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	132	84	9.3E+02	9.2E+02	1.2	2.9
	CCSM4	196	93	2.0E+03	2.0E+03	0.5	1.4
	CNRM-CM5	198	94	2.0E+03	2.0E+03	0.5	1.3
	CSIRO	194	90	2.0E+03	2.0E+03	0.5	1.4
	MRI	190	91	1.9E+03	1.9E+03	0.6	1.4
2016-2040	CCSM4	199	96	2.0E+03	2.0E+03	1.0	2.4
	CNRM-CM5	186	101	1.7E+03	1.6E+03	1.2	3.0
	CSIRO	199	95	2.0E+03	2.0E+03	1.0	2.4
	MRI	203	94	2.1E+03	2.1E+03	0.9	2.3
2041-2070	CCSM4	220	97	2.4E+03	2.3E+03	1.3	3.2
	CNRM-CM5	239	99	2.7E+03	2.7E+03	1.1	2.8
	CSIRO	238	96	2.8E+03	2.7E+03	1.1	2.8
	MRI	193	97	1.9E+03	1.8E+03	1.6	4.1

[a]Trucked water use was estimated to be 11 ML in 2015; 20 ML in 2040; and 31 ML in 2070.
[b]Piped water use was estimated to be 28 ML in 2015; 49 ML in 2040; and 78 ML in 2070.

Table D - 7 Clyde River.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	89	63	-2.2E+01	-7.8E+01	250	626	89
	177	81	1.8E+01	-3.8E+01	67	168	177
	177	67	2.6E+01	-3.0E+01	59	148	177
	166	73	1.6E+01	-4.0E+01	70	175	166
	171	65	2.4E+01	-3.2E+01	61	153	171
2016-2040	173	76	-1.1E+01	-1.1E+02	120	300	173
	178	73	-6.3E+00	-1.1E+02	111	276	178
	168	74	-1.3E+01	-1.1E+02	123	308	168
	175	61	-1.2E+00	-1.0E+02	102	255	175
2041-2070	213	80	-4.2E+01	-2.2E+02	155	387	213
	195	73	-4.9E+01	-2.3E+02	170	424	195
	204	76	-4.5E+01	-2.2E+02	160	401	204
	197	66	-4.3E+01	-2.2E+02	157	393	197

[a]Trucked water use was estimated to be 37 ML in 2015; 66 ML in 2040; and 118 ML in 2070.
[b]Piped water use was estimated to be 93 ML in 2015; 166 ML in 2040; and 296 ML in 2070.

Table D - 8 Coral Harbour.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	187	69	3.0E+04	3.0E+04	0.1	0.2
	CCSM4	206	93	2.9E+04	2.9E+04	0.1	0.2
	CNRM-CM5	202	86	3.0E+04	3.0E+04	0.1	0.2
	CSIRO	222	85	3.5E+04	3.5E+04	0.1	0.2
	MRI	192	79	2.9E+04	2.9E+04	0.1	0.2
2016-2040	CCSM4	229	95	3.4E+04	3.4E+04	0.2	0.4
	CNRM-CM5	223	95	3.3E+04	3.3E+04	0.2	0.4
	CSIRO	217	89	3.3E+04	3.3E+04	0.2	0.4
	MRI	255	84	4.4E+04	4.4E+04	0.2	0.3
2041-2070	CCSM4	251	96	3.9E+04	3.9E+04	0.4	0.6
	CNRM-CM5	268	94	4.4E+04	4.4E+04	0.4	0.6
	CSIRO	263	91	4.4E+04	4.4E+04	0.4	0.6
	MRI	232	87	3.7E+04	3.7E+04	0.4	0.7

[a]Trucked water use was estimated to be 27 ML in 2015; 81 ML in 2040; and 156 ML in 2070.
[b]Piped water use was estimated to be 68 ML in 2015; 131 ML in 2040; and 251 ML in 2070.

