Water Balance Assessment for Unnamed Lake

Modelling Report

Submitted to:

City of Iqaluit

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1.0 INTRODUCTION

This report has been prepared by Golder Associates Ltd. (Golder) for the City of Iqaluit (the City) in accordance with Proposal Number P20146631, dated June 22, 2020. The report documents model development and an ensuing water balance assessment carried out for Unnamed Lake located to the northeast of the City, which has been identified as a potential long-term supplementation source for the Lake Geraldine water supply.

1.1 Background

The City of Iqaluit currently depends on the Lake Geraldine Reservoir to service its year-round municipal water supply. Given that the Lake Geraldine watershed is frozen over for eight to nine months a year, raw water supplies at the outset of winter need to be sufficient to service the City over the following winter, until snowmelt runoff replenishes the reservoir during the freshet. Typically, the benefits of freshet as a mechanism to replenish Lake Geraldine's water supplies are relatively short-lived as continued water consumption and evaporation throughout the summer months are compounded by often insufficient precipitation surpluses to fill the reservoir to a level that will sustain the following winter's water supply requirements. Increasing population growth, as well as increasing interannual variability in precipitation surpluses, is further accelerating the urgency of identifying and securing a long-term viable supplementation alternative to address the City's needs. Understanding the implications of climate change on winter durations, precipitation and surpluses will also be important for evaluating the range of annual water supply deficits that may need to be addressed in the future.

As early as 2004, work completed by Trow identified that increasing the storage capacity of the reservoir and supplementing reservoir supplies with water from another source would be needed to address water supply deficits. Pumping from the nearby Niaqungok (Apex) River during the summer months has addressed this need in some recent years, however, it is recognized that the hydrograph for the Apex River (high freshet surpluses, lower summer and fall surpluses) compromises the City's ability to top up the Lake Geraldine reservoir before freeze-up when flows in the Apex River are generally scarce. In other words, water supplies in nearby river systems have a tendency to be abundant when they are least needed but are greatly diminished when they are required to top up reservoir supplies in time for winter. A more stable supplementation source, such as a nearby lake basin, would potentially be a more reliable source to overcome these challenges in timing. Unnamed Lake represents the largest lake by surface area in the vicinity of Lake Geraldine and potentially provides the City with a long-term supplementation solution. Unnamed Lake's location also confers a logistical advantage relative to other lakes in that its location is relatively close to the Apex River, which could potentially be used to convey lake water part of the distance to Lake Geraldine, from where pumps could be used to bridge the shorter distance to the reservoir.

The benefits of using Unnamed Lake as a supplementation source must be weighed against the potentially negative effects of reduced outflows to the Apex River and, thus, the resulting reduction in river flow and hydroperiod. The potential ecological effects of such reduced flows and shortened hydroperiods within the Apex River will need to be evaluated and quantified to determine whether using Unnamed Lake is acceptable to the Nunavut Water Board (NWB). Establishing whether annual recharge to Unnamed Lake is sufficient to fully address the City's supplementation needs, over a range of historical meteorological and projected climate change conditions, within the constraints noted above is an important next step in identifying a long-term solution for the City of Iqaluit. Development of an integrated water balance model of Lake Geraldine (already constructed and calibrated by Golder) and Unnamed Lake is a critical step to completing this work.

1.2 Study Purpose

With the above context in mind, the main purposes of this scope of work were to:

- Determine whether Unnamed Lake represents a viable long-term supplementation source for addressing anticipated storage deficits in Lake Geraldine
- Develop a calibrated water balance model that may be used to address future decision-support requests from the City with regards to evaluating water supply and supplementation requirements under variable meteorological or water consumption conditions.

1.3 Report Objectives

This report addresses a number of specific objectives as set out in Golder's proposal P20146631, dated June 22 2020, within the context of three water consumption scenarios (no consumption, low consumption (100,000 m^3/month) and high consumption (115,000 m^3/month)) under historical (2008 to 2017) and future (2050s and 2080s) climate conditions, including:

- Expected dates of melt and freeze up (before, and after, which supplementation is considered unviable, respectively);
- Daily precipitation amounts and corresponding water budget surpluses entering Lake Geraldine and Unnamed Lake;
- The resulting daily lake level and available water storage within Lake Geraldine and Unnamed Lake (assuming supplementation of Lake Geraldine with water from Unnamed Lake is applied in those years when Lake Geraldine storage deficits are identified at freeze-up), with a particular focus on the dates corresponding to melt and freeze-up;
- The additional precipitation and meteorological surplus required to replenish Lake Geraldine and Unnamed Lake (in the absence of supplementation);
- Required pumping rates to compensate for Lake Geraldine storage deficit (difference between current reservoir volume and full capacity) at the end of the open water season based on model-predicted water levels following the spring freshet;
- The implication to flow contributions to the Apex River from Unnamed Lake (in those years when supplementation from Unnamed Lake is required); and
- The estimated maximum and minimum lake levels that can be used for storage volume and extraction.

2.0 CONCEPTUAL MODEL

The combined water balance model of Lake Geraldine and Unnamed Lake is intended to capture the same hydrologic processes in the previous Lake Geraldine model developed in Golder (2013) and refined over subsequent water balance assessments conducted for the City of Iqaluit. The calibrated parameters used in the most recently developed model for Lake Geraldine were applied to the Unnamed Lake model, with some exceptions. Measured data in Unnamed Lake were scarce and not available year-round and it was not possible to develop a full site-specific calibration for Unnamed Lake. Golder does not anticipate that the selected values for the calibration parameters (referred to ice formation processes and correction factors for evaporative processes) would significantly differ between the two watersheds. The combined water balance models for Lake Geraldine and Unnamed Lake were developed to run continuously for a period of ten years (simulating various historic and future climate conditions and consumption scenarios), including during the winter period as melting of snow and ice, sublimation, and ice formation processes are represented.

The objective of pumping activities is to provide enough supplementation volume to fill Lake Geraldine prior to freeze-up in order to minimize any potential storage deficit over the winter period. The model assumes that pumping would take place from Unnamed Lake to Lake Geraldine to compensate for storage deficit in the four weeks prior to freeze-up. Performing pumping activities closer to freeze-up (end of summer) is more efficient as only one pumping period is needed. Pumping activities may take place earlier in the season, however additional pumping may be needed to top up Lake Geraldine prior to freeze-up.

In the context of this report, reservoir storage deficit refers to spare reservoir storage capacity in the reservoir prior to freeze up. The water balance model is represented conceptually in Figure 1, which illustrates the hydrological processes acting on both lakes including water withdrawal for the City of Iqaluit and pumping from Unnamed Lake to supplement Lake Geraldine.

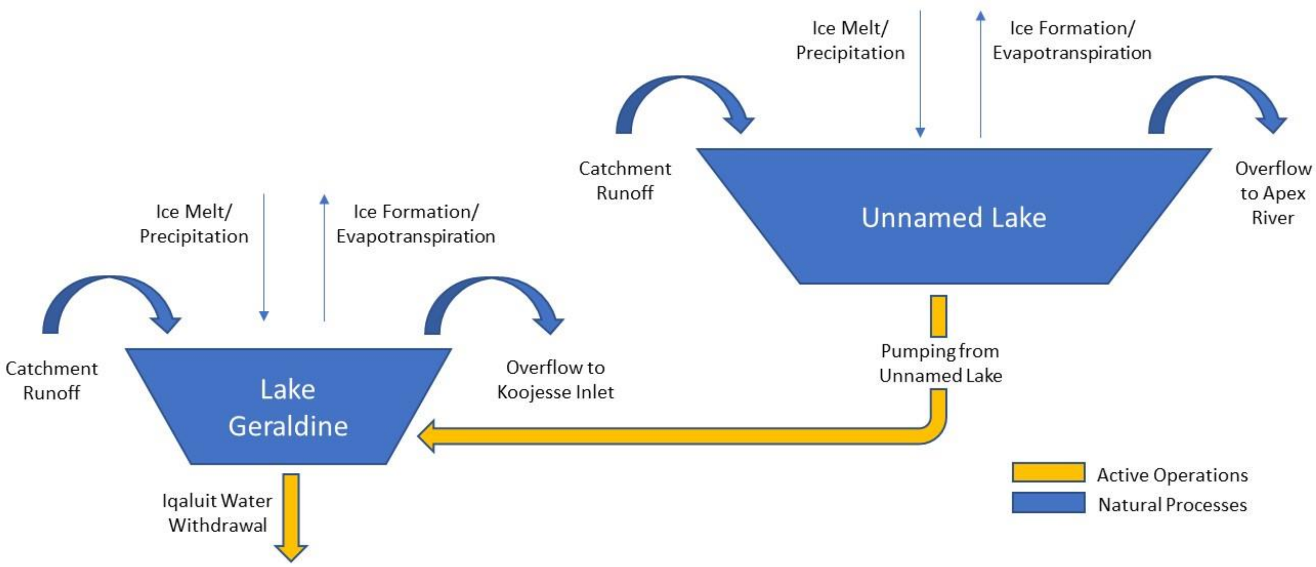

Figure 1: Conceptual Model of Lake Geraldine and Unnamed Lake Water Balance

2.1 Existing Water Balance Model for Lake Geraldine

A water balance model of the Lake Geraldine watershed and reservoir was previously developed and has been applied to numerous water supply forecasts for the City, most recently in May, 2020 (Golder 2020). The calibration of the Lake Geraldine model has been refined over the years and has generally decreased model error over time, particularly with respect to water level and water supply predictions.

The Lake Geraldine model was developed in Goldsim, which is a graphical, object-oriented computer program for carrying out dynamic, probabilistic simulations (Goldsim Technology Group 2018). The object-oriented nature of the software allows for complex simulation models to be constructed by combining different function, stock, and input elements. In the case of the Lake Geraldine water balance model, a stock element is used to represent volume of the lake, while function elements describe the hydrological processes that affect it, and input elements are used to describe meteorological data or supplementation inputs as well as consumption losses.

The existing Lake Geraldine model setup incorporates specifics regarding catchment size, topography and land use, a representation of snow-melt, ice-melt and freeze rates that respond to air temperature, a stage-storage and spillway representation of the reservoir as well as calibrated soil storage capacity, sublimation and evapotranspiration configurations that are used to convert recorded precipitation into run-off values.

The data inputs required to drive the existing Goldsim model include meteorology (historic, real time, future or a combination of these), a recent water level measurement (to initialize existing water storage within the reservoir) and projected water consumption and supplementation inputs, each provided at a daily timestep.

2.2 Cloning, Reconfiguration and Validation of the Lake Geraldine Water Balance Model for Unnamed Lake

On the basis that the existing Lake Geraldine model provides a reasonable representation of the water balance dynamics in the area surrounding Iqaluit, the approach adopted for this scope of work was to clone the existing Lake Geraldine model, reconfigure it to physiographic specifics of the Unnamed Lake catchment and lake basin and validate it to measured water level data and outflows collected by Stantec (2019) between 2018 and 2019.

2.3 Determination of Long-Term Supplementation Requirements for Lake Geraldine

The amount of water required to supplement Lake Geraldine before winter freeze-up is conservatively estimated as the amount of water needed to fill Lake Geraldine prior to freeze-up. Although the demand over the winter months is typically lower than the full volume of Lake Geraldine, the volume to fill Lake Geraldine is used to account for the volume of water locked up in ice formation and growing water demand in the future.

2.4 Determination of Long-Term Water Supplies in Unnamed Lake

The combined water balance model of Lake Geraldine and Unnamed Lake allows for the volume of Unnamed Lake to be simulated in response to changing meteorological conditions and pumping scenarios which are affected by water withdrawal rates of Lake Geraldine. The change in volume of Unnamed Lake is to be examined with and without pumping to illustrate the impact of supplementation on Unnamed Lake.

2.5 Determination of Flow Responses in Apex River

Outflow from Unnamed Lake to the Apex River is included in the conceptual model for Lake Geraldine and Unnamed Lake. This allows for the examination of flow rates in response to both climate change and pumping rates based on the required supplementation volumes for Lake Geraldine.

3.0 DATA REVIEW

The data review presented throughout Section 3 of this report specifically focuses on new data reviewed for the purposes of developing and validating the Unnamed Lake portion of the combined water balance model. It is noted that the water balance model configuration for Lake Geraldine has remained unchanged from recent work completed by Golder for the City of Iqaluit in June 2020. For a discussion of data used as input and for validation of the Lake Geraldine module, please refer to Golder (2013).

3.1 Watershed Topography and Catchment Delineation

Data collected via a LIDAR survey, completed by Tetra Tech Canada between August 16 and 17 2019, were used for the purposes of characterizing watershed topography and delineating the watershed draining to Unnamed Lake. Based on the topography, high points were identified in the bathymetric maps which suggested some portions of Unnamed Lake would become disconnected from the main body of the lake (referred to as the Central basin) under low water level conditions. Golder assumed that pumping would take place from the main body of Unnamed Lake, therefore once water is depleted beyond a certain level, it was assumed that water stored in some of these basins would not be available for supplementation activities. The sub-catchments of the Unnamed Lake watershed delineated from these data are illustrated in Figure 2. Unnamed Lake is made up of three main lake basins referred to in this report as the North, Central, and South basins which fall into Catchment A, B, and C, respectively. Catchment D is assumed to contribute intermittent flow to the South basin, while Catchment E denotes the ponded area that includes the lake outlet. The total catchment area of the Unnamed Lake watershed was found to be approximately 748 hectares.

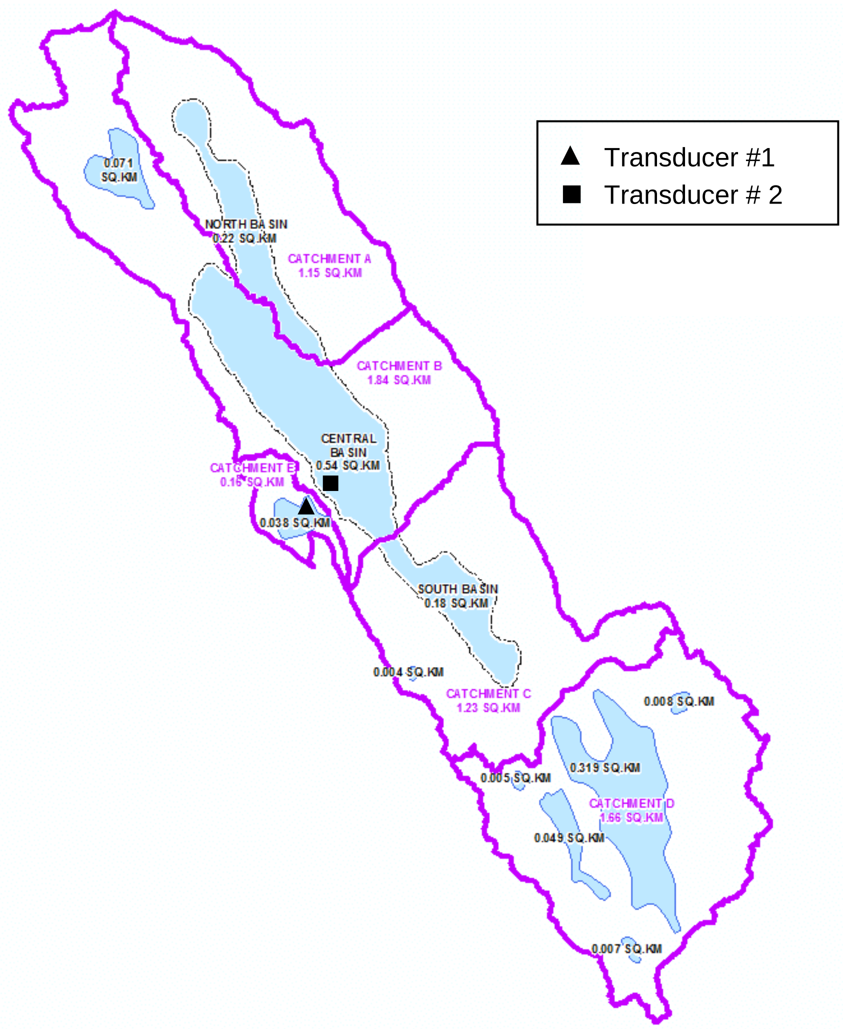

Figure 2: Sub-catchment Delineation of the Unnamed Lake Watershed and Monitoring Locations

3.2 Surficial Geology

The land use and cover types which make up the Unnamed Lake catchment area used in this assessment are taken from a surficial data model developed by Geological Survey of Canada (2018) with a map scale of 1:100 000. The percentage of total catchment area for the land use and soil types considered for both Lake Geraldine an Unnamed Lake are shown in Table 1. Lake Geraldine is composed mostly of till veneer with a small amount of bedrock and a lake area of 8%. In contrast, Unnamed Lake is composed mostly of till blanket with almost a quarter of the area made up of till veneer. The percentage of lake area is also slightly larger in Unnamed Lake at 13%. Despite the difference in land use and soil composition between catchments, it may be expected that a similar amount of meteorological surplus is generated between catchments. Although the catchment of Unnamed Lake has a greater percentage of water and lake area, Lake Geraldine has a higher percentage of bedrock which has a lower water holding capacity compared to till blanket and veneer soil types.

Table 1: Catchment Composition of Land Use and Soil Types for Lake Geraldine and Unnamed Lake

Land Use Type	Lake Geraldine	Unnamed Lake
Till Veneer	78%	23%
Till Blanket	0%	58%
Bedrock	9%	1%
Water	5%	7%
Lake	8%	13%

3.3 Bathymetry

The bathymetric data for Unnamed Lake were obtained from a bathymetric survey completed by Tetra Tech Canada (Tetra Tech) conducted between July 23 and 25, 2019 and summarized in Tetra Tech's Iqaluit DFO Bathymetric Lake Surveys Report, dated July 31, 2019.

3.4 Water Consumption

The water balance assessment presented in this report considers three water consumption scenarios for the City of Iqaluit as used in Golder (2020). These scenarios include:

- No Water Consumption Scenario – 0 m^3/month (0 m^3/day);
- Low Water Consumption Scenario – 100,000 m^3/month (3,335 m^3/day);
- High Water Consumption Scenario – 115,000 m^3/month (3,850 m^3/day).

3.5 Lake Outlet Configuration

In the absence of cross-sectional survey data with which to characterize the lake outlet, a rating curve for the lake was estimated to match measured flows at (ID) UNL-1 with corresponding lake level measurements for Unnamed Lake over the period between June 7th, 2019 and October 15th, 2019. This period was selected to cover peak water levels occurring at the start of spring freshet and receding water levels that follow. Some of the flow measurement data did not fit the expected range of flow vs. water level relationships and were excluded as outliers to better capture the observed water level and outflow observations.

3.6 Pump Location and Configuration

The 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019) involved the installation of two submersible pumps in the northwest portion of the Unnamed Lake central basin. Although the installation of these pumps was considered temporary, it was assumed that the same pumping configuration would be used for future supplementation activities from Unnamed Lake. The depth at which the pumps were installed was not provided in Stantec (2019), therefore it was assumed that the pumps would be installed deep enough in the central basin, such that supplementation would not be limited by lower lake water levels.

3.7 Supplementation Requirements and Pumping Rates

All supplementation requirements identified for Lake Geraldine were assumed to be acquired from Unnamed Lake in the four weeks prior to predicted freeze-up, noting that the date of freeze up each year varies according to differences in the historic (2008 through 2017) meteorological record and future climate change projections.

Pumping rates for dewatering from Unnamed Lake for the period between August 25th, 2019 and October 1st, 2019 were provided by the City of Iqaluit and used to characterize daily water taking volumes during model validation, as well as to add context to the pumping rates calculated in this report for alleviating predicted reservoir storage deficit in Lake Geraldine.

3.8 Meteorology

3.8.1 Historical Conditions

The same historical meteorological dataset used in Golder (2019), featuring precipitation, air temperature, wind speed and relative humidity records for the 2008 through 2017 period, was applied to this study. As a reminder of the 2019 approach, historical meteorological records were predominantly obtained for Iqaluit Climate (Station ID: 2402592) and supplemented with data from the four overlapping years (2008 through 2011) of data recorded at Iqaluit A (Station ID: 2402590). A few minor remaining data gaps of a few days or less were identified for wind speed and relative humidity (both used in the determination of potential evapotranspiration estimates) as well as precipitation and air temperature. To develop a complete meteorological record for the water balance model, these data gaps were filled using linear interpolation. The historical meteorological records for calendar years 2008 through 2017 were selected to represent baseline climate conditions for Iqaluit

3.8.2 Projected Future Meteorological Conditions under Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is generally considered to be the definitive source of information related to past and future climate change as well as climate science. As an international body, the IPCC provides a common source of information relating to emission scenarios, provides third party reviews of models, and recommends approaches to document future climate projections. Periodically, the IPCC issues assessment reports summarizing the most current state of climate science. The Fifth Assessment Report (AR5) (IPCC 2013) represents the most current complete synthesis of information regarding climate change to date. The next assessment report (Sixth Assessment Report) is anticipated in 2022 and will build on the results from AR5.

Future climate is typically projected using GCMs that involve the mathematical representation of global land, sea, and atmosphere interactions over a long time period. These GCMs have been developed by different government agencies but share common elements described by the IPCC. The IPCC does not run the models but acts as a clearinghouse for the distribution and sharing of the model forecasts. Future climate projections are made using scenarios that incorporate different representative concentrations pathways (RCPs) to drive the GCM simulations. The RCPs represent different trajectories for radiative forcing due to mainly anthropogenic influence on the climate cycle. The pathways are named after the radiative forcing projected to occur by 2100. Future climate projections are available from about 30 GCMs and four representative concentration pathways (RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5) in AR5. Further details regarding each of the RCP scenarios and how they relate to the Special Report on Emissions Scenarios (SRES) from AR4 are provided in Table 2.

Table 2: Characterization of Representative Concentration Pathways

Pathways	Radiative Forcing in 2100	Characterization
RCP 8.5	8.5 W/m²	Increasing greenhouse gas emissions over time, with no stabilization, representative of scenarios leading to high greenhouse gas concentration levels; and comparable to the SRES A2/A1FI scenarios.
RCP 6.0	6.0 W/m2	Without additional efforts to constrain emissions (baseline scenarios); and comparable to SRES B2 scenario.
RCP 4.5	4.5 W/m²	Total radiative forcing is stabilized shortly after 2100, without overshoot. This is achieved through a reduction in greenhouse gases over time through climate policy; and comparable to SRES B1 scenario.
RCP 2.6	2.6 W/m²	"Peak and decline" scenario where the radiative forcing first reaches 3.1 W/m² by mid-century and returns to 2.6 W/m² by 2100. This is achieved through a substantial reduction in greenhouse gases over time through stringent climate policy.

Downscaling procedures allow GCM model output to be represented at a finer spatial scale which better represents local climate. Statistical downscaling refines GCM projections by incorporating observed data, and statistical methods are applied to allow for a better match between local observed climate and historical GCM model output. These methods are then applied to future GCM projections which are assumed to be more representative of local climate. This report focuses on analysis using the statistically downscaled daily data using the Bias Correction/Construction Analogues with Quantile mapping reordering version 2 (BCCAQv2) model from ClimateData.ca (ClimateData 2019). Climate variables of daily minimum and maximum temperature and precipitation values were obtained from these datasets. Three RCP scenarios (RCP 2.6, RCP 4.5, and RCP 8.5) are currently available from ClimateData.ca for the BCCAQv2 model and are used in this report.

Since no one model or climate scenario can be viewed as completely accurate, the IPCC recommends that climate change assessments use as many models and climate scenarios as possible, or a "multi-model ensemble". For this reason, the multi-model ensemble approach is used to delineate the probable range of results using percentiles. The percentiles are used to show the distribution of projected changes. This allows for uncertainty in the projections to be understood, while the 50th percentile is used to illustrate general trends. For critical infrastructure, selection of future projections at higher percentiles and higher return periods should be considered. For example, for critical infrastructure whose failure is considered unacceptable, a 95th percentile could be considered over the typical 50th percentile. The projected changes in climate for the site were calculated using three separate time periods including:

- Model baseline (2008 to 2017) – this time-period represents the current climate conditions for which the changes are estimated using each member of the multi-model ensemble.
- Mid-century (2041 to 2070) – used to represent changes in climate projected for the near future.
- End-of-century (2071 to 2100) – used to represent the furthest projections into the future possible with the available climate model scenarios. Changes in climate are typically greater for this period compared to the mid-century for the RCP4.5 and RCP8.5 scenarios.