Table D - 9 Gjoa Haven.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	101	67	2.6E+02	1.8E+02	17	43
	CCSM4	116	79	2.9E+02	2.1E+02	16	39
	CNRM-CM5	121	69	4.3E+02	3.5E+02	11	28
	CSIRO	119	75	3.5E+02	2.7E+02	13	33
	MRI	107	67	3.2E+02	2.4E+02	15	37
2016-2040	CCSM4	136	85	3.9E+02	3.1E+02	18	35
	CNRM-CM5	113	80	2.2E+02	1.4E+02	28	54
	CSIRO	131	81	3.9E+02	3.1E+02	18	35
	MRI	113	69	3.3E+02	2.5E+02	21	40
2041-2070	CCSM4	142	83	4.2E+02	2.6E+02	24	54
	CNRM-CM5	128	80	3.2E+02	1.6E+02	29	65
	CSIRO	138	81	4.0E+02	2.4E+02	25	56
	MRI	122	74	3.2E+02	1.5E+02	30	66

[a]Trucked water use was estimated to be 54 ML in 2015; 86 ML in 2040; and 134 ML in 2070.
[b]Piped water use was estimated to be 136 ML in 2015; 166 ML in 2040; and 296 ML in 2070.

Table D - 10 Grise Fiord.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	107	115	-6.7E+00	-1.3E+01	-194	-485
	CCSM4	127	60	1.4E+01	7.4E+00	24	60
	CNRM-CM5	127	60	1.4E+01	7.3E+00	24	60
	CSIRO	124	62	1.3E+01	6.1E+00	26	64
	MRI	128	59	1.5E+01	7.9E+00	23	58
2016-2040	CCSM4	142	75	1.3E+01	3.9E+00	32	79
	CNRM-CM5	139	62	1.5E+01	6.5E+00	28	69
	CSIRO	146	71	1.5E+01	6.0E+00	28	71
	MRI	126	62	1.2E+01	3.0E+00	33	83
2041-2070	CCSM4	174	73	2.1E+01	1.0E+01	25	63
	CNRM-CM5	150	67	1.6E+01	5.5E+00	30	76
	CSIRO	164	70	1.9E+01	8.4E+00	27	67
	MRI	152	64	1.7E+01	6.7E+00	29	72

[a]Trucked water use was estimated to be 4 ML in 2015; 6 ML in 2040; and 7 ML in 2070.
[b]Piped water use was estimated to be 11 ML in 2015; 15 ML in 2040; and 17 ML in 2070.

Table D - 11 Hall Beach.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	116	63	5.1E+02	4.8E+02	3.8	9.5
	CCSM4	177	82	9.4E+02	9.1E+02	2.1	5.3
	CNRM-CM5	171	67	1.0E+03	1.0E+03	1.9	4.8
	CSIRO	169	71	9.6E+02	9.3E+02	2.1	5.1
	MRI	180	66	1.1E+03	1.1E+03	1.7	4.4
2016-2040	CCSM4	197	81	1.1E+03	1.0E+03	5.5	14
	CNRM-CM5	165	76	8.3E+02	7.4E+02	7.1	18
	CSIRO	188	76	1.1E+03	9.8E+02	5.6	14
	MRI	185	66	1.1E+03	1.0E+03	5.3	13
2041-2070	CCSM4	219	81	1.3E+03	1.0E+03	10.0	25
	CNRM-CM5	190	79	9.9E+02	7.8E+02	12	31
	CSIRO	221	78	1.3E+03	1.1E+03	9.6	24
	MRI	184	70	1.0E+03	8.0E+02	12	30

[a]Trucked water use was estimated to be 20 ML in 2015; 64 ML in 2040; and 139 ML in 2070.
[b]Piped water use was estimated to be 50 ML in 2015; 160 ML in 2040; and 348 ML in 2070.