3.9 Lake Levels

Pressure transducers were installed by Stantec in September 2018 and June 2019 to assess the impact of water withdrawal on Unnamed Lake water levels. A total of three transducers were installed, including one in the central basin of Unnamed Lake and two in the sub-basin where the outlet is located as shown on Figure 2. Data are available continuously on a daily basis from late September 2018 to mid-October 2019 (Figure 3). Peak water levels during the 2019 spring freshet are captured, along with the recession of water levels to follow. Here the peak water level is shown to be approximately 0.7 m above the estimated lake outlet elevation. Lake freeze-up is also captured and is characterized by a decrease in the measured water level due to reduced pressure levels from ice formation. The water levels in the central based measured by transducer 2 were used to validate the simulated water levels and develop the lake outflow rating curve.

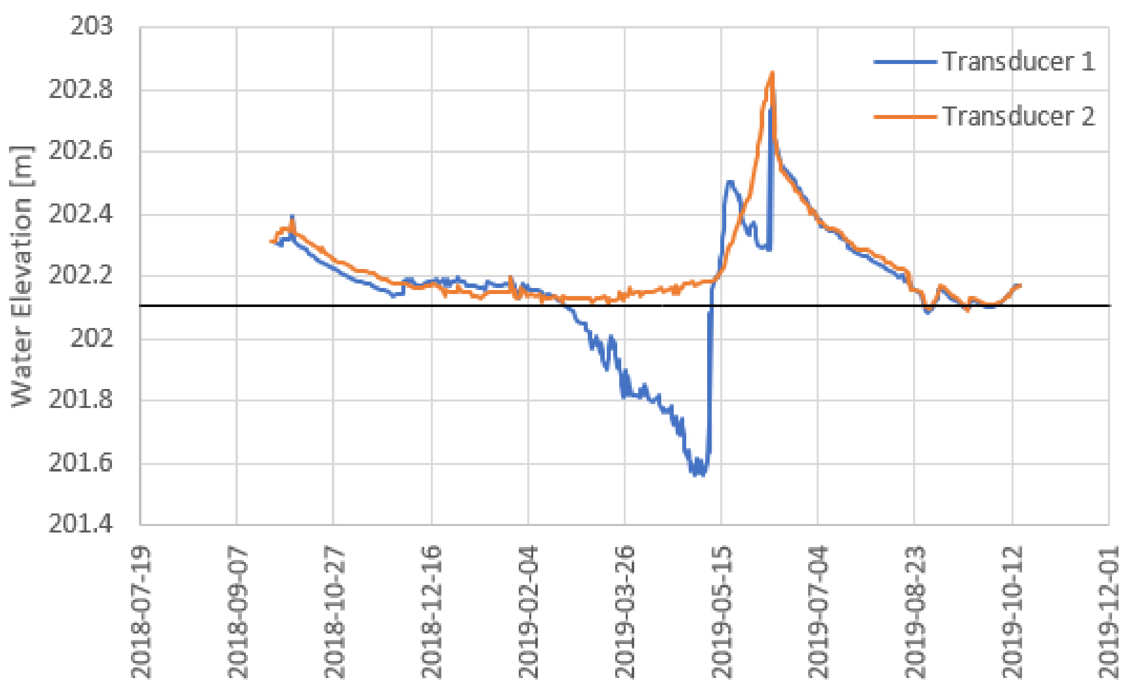

Figure 3: Measured Unnamed Lake Water Elevations from Transducer 1 (Lake Outlet Basin) and Transducer 2 (Central Basin) from Stantec (2019)

3.10 Flows from Unnamed Lake

Outflow rate from Unnamed Lake were measured downstream on the north branch of the Apex River in the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019). Only limited data are available, as flows were only recorded from August 25th, 2019 to October 1st, 2019, and included missing days where monitoring equipment was not operational. It should be noted that due to the downstream location of the measurements, flow rates may also be influenced by runoff from contributing areas between the lake outlet and the flow monitoring location. Because of this, the streamflow measurements were prorated based on the ratio of drainage areas between that of the Unnamed Lake outlet and the point at which measurements were taken when developing the outlet rating curve in Section 4.2.

3.11 Apex River Flows

Flow rates for the west branch of the Apex River were obtained from the Water Survey of Canada for the years corresponding to the baseline meteorological period of 2007 to 2018. These flow rates are used for comparison to Unnamed Lake outflow rates and the reductions in outflow as a result of supplementation to Lake Geraldine.

4.0 METHODOLOGY

This section details the methodology used to develop mathematical models of the Lake Geraldine and Unnamed Lake water balance considering the geometry of the lakes, effects of ice formation and melt, meteorological conditions for both current and future climate conditions, and water withdrawal from Unnamed Lake to Lake Geraldine. The model validation process is then discussed along with a description of how the model was simulated.

4.1 Development of Unnamed Lake Inflow Representations

Inflow to Unnamed Lake was represented using the same methods as Lake Geraldine in Golder (2019), Golder (2018a/b/c) and Golder (2013). Each of the sub-catchments shown in Section 3.1 is split into different reservoirs which store a limited quantity of water prior to reaching the lake. The water holding capacity for each of these reservoirs are based on the different land surface types of each sub-catchment, consisting of till veneer, till blanket, bedrock, and water surfaces. When rainfall reaches the surface of the catchment, runoff to the lake is generated when the water holding capacity is exceeded for each of the different surface reservoirs.

4.2 Development of Stage-Storage Relationship for Unnamed Lake

To represent the geometry of Unnamed Lake, stage-storage curves are needed to describe the cumulative volume of the lake with increasing elevation from the base. Upon review of the lake bathymetry discussed in Section 3.2, it was decided that the lake be modelled as five connected reservoirs which fill and spill into one another until water eventually flows over the lake outlet when its elevation is exceeded. Because of this, five separate stage storage curves are used to represent the geometry of Unnamed Lake.

Stage-storage curves were developed using the bathymetry survey provided Tetra Tech using geographical information system (GIS) software. However, the survey data did not include bathymetry for Watershed E where the lake outlet is located, and the ponded area on the northern edge of Watershed A. Therefore, assumptions needed to be made to obtain stage-storage relationships for these catchments. The resulting stage-storage curves used for Lake Geraldine and Unnamed Lake are provided in Appendix B.

First, the lake outlet invert elevation was estimated to be at an elevation of 202.1 m by plotting Apex N-1 flowrates and water level pressure transducer readings measured during the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019). The bottom elevation of the pond in Catchment E was taken as the lowest pressure transducer reading for the year of 2019 in Stantec (2019). Next, the water surface area at the outlet invert was assumed as 0.03 km^2 based on the indicated water surface areas provided in (Figure 2). The pond storage was assumed to vary linearly from the bottom elevation to the outlet invert. For elevations above the outlet invert, lidar data were integrated to obtain the stage-area relationship.

The invert elevation of the shallow pond on the northern edge of Watershed A was taken from the edge of the bathymetry survey data. The mapped pond area of 0.035 km^2 (Figure 2) was assumed to correspond to the water surface at the invert elevation. The depth of the pond was assumed to be 0.5 m, with storage varying linearly from the bottom of the pond to this invert elevation. Above the water surface, lidar data were integrated to construct the stage-storage relationship. The mathematical form of the stage-storage relationship is represented as:

$$Q_{UNL} = 2.562 \cdot (H_E - 202.05)^3$$ Equation 2

where Q_{UNL} represent the outflow from Unnamed Lake in m^3/sec, and H_E is the water elevation (metres above sea level) in catchment E.

4.3 Effects of Ice Formation on Reservoir Storage

The effect of ice formation and melt on reservoir storage was included in the Lake Geraldine water balance model in Golder (2020) and is used to represent the same processes at Unnamed Lake. As weather conditions become colder, ice begins to form moving water to a separate reservoir element in the model. During the spring when weather conditions become warmer, ice begins to melt and moves back into lake storage. Ice formation and melt parameters for both Lake Geraldine and Unnamed Lake were adjusted to provide more realistic ice depths and peak water levels during spring freshet. After the adjustments, simulated annual maximum ice depths range from approximately 1.3 to 1.8 m under current climate conditions.

4.4 Representation of Water Withdrawal from Unnamed Lake

During the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019), water was pumped from the central basin of Unnamed Lake into the Apex River, then pumped from the Apex River to Lake Geraldine further downstream. For the purpose of this assessment, available water is pumped from Unnamed Lake directly to Lake Geraldine. The amount of pumped water is assessed by first simulating Lake Geraldine storage deficit prior to freeze-up conditions in each year. Based on this deficit amount, pumping rates are calculated by assuming that the entire storage deficit will be pumped from Unnamed Lake over a 4-week period. No assumptions are made based on the elevation of the pump invert, and that all available water within the central basin is available for pumping.

4.5 Development of Water Balance Model

The water balance model for Unnamed Lake was initially developed as a clone of the Lake Geraldine water balance model, as many parameters will share similarities due to the proximity of the lakes. These include parameters related to water holding capacity for similar soil types in the contributing catchment area and meteorological inputs (precipitation, temperature, and evapotranspiration). The geometry of the lakes are substantially different, therefore significant modifications to the structure of the model were needed. to account for the presence of multiple basins in Unnamed Lake and connectivity between them.

Bathymetry surveys for Unnamed Lake identified 3 main basins (north, central, and south), along with 2 smaller storage areas (pond north of the north basin and outlet basin west of the main basin). Stage-storage relationships were developed in Section 4.2 and applied to each of the basins. The lake outlet also needed to be developed specifically for Unnamed Lake to provide realistic simulated water levels in comparison to the measured data. The combined water balance model for Lake Geraldine and Unnamed Lake was developed to run continuously for a period of ten years (simulating various historic and future climate conditions and consumption scenarios), including the winter period as melting of snow and ice, sublimation, and ice formation processes are represented.

4.6 Development of Future Climate Meteorology

This report focuses on analysis using the statistically downscaled daily data from ClimateData.ca, which uses the Bias Correction/Construction Analogues with Quantile mapping reordering version 2 (BCCAQv2) downscaling model (ClimateData 2019). The use of statistically downscaled projections allows for GCM model output to be represented at a finer spatial scale which better represents local climate. Statistical downscaling is used to refine GCM projections by incorporating observed data into statistical methods that, when applied, allow for a better match between local observed climate and historical GCM model output.

Although the GCM model output has been downscaled, bias still typically exists in the form of drizzle (more frequent wet days) and underestimation of heavy precipitation events. This is due to the use of gridded observed datasets in the statistical downscaling procedure, which may have been based on sparse observations. To further mitigate model bias, this methodology uses a change factor approach to calculate changes in climate between a model baseline period, and a set of future periods. The changes are then applied to the observed dataset, effectively scaling the site level observations for future climate change (see Appendix for details). The current climate and future climate periods used in this work are defined as:

- 2008 – 2017 (current climate baseline)
- 2041 – 2070 (2050s future period)
- 2071 – 2100 (2080s future period)

The drawback of this approach is that the future scaled observations are limited to the length of the observations (2007 through 2017). To improve the robustness of the water balance assessment, this period is extended using a weather generator approach. The K-nearest neighbor weather generator of King et al. (2014) known as KnnCADv4, is a multivariate, non-parametric weather generator, that can generate long synthetic climate series by resampling historical data with replacement. Using this approach, 10 alternate replications of future scaled precipitation and temperature series are generated, resulting in a total of 100 years of climate inputs for each climate scenario. This allows for the impact of variability in climate through wet and dry day sequencing and timing of precipitation events to be assessed in the water balance model.

Climatedata.ca provides 72 statistically downscaled daily Canada-wide climate scenarios, at a gridded resolution of roughly 10 km for the simulated period of 1950-2100 (Climatedata.ca 2020) with projections ranging from 1950 through to 2100. Since no one model or climate scenario can be viewed as completely accurate, the IPCC recommends that climate change assessments use as many models and climate scenarios as possible, or a “multi-model ensemble” to capture uncertainty in future climate.

Incorporating all 72 models into the water balance assessment is not feasible for this scope of work, therefore the general approach discussed in Murdoch and Spittlehouse (2011) is used to select a subset of climate scenarios likely to capture the range of impacts in the water balance assessment. In the approach, the range of uncertainty is captured by first calculating climate indices that are likely to be correlated with the range of outcomes in the water balance assessment, then identifying the scenarios that capture the range of the climate indices by using the most extreme cases or a set of percentiles. For this water balance assessment, scenarios are identified which correspond to 10th, 50th, and 90th percentile changes in water year total precipitation for the 2050s and 2080s future periods. It is expected that the water year total precipitation will allow for the range of uncertainty to be reasonably captured, as this parameter will likely have the largest impact on the water balance assessment.

4.6.1 Climate Change Factor Application

Climate change factors are calculated from the modelled baseline period (2007 through 2017) to the future periods (2050s and 2080s). The multi-change factor approach of Anandhi et al. (2011) is used such that change factors are calculated across the distribution temperature and precipitation variables, allowing for changes in climate extremes to be represented. Due to the seasonal nature of the water balance assessment and the need to accurately represent ice formation and melt, multiple change factors are calculated separately for each month across the distribution of temperature and precipitation climate variables. The change factors are then applied to the month for which they were calculated and are interpolated across neighboring calendar months. Further details of the change factor approach used are provided in Appendix A.

The range of projected changes in temperature and precipitation (shaded area) and 50th percentile values (solid lines) on a monthly scale using this approach are shown in Figure 4. With respect to the total precipitation, a projected increase is found across all calendar months for both the 2050s and 2080s at the 50th percentile. A small increase in monthly precipitation is shown for most months in the 2080s compared with the 2050s; however, the range of projected changes is also greater with the potential for some months to have lower projected changes in the 2080s than the 2050s period. Average temperatures are also shown to increase for each calendar month at the 50th percentile, with the greatest changes found for the winter months. The range of projected changes across the model ensemble is greatest for the month of February, showing a nearly 10°C difference across projections.

Change factors are applied to the observed dataset additively, which allows for wet and dry spell lengths (number of consecutive days above and below 1 mm, respectively) to be modified based on the projected changes in the distribution of daily precipitation. This is an important consideration, as wet and dry spell lengths will influence water levels prior to precipitation events and affect peak water levels during prolonged wet periods. The resulting mean wet and dry spell lengths, compared to the observations, are shown on Figure 5. Wet spell length is shown to be relatively short on average, varying from approximately 1.3 to 2.6 days on average under current climate conditions. Dry spell lengths are typically longer ranging from 4 to 11 days on average. At the 50th percentile the projected changes in wet spell length are relatively minor in both the 2050s and 2080s with slightly longer wet spells from August to March. Dry spell lengths are expected to decrease at the 50th percentile, with the greatest change shown for the same months as the wet spell lengths. This indicates that due to climate change; the future is expected to become wetter with shorter dry periods, which may mean greater runoff volumes due to shorter drying periods between precipitation events. However, the range of projections for wet and dry spell lengths is large, as there is considerable uncertainty among model projections. This observation confirms that an ensemble approach should be taken for the water balance assessment.

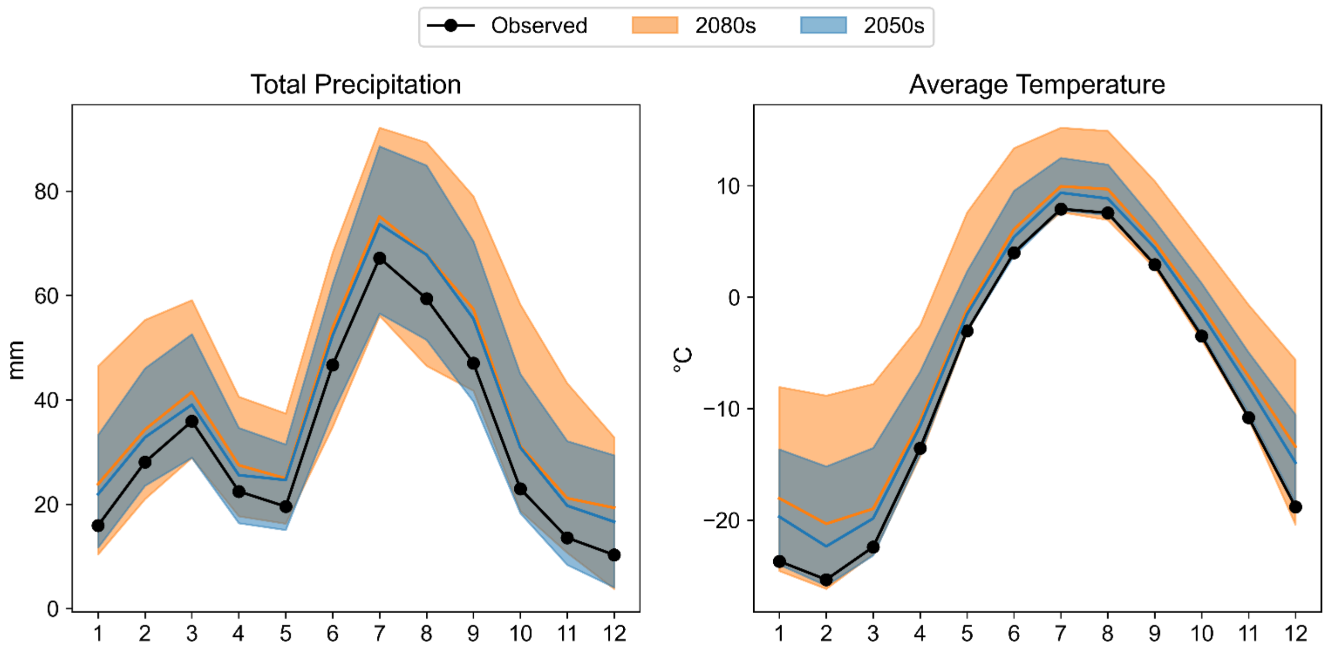

Figure 4: Range of Monthly Projected Changes in Total Precipitation and Average Temperature

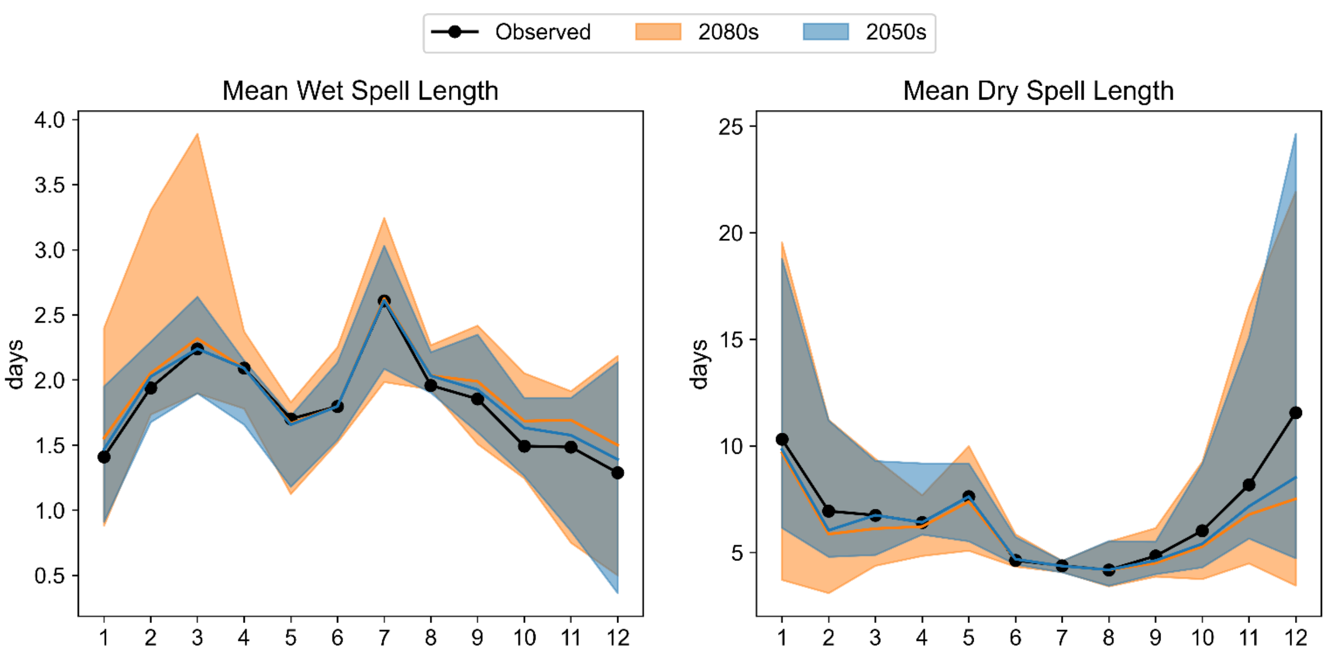

Figure 5: Range of Monthly Projected Changes in Mean Wet and Dry Spell Lengths

4.6.2 Weather Generation of Future Climate

The relatively short period of observations (2007 through 2017) only allows for limited climate variability to be assessed after climate change factors have been applied. Incorporating a weather generator approach allows for a longer period to be examined with an opportunity to explore climate variability including the sequencing of wet and dry periods, and the timing and magnitude of ice formation and melt which are key to the water balance assessment.

The K-nearest neighbor weather generator of King et al. (2014) known as KnnCADv4, is a multivariate, non-parametric weather generator, that can generate long synthetic climate series by resampling climate data with replacement. Using this approach, 10 alternate replications of both the historical (2007 to 2018) and future scaled (2050s and 2080s) precipitation and temperature series are generated, resulting in a total of 100 years of climate inputs for each climate scenario.

An important consideration when using a weather generator approach to generate synthetic climate timeseries is the ability to reproduce seasonal climate statistics. The generated climate series should preserve these statistics to reliably use the synthetic replicates for the water balance assessment. To test this, the observed dataset from 2007 through 2017 is replicated 10 times. The 10 replications are shown as a boxplot and compared to the original observations (solids line) in Figure 6. Using descriptive statistics of the precipitation distribution (total, mean, standard, deviation, high percentiles) as well as wet and dry spell lengths, it is shown that the weather generator is able to replicate the seasonal precipitation patterns at Iqaluit, while providing an extended timeseries that can be assessed.

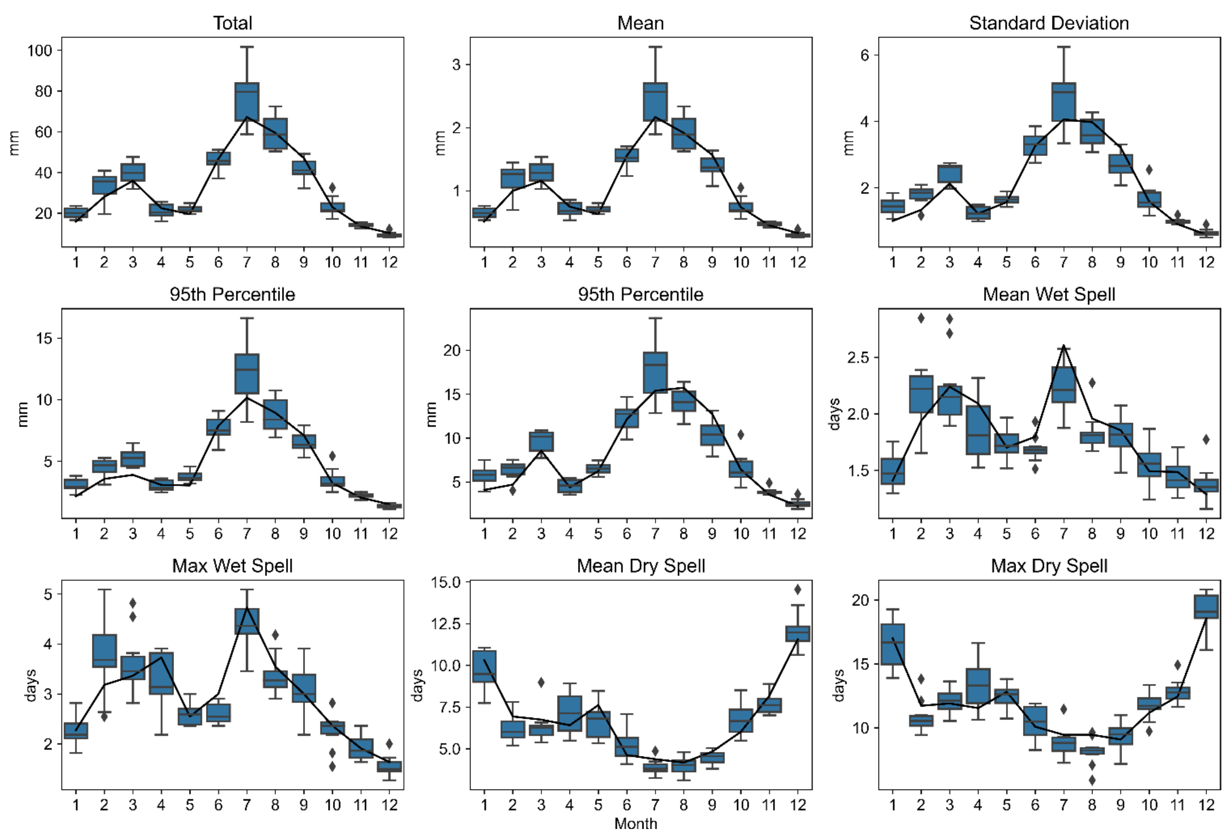

Figure 6: Comparison of Precipitation Statistics for Iqaluit Between Weather Generated Results and Observations for the Period of 2007 through 2017

Accurately capturing observed temperature statistics in the weather generated timeseries is important for simulating the timing and magnitude of ice formation and break up in Iqaluit. In Figure 7 key temperature statistics related to mean daily values, distribution statistics, and the temporal autocorrelation are compared between weather generated and observed data series. The comparison shows that the seasonal variation of temperature statistics is satisfactorily replicated by the weather generator. Using this approach, climate variability can be assessed by using the weather generated outputs as inputs to the water balance model for Lake Geraldine and Unnamed Lake. This allows for the impact of alternate wet and dry day sequences, as well as variability in the timing of lake ice formation and melt, to be assessed. To mitigate the potential for non-stationary conditions to occur in the water balance model due to the use of the extended, weather generated timeseries, the water levels are reset to their initial values at the start of each weather generated climate replication (approximately every ten years).