Table D - 12 Igloolik.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	171	66	7.1E+01	-2.5E+01	47	118
	CCSM4	177	82	5.9E+01	-3.7E+01	52	130
	CNRM-CM5	171	67	7.1E+01	-2.4E+01	47	118
	CSIRO	169	71	6.2E+01	-3.4E+01	51	127
	MRI	180	66	8.4E+01	-1.2E+01	43	108
2016-2040	CCSM4	197	81	-3.9E+00	-2.3E+02	103	257
	CNRM-CM5	165	76	-3.9E+01	-2.7E+02	134	334
	CSIRO	188	76	-7.7E+00	-2.4E+02	105	263
	MRI	185	66	5.1E-01	-2.3E+02	100	249
2041-2070	CCSM4	219	81	-9.4E+01	-5.0E+02	153	383
	CNRM-CM5	190	80	-1.3E+02	-5.4E+02	191	478
	CSIRO	221	78	-8.8E+01	-5.0E+02	148	369
	MRI	182	70	-1.3E+02	-5.4E+02	188	469

[a]Trucked water use was estimated to be 64 ML in 2015; 153 ML in 2040; and 272 ML in 2070.
[b]Piped water use was estimated to be 159 ML in 2015; 383 ML in 2040; and 681 ML in 2070.

Table D - 13 Kimmirut.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)	Net Water Availability - Piped (ML)	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	254	81	1.4E+03	1.4E+03	1.2	2.9
	CCSM4	317	84	1.9E+03	1.8E+03	0.9	2.2
	CNRM-CM5	315	83	1.9E+03	1.8E+03	0.9	2.2
	CSIRO	324	79	2.0E+03	1.9E+03	0.8	2.1
	MRI	314	81	1.9E+03	1.9E+03	0.9	2.2
2016-2040	CCSM4	353	85	2.1E+03	2.1E+03	1.0	2.4
	CNRM-CM5	324	87	1.9E+03	1.9E+03	1.1	2.7
	CSIRO	325	81	2.0E+03	1.9E+03	1.1	2.7
	MRI	322	80	1.9E+03	1.9E+03	1.1	2.7
2041-2070	CCSM4	360	86	2.2E+03	2.2E+03	2.0	3.0
	CNRM-CM5	352	84	2.1E+03	2.1E+03	2.1	3.0
	CSIRO	372	81	2.3E+03	2.3E+03	1.9	2.8
	MRI	355	84	2.1E+03	2.1E+03	2.1	3.0

[a]Trucked water use was estimated to be 17 ML in 2015; 21 ML in 2040; and 45 ML in 2070.
[b]Piped water use was estimated to be 41 ML in 2015; 53 ML in 2040; and 66 ML in 2070.

Table D - 14 Kugaaruk.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	115	70	8.2E+04	8.2E+04	0.0	0.1
	CCSM4	159	80	1.4E+05	1.4E+05	0.0	0.1
	CNRM-CM5	159	69	1.7E+05	1.7E+05	0.0	0.0
	CSIRO	155	74	1.5E+05	1.5E+05	0.0	0.1
	MRI	157	70	1.6E+05	1.6E+05	0.0	0.0
2016-2040	CCSM4	198	82	2.1E+05	2.1E+05	0.0	0.1
	CNRM-CM5	152	76	1.4E+05	1.4E+05	0.0	0.1
	CSIRO	169	79	1.6E+05	1.6E+05	0.0	0.1
	MRI	166	72	1.7E+05	1.7E+05	0.0	0.1
2041-2070	CCSM4	198	82	2.1E+05	2.1E+05	0.0	0.1
	CNRM-CM5	177	75	1.9E+05	1.9E+05	0.1	0.1
	CSIRO	203	81	2.2E+05	2.2E+05	0.0	0.1
	MRI	165	76	1.6E+05	1.6E+05	0.1	0.1

[a]Trucked water use was estimated to be 30 ML in 2015; 57 ML in 2040; and 95 ML in 2070.
[b]Piped water use was estimated to be 75 ML in 2015; 141 ML in 2040; and 237 ML in 2070.

Table D - 15 Kugluktuk.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	136	84	2.7E+06	2.7E+06	0	0
	CCSM4	167	90	3.9E+06	3.9E+06	0	0
	CNRM-CM5	164	93	3.6E+06	3.6E+06	0	0
	CSIRO	166	85	4.1E+06	4.1E+06	0	0
	MRI	163	91	3.7E+06	3.7E+06	0	0
2016-2040	CCSM4	196	95	5.2E+06	5.2E+06	0	0
	CNRM-CM5	178	94	4.3E+06	4.3E+06	0	0
	CSIRO	157	91	3.4E+06	3.4E+06	0	0
	MRI	178	90	4.5E+06	4.5E+06	0	0
2041-2070	CCSM4	203	98	5.4E+06	5.4E+06	0	0
	CNRM-CM5	178	95	4.3E+06	4.3E+06	0	0
	CSIRO	208	91	6.0E+06	6.0E+06	0	0
	MRI	217	93	6.4E+06	6.4E+06	0	0

[a]Trucked water use was estimated to be 64 ML in 2015; 90 ML in 2040; and 117 ML in 2070.
[b]Piped water use was estimated to be 159 ML in 2015; 225 ML in 2040; and 292 ML in 2070.

Table D - 16 Naujaat.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	187	70	3.0E+03	2.9E+03	1.2	3.1
	CCSM4	206	80	3.2E+03	3.2E+03	1.2	2.9
	CNRM-CM5	202	69	3.4E+03	3.4E+03	1.1	2.7
	CSIRO	222	74	3.8E+03	3.7E+03	1.0	2.5
	MRI	192	70	3.1E+03	3.1E+03	1.2	3.0
2016-2040	CCSM4	229	82	3.7E+03	3.6E+03	2.5	6.3
	CNRM-CM5	223	76	3.7E+03	3.6E+03	2.5	6.3
	CSIRO	217	79	3.5E+03	3.3E+03	2.7	6.7
	MRI	255	72	4.6E+03	4.5E+03	2.0	5.1
2041-2070	CCSM4	251	82	4.1E+03	3.7E+03	7.0	15
	CNRM-CM5	268	75	4.7E+03	4.3E+03	6.1	13
	CSIRO	263	81	4.4E+03	4.1E+03	6.5	14
	MRI	232	76	3.7E+03	3.4E+03	7.5	16

[a]Trucked water use was estimated to be 38 ML in 2015; 96 ML in 2040; and 304 ML in 2070.
[b]Piped water use was estimated to be 94 ML in 2015; 239 ML in 2040; and 656 ML in 2070.

Table D - 17 Pangnirtung.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	153	64	8.2E+03	8.1E+03	0.7	1.9
	CCSM4	185	83	9.4E+03	9.3E+03	0.7	1.6
	CNRM-CM5	172	78	8.7E+03	8.6E+03	0.7	1.8
	CSIRO	167	78	8.1E+03	8.0E+03	0.8	1.9
	MRI	172	71	9.4E+03	9.3E+03	0.7	1.6
2016-2040	CCSM4	175	83	8.4E+03	8.3E+03	1.2	3.1
	CNRM-CM5	185	85	9.2E+03	9.0E+03	1.1	2.8
	CSIRO	162	75	8.0E+03	7.8E+03	1.3	3.2
	MRI	200	69	1.2E+04	1.2E+04	0.9	2.1
2041-2070	CCSM4	192	89	9.5E+03	9.3E+03	1.3	3.2
	CNRM-CM5	206	83	1.1E+04	1.1E+04	1.1	2.7
	CSIRO	174	78	8.7E+03	8.6E+03	1.4	3.5
	MRI	224	79	1.3E+04	1.3E+04	0.9	2.3

[a]Trucked water use was estimated to be 62 ML in 2015; 104 ML in 2040; and 124 ML in 2070.
[b]Piped water use was estimated to be 155 ML in 2015; 260 ML in 2040; and 311 ML in 2070.