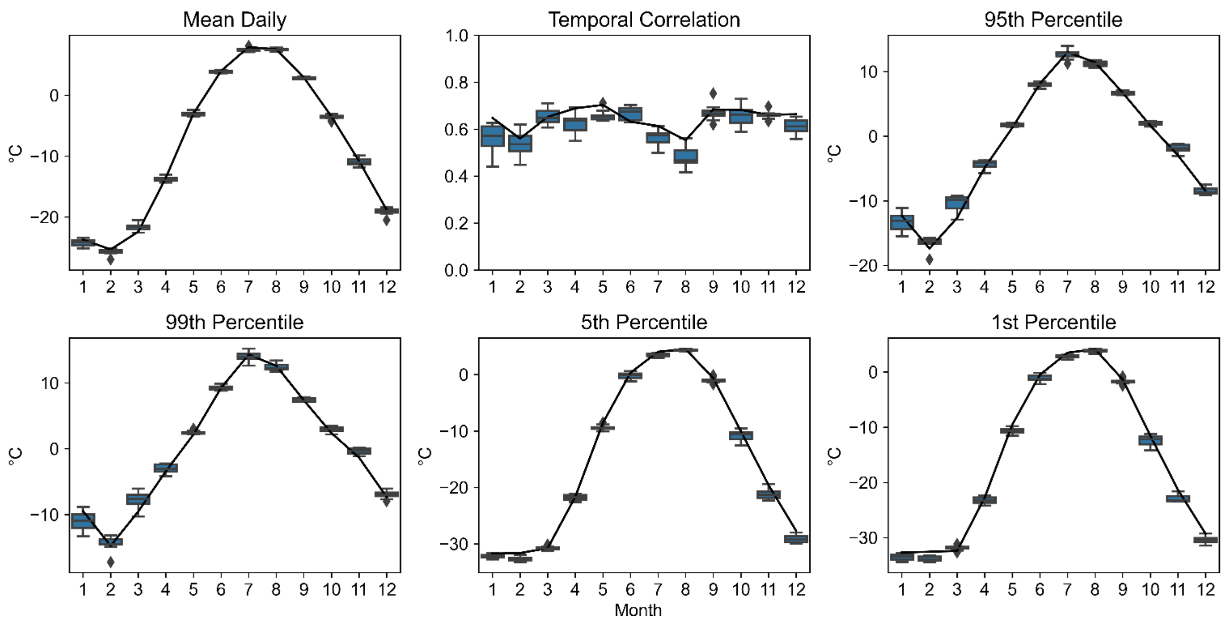

Figure 7: Comparison of Temperature Statistics for Iqaluit Between Weather Generated Results and Observations for the Period of 2007 through 2017

4.7 Validation of Water Balance Model for Unnamed Lake

Validation of the Unnamed Lake water balance models relies on data collected during the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019), including lake water levels (Section 3.9 and Apex River flow rates measured downstream of the lake outlet (Section 3.10). The Apex River flow rate measurements provided by Stantec (2019) were found to be relatively sparse, with only 24 out of 27 days available during the measurement period of August 25th, 2019 to October 1st, 2019. Water levels were measured using pressure transducers installed in September 2018 and provided enough information to validate the model.

The time period used for validation was defined as June 7th, 2019 to October 15th, 2019 to focus on obtaining accurate peak water levels during the spring freshet, and the recession of water levels into the fall before freeze-up. Using this period also allowed for the effects of ice formation on the measured water levels to be avoided during validation.

Validation of the model focused on obtaining realistic simulated water levels by adjusting parameters related to ice formation and melt, as well as adjustments to the lake outlet rating curve. The final values for these parameters are provided in Table 3, and a comparison of simulated water levels to those measured during the period following the 2019 freshet is shown in Figure 8. The simulated water levels are shown to capture the peak water levels following spring freshet and the general shape of the water levels receding into the Fall.

Table 3: Selected Parameter Values for Goldsim Unnamed Lake Water Balance

Goldsim Variable Name	Description	Selected Value
Rating_Curve_Multiplier	Parameter used to describe the scale of the Unnamed Lake outlet rating curve	3
Rating_Curve_Exponent	Parameter used to describe the shape of the Unnamed Lake outlet rating curve	2.562 m^3/s
PET_Multiplier_UNL	Parameter used to scale potential evapotranspiration rates for Unnamed Lake	0.9[1]
Lake_Ice_Formation_Multiplier	Parameter used to scale ice formation rates to realistic ice depths for Unnamed Lake	3
Lake_Ice_Melting_Multiplier	Parameter used to scale ice melting rates to capture spring freshet water levels	4

[1] Potential evapotranspiration multiplier for Lake Geraldine has a value of 0.65. Multiplier was used primarily as a parameter to match simulated water levels

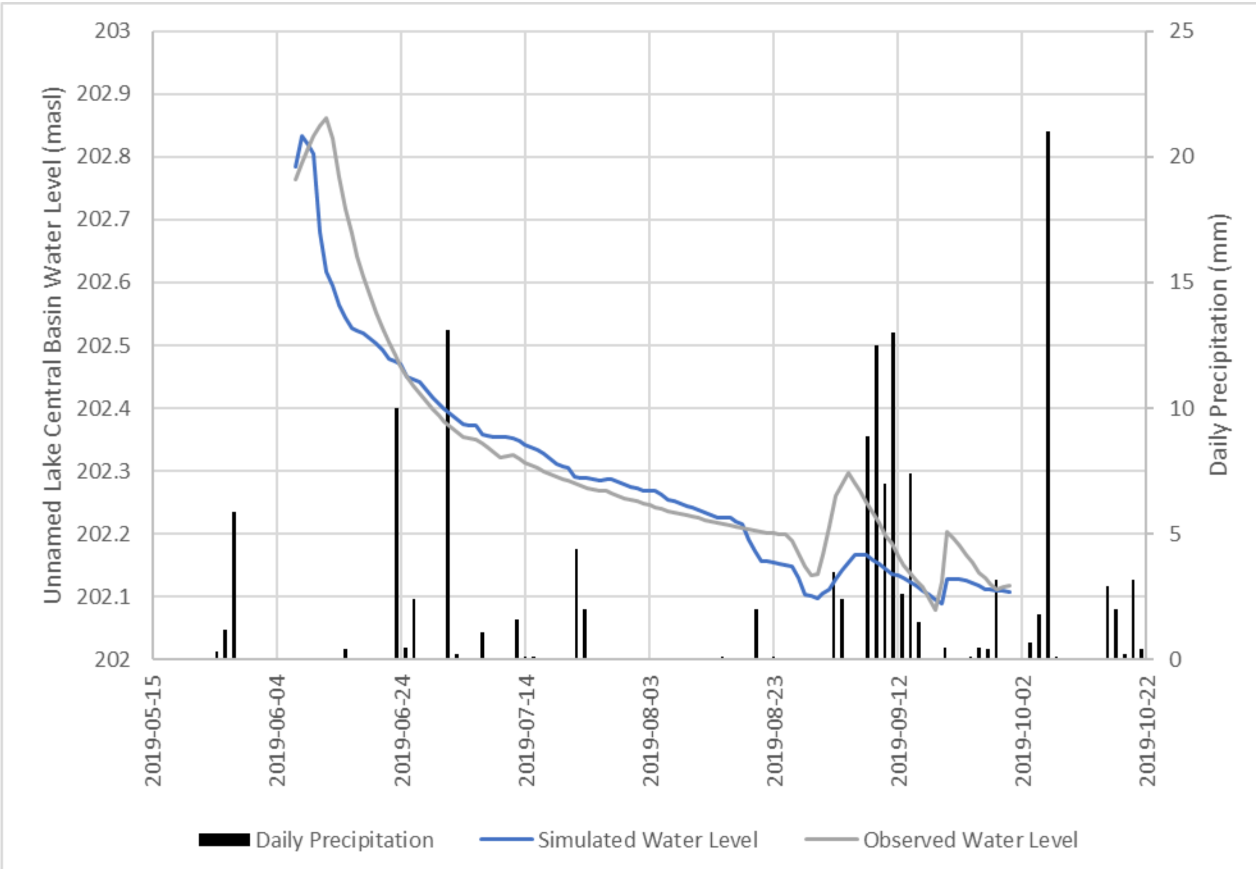

Figure 8: Comparison of Simulated Water Levels Versus Measured Following 2019 Spring Freshet

4.8 Simulation and Representation of Historical Meteorology Outcomes

The weather generated meteorological baseline for the 2007 to 2018 period provides a total of 100 years for water balance model simulation. All 100 years are included in a single simulation; however, the water level is reset every 10 years to its initial value. Using this approach, the extended timeseries allows for internal variability in meteorological conditions to be represented, without artificially introducing non-stationary hydrologic conditions for the lake water balance. It was verified that resetting the water level after every weather generated run did not introduce bias in the results as the water level reset did not result in consistently increasing water levels at the end of each 10-year period.

The results of the simulation are extracted for water levels in both Lake Geraldine and Unnamed Lake, storage deficit for Lake Geraldine, and lake outlet flow rates to the Apex River from Unnamed Lake under the three different consumption scenarios.

4.9 Simulation and Representation of Climate Change Meteorology Outcomes

The weather generated future climate timeseries for the 2050s and 2080s period were used to simulate supplementation of Lake Geraldine from Unnamed Lake (see Section 4.8). Uncertainty in the climate projections is represented using three different scenarios for each future period, consisting of the 10^{th}, 50^{th}, and 90^{th} percentile.

The results of the simulation are extracted for water levels in both Lake Geraldine and Unnamed Lake, storage deficit for Lake Geraldine, and lake outlet flow rates to the Apex River from Unnamed Lake under the three different consumption scenarios.

5.0 ASSUMPTIONS AND LIMITATIONS

Several assumptions were made to account for data and methodological limitations during the process of modelling the water balance of Lake Geraldine and Unnamed Lake. These include:

- All available water within the central basin of Unnamed Lake is assumed to be available for supplementation of water storage deficits in Lake Geraldine. Although none of the water storage deficits evaluated for Lake Geraldine in this assessment necessitated full withdrawal of water supplies with the central basin of Unnamed Lake, it is important to note that this assumption could lead to overestimates of the raw water supply under a different set of conditions.
- To obtain stage-storage relationships for the two un-surveyed pools within Unnamed Lake, linear relationships between stage and storage were used below the water surface measured using lidar. Additional assumption were made regarding the depth of these pools within Unnamed Lake, however due to their size relative to the main storage basins the impact of these assumptions are likely to be negligible.
- The outlet structure of Unnamed Lake was un-surveyed and very limited flow data were available to develop an accurate rating curve. Assumptions were made regarding the elevation of the outlet and a provisional rating curve was developed with the information available from the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019). A detailed survey should be carried out to confirm or refine this relationship and, if necessary, recalibrate the model.
- Measurements for ice thickness, formation, and melting rates were not available for Unnamed Lake. Because of this, assumptions were made regarding ice formation and melting rates to acquire realistic ice depths and spring freshet water levels. Additional measurements may be used to refine these assumptions in subsequent studies.
- While delineating sub-catchments for Unnamed Lake, it was found that Catchment D in Figure 2 was part of the lake watershed but did not contain one of the main basins (Central, North, and South). It was assumed that all runoff from this catchment routes directly to the South basin due to its proximity. If Iqaluit proceeds to develop the Unnamed Lake water supply alternative, this assumption should be confirmed and any berming or drainage alteration required to ensure water flows from Catchment D to the South Basin, should be considered.
- Sparse water level and flow information limited the ability to perform a full calibration of the Unnamed Lake model. Further monitoring of these parameters concurrently should be considered in order to perform a full model calibration.
- All ice formed within the reservoir is assumed to be inaccessible, and commensurately diminishes available water supplies, until the following spring freshet when it becomes available at a rate determined by meteorology and simplified model assumptions.
- For the incorporation of future climate into the 2007 to 2018 meteorological baseline, the change factor approach was used. In this approach changes in climate between a modelled baseline and future period are applied to the historical data. Therefore, it is assumed that any bias from the historical data is eliminated in the calculation of these changes.

- The use of climate scenarios corresponding to the 10th, 50th, and 90th percentile changes in water year precipitation was made to capture uncertainty in climate change while minimizing the number of scenarios to run through the water balance model. This method assumes that the variability in water year precipitation is directly linked to the outcomes of this assessment.
- The incorporation of climate change by calculating projected changes in the 2050s and 2080s future time periods allows for changes to be incorporated into the baseline meteorological data. However, with this method trends cannot be assessed. This is a limitation of the methodology, and if meteorological trends are to be assessed, a continuous future timeseries must be developed from the projections.
- The Water Balance model used in this assessment has been developed based on a methodology and functional knowledge familiar to the project team. Given the complexity of the model, it is possible that its use by third party consultants could render unreliable results. Accordingly, Golder accepts no responsibility for results or conclusions made by third party consultants using the water balance model.

6.0 RESULTS

The following sections present the results of the water balance analysis for Lake Geraldine and Unnamed Lake under each of the climate conditions described in preceding sections.

6.1 Water Balance Results for Historical Climate Meteorology

The water balance results considering historical climate conditions are discussed in the following sections, while results of the future climate changed meteorology water balance assessment are discussed in Section 6.2.

6.1.1 Water Balance Model Verification

The Lake Geraldine and Unnamed Lake water balance model was tested to ensure that the water balance holds true on a monthly basis. To perform this test, the following water balance equation was used to ensure that all components were captured:

$$\Delta Storage = (Rain + Snowmelt + Ice\ Melt) - (Evapotranspiration + Reservoir\ Evaporation + Ice\ Formation + Outflow) \quad \text{Equation 2}$$

The model considers rainfall rather than precipitation, because snow is accumulated within a snow storage layer, ultimately resulting in snowmelt, after accounting for snow storage losses due to sublimation. Ice melt and formation are included in this formulation due to lake ice being represented as a separate reservoir for the lake area in each catchment. Evapotranspiration and reservoir evaporation are distinguished from one another, as they are associated with different areas of the watershed (land and lake areas) and storage capacities. The water balance test is performed for baseline climate conditions under a no consumption scenario to verify that the configuration of the modelled watershed is valid.

The results averaged on a monthly basis are provided in Table 4 and Table 5 for Lake Geraldine and Unnamed Lake. Considering the same terms in Equation 2, it is shown the terms are well balanced on average for each month, as the volume of the remaining balance is much lower than the volume of the hydrologic processes occurring within the watershed for both Lake Geraldine and Unnamed Lake. Dividing the remaining balance across the catchment areas of Lake Geraldine and Unnamed Lake the balance is shown to be significantly less than 1 mm.

Table 4: Monthly Average Water Balance for Lake Geraldine

Month	Rain (m^3)	Snowmelt (m^3)	Evapotranspiration (m^3)	Reservoir Evaporation (m^3)	Outflow (m^3)	Ice Formation (m^3)	Ice Melting (m^3)	ΔStorage (m^3)	Balance (m^3)	Balance (mm)
Jan	1283	0	0	0	280	60894	0	-59866	-25	-0.007
Feb	0	0	0	0	246	63790	0	-64012	-24	-0.007
Mar	0	0	0	0	259	79374	0	-79607	-26	-0.007
Apr	3029	0	0	0	238	82186	116	-79346	67	0.019
May	45389	15255	2770	252	241	48434	17101	25745	304	0.087
Jun	153873	236746	67167	6109	365602	34995	438846	355582	10	0.003
Jul	268296	0	99570	9105	208541	35443	77877	-6611	126	0.036
Aug	207198	0	72237	6630	120942	35443	35443	7311	77	0.022
Sep	143850	0	35728	3250	92485	34876	30377	7814	73	0.021
Oct	49926	229	2200	200	39165	41535	13206	-19736	-3	-0.001
Nov	13013	0	7	1	1452	44612	134	-32903	-22	-0.006
Dec	1788	0	0	0	303	52752	50	-51195	-22	-0.006
Annual Total	887645	252230	279679	25547	829754	614334	613150	3176	535	0.154

Table 5: Monthly Average Water Balance for Unnamed Lake

Month	Rain (m^3)	Snowmelt (m^3)	Evapotranspiration (m^3)	Reservoir Evaporation (m^3)	Outflow (m^3)	Ice Formation (m^3)	Ice Melting (m^3)	ΔStorage (m^3)	Balance (m^3)	Balance (mm)
Jan	2757	0	0	0	0	194323	0	-191530	-36	-0.005
Feb	0	0	0	0	0	199440	0	-199404	-36	-0.005
Mar	0	0	0	0	0	247724	0	-247683	-41	-0.005
Apr	6508	0	0	0	0	256672	391	-249886	113	0.015
May	97528	32779	7907	933	59	156274	57614	22120	628	0.084
Jun	330627	508697	189054	22628	407849	117047	1408366	1510169	943	0.126
Jul	576490	0	260390	33726	624316	119529	251952	-211078	1559	0.208
Aug	445208	0	192610	24561	248844	119529	119529	-22156	1349	0.180
Sep	309091	0	100571	12040	193662	117603	102444	-13283	942	0.126
Oct	107277	492	6280	741	105279	140047	44537	-99890	-151	-0.020
Nov	27961	0	21	2	11644	149113	453	-132347	-19	-0.003
Dec	3843	0	0	0	275	172000	169	-168228	-35	-0.005
Annual Total	1907290	541968	756833	94631	1591928	1989301	1985455	-3196	5216	0.697

6.1.2 Predicted Precipitation and Surplus in Lake Geraldine and Unnamed Lake

After applying the gap-filled meteorology data (Section 3.8.1) and extending the baseline period using the weather generator methodology and water level reset function (Section 4.6.2) to the model, simulations were carried out for the three water consumption scenarios identified in Section 3.4 to ascertain the quantity of surplus that would need to be delivered to the Lake Geraldine Reservoir between predicted thaw and freeze-up of each year.

Table 6 and Table 7 provide a simplified presentation of key periods of interest for the 2008 through 2017 meteorological window considered in this assessment. This information is presented with a view of providing baseline information against which subsequent changes in precipitation and meteorological surplus due to climate change presented in Section 6.2.1 are compared.

Table 6 shows that a significant portion of total precipitation over the Lake Geraldine catchment is lost in the form of evapotranspiration either directly from ground surface or from soil and depression storage within the catchment. In the earliest portion of the open water season from thaw to June 30 the percentage of precipitation converted to meteorological surplus is above 100%. This is due to large amounts of snowmelt during freshet inflating the meteorological surplus amount in excess of precipitation. With cooling air temperatures and reasonable precipitation amounts, the proportion of rainfall translated to surplus is shown to peak in September. Although higher precipitation is typically observed in July and August, the amount of generated surplus is likely limited because of increased thermal exposure at ground surface (i.e., increased losses in the form of evaporation). Despite lower average temperatures in October than September, it is likely that a more significant portion of October rainfall is intercepted within soil storage and ground depressions, thus limiting catchment runoff to the reservoir. Another potential explanation for greater meteorological surplus in September compared to October may be the presence of early snow accumulation. Total meteorological surpluses in the final weeks (October) before freeze-up are limited relative to earlier portions of the open-water period and thus reduce the catchments capacity to fully replenish the reservoir before freeze-up occurs.

For Unnamed Lake the same meteorological inputs are used as in Lake Geraldine, however differences in surplus exist due to catchment area and surface characteristics such as soil and land use composition, therefore the percentage of precipitation converted to meteorological surplus is very similar between the two lakes.

Table 6: Average (Arithmetic) Precipitation and Meteorological Surplus for Lake Geraldine recorded for Iqaluit over the 2008 through 2017 Period

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	239	168	70%
Thaw through June 30 (Varies)	45	85	187%
July	77	41	54%
August	60	30	51%
September	42	24	58%
October 1 to Freeze-Up (Varies)[1]	26	13	49%
November 1 to Freeze-Up (Varies)[1]	3	1	22%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimated thaw, or identified date, to freeze up day) differs between years.

Table 7: Average (Arithmetic) Precipitation and Meteorological Surplus for Unnamed Lake recorded for Iqaluit over the 2008 through 2017 Period

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)	239	166	70%
Thaw to June 30 (Varies)	45	89	196%
July	77	40	52%
August	60	28	47%
September	42	23	55%
October 1 to Freeze-Up (Varies)	26	13	49%
November 1 to Freeze-Up (Varies)	3	1	22%

Notes:

1. Effective length of ice-free period (i.e., the number of days since estimated thaw, or identified date, to freeze up day) differs between years.

6.1.3 Predicted Reservoir Level and Storage Deficit at Freeze Up in Lake Geraldine

Obtaining estimates of Lake Geraldine water level and reservoir storage deficit at freeze up allow for the calculation of required pumping rates from Unnamed Lake for each year of the simulation. In this section the distributions of predicted freeze and thaw dates along with reservoir storage deficits and available water supply from Lake Geraldine are presented. Thaw dates may be subject to uncertainty based on the method that is used for their prediction. It should be noted that reservoir storage deficit in this context refers a difference between the current and full reservoir volumes prior to freeze-up.

6.1.3.1 Predicted Reservoir Level and Storage Deficit at Freeze Up in Lake Geraldine Under No Consumption Scenario

Table 8 presents precipitation amounts and corresponding meteorological surpluses between estimated thaw and freeze-up for a range of percentage probabilities over the considered ten weather generated replications of the 2008 to 2017 period. Depending on the wind and air temperature magnitudes as well as intensity and distribution of rainfall, both precipitation and meteorological surplus amounts are greater in July and decrease in August and September.

Based on the meteorological data considered, it is estimated that the median water storage deficit without any consumption would be approximately 28,091 cubic metres. It is noted that depending on the extreme annual water balances over the same period, there is a possibility that the reservoir storage deficit at the predicted freeze-up date would range from approximately 11,000 cubic metres to approximately 203,000 cubic metres.

Golder (2013) has previously inferred a relationship between winter length and the quantity of reservoir water that is converted to ice. Based on this relationship, an average winter length of 8 months was shown to lock up as much as 505,000 m^3 of reservoir water (unavailable until melt) and a longer winter duration of 9 months could lock up as much as 585,000 m^3 of reservoir water. For the purposes of evaluating water storage deficits in a conservative manner, a 9-month winter and equivalent ice storage was selected for this assessment.