Table D - 18 Pond Inlet.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	92	66	9.2E+02	8.1E+02	7.0	17
	CCSM4	118	81	1.3E+03	1.2E+03	4.9	12.4
	CNRM-CM5	113	75	1.3E+03	1.2E+03	5.0	12.4
	CSIRO	117	75	1.5E+03	1.4E+03	4.3	10.8
	MRI	122	66	2.0E+03	1.9E+03	3.3	8.2
2016-2040	CCSM4	146	81	2.4E+03	2.2E+03	3.4	8.5
	CNRM-CM5	137	84	1.9E+03	1.8E+03	4.2	10.4
	CSIRO	122	76	1.6E+03	1.5E+03	4.8	12
	MRI	110	67	1.5E+03	1.4E+03	5.2	13
2041-2070	CCSM4	173	83	3.3E+03	3.0E+03	4.1	10
	CNRM-CM5	126	89	1.2E+03	1.0E+03	10.0	25
	CSIRO	155	77	2.8E+03	2.6E+03	4.8	12
	MRI	139	68	2.5E+03	2.3E+03	5.2	13

[a]Trucked water use was estimated to be 69 ML in 2015; 126 ML in 2040; and 235 ML in 2070.
[b]Piped water use was estimated to be 173 ML in 2015; 316 ML in 2040; and 588 ML in 2070.

Table D - 19 Qikiqtarjuaq.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	153	64	2.1E+03	2.1E+03	0.9	2.2
	CCSM4	185	83	2.4E+03	2.4E+03	0.8	2.0
	CNRM-CM5	172	78	2.2E+03	2.2E+03	0.8	2.1
	CSIRO	167	78	2.1E+03	2.1E+03	0.9	2.3
	MRI	172	71	2.4E+03	2.4E+03	0.8	2.0
2016-2040	CCSM4	175	83	2.2E+03	2.2E+03	1.0	2.5
	CNRM-CM5	185	85	2.4E+03	2.3E+03	0.9	2.3
	CSIRO	162	75	2.1E+03	2.0E+03	1.1	2.7
	MRI	200	69	3.1E+03	3.1E+03	0.7	1.8
2041-2070	CCSM4	192	89	2.5E+03	2.4E+03	1.1	2.7
	CNRM-CM5	206	83	2.9E+03	2.9E+03	0.9	2.2
	CSIRO	174	78	2.3E+03	2.2E+03	1.1	2.9
	MRI	224	79	3.5E+03	3.4E+03	0.8	1.9

[a]Trucked water use was estimated to be 19 ML in 2015; 22 ML in 2040; and 26 ML in 2070.

[b]Piped water use was estimated to be 48 ML in 2015; 56 ML in 2040; and 66 ML in 2070.

Table D - 20 Rankin Inlet (Char).

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	206	82	8.3E+03	8.1E+03	1.3	3.3
	CCSM4	196	82	7.6E+03	7.4E+03	1.4	3.6
	CNRM-CM5	198	77	8.1E+03	8.0E+03	1.4	3.4
	CSIRO	194	77	7.8E+03	7.6E+03	1.4	3.5
	MRI	190	70	8.0E+03	7.8E+03	1.4	3.4
2016-2040	CCSM4	199	81	7.8E+03	7.4E+03	2.8	7.1
	CNRM-CM5	186	83	6.7E+03	6.4E+03	3.3	8.2
	CSIRO	199	75	8.2E+03	7.9E+03	2.7	6.7
	MRI	203	70	8.7E+03	8.4E+03	2.5	6.3
2041-2070	CCSM4	220	84	8.8E+03	8.2E+03	4.3	11
	CNRM-CM5	235	81	1.0E+04	9.4E+03	3.8	9.5
	CSIRO	238	76	1.1E+04	1.0E+04	3.6	9.0
	MRI	193	77	7.4E+03	6.8E+03	5.1	13

[a]Trucked water use was estimated to be 111 ML in 2015; 227 ML in 2040; and 395 ML in 2070.

[b]Piped water use was estimated to be 278 ML in 2015; 568 ML in 2040; and 988 ML in 2070.

Table D - 21 Rankin Inlet (Nipissar).

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	206	82	2.2E+02	5.6E+01	33	83
	CCSM4	196	82	2.0E+02	2.9E+01	36	91
	CNRM-CM5	198	77	2.2E+02	4.9E+01	34	85
	CSIRO	194	77	2.0E+02	3.5E+01	36	89
	MRI	190	70	2.1E+02	4.4E+01	35	86
2016-2040	CCSM4	199	81	9.0E+01	-2.5E+02	72	179
	CNRM-CM5	186	83	5.0E+01	-2.9E+02	82	205
	CSIRO	199	75	1.1E+02	-2.3E+02	68	169
	MRI	203	70	1.3E+02	-2.1E+02	64	159
2041-2070	CCSM4	220	84	-2.8E+01	-6.2E+02	108	269
	CNRM-CM5	235	81	1.8E+01	-5.7E+02	96	239
	CSIRO	238	76	4.1E+01	-5.5E+02	91	227
	MRI	193	77	-8.4E+01	-6.8E+02	127	318

[a]Trucked water use was estimated to be 111 ML in 2015; 227 ML in 2040; and 395 ML in 2070.
[b]Piped water use was estimated to be 278 ML in 2015; 568 ML in 2040; and 988 ML in 2070.

Table D - 22 Resolute.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	87	74	4.9E+01	3.8E+01	13.1	33
	CCSM4	127	59	2.7E+02	2.6E+02	2.6	6.5
	CNRM-CM5	127	59	2.7E+02	2.6E+02	2.6	6.6
	CSIRO	124	60	2.6E+02	2.4E+02	2.8	7.0
	MRI	128	58	2.8E+02	2.7E+02	2.6	6.4
2016-2040	CCSM4	142	73	2.7E+02	2.6E+02	3.5	8.8
	CNRM-CM5	139	62	3.1E+02	3.0E+02	3.1	7.8
	CSIRO	146	70	3.1E+02	2.9E+02	3.2	8.0
	MRI	126	61	2.6E+02	2.4E+02	3.7	9.3
2041-2070	CCSM4	174	72	4.1E+02	3.9E+02	2.9	7.2
	CNRM-CM5	150	66	3.3E+02	3.2E+02	3.5	8.7
	CSIRO	164	70	3.8E+02	3.6E+02	3.1	7.7
	MRI	152	64	3.5E+02	3.3E+02	3.3	8.3

[a]Trucked water use was estimated to be 7 ML in 2015; 10 ML in 2040; and 12 ML in 2070.
[b]Piped water use was estimated to be 18 ML in 2015; 25 ML in 2040; and 30 ML in 2070.

Table D - 23 Sanikiluaq.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	468	103	6.4E+03	6.4E+03	0.5	1.2
	CCSM4	475	109	6.5E+03	6.4E+03	0.5	1.2
	CNRM-CM5	448	110	6.0E+03	5.9E+03	0.5	1.3
	CSIRO	475	107	6.5E+03	6.5E+03	0.5	1.2
	MRI	464	107	6.3E+03	6.2E+03	0.5	1.3
2016-2040	CCSM4	531	110	7.4E+03	7.3E+03	0.8	2.0
	CNRM-CM5	430	115	5.5E+03	5.4E+03	1.1	2.7
	CSIRO	502	108	6.9E+03	6.8E+03	0.9	2.2
	MRI	512	109	7.1E+03	7.0E+03	0.9	2.1
2041-2070	CCSM4	502	118	6.7E+03	6.5E+03	2.3	4.4
	CNRM-CM5	547	117	7.5E+03	7.3E+03	2.1	3.9
	CSIRO	549	107	7.7E+03	7.6E+03	2.0	3.8
	MRI	523	111	7.1E+03	7.0E+03	2.2	4.1

[a]Trucked water use was estimated to be 32 ML in 2015; 61 ML in 2040; and 158 ML in 2070.
[b]Piped water use was estimated to be 79 ML in 2015; 153 ML in 2040; and 298 ML in 2070.