Table 8: Precipitation and Predicted Lake Geraldine Catchment Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under No Water Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Storage Deficit at Freeze-Up (m^3)	Predicted Available Water Supply at Freeze-up (m^3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	27-Nov	182.00	147.00	426.17	240.69	136.83	104.90	414.93	195.77	100.67	84.69	203,197	1,087,329	110.67
5	17-Jun	20-Nov	166.75	126.25	371.74	205.50	101.14	87.40	361.48	159.21	68.67	66.78	39,688	1,250,838	111.20
10	16-Jun	17-Nov	163.50	119.00	351.37	177.49	93.35	73.34	305.34	134.90	57.69	51.90	39,602	1,250,924	111.20
25	14-Jun	14-Nov	157.00	114.00	286.97	103.86	80.60	53.54	230.43	59.42	48.20	34.69	35,567	1,254,959	111.21
50	11-Jun	04-Nov	144.50	104.00	231.68	55.88	56.63	38.25	149.18	21.79	27.90	20.21	28,091	1,262,435	111.24
75	07-Jun	28-Oct	139.25	95.00	183.04	38.21	40.34	25.69	99.48	5.81	10.45	10.78	20,319	1,270,207	111.26
90	03-Jun	22-Oct	132.50	91.00	156.90	26.76	21.23	20.32	64.32	0	0	4.89	16,374	1,274,152	111.28
95	29-May	19-Oct	126.25	83.75	137.35	23.66	16.02	17.17	44.06	0	0	0.73	15,122	1,275,404	111.28
100 (Min)	28-May	10-Oct	116.00	73.00	104.52	14.02	8.20	11.73	11.84	0	0	0	10,856	1,279,670	111.29

Notes:

1. Predicted freeze and thaw dates are shown across the distribution of possible dates and are independent of each other and the values in their corresponding rows.
2. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
3. Values for available water supply and reservoir level are calculated from reservoir storage deficit. All other columns are independent based only on the probability of exceedance.
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

6.1.3.2 Predicted Reservoir Level and Storage Deficit at Freeze Up in Lake Geraldine Under Low Water Consumption Scenario (100,000 m^3 per month)

Table 9 considers the same meteorological data discussed for Table 8, but accounts for the additional effects of a daily water consumption rate of 3,335 m^3 (or 100,000 m^3 per month).

Based on the ten weather generated replications of the 2008 to 2017 period considered, it is estimated that the median water storage deficit at a consumption rate of 100,000 m^3 would approximate 620,000 cubic metres. At the extreme ends of the annual water balances for the same period, there is a possibility that this water storage deficit could decrease, or increase, to 65,000 or 1,145,000 cubic metres, respectively.

Considering the Golder (2013) relationship between winter length and quantity of the reservoir storage that is converted to ice (discussed in Section 6.1.2.1) and given that up to 585,000 cubic metres of active (accessible) reservoir storage (circa 1,875,500 m^3) may be converted to ice during the winter months (Golder 2013) and assuming an average winter length of 9 months, a 100,000 m^3/month water consumption rate (i.e., a total winter consumption of 900,000 m^3) could potentially lead to over-winter water shortages for the 0 through 50 percent probability outcomes presented in Table 9. In the worst-case scenario, it is shown that there exists the potential for a severely depleted reservoir (145,103 m^3) prior to freeze-up given consumption and variability in weather generated climate conditions.

Table 9: Precipitation and Predicted Lake Geraldine Catchment Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under Low Water Consumption Scenario (100,000m^3 per month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Storage Deficit at Freeze-Up (m^3)	Predicted Available Water Supply at Freeze-up (m^3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	27-Nov	182.00	147.00	426.17	240.69	136.83	104.90	414.93	195.77	100.67	84.69	1,145,423	145,103	107.21
5	17-Jun	20-Nov	166.75	126.25	371.74	205.50	101.14	87.40	361.48	159.21	68.67	66.78	1,083,792	206,734	107.48
10	16-Jun	17-Nov	163.50	119.00	351.37	177.49	93.35	73.34	305.34	134.90	57.69	51.90	1,036,344	254,182	107.68
25	14-Jun	14-Nov	157.00	114.00	286.97	103.86	80.60	53.54	230.43	59.42	48.20	34.69	830,572	459,954	108.51
50	11-Jun	04-Nov	144.50	104.00	231.68	55.88	56.63	38.25	149.18	21.79	27.90	20.21	619,938	670,588	109.28
75	07-Jun	28-Oct	139.25	95.00	183.04	38.21	40.34	25.69	99.48	5.81	10.45	10.78	328,931	961,595	110.26
90	03-Jun	22-Oct	132.50	91.00	156.90	26.76	21.23	20.32	64.32	0	0	4.89	129,461	1,161,065	110.91
95	29-May	19-Oct	126.25	83.75	137.35	23.66	16.02	17.17	44.06	0	0	0.73	110,667	1,179,859	110.97
100 (Min)	28-May	10-Oct	116.00	73.00	104.52	14.02	8.20	11.73	11.84	0	0	0	65,247	1,225,279	111.12

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir storage deficit. All other columns are independent based only on the probability of exceedance.
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

6.1.3.3 Predicted Reservoir Level and Storage Deficit at Freeze Up in Lake Geraldine Under High Consumption Scenario (115,000 m^3/Month)

Table 10 considers the same meteorological data previously discussed for Table 8, but accounts for the additional effects of a daily water consumption rate of 3,850 m^3 (or 115,000 m^3 per month).

Based on ten weather generated replications of the 2008 to 2017 period considered, it is estimated that the median water storage deficit at a consumption rate of 115,000 m^3 would be approximately 763,121 cubic metres. At the extreme ends of annual water balances for the same period, there is a possibility that this water storage deficit could decrease, or increase, to approximately 86,396 or 1,306,165 cubic metres, respectively.

Considering the Golder (2013) relationship between winter length and quantity of the reservoir storage that is converted to ice (discussed in Section 6.1.2.1) and given that up to 585,000 cubic metres of active (accessible) reservoir storage (circa 1,875,500 m^3) may be converted to ice during the winter months (Golder 2013) and assuming an average winter length of 9 months, a 115,000 m^3/month water consumption rate (i.e., a total winter consumption of 1,035,000 m^3) could potentially lead to over-winter water shortages for 0 through 75 percent probability outcomes presented in Table 10.

Table 10: Precipitation and Predicted Like Geraldine Catchment Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under High Water Consumption Scenario (115,000m^3 per month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Storage Deficit at Freeze-Up (m^3)	Predicted Available Water Supply at Freeze-up (m^3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	27-Nov	182.00	147.00	426.17	240.69	136.83	104.90	414.93	195.77	100.67	84.69	1,306,165	-15,639	106.44
5	17-Jun	20-Nov	166.75	126.25	371.74	205.50	101.14	87.40	361.48	159.21	68.67	66.78	1,232,575	57,951	106.79
10	16-Jun	17-Nov	163.50	119.00	351.37	177.49	93.35	73.34	305.34	134.90	57.69	51.90	1,193,944	96,582	106.97
25	14-Jun	14-Nov	157.00	114.00	286.97	103.86	80.60	53.54	230.43	59.42	48.20	34.69	992,410	298,116	107.86
50	11-Jun	04-Nov	144.50	104.00	231.68	55.88	56.63	38.25	149.18	21.79	27.90	20.21	763,121	527,405	108.75
75	07-Jun	28-Oct	139.25	95.00	183.04	38.21	40.34	25.69	99.48	5.81	10.45	10.78	459,151	831,375	109.82
90	03-Jun	22-Oct	132.50	91.00	156.90	26.76	21.23	20.32	64.32	0	0	4.89	207,713	1,082,813	110.66
95	29-May	19-Oct	126.25	83.75	137.35	23.66	16.02	17.17	44.06	0	0	0.73	171,482	1,119,044	110.77
100 (Min)	28-May	10-Oct	116.00	73.00	104.52	14.02	8.20	11.73	11.84	0	0	0	86,396	1,204,130	111.05

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir storage deficit. All other columns are independent based only on the probability of exceedance.
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

6.1.4 Predicted Supplementation Requirements for Geraldine Lake, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine

Supplemental volume requirements are predicted based on the volume of storage deficit prior to freezing in a given year. Pumping is assumed to take place 4 weeks prior to freeze-up to compensate for the Lake Geraldine storage deficit, which varies with water consumption. In this section the pumping rates resulting from the water storage deficit in Lake Geraldine is examined, along with the impact on Unnamed Lake reservoir volume before and after pumping supplementation to Lake Geraldine in a given year.

6.1.4.1 Predicted Supplementation Requirements for Lake Geraldine, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine under No Consumption Scenario

Supplementation to Lake Geraldine is simulated by assessing the reservoir storage deficit at freeze-up in order to back-calculate required pumping rates which begin four weeks prior to freeze-up for each year a reservoir storage deficit is identified. Table 11 shows that the unmitigated reservoir storage deficit at freeze-up ranges from approximately 11,000 m^3 to 203,000 m^3 with a median value of 28,000 m^3. To compensate for these storage deficit values, the required pumping rate from Unnamed Lake over a four-week period ranges from 0.004 m^3/s to 0.084 m^3/s with a median value of 0.012 m^3/s. Under the no consumption scenario, pumping rates are relatively low compared to those which were previously used during the Emergency Water Supply Project in 2019. The Emergency Water Supply Project in 2019 reportedly used pumping rates of 0.094 m^3/s to 0.218 m^3/s (Stantec 2019). The resulting change in volume of Unnamed Lake, required to compensate for Lake Geraldine storage deficits prior to freeze-up, ranges from -0.05% to -2.68%. with a corresponding change in water level of 0.1 m to -0.34 m.

Table 11: Pumping Requirements for Lake Geraldine Supplementation and Volumetric Effect on Unnamed Lake Under No Consumption Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Storage Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	203,197	0.084	202.345	5,745,418	202.342	5,742,741	-0.05%	0.10
5	39,688	0.016	202.316	5,720,257	202.313	5,717,424	-0.05%	-0.01
10	39,602	0.016	202.286	5,694,474	202.281	5,690,340	-0.07%	-0.03
25	35,567	0.015	202.241	5,656,403	202.236	5,651,267	-0.09%	-0.11
50	28,091	0.012	202.196	5,616,724	202.192	5,613,528	-0.06%	-0.15
75	20,319	0.008	202.167	5,591,022	202.161	5,585,917	-0.09%	-0.18
90	16,374	0.007	202.133	5,561,359	202.122	5,552,441	-0.16%	-0.24
95	15,122	0.006	202.113	5,544,981	202.088	5,523,934	-0.38%	-0.30
100 (Min)	10,856	0.004	202.073	5,511,636	201.884	5,364,102	-2.68%	-0.34

6.1.4.2 Predicted Supplementation Requirements for Lake Geraldine, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine under Low Consumption Scenario

Supplementation to Lake Geraldine is simulated by assessing the reservoir storage deficit at freeze-up in order to back-calculate required pumping rates which begin four weeks prior to freeze-up. Table 12shows that the unmitigated reservoir storage deficit at freeze-up ranges from approximately 65,000 m^3 to 1,145,000 m^3 with a median value of 620,000 m^3. To compensate for these storage deficit values the required pumping rate from Unnamed Lake over a four-week period ranges from 0.027 m^3/s to 0.473 m^3/s with a median value of 0.256 m^3/s. Under the low consumption scenario, required pumping rates can potentially be almost double compared to those which were previously used during the Emergency Water Supply Project in 2019, which used pumping rates of 0.094 m^3/s to 0.218 m^3/s (Nunami Stantec 2019). The resulting change in volume of Unnamed Lake to compensate for Lake Geraldine storage deficits prior to freeze-up ranges from -0.5% to -30.7%, with a corresponding change in water level of -0.01 m to -2.06 m.

Table 12: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under Low Consumption Scenario (100,000 m^3 per month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Storage Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,145,423	0.473	202.345	5,745,418	202.312	5,716,935	-0.50%	-0.01
5	1,083,792	0.448	202.316	5,720,257	202.262	5,673,317	-0.82%	-0.01
10	1,036,344	0.428	202.286	5,694,474	202.194	5,614,965	-1.40%	-0.02
25	830,572	0.343	202.241	5,656,403	202.095	5,530,017	-2.23%	-0.09
50	619,938	0.256	202.196	5,616,724	201.713	5,236,862	-6.76%	-0.34
75	328,931	0.136	202.167	5,591,022	201.241	4,890,149	-12.54%	-0.66
90	129,461	0.054	202.133	5,561,359	200.873	4,634,946	-16.66%	-1.09
95	110,667	0.046	202.113	5,544,981	200.512	4,404,117	-20.57%	-1.54
100 (Min)	65,247	0.027	202.073	5,511,636	199.403	3,821,344	-30.67%	-2.06

6.1.4.3 Predicted Supplementation Requirements for Lake Geraldine, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine under High Consumption Scenario

Supplementation to Lake Geraldine is simulated by assessing the reservoir storage deficit at freeze-up in order to back-calculate required pumping rates which begin four weeks prior to freeze-up. In Table 13it is shown that the unmitigated reservoir storage deficit at freeze-up ranges from approximately 86,000 m^3 to 1,306,000 m^3 with a median value of 763,000 m^3. To compensate for these storage deficit values the required pumping rate from Unnamed Lake, over a four-week period, ranges from 0.036 m^3/s to 0.540 m^3/s with a median value of 0.315 m^3/s. Under the high consumption scenario, pumping rates can be over double compared to those used during the Emergency Water Supply Project in 2019, which used pumping rates of 0.094 m^3/s to 0.218 m^3/s (Stantec 2019). The resulting change in volume of Unnamed Lake to compensate for Lake Geraldine storage deficits prior to freeze-up ranges from -0.51% to -37.47%, with a corresponding change in water level of -0.01 m to -3.12 m.

Table 13: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under High Consumption Scenario (115,000 m^3 per month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Storage Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,306,165	0.540	202.345	5,745,418	202.312	5,716,395	-0.51%	-0.01
5	1,232,575	0.509	202.316	5,720,257	202.221	5,639,634	-1.41%	-0.02
10	1,193,944	0.494	202.286	5,694,474	202.164	5,589,602	-1.84%	-0.04
25	992,410	0.410	202.241	5,656,403	201.980	5,439,364	-3.84%	-0.13
50	763,121	0.315	202.196	5,616,724	201.540	5,105,088	-9.11%	-0.48
75	459,151	0.190	202.167	5,591,022	200.949	4,687,622	-16.16%	-0.89
90	207,713	0.086	202.133	5,561,359	200.353	4,316,033	-22.39%	-1.38
95	171,482	0.071	202.113	5,544,981	199.668	3,946,950	-28.82%	-2.09
100 (Min)	86,396	0.036	202.073	5,511,636	198.646	3,446,634	-37.47%	-3.12

6.1.5 Estimated Effects of Reduced Unnamed Lake Outflows on Apex River Flows

Outflow rates from Unnamed Lake typically peak during the freshet period in June and July, then decrease towards the end of Fall and become low to negligible after freeze-up occurs. With no supplementation to Lake Geraldine, simulated mean daily flow rates averaged across calendar months reach their maximum value in June, corresponding to 0.231 m^3/s. With supplementation, changes in the mean flow rates across all calendar months range from 0 to 0.1 m^3/s.

The most significant changes were found for outflow rates in June during spring freshet. This indicates that supplementation to Lake Geraldine in the fall has a lasting effect on storage and flow rates for Unnamed Lake during the spring freshet when flow rates are highest. The influence of reduced flows from Unnamed Lake on Apex River flow appears to be minimal, as mean flow rates are typically much larger than those from Unnamed Lake over the 2007 to 2018 period. The percentage reductions in mean and maximum monthly flowrates compared to the Apex River are less than 10 percent during the spring freshet. Higher percentage changes are possible during the month of October to December, however these larger percentage changes are caused by a small absolute change in Unnamed Lake outflow when the Apex River flow rates are near to zero.

The effect of storage reductions during the spring freshet due to pumping is illustrated in Figure 9 by presenting water levels in the central basin of Unnamed Lake with and without supplementation to Lake Geraldine for the baseline high consumption scenario. By pumping water from Unnamed Lake, in the years 2045 and 2046 water levels do not reach the outlet elevation during spring freshet. Because of this, there are years in the simulated record where flows from Unnamed Lake are severely reduced. The percentage of years where no flow is simulated across pumping and consumption scenarios is given in Table 17. Without pumping, years where the water level does not reach the Unnamed Lake outlet elevation do not occur, however in the low and high consumption scenarios with pumping to Lake Geraldine, this occurs in 7.3% and 15.6% of the simulated years respectively.

Table 14: No Consumption - Daily Flow Rate from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E-02	1.77E-02	1.30E-02	1.23E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.98E-05	2.31E-01	1.69E-01	8.95E-02	7.44E-02	4.19E-02	6.17E-03	2.30E-04	5.07E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.95E-01	3.31E-01	1.98E-01	1.63E-01	9.11E-02	1.90E-02	2.24E-07	1.37E-01
Unnamed Lake Outflow - Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.85E-02	1.76E-02	1.25E-02	5.50E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.98E-05	2.28E-01	1.69E-01	8.94E-02	7.34E-02	3.95E-02	5.79E-03	2.13E-04	5.01E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-01	3.31E-01	1.98E-01	1.62E-01	8.75E-02	1.81E-02	1.20E-08	1.36E-01
Absolute Difference (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.00E-04	-9.36E-05	-4.88E-04	-6.83E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	-2.63E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.37E-03	-4.90E-04	-1.22E-04	-1.02E-03	-2.42E-03	-3.79E-04	-1.72E-05	-5.63E-04
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.02E-03	-5.11E-05	-5.89E-06	-1.16E-03	-3.53E-03	-8.59E-04	-2.12E-07	-9.98E-04
Apex River Flow Rate (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.10%	-0.03%	-0.14%	-11.38%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-0.07%	-0.03%	-0.01%	-0.09%	-0.69%	-4.51%	-11.89%	-0.05%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.03%	0.00%	0.00%	-0.06%	-0.37%	-4.30%	—	-0.04%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.4. Percentage change cannot be calculated as Apex River flow is 0 m³/s for the corresponding month and statistic.

Table 15: Low Consumption - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E-02	1.77E-02	1.30E-02	1.23E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.98E-05	2.31E-01	1.69E-01	8.95E-02	7.44E-02	4.19E-02	6.17E-03	2.30E-04	5.07E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.95E-01	3.31E-01	1.98E-01	1.63E-01	9.11E-02	1.90E-02	2.24E-07	1.37E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-04	6.99E-05	4.53E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.93E-05	1.37E-01	1.40E-01	8.05E-02	5.43E-02	1.15E-02	9.19E-04	1.31E-05	3.52E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E-01	2.95E-01	1.92E-01	1.43E-01	3.27E-02	4.03E-04	0.00E+00	1.04E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.88E-02	-1.76E-02	-1.25E-02	-1.23E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	2.10E-08	0.00E+00	0.00E+00	0.00E+00	-5.63E-07	-9.37E-02	-2.92E-02	-8.99E-03	-2.01E-02	-3.04E-02	-5.25E-03	-2.17E-04	-1.55E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.02E-01	-3.54E-02	-6.12E-03	-2.07E-02	-5.84E-02	-1.86E-02	-2.24E-07	-3.29E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-8.14%	-5.16%	-3.50%	-20.55%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-2.91%	-1.60%	-0.79%	-1.85%	-8.67%	-62.52%	-150.06%	-1.51%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.00%	-0.92%	-0.28%	-1.00%	-6.14%	-92.91%	—	-1.24%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 16: High Consumption - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E-02	1.77E-02	1.30E-02	1.23E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.98E-05	2.31E-01	1.69E-01	8.95E-02	7.44E-02	4.19E-02	6.17E-03	2.30E-04	5.07E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.95E-01	3.31E-01	1.98E-01	1.63E-01	9.11E-02	1.90E-02	2.24E-07	1.37E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-04	1.44E-05	1.52E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	1.31E-04	2.33E-09	0.00E+00	0.00E+00	3.93E-05	1.16E-01	1.30E-01	7.78E-02	5.06E-02	8.69E-03	4.02E-04	4.03E-08	3.18E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.26E-01	2.87E-01	1.91E-01	1.40E-01	2.33E-02	8.11E-05	0.00E+00	9.61E-02
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.89E-02	-1.77E-02	-1.28E-02	-1.23E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	2.10E-08	0.00E+00	0.00E+00	0.00E+00	-5.63E-07	-1.15E-01	-3.88E-02	-1.17E-02	-2.38E-02	-3.32E-02	-5.77E-03	-2.30E-04	-1.88E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.69E-01	-4.36E-02	-7.20E-03	-2.35E-02	-6.78E-02	-1.89E-02	-2.24E-07	-4.05E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-8.16%	-5.18%	-3.58%	-20.55%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-3.57%	-2.12%	-1.04%	-2.19%	-9.47%	-68.67%	-159.13%	-1.84%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-4.00%	-1.13%	-0.33%	-1.13%	-7.13%	-94.52%	—	-1.53%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

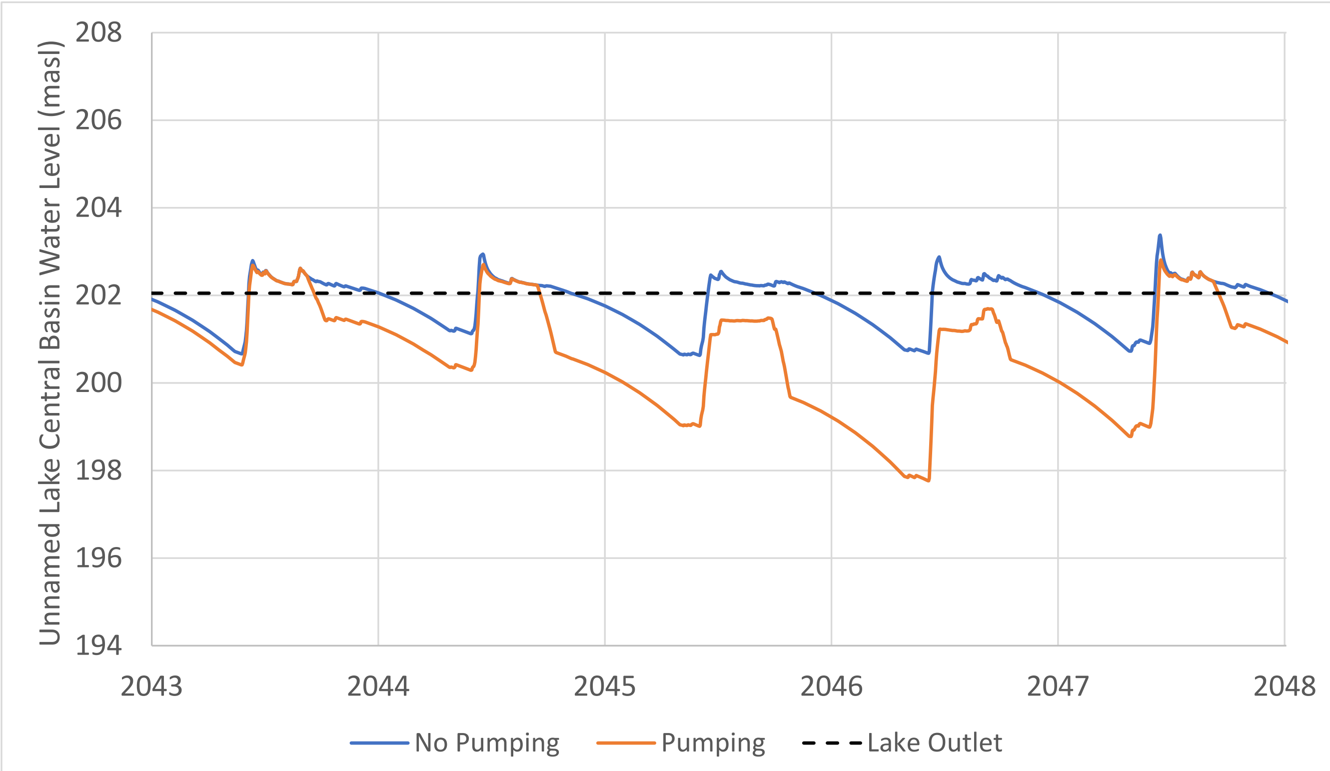

Figure 9: Simulated Water Level in Central Basin of Unnamed Lake for One Replication of Weather Generated 2007 to 2018 Period Under the High Consumption Scenario

Table 17: Percentage of Years Where Unnamed Lake Outlet Elevation Remains below Invert for 100-Year Weather Generated Meteorological Series

Consumption Scenario	No Pumping	Pumping
No Consumption	0.0%	0.0%
Low Consumption	0.0%	7.3%
High Consumption	0.0%	15.6%

6.2 Water Balance Results for Future Climate Meteorology

Consideration of future climate conditions for Iqaluit are important to the assessment of Lake Geraldine reservoir storage deficits and required supplementation volumes from Unnamed Lake because future changes in precipitation and temperature have the ability to affect lake recharge, through changes in meteorological surplus as well as the timing and duration of the open water period. In this section the impact of climate change on reservoir storage deficit, required supplementation volumes, and Unnamed Lake outflow rates are assessed. Projected changes in climate for the 2050s and 2080s future periods were used to adjust 2007 to 2018 observations, which are then extended through ten replications of weather generation.

The tables presented in this section illustrate the results of the climate scenario corresponding to the 50th percentile of the projected average total water year precipitation (as described in Section 4.6), and are aggregated across consumption scenarios (no demand, low demand, and high demand). Additional tables are provided in Appendix A for each consumption and climate scenario.

6.2.1 Predicted Precipitation and Surplus in Lake Geraldine and Unnamed Lake

After applying the gap-filled meteorology data (Section 3.8.1) and extending the baseline period using the weather generator methodology and water level reset function (Section 4.6.2) to the model, simulations were carried out for the three water consumption scenarios identified in Section 3.4 to ascertain the quantity of surplus that would need to be delivered to the Lake Geraldine Reservoir between predicted thaw and freeze-up of each year.

Table 18 through Table 21 provide a simplified presentation of key periods of interest for the 2008 through 2017 meteorological window considered in this assessment for the 2050s and 2080s future climate periods for Lake Geraldine and Unnamed Lake. This information is then compared to that provided for the baseline climate period provided in Section 6.1.2.

Table 18 shows that in Lake Geraldine a significant portion of total precipitation over the catchment is lost in the form of evapotranspiration, either directly from ground surface or from soil and depression storage within the catchment. In the earliest portion of the open water season from thaw to June 30 the percentage of precipitation converted to meteorological surplus is above 100%. This is due to large amounts of snowmelt during freshet inflating the meteorological surplus amount in excess of precipitation. With cooling air temperatures and reasonable precipitation amounts, the proportion of rainfall translated to surplus is shown to peak in September, which is consistent with that shown for the baseline climate period (Table 6). Precipitation and meteorological surplus in the 2050s climate period are shown to have increased in all meteorological periods considered compared to the baseline period. The percentage of precipitation converted to meteorological surplus is shown to have increased overall, with the greatest increases occurring earlier in the open water season and either unchanged or slight decreases in the late open water season. This may be due to more runoff as a result of greater precipitation rates with less of a change to evapotranspiration.

Table 19 presents the same statistics as Table 18 for Lake Geraldine under the 2080s climate scenario. The same overall pattern is shown, with greater precipitation, meteorological surplus, and percentage conversion to meteorological surplus for most of the meteorological periods considered. However, the earliest period from thaw to June 30 shows a lower percentage of precipitation converted to meteorological surplus. The reason for this is that warmer temperatures in the 2080s period results in less snowpack to melt in the spring and therefore less meteorological surplus compared to the 2050s.

For Unnamed Lake the same meteorological inputs are used as in Lake Geraldine, however differences in surplus exist due to differences in catchment area and surface characteristics such as soil and land use composition, as well as the potential evapotranspiration multipliers between catchments used for calibration (Table 3). Therefore, the percentage of precipitation converted to meteorological surplus is very similar between the two lakes (Table 20 and Table 21).

Table 18: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2050s Climate Change Scenario for the Median Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	287	227	79%
Thaw through June 30	49	100	205%[2]
July	95	58	61%
August	66	35	53%
September	53	34	65%
October 1 to Freeze-Up (Varies)[1]	28	15	54%
November 1 to Freeze-Up (Varies)[1]	3	1	27%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 19: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2080s Climate Change Scenario for the Median Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	264	201	76%
Thaw through June 30	61	111	180%[2]
July	81	45	55%
August	56	28	49%
September	48	29	62%
October 1 to Freeze-Up (Varies)[1]	26	12	49%
November 1 to Freeze-Up (Varies)[1]	4	1	31%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 20: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2050s Climate Change Scenario for the Median Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	287	229	80%
Thaw through June 30	49	105	215%[2]
July	95	58	61%
August	66	33	50%
September	53	34	63%
October 1 to Freeze-Up (Varies)[1]	28	15	54%
November 1 to Freeze-Up (Varies)[1]	3	1	27%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 21: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2080s Climate Change Scenario for the Median Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	264	200	76%
Thaw through June 30	61	116	189%[2]
July	81	43	53%
August	56	26	46%
September	48	28	59%
October 1 to Freeze-Up (Varies)[1]	26	12	49%
November 1 to Freeze-Up (Varies)[1]	4	1	31%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

6.2.1.1 Predicted Precipitation, Surplus and Reservoir Level in Lake Geraldine under 2050s Climate Change Scenario

Table 22 presents precipitation amounts and corresponding meteorological surplus between estimated thaw and freeze-up for a range of percentage probabilities over the considered ten weather generated replications of the 2050s climate period for the median water year precipitation scenario, aggregated across all consumption scenarios. Depending on the wind and air temperature magnitudes as well as intensity and distribution of rainfall, both precipitation and meteorological surplus amounts are greater in July and decrease in August and September. Compared to the baseline period, precipitation and meteorological surplus are generally greater in the 2050s climate period as discussed in the previous section.

In Section 6.1.3, the differences in Lake Geraldine storage deficits across consumption scenarios were discussed. Here, the results across consumption scenarios are aggregated, focusing on the impact of changes in climate, while additional tables broken out across climate and consumption scenarios are provided in Appendix A.
An important consideration for lake recharge prior to freeze-up in Iqaluit is the timing and duration of the open water season. In the 2050s climate scenario, the median thaw date is shown to be the same as in the baseline, while the median freeze-up date is shown to be slightly less than 1 week later compared to the baseline. This results in an open water season that is longer compared to the baseline, allowing for more lake recharge to occur.

Based on the 2050s future climate data considered, it is estimated that the median water storage deficit would be approximately 237,419 cubic metres. It is noted that depending on the extreme annual water balances over the same period, there is a possibility that the reservoir storage deficit at the predicted freeze-up date would range from approximately 8,600 cubic metres to approximately 1,179,000 cubic metres. This range is lower than what was shown across baseline consumption scenarios indicating that due to the prolonged open water season, there is the potential for more recharge with increased precipitation. This also means that there is a longer period for which consumption can take place prior to freeze-up, which can show increased levels of storage deficit for the 10^{th} percentile water year precipitation under a high consumption scenario as shown in Appendix A.

Golder (2013) has previously inferred a relationship between winter length and the quantity of reservoir water that is converted to ice. Based on this relationship, an average winter length of 8 months was shown to lock up as much as 505,000 m^3 of reservoir water (unavailable until melt) and a longer winter duration of 9 months could lock up as much as 585,000 m^3 of reservoir water. For the purposes of evaluating water storage deficits in a conservative manner, a 9-month winter and equivalent ice storage was selected for this assessment.

Given that up to 585,000 cubic metres of active (accessible) reservoir storage (circa 1,875,500 m^3) may be converted to ice during the winter months (Golder 2013) and assuming an average winter length of 9 months, a the 100,000 m^3/month and 115,000 m^3/month water consumption rates (i.e., a total winter consumption of 900,000 m^3 and 1,035,000 m^3) could potentially lead to over-winter water shortages for 0 through 5 percent probability outcomes presented in Table 22.

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Table 22: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s Median Water Year Precipitation Climate Change Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Storage Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	22-Jun	27-Nov	166.00	127.00	506.32	277.78	161.86	123.31	367.99	222.45	125.06	96.07	1,179,271	111,255	107.05
5	22-Jun	21-Nov	158.00	124.00	456.60	254.13	116.67	100.77	328.34	204.20	84.67	74.07	991,417	299,109	107.86
10	22-Jun	18-Nov	152.70	117.70	412.99	236.04	105.86	83.55	294.54	183.55	67.07	65.34	891,740	398,786	108.28
25	21-Jun	16-Nov	149.00	109.00	329.10	123.32	82.67	67.31	222.29	78.32	48.61	47.50	724,765	565,761	108.89
50	21-Jun	09-Nov	142.00	103.00	242.93	67.76	60.05	53.84	135.64	31.75	31.11	34.43	237,419	1,053,107	110.56
75	21-Jun	03-Nov	135.00	94.75	200.80	41.91	47.08	34.12	93.96	14.07	15.60	17.21	37,167	1,253,359	111.21
90	16-Jun	29-Oct	132.00	87.00	159.20	30.42	33.41	27.74	63.50	-2.09	4.25	11.13	24,982	1,265,544	111.25
95	13-Jun	25-Oct	128.00	85.00	154.63	21.20	29.30	23.28	48.16	-2.81	1.44	3.77	21,165	1,269,361	111.26
100 (Min)	01-Jun	16-Oct	117.00	69.00	121.25	6.32	13.00	17.48	23.22	-3.64	-2.10	-1.31	8,636	1,281,890	111.30

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir storage deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

6.2.1.2 Predicted Precipitation, Surplus and Reservoir Level in Lake Geraldine under 2080s Climate Change Scenario

Table 23 presents precipitation amounts and corresponding meteorological surplus between estimated thaw and freeze-up for a range of percentage probabilities over the considered ten weather generated replications of the 2080s climate period. Depending on the wind and air temperature magnitudes as well as intensity and distribution of rainfall, both precipitation and meteorological surplus amounts are greater in July and decrease in August and September. Compared to the baseline period, precipitation and meteorological surplus are generally greater in the 2080s climate period as discussed in Section 6.2.1.

In Section 6.1.2, the differences in Lake Geraldine storage deficits across consumption scenarios were discussed. Here, the results across consumption scenarios are aggregated, focusing on the impact of changes in climate, while additional tables broken out across climate and consumption scenarios are provided in Appendix A.
An important consideration for lake recharge prior to freeze-up in Iqaluit is the timing and duration of the open water season. In the 2050s climate scenario, the median thaw date is shown to be about the same as in the baseline, while the median freeze-up date is shown to be slightly less than 1 week later compared to the baseline. This results in an open water season that is longer compared to the baseline, allowing for more lake recharge to occur.

Based on the 2080s future climate data considered, it is estimated that the median reservoir storage deficit would be approximately 406,191 cubic metres. It is noted that depending on the extreme annual water balances over the same period, there is a possibility that the reservoir storage deficit at the predicted freeze-up date would range from approximately 7,000 cubic metres to approximately 1,205,000 cubic metres. Similar to the 2050s climate scenario, this range is lower than that shown across baseline consumption scenarios indicating that due to the prolonged open water season, there is the potential for more recharge with increased precipitation. This also means that there is a longer period for which consumption can take place prior to freeze-up, which can show increased levels of storage deficit for the 10th percentile water year precipitation under a high consumption scenario as shown in Appendix A.

Golder (2013) has previously inferred a relationship between winter length and the quantity of reservoir water that is converted to ice. Based on this relationship, an average winter length of 8 months was shown to lock up as much as 505,000 m^3 of reservoir water (unavailable until melt) and a longer winter duration of 9 months could lock up as much as 585,000 m^3 of reservoir water. For the purposes of evaluating reservoir storage deficits in a conservative manner, a 9-month winter and equivalent ice storage was selected for this assessment.

Given that up to 585,000 cubic metres of active (accessible) reservoir storage (circa 1,875,500 m^3) may be converted to ice during the winter months (Golder 2013) and assuming an average winter length of 9 months, at the 100,000 m^3/month and 115,000 m^3/month water consumption rates (i.e., a total winter consumption of 900,000 m^3 and 1,035,000 m^3) could potentially lead to over-winter water shortages for nearly all of the 0 through 10 probability outcomes presented in Table 23, respectively.

Table 23: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s Median Water Year Precipitation Climate Change Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Storage Deficit at Freeze-Up (m^3)	Predicted Available Water Supply at Freeze-up (m^3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	22-Jun	28-Nov	179.00	137.00	472.61	216.98	143.07	113.53	338.72	173.01	96.06	92.73	1,204,661	85,865	106.92
5	22-Jun	27-Nov	160.00	126.00	362.07	175.58	110.26	95.04	249.00	133.48	78.04	70.15	1,014,597	275,929	107.77
10	22-Jun	19-Nov	153.70	118.00	326.18	161.89	94.29	77.35	219.64	117.54	62.00	57.92	911,273	379,253	108.20
25	21-Jun	14-Nov	148.00	108.25	282.65	100.86	68.15	62.11	172.62	60.34	43.69	41.49	728,259	562,267	108.88
50	21-Jun	08-Nov	139.50	100.00	231.68	68.77	55.24	46.68	124.30	30.90	24.06	26.27	406,191	884,335	110.00
75	20-Jun	02-Nov	134.00	92.00	185.68	46.35	35.98	29.66	75.59	14.81	5.79	13.21	36,351	1,254,175	111.21
90	18-Jun	27-Oct	128.30	85.30	151.87	33.97	22.16	21.14	51.40	3.97	-1.48	5.53	24,335	1,266,191	111.25
95	12-Jun	24-Oct	126.00	83.00	144.88	22.21	15.01	17.29	37.67	-2.52	-2.11	1.75	19,415	1,271,111	111.27
100 (Min)	01-Jun	17-Oct	117.00	70.00	123.95	11.75	7.13	6.08	28.81	-3.42	-2.22	-0.98	6,707	1,283,819	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir storage deficit. All other columns are independent based only on the probability of exceedance.
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir storage deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

6.2.2 Predicted Supplementation Requirements for Geraldine Lake, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine

Pumping rates, required to mitigate Lake Geraldine storage deficits presented in the previous section, have been estimated. The pumping rate is assumed to be equal to the storage deficit in a given year, pumped over a four-week period. The implementation of pumping from Unnamed Lake results in a volume difference compared to if pumping had not occurred. The predicted volume difference is discussed in the following sub-sections for the 2050s and 2080s future climate periods.

6.2.2.1 Predicted Supplementation Requirements for Lake Geraldine, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine under 2050s Climate Change Scenario

Supplementation to Lake Geraldine is simulated by assessing the reservoir storage deficit at freeze-up in order to back-calculate required pumping rates which begin four weeks prior to freeze-up. In Table 24 it is shown that the unmitigated reservoir storage deficit at freeze-up ranges from approximately 8,600 m^3 to 1,179,000 m^3 with a median value of 237,000 m^3. To compensate for these reservoir storage deficit values the pumping rate from Unnamed Lake over a four-week period ranges from 0.003 m^3/s to 0.487 m^3/s with a median value of 0.098 m^3/s. The median required pumping value on the lower end of the range used during the Emergency Water Supply Project in 2019, which used pumping rates of 0.094 m^3/s to 0.218 m^3/s (Stantec 2019). However, the maximum value is over double the high end of this range. The resulting change in volume of Unnamed Lake to compensate for Lake Geraldine storage deficits prior to freeze-up ranges from -0.02% to -18.45%, and a corresponding change in water elevation ranging from 0 m to -1.28 m. This change in volume for Unnamed Lake is slightly lower than the baseline low and high consumption scenarios, due to greater surplus as a result of climate change during the pumping period before freeze-up.

Table 24: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s Median Water Year Precipitation Climate Change Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Storage Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,179,271	0.487	202.274	5,683,385	202.272	5,681,974	-0.02%	0.00
5	991,417	0.410	202.260	5,671,801	202.250	5,662,909	-0.16%	0.00
10	891,740	0.369	202.252	5,665,107	202.234	5,650,454	-0.26%	-0.01
25	724,765	0.300	202.218	5,635,503	202.196	5,616,314	-0.34%	-0.01
50	237,419	0.098	202.196	5,615,582	202.103	5,536,991	-1.40%	-0.07
75	37,167	0.015	202.168	5,591,380	201.585	5,138,045	-8.11%	-0.42
90	24,982	0.010	202.138	5,565,259	201.276	4,914,244	-11.70%	-0.67
95	21,165	0.009	202.123	5,552,429	201.144	4,820,914	-13.17%	-0.82
100 (Min)	8,636	0.004	202.066	5,504,933	200.663	4,489,174	-18.45%	-1.28

6.2.2.2 Predicted Supplementation Requirements for Lake Geraldine, and ensuing Water Level and Storage Effects in Unnamed Lake resulting from Supplementation of Lake Geraldine under 2080s Climate Change Scenario

Supplementation to Lake Geraldine is simulated by assessing the reservoir storage deficit at freeze-up in order to back-calculate required pumping rates which begin four weeks prior to freeze-up. Table 25 it is shown that the unmitigated reservoir storage deficit at freeze-up ranges from approximately 7,000 m^3 to 1,204,000 m^3 with a median value of 406,000 m^3. To compensate for these storage deficit values the pumping rate from Unnamed Lake over a four-week period ranges from 0.003 m^3/s to 0.498 m^3/s with a median value of 0.168 m^3/s. The median required pumping value is within the range used during the Emergency Water Supply Project in 2019, which used pumping rates of 0.094 m^3/s to 0.218 m^3/s (Stantec 2019). However, the maximum value is over 2.25 times greater than the high end of this range. The resulting change in volume of Unnamed Lake to compensate for Lake Geraldine storage deficits prior to freeze-up ranges from -0.03% to -18.05%. This change in volume for Unnamed Lake is significantly lower than that of both the baseline low and high consumption scenarios. This is due to greater surplus as a result of climate change during the pumping period before freeze-up.

Table 25: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2080s Median Water Year Precipitation Climate Change Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Storage Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,204,661	0.498	202.267	5,678,624	202.265	5,676,679	-0.03%	0.00
5	1,014,597	0.419	202.247	5,659,459	202.234	5,649,801	-0.17%	0.00
10	911,273	0.377	202.239	5,654,018	202.218	5,636,140	-0.32%	-0.01
25	728,259	0.301	202.218	5,636,202	202.184	5,606,132	-0.53%	-0.01
50	406,191	0.168	202.194	5,614,662	201.977	5,435,295	-3.19%	-0.16
75	36,351	0.015	202.165	5,588,423	201.534	5,103,708	-8.67%	-0.41
90	24,335	0.010	202.115	5,545,851	201.129	4,809,877	-13.27%	-0.74
95	19,415	0.008	202.095	5,529,726	200.974	4,706,128	-14.89%	-0.95
100 (Min)	6,707	0.003	202.049	5,489,258	200.679	4,498,413	-18.05%	-1.47

6.2.3 Estimated Effects of Reduced Unnamed Lake Outflows on Apex River Flows

Outflow rates from Unnamed Lake typically peak during the freshet period in June, then decrease towards the end of Fall and become low to negligible after freeze-up occurs. simulated mean daily flow rates averaged across calendar months reach their maximum value in June, corresponding to 0.325 m^3/s under the 2050s median water year precipitation scenario (Table 26). With supplementation, this value is shown to decrease to 0.261 m^3/s. The absolute difference in flow rate from supplementation (averaged across all consumption scenarios), across all calendar months ranges from -0.011 to 0 m^3/s for mean daily flow. Relative to Apex River flows for the months of June and July, decreases in flow range from -5.89% to -2.09%. The greatest changes in Unnamed Lake outflow rates occur in October to December, however this is due to small absolute changes in outflow relative to little to no flow in the Apex River.

Under the 2080s climate change scenario without supplementation, simulated mean daily flows rates averaged across calendar months also reach their maximum value in in June corresponding to 0.655 m^3/s (Table 27). With supplementation, flow rates during the spring freshet (June and July), are reduced by -2.36% to 0% relative to the Apex River flows, with larger percentage changes where the absolute difference is small and Apex River flows are near zero. Compared to the baseline scenario under low and high consumption, in the 2050s and 2080s the percentage of years where no flow was simulated is significantly lower, ranging from 0% to 6.4% of the simulated years. This is likely due to the increased precipitation amounts, and longer open water period projected for future climate conditions in Iqaluit. Additional tables for each climate and consumption scenario are provided in Appendix A.

Table 26: 2050s Median Water Year Climate Change Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-02	2.08E-02	2.66E-02	1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	4.73E-04	3.25E-01	1.91E-01	1.13E-01	1.03E-01	5.37E-02	6.26E-03	6.71E-05	6.54E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.66E-01	3.10E-01	2.60E-01	2.06E-01	1.08E-01	2.01E-02	0.00E+00	1.77E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.31E-02	1.83E-02	1.05E-02	7.76E-06	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	3.14E-04	2.61E-01	1.80E-01	1.10E-01	8.95E-02	3.00E-02	2.87E-03	2.01E-05	5.57E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.61E-01	3.05E-01	2.57E-01	1.91E-01	8.13E-02	1.17E-02	0.00E+00	1.58E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.14E-02	-2.52E-03	-1.60E-02	-1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-08	0.00E+00	0.00E+00	0.00E+00	-1.60E-04	-6.38E-02	-1.07E-02	-3.07E-03	-1.30E-02	-2.37E-02	-3.38E-03	-4.70E-05	-9.70E-03
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.05E-01	-5.06E-03	-3.03E-03	-1.48E-02	-2.64E-02	-8.33E-03	0.00E+00	-1.92E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.73E-01	5.47E-01	4.00E-01	4.74E-01	7.00E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.37E-02	3.89E+00	1.77E+00	1.19E+00	1.16E+00	3.57E-01	1.07E-02	2.28E-04	6.91E-01
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.45E-02	7.50E+00	3.45E+00	2.35E+00	2.29E+00	9.96E-01	2.91E-02	0.00E+00	2.20E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.09%	-0.63%	-3.38%	-143.11%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.19%	-1.64%	-0.61%	-0.26%	-1.12%	-6.62%	-31.65%	-20.57%	-1.40%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-1.40%	-0.15%	-0.13%	-0.65%	-2.65%	-28.64%	0.00%	-0.87%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 27: 2080s Median Water Year Climate Change Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-02	2.16E-02	1.61E-02	2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	6.72E-05	0.00E+00	0.00E+00	0.00E+00	6.64E-04	3.64E-01	1.63E-01	8.83E-02	8.17E-02	4.39E-02	6.21E-03	2.51E-04	6.17E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.89E-01	3.24E-01	1.97E-01	1.82E-01	9.78E-02	1.99E-02	3.24E-07	1.56E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.58E-02	1.94E-02	4.34E-03	3.03E-10	0.00E+00	0.00E+00	0.00E+00
	Mean	6.68E-05	0.00E+00	0.00E+00	0.00E+00	3.04E-04	2.87E-01	1.47E-01	8.47E-02	7.10E-02	2.13E-02	2.40E-03	9.12E-05	5.06E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.22E-01	3.03E-01	1.94E-01	1.68E-01	6.59E-02	9.20E-03	0.00E+00	1.35E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.29E-02	-2.19E-03	-1.18E-02	-2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-4.09E-07	0.00E+00	0.00E+00	0.00E+00	-3.61E-04	-7.76E-02	-1.59E-02	-3.62E-03	-1.07E-02	-2.25E-02	-3.81E-03	-1.59E-04	-1.11E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.67E-01	-2.13E-02	-2.41E-03	-1.40E-02	-3.19E-02	-1.07E-02	-3.24E-07	-2.11E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.73E-01	5.47E-01	4.00E-01	4.74E-01	7.00E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.37E-02	3.89E+00	1.77E+00	1.19E+00	1.16E+00	3.57E-01	1.07E-02	2.28E-04	6.91E-01
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.45E-02	7.50E+00	3.45E+00	2.35E+00	2.29E+00	9.96E-01	2.91E-02	0.00E+00	2.20E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.36%	-0.55%	-2.49%	-32.98%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.43%	-2.00%	-0.90%	-0.30%	-0.92%	-6.31%	-35.64%	-69.79%	-1.60%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.23%	-0.62%	-0.10%	-0.61%	-3.20%	-36.61%	—	-0.96%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

7.0 CONCLUSIONS

In this work the potential for Lake Geraldine supplementation from Unnamed Lake was explored for current (2007 through 2018) and future projected (2050s and 2080s) meteorological conditions using water balance model simulations. The addition of Unnamed Lake to the existing Lake Geraldine water balance model allowed for required pumping rates to be determined based on the Lake Geraldine storage deficit at freeze-up. The effect of these pumping rates on Unnamed Lake volume and outflow rate was then assessed.

Based on the results under current climate conditions, Unnamed Lake supplementation has the potential to be a feasible additional water supply for the City of Iqaluit. Projected Lake Geraldine reservoir storage deficits under the high consumption scenario (115,000 m^3/month) ranged from 86,369 to 1,306,165 m^3 with a median value of 763,121 m^3. This translated to pumping rates ranging between 0.036 to 0.540 m^3/s with a median value of 0.315 m^3/s over an assumed four-week annual pumping period to ensure full reservoir capacity prior to freeze-up. The required pumping rates are greater than the range of pumping rates used in the 2019 Iqaluit Emergency Water Supply Project completed by Stantec (2019). Therefore, pumps and conveyance infrastructure should consider greater design specifications than used by Stantec (2019) to account for variance in meteorological conditions and Lake Geraldine storage deficit before freeze-up. It is recommended that Iqaluit consider design pumping rates to include a factor of safety of at least 50 percent above the 0.584 m^3/s maximum value that was obtained in this assessment.