Table D - 24 Taloyoak.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	89	68	3.4E+01	-2.0E+01	51	128
	CCSM4	117	76	9.9E+01	4.6E+01	26	66
	CNRM-CM5	122	69	1.4E+02	8.6E+01	20	51
	CSIRO	123	74	1.2E+02	7.0E+01	22	56
	MRI	116	68	1.2E+02	6.8E+01	23	57
2016-2040	CCSM4	141	83	1.3E+02	3.8E+01	32	80
	CNRM-CM5	114	75	6.6E+01	-2.7E+01	48	121
	CSIRO	134	80	1.2E+02	2.5E+01	34	86
	MRI	123	68	1.2E+02	2.7E+01	34	85
2041-2070	CCSM4	154	80	1.3E+02	-2.8E+01	45	111
	CNRM-CM5	133	74	8.8E+01	-7.4E+01	55	138
	CSIRO	135	78	8.0E+01	-8.2E+01	57	143
	MRI	123	69	6.9E+01	-9.3E+01	61	152

[a]Trucked water use was estimated to be 36 ML in 2015; 62 ML in 2040; and 108 ML in 2070.
[b]Piped water use was estimated to be 89 ML in 2015; 155 ML in 2040; and 270 ML in 2070.

Table D - 25 Whale Cove.

Simulation Period	Climate Model	50 Year Low Precipitation (mm)	50 Year High ET (mm)	Net Water Availability - Trucked (ML)[a]	Net Water Availability - Piped (ML)[b]	Water Availability Indicator - Trucked (%)	Water Availability Indicator - Piped (%)
1950-2015	Historical	206	82	2.8E+02	2.6E+02	5.0	12
	CCSM4	196	82	2.6E+02	2.3E+02	5.4	14
	CNRM-CM5	198	77	2.7E+02	2.5E+02	5.1	13
	CSIRO	194	77	2.6E+02	2.4E+02	5.3	13
	MRI	190	70	2.7E+02	2.5E+02	5.2	13
2016-2040	CCSM4	199	81	2.5E+02	2.2E+02	8.8	22
	CNRM-CM5	186	83	2.2E+02	1.8E+02	10	25
	CSIRO	199	75	2.7E+02	2.3E+02	8.4	21
	MRI	203	70	2.9E+02	2.5E+02	7.9	20
2041-2070	CCSM4	220	84	2.8E+02	2.2E+02	13	32
	CNRM-CM5	235	81	3.2E+02	2.6E+02	11	28
	CSIRO	238	76	3.4E+02	2.8E+02	11	27
	MRI	193	77	2.3E+02	1.7E+02	15	38

[a]Trucked water use was estimated to be 15 ML in 2015; 25 ML in 2040; and 41 ML in 2070.
[b]Piped water use was estimated to be 37 ML in 2015; 62 ML in 2040; and 104 ML in 2070.

Appendix E:

Mann-Kendall Statistics

Table E - 1 Results of the Mann-Kendall statistical analysis on historical climate data and hindcast PCIC climate model datasets. Red highlighted cells are statistically significant, positive z values denote increasing trends, and negative z values indicate decreasing trends.

Community	Model	Precipitation	ET
		Z value	
Arctic Bay	CCSM4	2.6121	
	CNRM	2.0033	
	CSIRO	2.1251	
	MRI	0.7305	
Arviat	Historic		3.3892
	CCSM4	0.155	
	CNRM	0.0664	
	CSIRO	0.2878	
	MRI	0.2435	
Baker Lake	Historic	1.8149	-1.0072
	CCSM4	1.8149	
	CNRM	-0.2546	
	CSIRO	1.5606	
	MRI	0.5866	
Cambridge Bay	Historic	1.948	2.8667
	CCSM4	1.5495	
	CNRM	0.7748	
	CSIRO	1.3171	
	MRI	1.6824	
Cape Dorset	CCSM4	1.1732	
	CNRM	2.0587	
	CSIRO	1.1068	
	MRI	0.4317	
Chesterfield Inlet	CCSM4	1.5828	
	CNRM	1.1622	
	CSIRO	1.0625	
	MRI	0.1439	
Clyde River	Historic	0.8421	
	CCSM4	0.7969	
	CNRM	0.4206	
	CSIRO	0.1771	
	MRI	0.1771	
Coral Harbour	Historic	2.922	3.9442
	CCSM4	2.4417	
	CNRM	0.5769	
	CSIRO	1.5428	
	MRI	0.9257	
Gjoa Haven	Historic		1.6996
	CCSM4	1.4942	

	CNRM	1.627	
	CSIRO	2.1472	
	MRI	1.5163	
Grise Fiord	CCSM4	1.9701	
	CNRM	1.8263	
	CSIRO	2.3354	
	MRI	1.8705	
Hall Beach	Historic	0.7863	2.6812
	CCSM4	1.5606	
	CNRM	0.2214	
	CSIRO	1.3503	
	MRI	-1.129	
Igloolik	Historic		2.4946
	CCSM4	1.5606	
	CNRM	0.2214	
	CSIRO	1.3503	
	MRI	-1.129	
Kimmirut	Historic	-1.9976	-0.0913
	CCSM4	0.5866	
	CNRM	0.0111	
	CSIRO	0.7305	
	MRI	-0.0111	
Kugaaruk	Historic	0.1162	4.6741
	CCSM4	2.1472	
	CNRM	0.5866	
	CSIRO	2.3354	
	MRI	1.5053	
Kugluktuk	Historic	0.4618	3.8438
	CCSM4	1.0847	
	CNRM	2.5568	
	CSIRO	1.1622	
	MRI	0.7084	
Naujaat	Historic	2.922	3.544
	CCSM4	1.5717	
	CNRM	0.2103	
	CSIRO	1.306	
	MRI	1.1068	
Pangnirtung	Historic		3.014
	CCSM4	1.0404	
	CNRM	1.0072	
	CSIRO	1.6049	
	MRI	0.155	
Pond Inlet	Historic	0.4526	5.5424
	CCSM4	2.8113	

	CNRM	1.5606	
	CSIRO	0.2324	
	MRI	0.1439	
Qikiqtarjuaq	Historic		3.014
	CCSM4	1.0404	
	CNRM	1.0072	
	CSIRO	1.6049	
	MRI	0.155	
Rankin Inlet	Historic	1.69	2.0458
	CCSM4	1.5828	
	CNRM	1.1622	
	CSIRO	1.0625	
	MRI	0.1439	
Resolute	Historic	2.2247	4.854
	CCSM4	1.9701	
	CNRM	1.8263	
	CSIRO	2.3354	
	MRI	1.8705	
Sanikiluaq	Historic	1.7966	2.061
	CCSM4	0.2435	
	CNRM	0.0111	
	CSIRO	-0.5755	
	MRI	2.0476	
Taloyoak	Historic		2.1916
	CCSM4	1.8373	
	CNRM	0.5645	
	CSIRO	2.3575	
	MRI	1.3503	
Whale Cove	Historic	1.69	2.0458
	CCSM4	1.5828	
	CNRM	1.1622	
	CSIRO	1.0625	
	MRI	0.1439	