Under future meteorological conditions, a longer open water period is projected, which allows for more recharge to occur and more consumption to take place prior to freeze-up. Lake Geraldine storage deficits and required pumping rates are expected to be somewhat lower than current conditions for the median water year precipitation scenario, however at the 10th percentile, the opposite effect is shown due lower increase in precipitation and meteorological surplus and a longer period of consumption prior to freeze-up. Therefore, for design purposes the most conservative climate and consumption scenario should be used.

In this assessment it was assumed that pumping from Unnamed Lake would commence four weeks prior to freeze-up. The earliest freeze-up date found using the weather generated current climate meteorological series was October 10th, while under future climate conditions it was found that the earliest freeze-up date could shift to a week later. Therefore, it is recommended that if supplementation from Unnamed Lake is used to compensate for Lake Geraldine storage deficits prior to freeze-up, that a start date of September 10th or earlier should be used to commence pumping.

The effect of Unnamed Lake supplementation on lake volume and outflow rates was examined. Under current climate conditions it was found that the percentage volume reductions during spring freshet (June and July) relative to the Apex River flow were less than 10% when comparing model runs with and without supplementation across all climate and consumption scenarios. Larger percentage changes in the late fall and early winter months were found due to small absolute changes in Unnamed Lake outflow when the Apex River flow is typically low. It was found that pumping in the fall has the potential to significantly reduce Unnamed Lake outflow during the spring freshet and may cause dry years where little to no outflow comes from the lake. This was found to occur in 15.6% of the simulated weather generated years under the baseline climate conditions and the high consumption scenario. Year over year declines in water levels were also found to be possible.

8.0 RECOMMENDATIONS

In this report a preliminary assessment of water supplementation to Lake Geraldine from Unnamed Lake was completed. However, further steps should be taken if this supplementation option is considered further. These steps will help to confirm the results of the modelling approach where assumptions needed to be made and data limitations were present:

- This report only evaluates two water consumption scenarios for low demand (100,000 m^3/month) and high demand (115,000 m^3/month). In subsequent work, additional scenarios may be evaluated, including those with higher winter demand as well as increasing the maximum consumption scenario.
- The current study focussed on exploring the potential for water supplementation using Unnamed Lake but did not include an assessment of potential water quantity reductions on fish and/or fish habitat. To evaluate the implications of projected changes in Unnamed Lake water levels and Apex River flow rates, it is recommended that an opinion of potential fish/ fish habitat effects resulting from projected pumping requirements from Unnamed Lake to Lake Geraldine be rendered by a qualified biologist.
- A detailed sensitivity analysis may be conducted to verify the significance of the assumptions made and data limitations. This analysis could include:
  - Confirmation of assumptions made for smaller storage units of Unnamed Lake where topographical information was not available (Catchment E and North Pond). These storage volumes represent less than 1% of total Unnamed Lake volume and are not expected to affect study findings significantly.
  - The current model is based on four weeks of pumping prior to freeze-up. Sensitivity analysis for environmental effects of commencing pumping earlier in the year should be considered prior to design, although top up of Lake Geraldine prior to freeze-up may still be required but at a lower pumping rate.
  - Testing of Unnamed Lake outflow rating curve sensitivity. If significant sensitivity is identified, additional Unnamed Lake outflow data should be obtained to provide more reliable calibration data than what is currently available at this time.
- Additional water source options for Lake Geraldine supplementation may be available and should be evaluated prior to making a final decision, as the existing storage capacity may provide operational limitations with regards to supplementation

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APPENDIX A

Additional Climate Scenario Tables

In the main report, tables have been provided for precipitation and meteorological surplus, reservoir level and deficit at freeze-up, supplementation requirement for Lake Geraldine, and the effects of reduced Unnamed Lake outflows on Apex River flows. For future climate conditions, the main report shows only the results for the median water year scenario, aggregated across consumption scenarios. This is done to capture and present the main findings without adding excessive information into the report. In this Appendix, the same table structure will be maintained in the main report to include additional tables for the 2050s and 2080s future periods, 10th, 50th, and 90th, water year precipitation scenarios, and no consumption, low consumption (100,000 m^3/month), and high consumption (115,000 m^3/month) scenarios.

1.0 PREDICTED PRECIPITATION AND SURPLUS IN LAKE GERALDINE AND UNNAMED LAKE

Table 1: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2050s Climate Change Scenario for the 10th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	245	155	63%
Thaw through June 30	55	83	150%[2]
July	76	40	53%
August	57	28	49%
September	42	23	55%
October 1 to Freeze-Up (Varies)[1]	27	11	42%
November 1 to Freeze-Up (Varies)[1]	8	2	30%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 2: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2050s Climate Change Scenario for the 50th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	287	227	79%
Thaw through June 30	49	100	205%[2]
July	95	58	61%
August	66	35	53%
September	53	34	65%
October 1 to Freeze-Up (Varies)[1]	28	15	54%
November 1 to Freeze-Up (Varies)[1]	3	1	27%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 3: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2050s Climate Change Scenario for the 90th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	343	249	73%
Thaw through June 30	62	67	107%[2]
July	101	64	63%
August	68	37	55%
September	56	36	64%
October 1 to Freeze-Up (Varies)[1]	46	28	60%
November 1 to Freeze-Up (Varies)[1]	14	7	47%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 4: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2080s Climate Change Scenario for the 10th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	295	218	74%
Thaw through June 30	52	75	144%[2]
July	86	51	59%
August	57	29	50%
September	58	35	61%
October 1 to Freeze-Up (Varies)[1]	38	19	49%
November 1 to Freeze-Up (Varies)[1]	10	3	36%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 5: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2080s Climate Change Scenario for the 50th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	264	201	76%
Thaw through June 30	61	111	180%[2]
July	81	45	55%
August	56	28	49%
September	48	29	62%
October 1 to Freeze-Up (Varies)[1]	26	12	49%
November 1 to Freeze-Up (Varies)[1]	4	1	31%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 6: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Lake Geraldine Catchment Under the 2080s Climate Change Scenario for the 90th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	322	236	73%
Thaw through June 30	54	76	141%[2]
July	83	48	57%
August	66	35	53%
September	59	37	62%
October 1 to Freeze-Up (Varies)[1]	57	35	61%
November 1 to Freeze-Up (Varies)[1]	18	6	37%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 7: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2050s Climate Change Scenario for the 10th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	245	150	61%
Thaw through June 30	55	86	156%[2]
July	76	38	50%
August	57	26	46%
September	42	21	51%
October 1 to Freeze-Up (Varies)[1]	27	11	42%
November 1 to Freeze-Up (Varies)[1]	8	2	30%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 8: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2050s Climate Change Scenario for the 50th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	287	229	80%
Thaw through June 30	49	105	215%[2]
July	95	58	61%
August	66	33	50%
September	53	34	63%
October 1 to Freeze-Up (Varies)[1]	28	15	54%
November 1 to Freeze-Up (Varies)[1]	3	1	27%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 9: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2050s Climate Change Scenario for the 90th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	343	249	73%
Thaw through June 30	62	68	109%[2]
July	101	63	62%
August	68	36	53%
September	56	34	61%
October 1 to Freeze-Up (Varies)[1]	46	28	60%
November 1 to Freeze-Up (Varies)[1]	14	7	47%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 10: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2080s Climate Change Scenario for the 10th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	295	219	74%
Thaw through June 30	52	77	148%[2]
July	86	51	59%
August	57	28	48%
September	58	35	60%
October 1 to Freeze-Up (Varies)[1]	38	19	49%
November 1 to Freeze-Up (Varies)[1]	10	3	36%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 11: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2080s Climate Change Scenario for the 50th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	264	200	76%
Thaw through June 30	61	116	189%[2]
July	81	43	53%
August	56	26	46%
September	48	28	59%
October 1 to Freeze-Up (Varies)[1]	26	12	49%
November 1 to Freeze-Up (Varies)[1]	4	1	31%

Notes:
1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

Table 12: Average (Arithmetic) Precipitation and Meteorological Surplus predicted for Unnamed Lake Catchment Under the 2080s Climate Change Scenario for the 90th Percentile Water Year Precipitation Run

Period	Precipitation (mm)	Meteorological Surplus (mm)	Percentage of Precipitation Converted to Meteorological Surplus
Thaw to Freeze-Up (Varies)[1]	322	236	73%
Thaw through June 30	54	78	144%[2]
July	83	47	56%
August	66	34	51%
September	59	35	60%
October 1 to Freeze-Up (Varies)[1]	57	35	61%
November 1 to Freeze-Up (Varies)[1]	18	6	37%

Notes:

1. Effective length of ice-free period (i.e., the number of days since estimate that to freeze up day) differs between years.
2. Large percentage of precipitation converted to meteorological surplus due to inclusion of snowmelt

2.0 PREDICTED RESERVOIR LEVEL AND DEFICIT AT FREEZE UP IN LAKE GERALDINE

Table 13: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	28-Nov	183.00	148.00	395.15	222.51	124.77	124.01	354.93	169.27	88.61	100.70	51,536	1,238,990	111.16
5	15-Jun	27-Nov	175.00	141.00	360.22	191.53	99.56	80.27	291.77	140.96	63.48	58.15	43,068	1,247,458	111.19
10	15-Jun	27-Nov	171.00	138.00	332.69	146.43	86.46	74.70	254.55	105.07	52.24	55.23	41,421	1,249,105	111.20
25	12-Jun	19-Nov	166.00	125.50	289.52	86.49	72.69	55.99	208.60	53.15	43.88	36.22	39,425	1,251,101	111.20
50	10-Jun	14-Nov	157.00	117.00	241.44	63.21	54.68	34.92	135.60	27.54	26.39	16.17	33,889	1,256,637	111.22
75	06-Jun	07-Nov	147.00	108.00	200.94	45.81	37.65	24.29	102.95	14.17	8.50	7.02	28,003	1,262,523	111.24
90	03-Jun	02-Nov	145.00	104.00	157.42	34.11	27.47	18.19	68.15	0.47	-0.61	0.90	17,880	1,272,646	111.27
95	01-Jun	30-Oct	144.00	98.60	147.29	30.52	16.53	15.98	51.23	-2.72	-1.77	-1.10	14,375	1,276,151	111.28
100 (Min)	28-May	25-Oct	138.00	82.00	121.95	18.48	6.30	9.84	34.07	-3.64	-2.14	-1.45	6,193	1,284,333	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 14: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	27-Nov	184.00	154.00	518.58	277.78	161.86	123.31	537.25	222.45	125.06	96.07	142,835	1,147,691	110.87
5	14-Jun	20-Nov	177.00	140.30	475.89	253.91	115.90	97.81	469.00	202.85	83.38	73.71	42,986	1,247,540	111.19
10	13-Jun	18-Nov	172.30	135.30	425.32	236.04	102.63	83.12	415.52	183.55	65.57	64.59	39,443	1,251,083	111.20
25	11-Jun	16-Nov	165.25	126.00	346.25	123.32	82.67	67.31	279.13	78.32	48.61	47.50	37,125	1,253,401	111.21
50	07-Jun	09-Nov	157.50	116.00	265.75	67.76	60.05	53.84	191.60	31.75	31.11	34.43	32,827	1,257,699	111.22
75	01-Jun	03-Nov	146.00	104.00	215.55	41.91	47.08	34.12	144.59	14.07	15.60	17.21	24,160	1,266,366	111.25
90	26-May	30-Oct	142.00	97.00	190.09	31.75	34.50	27.85	106.32	-1.63	4.80	11.46	19,329	1,271,197	111.27
95	19-May	25-Oct	139.35	96.00	180.72	22.56	29.37	24.02	85.60	-2.80	1.44	4.52	17,976	1,272,550	111.27
100 (Min)	15-May	16-Oct	130.00	75.00	128.27	6.32	13.00	17.48	62.71	-3.64	-2.10	-1.31	8,636	1,281,890	111.30

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 15: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	12-Jun	28-Nov	202.00	161.00	782.00	410.61	152.21	129.14	713.63	343.20	110.48	102.71	45,798	1,244,728	111.18
5	07-Jun	28-Nov	199.00	157.00	572.48	262.33	113.94	107.04	530.40	210.83	84.94	80.37	38,716	1,251,810	111.20
10	06-Jun	27-Nov	197.40	155.00	491.70	231.18	104.12	90.05	443.24	183.11	73.22	65.36	35,155	1,255,371	111.22
25	03-Jun	27-Nov	190.00	151.00	393.49	110.78	88.51	70.43	319.05	72.43	56.26	48.95	31,936	1,258,590	111.23
50	22-May	22-Nov	181.00	141.00	319.83	72.26	69.76	54.00	193.13	36.70	37.94	34.11	22,563	1,267,963	111.26
75	15-May	16-Nov	170.00	130.00	267.34	48.12	44.97	36.65	150.65	15.22	15.74	17.93	15,706	1,274,820	111.28
90	12-May	06-Nov	160.00	123.60	232.47	35.98	31.26	27.45	126.65	4.69	3.56	9.41	8,684	1,281,842	111.30
95	09-May	02-Nov	155.20	118.90	219.44	29.22	26.04	24.87	107.22	-1.59	-1.44	6.69	6,369	1,284,157	111.31
100 (Min)	08-May	27-Oct	145.00	111.00	168.25	16.11	15.97	20.46	53.73	-3.38	-2.24	2.76	6,193	1,284,333	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 16: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	28-Nov	183.00	148.00	395.15	222.51	124.77	124.01	354.93	169.27	88.61	100.70	1,237,277	53,249	106.77
5	15-Jun	27-Nov	175.00	141.00	360.22	191.53	99.56	80.27	291.77	140.96	63.48	58.15	1,082,931	207,595	107.48
10	15-Jun	27-Nov	171.00	138.00	332.69	146.43	86.46	74.70	254.55	105.07	52.24	55.23	999,880	290,646	107.83
25	12-Jun	19-Nov	166.00	125.50	289.52	86.49	72.69	55.99	208.60	53.15	43.88	36.22	859,169	431,357	108.40
50	10-Jun	14-Nov	157.00	117.00	241.44	63.21	54.68	34.92	135.60	27.54	26.39	16.17	669,399	621,127	109.10
75	06-Jun	07-Nov	147.00	108.00	200.94	45.81	37.65	24.29	102.95	14.17	8.50	7.02	499,254	791,272	109.69
90	03-Jun	02-Nov	145.00	104.00	157.42	34.11	27.47	18.19	68.15	0.47	-0.61	0.90	308,283	982,243	110.33
95	01-Jun	30-Oct	144.00	98.60	147.29	30.52	16.53	15.98	51.23	-2.72	-1.77	-1.10	230,460	1,060,066	110.58
100 (Min)	28-May	25-Oct	138.00	82.00	121.95	18.48	6.30	9.84	34.07	-3.64	-2.14	-1.45	144,795	1,145,731	110.86

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 17: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	27-Nov	184.00	154.00	518.58	277.78	161.86	123.31	537.25	222.45	125.06	96.07	966,579	323,947	107.97
5	14-Jun	20-Nov	177.00	140.30	475.89	253.91	115.90	97.81	469.00	202.85	83.38	73.71	887,389	403,137	108.29
10	13-Jun	18-Nov	172.30	135.30	425.32	236.04	102.63	83.12	415.52	183.55	65.57	64.59	836,954	453,572	108.48
25	11-Jun	16-Nov	165.25	126.00	346.25	123.32	82.67	67.31	279.13	78.32	48.61	47.50	712,841	577,685	108.94
50	07-Jun	09-Nov	157.50	116.00	265.75	67.76	60.05	53.84	191.60	31.75	31.11	34.43	554,700	735,826	109.50
75	01-Jun	03-Nov	146.00	104.00	215.55	41.91	47.08	34.12	144.59	14.07	15.60	17.21	186,645	1,103,881	110.73
90	26-May	30-Oct	142.00	97.00	190.09	31.75	34.50	27.85	106.32	-1.63	4.80	11.46	133,397	1,157,129	110.90
95	19-May	25-Oct	139.35	96.00	180.72	22.56	29.37	24.02	85.60	-2.80	1.44	4.52	122,450	1,168,076	110.93
100 (Min)	15-May	16-Oct	130.00	75.00	128.27	6.32	13.00	17.48	62.71	-3.64	-2.10	-1.31	113,678	1,176,848	110.96

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 18: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	12-Jun	28-Nov	202.00	161.00	782.00	410.61	152.21	129.14	713.63	343.20	110.48	102.71	1,074,686	215,840	107.52
5	07-Jun	28-Nov	199.00	157.00	572.48	262.33	113.94	107.04	530.40	210.83	84.94	80.37	884,257	406,269	108.31
10	06-Jun	27-Nov	197.40	155.00	491.70	231.18	104.12	90.05	443.24	183.11	73.22	65.36	832,547	457,979	108.50
25	03-Jun	27-Nov	190.00	151.00	393.49	110.78	88.51	70.43	319.05	72.43	56.26	48.95	688,954	601,572	109.03
50	22-May	22-Nov	181.00	141.00	319.83	72.26	69.76	54.00	193.13	36.70	37.94	34.11	485,372	805,154	109.73
75	15-May	16-Nov	170.00	130.00	267.34	48.12	44.97	36.65	150.65	15.22	15.74	17.93	243,196	1,047,330	110.54
90	12-May	06-Nov	160.00	123.60	232.47	35.98	31.26	27.45	126.65	4.69	3.56	9.41	127,366	1,163,160	110.92
95	09-May	02-Nov	155.20	118.90	219.44	29.22	26.04	24.87	107.22	-1.59	-1.44	6.69	113,555	1,176,971	110.96
100 (Min)	08-May	27-Oct	145.00	111.00	168.25	16.11	15.97	20.46	53.73	-3.38	-2.24	2.76	26,458	1,264,068	111.24

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 19: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	18-Jun	28-Nov	183.00	148.00	395.15	222.51	124.77	124.01	354.93	169.27	88.61	100.70	1,413,943	-123,417	105.84
5	15-Jun	27-Nov	175.00	141.00	360.22	191.53	99.56	80.27	291.77	140.96	63.48	58.15	1,252,529	37,997	106.69
10	15-Jun	27-Nov	171.00	138.00	332.69	146.43	86.46	74.70	254.55	105.07	52.24	55.23	1,163,296	127,230	107.12
25	12-Jun	19-Nov	166.00	125.50	289.52	86.49	72.69	55.99	208.60	53.15	43.88	36.22	1,022,887	267,639	107.73
50	10-Jun	14-Nov	157.00	117.00	241.44	63.21	54.68	34.92	135.60	27.54	26.39	16.17	823,851	466,675	108.53
75	06-Jun	07-Nov	147.00	108.00	200.94	45.81	37.65	24.29	102.95	14.17	8.50	7.02	651,266	639,260	109.16
90	03-Jun	02-Nov	145.00	104.00	157.42	34.11	27.47	18.19	68.15	0.47	-0.61	0.90	431,559	858,967	109.92
95	01-Jun	30-Oct	144.00	98.60	147.29	30.52	16.53	15.98	51.23	-2.72	-1.77	-1.10	362,708	927,818	110.15
100 (Min)	28-May	25-Oct	138.00	82.00	121.95	18.48	6.30	9.84	34.07	-3.64	-2.14	-1.45	259,771	1,030,755	110.49

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 20: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	27-Nov	184.00	154.00	518.58	277.78	161.86	123.31	537.25	222.45	125.06	96.07	1,179,271	111,255	107.05
5	14-Jun	20-Nov	177.00	140.30	475.89	253.91	115.90	97.81	469.00	202.85	83.38	73.71	1,038,518	252,008	107.67
10	13-Jun	18-Nov	172.30	135.30	425.32	236.04	102.63	83.12	415.52	183.55	65.57	64.59	1,010,188	280,338	107.79
25	11-Jun	16-Nov	165.25	126.00	346.25	123.32	82.67	67.31	279.13	78.32	48.61	47.50	892,680	397,846	108.27
50	07-Jun	09-Nov	157.50	116.00	265.75	67.76	60.05	53.84	191.60	31.75	31.11	34.43	731,510	559,016	108.87
75	01-Jun	03-Nov	146.00	104.00	215.55	41.91	47.08	34.12	144.59	14.07	15.60	17.21	263,244	1,027,282	110.48
90	26-May	30-Oct	142.00	97.00	190.09	31.75	34.50	27.85	106.32	-1.63	4.80	11.46	169,649	1,120,877	110.78
95	19-May	25-Oct	139.35	96.00	180.72	22.56	29.37	24.02	85.60	-2.80	1.44	4.52	135,938	1,154,588	110.89
100 (Min)	15-May	16-Oct	130.00	75.00	128.27	6.32	13.00	17.48	62.71	-3.64	-2.10	-1.31	128,872	1,161,654	110.91

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 21: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	12-Jun	28-Nov	202.00	161.00	782.00	410.61	152.21	129.14	713.63	343.20	110.48	102.71	1,256,837	33,689	106.67
5	07-Jun	28-Nov	199.00	157.00	572.48	262.33	113.94	107.04	530.40	210.83	84.94	80.37	1,064,386	226,140	107.56
10	06-Jun	27-Nov	197.40	155.00	491.70	231.18	104.12	90.05	443.24	183.11	73.22	65.36	1,011,250	279,276	107.78
25	03-Jun	27-Nov	190.00	151.00	393.49	110.78	88.51	70.43	319.05	72.43	56.26	48.95	831,798	458,728	108.50
50	22-May	22-Nov	181.00	141.00	319.83	72.26	69.76	54.00	193.13	36.70	37.94	34.11	650,181	640,345	109.17
75	15-May	16-Nov	170.00	130.00	267.34	48.12	44.97	36.65	150.65	15.22	15.74	17.93	327,027	963,499	110.27
90	12-May	06-Nov	160.00	123.60	232.47	35.98	31.26	27.45	126.65	4.69	3.56	9.41	186,580	1,103,946	110.73
95	09-May	02-Nov	155.20	118.90	219.44	29.22	26.04	24.87	107.22	-1.59	-1.44	6.69	140,715	1,149,811	110.87
100 (Min)	08-May	27-Oct	145.00	111.00	168.25	16.11	15.97	20.46	53.73	-3.38	-2.24	2.76	39,623	1,250,903	111.20

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 22: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 10th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	05-Dec	204.00	177.00	516.08	266.69	172.95	143.76	482.33	209.56	131.48	94.14	146,835	1,143,691	110.85
5	13-Jun	28-Nov	194.80	167.80	463.05	217.50	108.46	99.89	404.98	167.67	74.69	76.57	40,013	1,250,513	111.20
10	10-Jun	27-Nov	185.20	161.20	445.31	197.89	100.33	97.52	387.59	152.10	64.34	71.67	39,636	1,250,890	111.20
25	06-Jun	25-Nov	179.00	152.00	371.24	161.06	78.73	75.47	311.22	120.17	46.64	53.51	35,937	1,254,589	111.21
50	31-May	12-Nov	169.00	143.00	273.48	54.58	51.91	58.60	195.95	20.64	21.98	33.93	26,426	1,264,100	111.24
75	17-May	05-Nov	155.00	127.00	221.54	33.71	28.75	35.18	119.23	4.01	1.11	17.61	17,448	1,273,078	111.27
90	14-May	30-Oct	150.00	119.40	179.41	24.97	17.40	25.16	86.92	-2.71	-1.91	1.96	9,512	1,281,014	111.30
95	13-May	28-Oct	147.00	115.00	159.24	15.50	11.10	22.00	67.76	-2.93	-2.00	-1.03	6,847	1,283,679	111.31
100 (Min)	07-May	17-Oct	138.00	102.00	142.24	8.74	5.09	15.68	30.85	-3.44	-2.17	-1.41	6,193	1,284,333	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 23: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 50th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	16-Jun	28-Nov	197.00	152.00	490.68	216.98	143.07	113.53	522.69	173.01	96.06	92.73	49,825	1,240,701	111.17
5	14-Jun	27-Nov	177.00	145.00	403.79	174.31	109.62	93.38	412.06	132.51	77.35	69.47	39,972	1,250,554	111.20
10	13-Jun	19-Nov	168.60	134.30	358.79	160.87	93.80	77.14	333.45	116.97	61.89	57.72	39,886	1,250,640	111.20
25	11-Jun	14-Nov	162.00	121.25	308.64	100.86	68.15	62.11	257.56	60.34	43.69	41.49	36,152	1,254,374	111.21
50	08-Jun	08-Nov	153.00	110.50	257.20	68.77	55.24	46.68	185.11	30.90	24.06	26.27	31,035	1,259,491	111.23
75	04-Jun	02-Nov	145.75	100.75	208.58	46.35	35.98	29.66	119.87	14.81	5.79	13.21	23,610	1,266,916	111.25
90	31-May	27-Oct	141.00	95.70	186.42	34.26	22.16	21.20	96.35	4.08	-1.46	5.64	18,329	1,272,197	111.27
95	29-May	24-Oct	139.00	92.00	167.89	23.85	16.15	17.55	79.27	-1.91	-2.10	1.94	16,014	1,274,512	111.28
100 (Min)	14-May	17-Oct	127.00	77.00	135.30	11.75	7.13	6.08	59.21	-3.42	-2.22	-0.98	6,707	1,283,819	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 24: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 90th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	11-Jun	28-Nov	198.00	188.00	657.28	434.60	163.81	134.23	658.04	368.61	117.76	101.70	49,470	1,241,056	111.17
5	08-Jun	28-Nov	194.00	175.00	561.53	287.41	119.94	118.73	503.04	230.97	84.64	93.03	38,898	1,251,628	111.20
10	08-Jun	27-Nov	190.40	173.40	506.05	231.32	109.58	111.68	456.95	188.34	76.67	88.22	37,070	1,253,456	111.21
25	04-Jun	27-Nov	183.00	167.00	359.05	79.99	83.09	73.86	314.46	43.93	51.52	50.11	31,814	1,258,712	111.23
50	30-May	25-Nov	178.00	159.00	296.35	55.08	64.18	49.82	189.75	19.98	32.22	28.42	24,978	1,265,548	111.25
75	28-May	16-Nov	169.50	146.50	250.21	40.46	43.15	36.73	155.55	7.17	12.02	15.81	13,383	1,277,143	111.29
90	17-May	10-Nov	160.00	139.60	220.06	27.11	29.07	29.43	117.09	1.38	-0.92	7.70	7,603	1,282,923	111.31
95	16-May	05-Nov	154.60	136.30	195.41	20.18	24.04	26.59	99.31	-2.81	-1.90	6.05	6,225	1,284,301	111.31
100 (Min)	11-May	30-Oct	147.00	127.00	152.94	10.25	9.27	12.06	42.58	-3.43	-2.47	-1.37	6,193	1,284,333	111.31

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 25: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 10th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	05-Dec	204.00	177.00	516.08	266.69	172.95	143.76	482.33	209.56	131.48	94.14	1,157,420	133,106	107.15
5	13-Jun	28-Nov	194.80	167.80	463.05	217.50	108.46	99.89	404.98	167.67	74.69	76.57	1,054,160	236,366	107.60
10	10-Jun	27-Nov	185.20	161.20	445.31	197.89	100.33	97.52	387.59	152.10	64.34	71.67	998,748	291,778	107.83
25	06-Jun	25-Nov	179.00	152.00	371.24	161.06	78.73	75.47	311.22	120.17	46.64	53.51	814,300	476,226	108.57
50	31-May	12-Nov	169.00	143.00	273.48	54.58	51.91	58.60	195.95	20.64	21.98	33.93	555,162	735,364	109.50
75	17-May	05-Nov	155.00	127.00	221.54	33.71	28.75	35.18	119.23	4.01	1.11	17.61	244,208	1,046,318	110.54
90	14-May	30-Oct	150.00	119.40	179.41	24.97	17.40	25.16	86.92	-2.71	-1.91	1.96	165,240	1,125,286	110.79
95	13-May	28-Oct	147.00	115.00	159.24	15.50	11.10	22.00	67.76	-2.93	-2.00	-1.03	141,684	1,148,842	110.87
100 (Min)	07-May	17-Oct	138.00	102.00	142.24	8.74	5.09	15.68	30.85	-3.44	-2.17	-1.41	108,774	1,181,752	110.98

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 26: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 50th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	16-Jun	28-Nov	197.00	152.00	490.68	216.98	143.07	113.53	522.69	173.01	96.06	92.73	1,042,717	247,809	107.65
5	14-Jun	27-Nov	177.00	145.00	403.79	174.31	109.62	93.38	412.06	132.51	77.35	69.47	914,539	375,987	108.18
10	13-Jun	19-Nov	168.60	134.30	358.79	160.87	93.80	77.14	333.45	116.97	61.89	57.72	874,102	416,424	108.35
25	11-Jun	14-Nov	162.00	121.25	308.64	100.86	68.15	62.11	257.56	60.34	43.69	41.49	735,137	555,389	108.86
50	08-Jun	08-Nov	153.00	110.50	257.20	68.77	55.24	46.68	185.11	30.90	24.06	26.27	537,526	753,000	109.56
75	04-Jun	02-Nov	145.75	100.75	208.58	46.35	35.98	29.66	119.87	14.81	5.79	13.21	331,672	958,854	110.25
90	31-May	27-Oct	141.00	95.70	186.42	34.26	22.16	21.20	96.35	4.08	-1.46	5.64	180,423	1,110,103	110.75
95	29-May	24-Oct	139.00	92.00	167.89	23.85	16.15	17.55	79.27	-1.91	-2.10	1.94	124,379	1,166,147	110.93
100 (Min)	14-May	17-Oct	127.00	77.00	135.30	11.75	7.13	6.08	59.21	-3.42	-2.22	-0.98	100,648	1,189,878	111.00

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 27: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 90th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	11-Jun	28-Nov	198.00	188.00	657.28	434.60	163.81	134.23	658.04	368.61	117.76	101.70	1,061,223	229,303	107.57
5	08-Jun	28-Nov	194.00	175.00	561.53	287.41	119.94	118.73	503.04	230.97	84.64	93.03	1,012,400	278,126	107.78
10	08-Jun	27-Nov	190.40	173.40	506.05	231.32	109.58	111.68	456.95	188.34	76.67	88.22	944,964	345,562	108.06
25	04-Jun	27-Nov	183.00	167.00	359.05	79.99	83.09	73.86	314.46	43.93	51.52	50.11	799,759	490,767	108.62
50	30-May	25-Nov	178.00	159.00	296.35	55.08	64.18	49.82	189.75	19.98	32.22	28.42	574,381	716,145	109.44
75	28-May	16-Nov	169.50	146.50	250.21	40.46	43.15	36.73	155.55	7.17	12.02	15.81	265,390	1,025,136	110.47
90	17-May	10-Nov	160.00	139.60	220.06	27.11	29.07	29.43	117.09	1.38	-0.92	7.70	128,903	1,161,623	110.91
95	16-May	05-Nov	154.60	136.30	195.41	20.18	24.04	26.59	99.31	-2.81	-1.90	6.05	107,283	1,183,243	110.98
100 (Min)	11-May	30-Oct	147.00	127.00	152.94	10.25	9.27	12.06	42.58	-3.43	-2.47	-1.37	84,767	1,205,759	111.06

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 28: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 10th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	15-Jun	05-Dec	204.00	177.00	516.08	266.69	172.95	143.76	482.33	209.56	131.48	94.14	1,347,230	-56,704	106.22
5	13-Jun	28-Nov	194.80	167.80	463.05	217.50	108.46	99.89	404.98	167.67	74.69	76.57	1,234,099	56,427	106.78
10	10-Jun	27-Nov	185.20	161.20	445.31	197.89	100.33	97.52	387.59	152.10	64.34	71.67	1,151,020	139,506	107.18
25	06-Jun	25-Nov	179.00	152.00	371.24	161.06	78.73	75.47	311.22	120.17	46.64	53.51	989,259	301,267	107.87
50	31-May	12-Nov	169.00	143.00	273.48	54.58	51.91	58.60	195.95	20.64	21.98	33.93	729,023	561,503	108.88
75	17-May	05-Nov	155.00	127.00	221.54	33.71	28.75	35.18	119.23	4.01	1.11	17.61	401,606	888,920	110.02
90	14-May	30-Oct	150.00	119.40	179.41	24.97	17.40	25.16	86.92	-2.71	-1.91	1.96	216,314	1,074,212	110.63
95	13-May	28-Oct	147.00	115.00	159.24	15.50	11.10	22.00	67.76	-2.93	-2.00	-1.03	179,273	1,111,253	110.75
100 (Min)	07-May	17-Oct	138.00	102.00	142.24	8.74	5.09	15.68	30.85	-3.44	-2.17	-1.41	123,763	1,166,763	110.93

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 29: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 50th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	16-Jun	28-Nov	197.00	152.00	490.68	216.98	143.07	113.53	522.69	173.01	96.06	92.73	1,204,661	85,865	106.92
5	14-Jun	27-Nov	177.00	145.00	403.79	174.31	109.62	93.38	412.06	132.51	77.35	69.47	1,096,630	193,896	107.43
10	13-Jun	19-Nov	168.60	134.30	358.79	160.87	93.80	77.14	333.45	116.97	61.89	57.72	1,043,142	247,384	107.65
25	11-Jun	14-Nov	162.00	121.25	308.64	100.86	68.15	62.11	257.56	60.34	43.69	41.49	905,515	385,011	108.22
50	08-Jun	08-Nov	153.00	110.50	257.20	68.77	55.24	46.68	185.11	30.90	24.06	26.27	720,035	570,491	108.91
75	04-Jun	02-Nov	145.75	100.75	208.58	46.35	35.98	29.66	119.87	14.81	5.79	13.21	505,764	784,762	109.67
90	31-May	27-Oct	141.00	95.70	186.42	34.26	22.16	21.20	96.35	4.08	-1.46	5.64	265,393	1,025,133	110.47
95	29-May	24-Oct	139.00	92.00	167.89	23.85	16.15	17.55	79.27	-1.91	-2.10	1.94	220,926	1,069,600	110.61
100 (Min)	14-May	17-Oct	127.00	77.00	135.30	11.75	7.13	6.08	59.21	-3.42	-2.22	-0.98	135,212	1,155,314	110.89

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

Table 30: Precipitation and Predicted Surplus for 10 Weather Generated Replications of the 2008 to 2017 Period Under 2080s 90th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Thaw Date	Predicted Freeze-Up Date	Number of Open-Water Days from Thaw to Freeze Up	Number of Rainfall Days from Thaw to Freeze-Up	Historic Precipitation (mm)				Predicted Historic Surplus (mm)				Predicted Reservoir Deficit at Freeze-Up (m3)	Predicted Available Water Supply at Freeze-up (m3)	Predicted Reservoir Level at Freeze-Up (masl)
					Open Water Period	July	August	September	Open Water Period	July	August	September			
0 (Max)	11-Jun	28-Nov	198.00	188.00	657.28	434.60	163.81	134.23	658.04	368.61	117.76	101.70	1,234,158	56,368	106.78
5	08-Jun	28-Nov	194.00	175.00	561.53	287.41	119.94	118.73	503.04	230.97	84.64	93.03	1,193,949	96,577	106.97
10	08-Jun	27-Nov	190.40	173.40	506.05	231.32	109.58	111.68	456.95	188.34	76.67	88.22	1,117,223	173,303	107.34
25	04-Jun	27-Nov	183.00	167.00	359.05	79.99	83.09	73.86	314.46	43.93	51.52	50.11	970,041	320,485	107.95
50	30-May	25-Nov	178.00	159.00	296.35	55.08	64.18	49.82	189.75	19.98	32.22	28.42	739,417	551,109	108.84
75	28-May	16-Nov	169.50	146.50	250.21	40.46	43.15	36.73	155.55	7.17	12.02	15.81	469,903	820,623	109.79
90	17-May	10-Nov	160.00	139.60	220.06	27.11	29.07	29.43	117.09	1.38	-0.92	7.70	171,641	1,118,885	110.77
95	16-May	05-Nov	154.60	136.30	195.41	20.18	24.04	26.59	99.31	-2.81	-1.90	6.05	134,027	1,156,499	110.90
100 (Min)	11-May	30-Oct	147.00	127.00	152.94	10.25	9.27	12.06	42.58	-3.43	-2.47	-1.37	104,589	1,185,937	110.99

Notes:

1. For conservatism, evaporative losses from the reservoir are assumed to occur at the maximum water level of 111.33 masl with a calculated surface area of 29 ha. This rate will decline with reduced water levels.
2. Predicted Available Water Supply at Freeze-Up calculated by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).
3. Values for available water supply and reservoir level are calculated from reservoir deficit. All other columns are independent based only on the probability of exceedance
4. Predicted Available Water Supply at Freeze-Up calculate by removing 9 months of ice storage (585,000 m^3), reservoir deficit (tabulated) and dead storage (80,667 m^3) from total reservoir storage capacity (1,956,193 m^3).

3.0 PREDICTED SUPPLEMENTATION REQUIREMENTS FOR GERALDINE LAKE, AND ENSUING WATER LEVEL AND STORAGE EFFECTS IN UNNAMED LAKE RESULTING FROM SUPPLEMENTATION OF LAKE GERALDINE

Table 31: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	51,536	0.021	202.280	5,691,382	202.276	5,687,853	-0.06%	0.00
5	43,068	0.018	202.239	5,654,507	202.237	5,652,906	-0.03%	0.00
10	41,421	0.017	202.217	5,633,830	202.209	5,626,884	-0.12%	-0.01
25	39,425	0.016	202.189	5,610,105	202.183	5,604,536	-0.10%	-0.01
50	33,889	0.014	202.162	5,586,129	202.157	5,582,277	-0.07%	-0.01
75	28,003	0.012	202.127	5,556,472	202.117	5,548,666	-0.14%	-0.01
90	17,880	0.007	202.106	5,538,711	202.091	5,526,680	-0.22%	-0.01
95	14,375	0.006	202.075	5,513,045	202.060	5,500,796	-0.22%	-0.02
100 (Min)	6,193	0.003	202.058	5,497,366	202.029	5,475,048	-0.41%	-0.02

Table 32: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	142,835	0.059	202.274	5,683,385	202.272	5,681,974	-0.02%	0.00
5	42,986	0.018	202.260	5,671,487	202.259	5,670,594	-0.02%	0.00
10	39,443	0.016	202.252	5,664,484	202.249	5,662,119	-0.04%	0.00
25	37,125	0.015	202.218	5,635,503	202.213	5,631,505	-0.07%	0.00
50	32,827	0.014	202.196	5,615,582	202.189	5,609,851	-0.10%	-0.01
75	24,160	0.010	202.168	5,591,380	202.160	5,584,221	-0.13%	-0.01
90	19,329	0.008	202.138	5,565,812	202.132	5,559,991	-0.10%	-0.01
95	17,976	0.007	202.125	5,554,145	202.114	5,545,234	-0.16%	-0.01
100 (Min)	8,636	0.004	202.066	5,504,933	202.047	5,489,700	-0.28%	-0.08

Table 33: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and No Consumption Scenario

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	45,798	0.019	202.442	5,831,205	202.441	5,830,123	-0.02%	0.00
5	38,716	0.016	202.336	5,738,142	202.334	5,736,736	-0.02%	0.00
10	35,155	0.015	202.310	5,715,595	202.305	5,711,802	-0.07%	0.00
25	31,936	0.013	202.249	5,662,499	202.247	5,660,185	-0.04%	0.00
50	22,563	0.009	202.221	5,638,691	202.219	5,636,917	-0.03%	-0.01
75	15,706	0.006	202.194	5,614,294	202.191	5,611,765	-0.05%	-0.01
90	8,684	0.004	202.162	5,585,712	202.156	5,582,186	-0.06%	-0.01
95	6,369	0.003	202.146	5,572,319	202.139	5,566,206	-0.11%	-0.01
100 (Min)	6,193	0.003	202.105	5,536,930	202.089	5,524,105	-0.23%	-0.02

Table 34: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,237,277	0.511	202.280	5,691,382	202.186	5,607,701	-1.47%	-0.03
5	1,082,931	0.448	202.239	5,654,507	202.077	5,516,272	-2.44%	-0.08
10	999,880	0.413	202.217	5,633,830	202.055	5,498,283	-2.41%	-0.11
25	859,169	0.355	202.189	5,610,105	201.823	5,316,625	-5.23%	-0.22
50	669,399	0.277	202.162	5,586,129	201.488	5,067,461	-9.28%	-0.48
75	499,254	0.206	202.127	5,556,472	201.215	4,871,095	-12.33%	-0.70
90	308,283	0.127	202.106	5,538,711	200.873	4,631,755	-16.37%	-1.00
95	230,460	0.095	202.075	5,513,045	200.562	4,428,229	-19.68%	-1.18
100 (Min)	144,795	0.060	202.058	5,497,366	199.900	4,065,953	-26.04%	-2.49

Table 35: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	966,579	0.400	202.274	5,683,385	202.264	5,674,379	-0.16%	-0.01
5	887,389	0.367	202.260	5,671,487	202.242	5,655,593	-0.28%	-0.02
10	836,954	0.346	202.252	5,664,484	202.211	5,629,600	-0.62%	-0.02
25	712,841	0.295	202.218	5,635,503	202.144	5,571,901	-1.13%	-0.06
50	554,700	0.229	202.196	5,615,582	201.839	5,328,983	-5.10%	-0.27
75	186,645	0.077	202.168	5,591,380	201.492	5,069,935	-9.33%	-0.43
90	133,397	0.055	202.138	5,565,812	201.365	4,979,682	-10.53%	-0.63
95	122,450	0.051	202.125	5,554,145	201.255	4,897,369	-11.82%	-0.75
100 (Min)	113,678	0.047	202.066	5,504,933	200.968	4,697,757	-14.66%	-1.01

Table 36: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and Low Consumption Scenario (100,000 m³/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,074,686	0.444	202.442	5,831,205	202.427	5,815,859	-0.26%	-0.01
5	884,257	0.366	202.336	5,738,142	202.264	5,675,264	-1.10%	-0.02
10	832,547	0.344	202.310	5,715,595	202.228	5,644,353	-1.25%	-0.02
25	688,954	0.285	202.249	5,662,499	202.166	5,590,994	-1.26%	-0.08
50	485,372	0.201	202.221	5,638,691	202.018	5,468,840	-3.01%	-0.22
75	243,196	0.101	202.194	5,614,294	201.652	5,190,619	-7.55%	-0.46
90	127,366	0.053	202.162	5,585,712	201.399	5,004,950	-10.40%	-0.63
95	113,555	0.047	202.146	5,572,319	201.255	4,900,573	-12.06%	-0.75
100 (Min)	26,458	0.011	202.105	5,536,930	200.759	4,558,541	-17.67%	-1.09

Table 37: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 10th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m³/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,413,943	0.584	202.280	5,691,382	202.110	5,544,000	-2.59%	-0.07
5	1,252,529	0.518	202.239	5,654,507	202.018	5,467,655	-3.30%	-0.15
10	1,163,296	0.481	202.217	5,633,830	201.908	5,382,693	-4.46%	-0.18
25	1,022,887	0.423	202.189	5,610,105	201.662	5,195,060	-7.40%	-0.32
50	823,851	0.341	202.162	5,586,129	201.259	4,904,549	-12.20%	-0.61
75	651,266	0.269	202.127	5,556,472	200.948	4,685,350	-15.68%	-0.88
90	431,559	0.178	202.106	5,538,711	200.573	4,439,063	-19.85%	-1.29
95	362,708	0.150	202.075	5,513,045	200.054	4,145,379	-24.81%	-1.55
100 (Min)	259,771	0.107	202.058	5,497,366	199.083	3,637,384	-33.83%	-3.12

Table 38: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 50th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,179,271	0.487	202.274	5,683,385	202.263	5,673,702	-0.17%	-0.01
5	1,038,518	0.429	202.260	5,671,487	202.237	5,651,139	-0.36%	-0.02
10	1,010,188	0.418	202.252	5,664,484	202.209	5,627,705	-0.65%	-0.03
25	892,680	0.369	202.218	5,635,503	202.082	5,521,817	-2.02%	-0.09
50	731,510	0.302	202.196	5,615,582	201.654	5,188,526	-7.60%	-0.38
75	263,244	0.109	202.168	5,591,380	201.285	4,917,989	-12.04%	-0.57
90	169,649	0.070	202.138	5,565,812	201.108	4,793,398	-13.88%	-0.83
95	135,938	0.056	202.125	5,554,145	201.035	4,745,627	-14.56%	-0.99
100 (Min)	128,872	0.053	202.066	5,504,933	200.663	4,489,174	-18.45%	-1.28

Table 39: Pumping Requirements for Lake Geraldine Supplementation and Effect on Unnamed Lake Under 2050s 90th Percentile Water Year Precipitation Climate Change Scenario and High Consumption Scenario (115,000 m^3/month)

Percentage Probability of Exceedance	Predicted Unmitigated Reservoir Deficit at Freeze-Up for Geraldine Lake (m^3)	Assumed Pumping Rate from Unnamed Lake (m^3/s)	Predicted Unnamed Lake Level at Freeze-Up Prior to Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Without Pumping (m^3)	Predicted Unnamed Lake Level at Freeze-After Pumping (masl)	Predicted Unmitigated Unnamed Lake Volume at Freeze-Up Following Pumping (m^3)	Predicted Volume Difference (%)	Predicted Difference in Lake Water Level (m)
0 (Max)	1,256,837	0.520	202.442	5,831,205	202.426	5,815,559	-0.27%	-0.01
5	1,064,386	0.440	202.336	5,738,142	202.246	5,660,016	-1.36%	-0.02
10	1,011,250	0.418	202.310	5,715,595	202.220	5,637,797	-1.36%	-0.03
25	831,798	0.344	202.249	5,662,499	202.117	5,548,588	-2.01%	-0.14
50	650,181	0.269	202.221	5,638,691	201.822	5,315,513	-5.73%	-0.34
75	327,027	0.135	202.194	5,614,294	201.444	5,037,725	-10.27%	-0.62
90	186,580	0.077	202.162	5,585,712	201.128	4,811,384	-13.86%	-0.91
95	140,715	0.058	202.146	5,572,319	201.014	4,731,814	-15.08%	-0.96
100 (Min)	39,623	0.016	202.105	5,536,930	200.187	4,224,282	-23.71%	-1.35

4.0 ESTIMATED EFFECTS OF REDUCED UNNAMED LAKE OUTFLOWS ON APEX RIVER FLOWS

Table 40: 2050s 10th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.48E-02	1.92E-02	1.28E-02	1.34E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.59E-05	2.38E-01	1.54E-01	8.81E-02	7.06E-02	3.39E-02	5.09E-03	1.78E-04	4.88E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.54E-01	2.91E-01	1.89E-01	1.49E-01	7.17E-02	1.66E-02	2.13E-07	1.34E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.43E-02	1.90E-02	1.27E-02	5.91E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.55E-05	2.35E-01	1.54E-01	8.80E-02	7.02E-02	3.12E-02	4.44E-03	1.45E-04	4.82E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.50E-01	2.89E-01	1.89E-01	1.49E-01	6.80E-02	1.50E-02	0.00E+00	1.33E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.57E-04	-1.88E-04	-9.32E-05	-7.48E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	-1.85E-08	0.00E+00	0.00E+00	0.00E+00	-3.31E-07	-2.67E-03	-3.62E-04	-4.88E-05	-4.14E-04	-2.65E-03	-6.58E-04	-3.30E-05	-5.64E-04
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.35E-03	-2.09E-03	-3.67E-04	-1.94E-04	-3.72E-03	-1.64E-03	-2.13E-07	-8.78E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.10%	-0.05%	-0.03%	-12.46%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-0.08%	-0.02%	0.00%	-0.04%	-0.75%	-7.84%	-22.84%	-0.06%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.06%	-0.05%	-0.02%	-0.01%	-0.39%	-8.22%	—	-0.03%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 41: 2050s 50th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-02	2.08E-02	2.66E-02	1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	4.73E-04	3.25E-01	1.91E-01	1.13E-01	1.03E-01	5.37E-02	6.26E-03	6.71E-05	6.54E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.66E-01	3.10E-01	2.60E-01	2.06E-01	1.08E-01	2.01E-02	0.00E+00	1.75E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-02	2.08E-02	2.59E-02	6.46E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	4.63E-04	3.23E-01	1.91E-01	1.13E-01	1.02E-01	5.09E-02	5.79E-03	5.68E-05	6.50E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.64E-01	3.10E-01	2.60E-01	2.05E-01	1.04E-01	1.90E-02	0.00E+00	1.75E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.41E-05	-1.36E-06	-6.31E-04	-3.56E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.04E-05	-1.33E-03	-1.20E-04	-8.75E-06	-9.04E-04	-2.78E-03	-4.62E-04	-1.03E-05	-4.66E-04
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.82E-03	-2.41E-04	-5.20E-07	-1.14E-03	-3.34E-03	-1.04E-03	0.00E+00	-8.40E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.02%	0.00%	-0.18%	-59.37%	0.00%	0.00%	0.00%
	Mean	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.04%	-0.01%	0.00%	-0.08%	-0.79%	-5.50%	-7.14%	-0.05%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.03%	-0.01%	0.00%	-0.05%	-0.35%	-5.19%	0.00%	-0.03%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 42: 2050s 90th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E-03	3.86E-02	2.20E-02	2.21E-02	1.54E-02	9.12E-05	0.00E+00	0.00E+00
	Mean	9.99E-05	0.00E+00	0.00E+00	0.00E+00	4.26E-02	3.06E-01	1.87E-01	1.16E-01	1.04E-01	7.10E-02	2.16E-02	3.17E-03	7.04E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-02	7.31E-01	3.14E-01	2.67E-01	2.16E-01	1.43E-01	4.97E-02	1.07E-02	1.88E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.35E-03	3.86E-02	2.20E-02	2.20E-02	1.36E-02	4.81E-05	0.00E+00	0.00E+00
	Mean	9.71E-05	0.00E+00	0.00E+00	0.00E+00	4.24E-02	3.05E-01	1.87E-01	1.16E-01	1.04E-01	6.84E-02	2.05E-02	3.06E-03	7.00E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.58E-02	7.29E-01	3.14E-01	2.67E-01	2.16E-01	1.40E-01	4.83E-02	1.03E-02	1.88E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.53E-04	-1.37E-05	-3.21E-06	-1.64E-05	-1.72E-03	-4.30E-05	0.00E+00	0.00E+00
	Mean	-2.71E-06	0.00E+00	0.00E+00	0.00E+00	-2.04E-04	-5.73E-04	-3.14E-05	-3.02E-06	-2.91E-04	-2.52E-03	-1.07E-03	-1.11E-04	-3.99E-04
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.09E-03	-1.32E-03	-2.20E-05	-2.58E-08	-3.53E-07	-3.10E-03	-1.38E-03	-4.27E-04	-5.84E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.84%	0.00%	0.00%	0.00%	-28.70%	—	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.19%	-0.02%	0.00%	0.00%	-0.03%	-0.72%	-12.76%	-76.60%	-0.04%
	90%	0.00%	0.00%	0.00%	0.00%	-10.61%	-0.02%	0.00%	0.00%	0.00%	-0.33%	-6.91%	—	-0.02%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 43: 2050s 10th Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.48E-02	1.92E-02	1.28E-02	1.34E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.59E-05	2.38E-01	1.54E-01	8.81E-02	7.06E-02	3.39E-02	5.09E-03	1.78E-04	4.88E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.54E-01	2.91E-01	1.89E-01	1.49E-01	7.17E-02	1.66E-02	2.13E-07	1.34E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.80E-04	9.51E-03	1.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.53E-05	1.12E-01	1.21E-01	7.77E-02	6.02E-02	7.28E-03	1.33E-04	2.83E-07	3.14E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.64E-01	2.43E-01	1.79E-01	1.42E-01	2.16E-02	3.18E-05	0.00E+00	9.96E-02
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.41E-02	-9.71E-03	-1.10E-02	-1.34E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-5.87E-08	0.00E+00	0.00E+00	0.00E+00	-5.25E-07	-1.26E-01	-3.33E-02	-1.04E-02	-1.05E-02	-2.66E-02	-4.96E-03	-1.78E-04	-1.74E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.90E-01	-4.82E-02	-9.83E-03	-7.40E-03	-5.01E-02	-1.66E-02	-2.13E-07	-3.44E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-9.26%	-2.84%	-3.08%	-22.31%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-3.90%	-1.82%	-0.92%	-0.97%	-7.58%	-59.08%	-123.27%	-1.70%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-4.31%	-1.25%	-0.44%	-0.36%	-5.27%	-82.92%	—	-1.30%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 44: 2050s 50th Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-02	2.08E-02	2.66E-02	1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	4.73E-04	3.25E-01	1.91E-01	1.13E-01	1.03E-01	5.37E-02	6.26E-03	6.71E-05	6.54E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.66E-01	3.10E-01	2.60E-01	2.06E-01	1.08E-01	2.01E-02	0.00E+00	1.75E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E-02	1.82E-02	5.44E-03	4.66E-08	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	2.40E-04	2.43E-01	1.79E-01	1.10E-01	8.57E-02	2.11E-02	1.53E-03	1.89E-06	5.29E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.14E-01	3.02E-01	2.56E-01	1.87E-01	6.19E-02	1.92E-03	0.00E+00	1.51E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.21E-02	-2.59E-03	-2.11E-02	-1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	2.06E-08	0.00E+00	0.00E+00	0.00E+00	-2.33E-04	-8.20E-02	-1.24E-02	-3.42E-03	-1.69E-02	-3.26E-02	-4.73E-03	-6.52E-05	-1.25E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.52E-01	-8.13E-03	-3.51E-03	-1.87E-02	-4.58E-02	-1.81E-02	0.00E+00	-2.40E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.54%	-0.76%	-5.89%	-167.10%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.21%	-2.54%	-0.68%	-0.30%	-1.56%	-9.31%	-56.28%	-45.21%	-1.22%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.25%	-0.21%	-0.16%	-0.90%	-4.82%	-90.68%	0.00%	-0.91%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 45: 2050s 90th Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E-03	3.86E-02	2.20E-02	2.21E-02	1.54E-02	9.12E-05	0.00E+00	0.00E+00
	Mean	9.99E-05	0.00E+00	0.00E+00	0.00E+00	4.26E-02	3.06E-01	1.87E-01	1.16E-01	1.04E-01	7.10E-02	2.16E-02	3.17E-03	7.04E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-02	7.31E-01	3.14E-01	2.67E-01	2.16E-01	1.43E-01	4.97E-02	1.07E-02	1.88E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.96E-04	3.21E-02	1.95E-02	1.71E-02	1.28E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	5.91E-05	0.00E+00	0.00E+00	0.00E+00	2.74E-02	2.45E-01	1.80E-01	1.14E-01	9.74E-02	3.08E-02	6.70E-03	8.91E-04	5.82E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-02	6.31E-01	3.08E-01	2.67E-01	2.11E-01	9.14E-02	2.16E-02	2.45E-04	1.66E-01
Absolute Difference (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.01E-03	-6.48E-03	-2.50E-03	-4.93E-03	-1.52E-02	-9.12E-05	0.00E+00	0.00E+00
	Mean	-4.08E-05	0.00E+00	0.00E+00	0.00E+00	-1.53E-02	-6.07E-02	-6.73E-03	-1.66E-03	-6.38E-03	-4.01E-02	-1.49E-02	-2.28E-03	-1.22E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.99E-02	-9.93E-02	-5.82E-03	-3.59E-04	-5.34E-03	-5.13E-02	-2.81E-02	-1.05E-02	-2.25E-02
Apex River Flow Rate (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	**10%**	0.00%	0.00%	0.00%	0.00%	0.00%	-10.04%	-1.36%	-0.73%	-1.38%	-254.05%	—	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-14.06%	-1.88%	-0.37%	-0.15%	-0.59%	-11.45%	-176.95%	-1582.20%	-1.19%
	90%	0.00%	0.00%	0.00%	0.00%	-104.00%	-1.48%	-0.15%	-0.02%	-0.26%	-5.40%	-140.52%	—	-0.85%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 46: 2050s 10th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m³/month) - Daily Flow Rate (m³/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.48E-02	1.92E-02	1.28E-02	1.34E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.59E-05	2.38E-01	1.54E-01	8.81E-02	7.06E-02	3.39E-02	5.09E-03	1.78E-04	4.88E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.54E-01	2.91E-01	1.89E-01	1.49E-01	7.17E-02	1.66E-02	2.13E-07	1.34E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-04	5.95E-04	7.35E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	1.37E-04	3.36E-07	0.00E+00	0.00E+00	5.53E-05	8.71E-02	1.07E-01	7.25E-02	5.63E-02	4.84E-03	4.18E-05	2.96E-08	2.72E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.89E-01	2.22E-01	1.74E-01	1.35E-01	1.13E-02	9.75E-06	0.00E+00	8.68E-02
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.45E-02	-1.86E-02	-1.21E-02	-1.34E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-5.87E-08	0.00E+00	0.00E+00	0.00E+00	-5.25E-07	-1.51E-01	-4.73E-02	-1.56E-02	-1.43E-02	-2.90E-02	-5.05E-03	-1.78E-04	-2.16E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.66E-01	-6.86E-02	-1.56E-02	-1.45E-02	-6.04E-02	-1.66E-02	-2.13E-07	-4.73E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-9.34%	-5.45%	-3.37%	-22.31%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	0.00%	-4.68%	-2.59%	-1.38%	-1.32%	-8.27%	-60.17%	-123.45%	-2.11%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-5.44%	-1.78%	-0.70%	-0.70%	-6.35%	-83.03%	—	-1.79%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m³/s for the corresponding month and statistic.

Table 47: 2050s 50th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m³/month) - Daily Flow Rate (m³/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.45E-02	2.08E-02	2.66E-02	1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	4.73E-04	3.25E-01	1.91E-01	1.13E-01	1.03E-01	5.37E-02	6.26E-03	6.71E-05	6.54E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.66E-01	3.10E-01	2.60E-01	2.06E-01	1.08E-01	2.01E-02	0.00E+00	1.75E-01
Unnamed Lake Outflow - Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.24E-02	1.63E-02	3.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	5.82E-05	0.00E+00	0.00E+00	0.00E+00	2.38E-04	2.17E-01	1.72E-01	1.07E-01	8.12E-02	1.82E-02	1.30E-03	1.67E-06	4.93E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-01	3.00E-01	2.55E-01	1.83E-01	5.45E-02	7.61E-04	0.00E+00	1.42E-01
Absolute Difference (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.22E-02	-4.48E-03	-2.30E-02	-1.00E-02	0.00E+00	0.00E+00	0.00E+00
	Mean	2.06E-08	0.00E+00	0.00E+00	0.00E+00	-2.35E-04	-1.08E-01	-1.96E-02	-5.77E-03	-2.13E-02	-3.56E-02	-4.96E-03	-6.55E-05	-1.61E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.95E-01	-1.00E-02	-4.19E-03	-2.25E-02	-5.32E-02	-1.93E-02	0.00E+00	-3.29E-02
Apex River Flow Rate (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-4.65%	-1.31%	-6.42%	-167.10%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.22%	-3.35%	-1.07%	-0.51%	-1.97%	-10.14%	-59.08%	-45.36%	-1.57%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-2.89%	-0.26%	-0.19%	-1.09%	-5.60%	-96.46%	0.00%	-1.24%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m³/s for the corresponding month and statistic.

Table 48: 2050s 90th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E-03	3.86E-02	2.20E-02	2.21E-02	1.54E-02	9.12E-05	0.00E+00	0.00E+00
	Mean	9.99E-05	0.00E+00	0.00E+00	0.00E+00	4.26E-02	3.06E-01	1.87E-01	1.16E-01	1.04E-01	7.10E-02	2.16E-02	3.17E-03	7.04E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.09E-02	7.31E-01	3.14E-01	2.67E-01	2.16E-01	1.43E-01	4.97E-02	1.07E-02	1.88E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.99E-04	2.38E-02	1.72E-02	1.42E-02	5.83E-05	0.00E+00	0.00E+00	0.00E+00
	Mean	5.91E-05	0.00E+00	0.00E+00	0.00E+00	2.30E-02	2.19E-01	1.76E-01	1.13E-01	9.47E-02	2.49E-02	4.99E-03	6.75E-04	5.43E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.86E-03	5.91E-01	3.03E-01	2.66E-01	2.07E-01	8.05E-02	1.64E-02	1.14E-04	1.57E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.11E-03	-1.48E-02	-4.79E-03	-7.83E-03	-1.53E-02	-9.12E-05	0.00E+00	0.00E+00
	Mean	-4.08E-05	0.00E+00	0.00E+00	0.00E+00	-1.96E-02	-8.70E-02	-1.11E-02	-2.85E-03	-9.14E-03	-4.61E-02	-1.66E-02	-2.50E-03	-1.61E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.10E-02	-1.40E-01	-1.11E-02	-7.14E-04	-8.56E-03	-6.23E-02	-3.33E-02	-1.06E-02	-3.14E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	-10.36%	-3.12%	-1.40%	-2.18%	-255.21%	—	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-18.07%	-2.70%	-0.61%	-0.25%	-0.84%	-13.14%	-197.29%	-1731.84%	-1.57%
	90%	0.00%	0.00%	0.00%	0.00%	-106.22%	-2.08%	-0.29%	-0.03%	-0.41%	-6.56%	-166.61%	—	-1.19%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 49: 2080s 10th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-04	3.15E-02	1.40E-02	1.07E-02	5.65E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.35E-03	1.27E-05	0.00E+00	0.00E+00	2.89E-02	3.23E-01	1.52E-01	9.83E-02	9.94E-02	5.34E-02	1.24E-02	3.76E-03	6.38E-02
	90%	2.88E-04	0.00E+00	0.00E+00	0.00E+00	6.49E-02	8.10E-01	2.79E-01	2.39E-01	2.27E-01	1.18E-01	3.28E-02	1.42E-02	1.66E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-04	3.15E-02	1.40E-02	1.05E-02	2.16E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.33E-03	1.19E-05	0.00E+00	0.00E+00	2.87E-02	3.22E-01	1.52E-01	9.83E-02	9.89E-02	5.09E-02	1.17E-02	3.67E-03	6.34E-02
	90%	2.88E-04	0.00E+00	0.00E+00	0.00E+00	6.30E-02	8.05E-01	2.79E-01	2.39E-01	2.27E-01	1.14E-01	3.15E-02	1.39E-02	1.65E-01
Absolute Difference (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.85E-05	-2.46E-05	-2.18E-04	-3.49E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-2.19E-05	-7.91E-07	0.00E+00	0.00E+00	-2.33E-04	-1.19E-03	-7.14E-05	-7.66E-06	-5.07E-04	-2.48E-03	-6.23E-04	-8.94E-05	-4.33E-04
	90%	-4.11E-09	0.00E+00	0.00E+00	0.00E+00	-1.90E-03	-4.64E-03	-1.10E-04	-4.68E-07	-8.52E-04	-3.47E-03	-1.30E-03	-3.09E-04	-6.57E-04
Apex River Flow Rate (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	**10%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.06%	-58.15%	0.00%	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-0.21%	-0.04%	0.00%	0.00%	-0.05%	-0.71%	-7.42%	-61.95%	-0.04%
	90%	—	0.00%	0.00%	0.00%	-3.97%	-0.07%	0.00%	0.00%	-0.04%	-0.36%	-6.49%	—	-0.02%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 50: 2080s 50th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-02	2.16E-02	1.61E-02	2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	6.72E-05	0.00E+00	0.00E+00	0.00E+00	6.64E-04	3.64E-01	1.63E-01	8.83E-02	8.17E-02	4.39E-02	6.21E-03	2.51E-04	6.17E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.89E-01	3.24E-01	1.97E-01	1.82E-01	9.78E-02	1.99E-02	3.24E-07	1.54E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.86E-02	2.15E-02	1.58E-02	1.06E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	6.72E-05	0.00E+00	0.00E+00	0.00E+00	6.54E-04	3.63E-01	1.63E-01	8.83E-02	8.10E-02	4.14E-02	5.70E-03	2.33E-04	6.13E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.88E-01	3.24E-01	1.97E-01	1.80E-01	9.42E-02	1.89E-02	1.87E-08	1.54E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.56E-05	-1.94E-05	-3.21E-04	-1.25E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-8.71E-08	0.00E+00	0.00E+00	0.00E+00	-1.06E-05	-1.45E-03	-1.50E-04	-1.08E-05	-7.19E-04	-2.50E-03	-5.08E-04	-1.73E-05	-4.44E-04
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.32E-03	-7.65E-04	-4.62E-06	-2.03E-03	-3.59E-03	-9.88E-04	-3.05E-07	-5.36E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.09%	-20.84%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.01%	-0.04%	-0.01%	0.00%	-0.07%	-0.71%	-6.05%	-12.00%	-0.04%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.02%	0.00%	-0.10%	-0.38%	-4.94%	—	-0.02%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 51: 2080s 90th Percentile Water Year Climate Change Scenario and No Consumption Scenario - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.60E-03	3.44E-02	1.62E-02	2.16E-02	2.11E-02	2.22E-04	0.00E+00	0.00E+00
	Mean	9.91E-04	3.35E-05	0.00E+00	0.00E+00	9.19E-03	3.18E-01	1.49E-01	1.02E-01	1.06E-01	8.29E-02	2.86E-02	4.76E-03	6.62E-02
	90%	2.50E-05	0.00E+00	0.00E+00	0.00E+00	6.25E-03	7.41E-01	2.05E-01	2.40E-01	2.39E-01	1.60E-01	6.50E-02	1.36E-02	1.68E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.57E-03	3.44E-02	1.62E-02	2.15E-02	1.96E-02	1.08E-04	0.00E+00	0.00E+00
	Mean	9.74E-04	3.34E-05	0.00E+00	0.00E+00	9.07E-03	3.17E-01	1.49E-01	1.02E-01	1.06E-01	8.08E-02	2.73E-02	4.64E-03	6.58E-02
	90%	2.30E-05	0.00E+00	0.00E+00	0.00E+00	6.21E-03	7.39E-01	2.05E-01	2.40E-01	2.39E-01	1.56E-01	6.27E-02	1.33E-02	1.68E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.95E-05	-2.47E-06	-7.89E-06	-1.30E-05	-1.50E-03	-1.14E-04	0.00E+00	0.00E+00
	Mean	-1.70E-05	-1.01E-07	0.00E+00	0.00E+00	-1.13E-04	-8.15E-04	-4.76E-05	-6.41E-06	-5.85E-05	-2.05E-03	-1.31E-03	-1.17E-04	-3.76E-04
	90%	-2.02E-06	0.00E+00	0.00E+00	0.00E+00	-4.27E-05	-2.51E-03	-3.57E-05	-2.71E-08	-4.64E-07	-3.39E-03	-2.26E-03	-3.66E-04	-6.69E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.10%	0.00%	0.00%	0.00%	-25.00%	—	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-0.10%	-0.03%	0.00%	0.00%	-0.01%	-0.59%	-15.59%	-81.36%	-0.04%
	90%	—	0.00%	0.00%	0.00%	-0.09%	-0.04%	0.00%	0.00%	0.00%	-0.36%	-11.31%	—	-0.03%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 52: 2080s 10^{th} Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-04	3.15E-02	1.40E-02	1.07E-02	5.65E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.35E-03	1.27E-05	0.00E+00	0.00E+00	2.89E-02	3.23E-01	1.52E-01	9.83E-02	9.94E-02	5.34E-02	1.24E-02	3.76E-03	6.38E-02
	90%	2.88E-04	0.00E+00	0.00E+00	0.00E+00	6.49E-02	8.10E-01	2.79E-01	2.39E-01	2.27E-01	1.18E-01	3.28E-02	1.42E-02	1.66E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-04	3.15E-02	1.40E-02	1.05E-02	2.16E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.33E-03	1.19E-05	0.00E+00	0.00E+00	2.87E-02	3.22E-01	1.52E-01	9.83E-02	9.89E-02	5.09E-02	1.17E-02	3.67E-03	6.34E-02
	90%	2.88E-04	0.00E+00	0.00E+00	0.00E+00	6.30E-02	8.05E-01	2.79E-01	2.39E-01	2.27E-01	1.14E-01	3.15E-02	1.39E-02	1.65E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.85E-05	-2.46E-05	-2.18E-04	-3.49E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-2.19E-05	-7.91E-07	0.00E+00	0.00E+00	-2.33E-04	-1.19E-03	-7.14E-05	-7.66E-06	-5.07E-04	-2.48E-03	-6.23E-04	-8.94E-05	-4.33E-04
	90%	-4.11E-09	0.00E+00	0.00E+00	0.00E+00	-1.90E-03	-4.64E-03	-1.10E-04	-4.68E-07	-8.52E-04	-3.47E-03	-1.30E-03	-3.09E-04	-6.57E-04
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.06%	-58.15%	0.00%	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-0.21%	-0.04%	0.00%	0.00%	-0.05%	-0.71%	-7.42%	-61.95%	-0.04%
	90%	—	0.00%	0.00%	0.00%	-3.97%	-0.07%	0.00%	0.00%	-0.04%	-0.36%	-6.49%	—	-0.02%

Notes:
1. Statistics shown correspond to the 10^{th}, 90^{th}, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 53: 2080s 50th Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m³/month) - Daily Flow Rate (m³/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-02	2.16E-02	1.61E-02	2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	6.72E-05	0.00E+00	0.00E+00	0.00E+00	6.64E-04	3.64E-01	1.63E-01	8.83E-02	8.17E-02	4.39E-02	6.21E-03	2.51E-04	6.17E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.89E-01	3.24E-01	1.97E-01	1.82E-01	9.78E-02	1.99E-02	3.24E-07	1.54E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-02	1.89E-02	2.83E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	6.67E-05	0.00E+00	0.00E+00	0.00E+00	1.31E-04	2.66E-01	1.44E-01	8.39E-02	6.82E-02	1.30E-02	9.38E-04	2.48E-05	4.76E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.75E-01	2.96E-01	1.93E-01	1.63E-01	4.01E-02	2.74E-04	0.00E+00	1.29E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.96E-02	-2.64E-03	-1.33E-02	-2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-5.69E-07	0.00E+00	0.00E+00	0.00E+00	-5.34E-04	-9.81E-02	-1.90E-02	-4.42E-03	-1.34E-02	-3.09E-02	-5.27E-03	-2.26E-04	-1.41E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.14E-01	-2.85E-02	-3.35E-03	-1.88E-02	-5.77E-02	-1.96E-02	-3.24E-07	-2.53E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-4.12%	-0.77%	-3.70%	-38.48%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.49%	-3.04%	-1.04%	-0.39%	-1.24%	-8.80%	-62.74%	-156.48%	-1.38%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.18%	-0.74%	-0.15%	-0.91%	-6.07%	-97.92%	—	-0.95%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 54: 2080s 90th Percentile Water Year Climate Change Scenario and Low Consumption Scenario (100,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.60E-03	3.44E-02	1.62E-02	2.16E-02	2.11E-02	2.22E-04	0.00E+00	0.00E+00
	Mean	9.91E-04	3.35E-05	0.00E+00	0.00E+00	9.19E-03	3.18E-01	1.49E-01	1.02E-01	1.06E-01	8.29E-02	2.86E-02	4.76E-03	6.62E-02
	90%	2.50E-05	0.00E+00	0.00E+00	0.00E+00	6.25E-03	7.41E-01	2.05E-01	2.40E-01	2.39E-01	1.60E-01	6.50E-02	1.36E-02	1.68E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.27E-04	1.55E-02	1.09E-02	1.63E-02	3.23E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	7.36E-04	3.30E-05	0.00E+00	0.00E+00	5.34E-03	2.28E-01	1.37E-01	9.95E-02	1.01E-01	4.34E-02	7.85E-03	1.95E-03	5.17E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.52E-03	5.96E-01	1.92E-01	2.39E-01	2.32E-01	1.22E-01	2.85E-02	3.48E-04	1.40E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.88E-03	-1.89E-02	-5.29E-03	-5.26E-03	-2.08E-02	-2.22E-04	0.00E+00	0.00E+00
	Mean	-2.55E-04	-4.97E-07	0.00E+00	0.00E+00	-3.85E-03	-8.97E-02	-1.18E-02	-2.79E-03	-4.73E-03	-3.95E-02	-2.07E-02	-2.81E-03	-1.45E-02
	90%	-2.50E-05	0.00E+00	0.00E+00	0.00E+00	-2.73E-03	-1.45E-01	-1.29E-02	-1.55E-03	-7.67E-03	-3.76E-02	-3.65E-02	-1.33E-02	-2.90E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	-16.26%	-3.96%	-1.55%	-1.47%	-346.07%	—	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-3.55%	-2.78%	-0.65%	-0.25%	-0.44%	-11.26%	-246.82%	-1945.32%	-1.42%
	90%	—	0.00%	0.00%	0.00%	-5.68%	-2.16%	-0.33%	-0.07%	-0.37%	-3.96%	-182.28%	—	-1.09%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 55: 2080s 10th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E-04	3.15E-02	1.40E-02	1.07E-02	5.65E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	1.35E-03	1.27E-05	0.00E+00	0.00E+00	2.89E-02	3.23E-01	1.52E-01	9.83E-02	9.94E-02	5.34E-02	1.24E-02	3.76E-03	6.38E-02
	90%	2.88E-04	0.00E+00	0.00E+00	0.00E+00	6.49E-02	8.10E-01	2.79E-01	2.39E-01	2.27E-01	1.18E-01	3.28E-02	1.42E-02	1.66E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.07E-05	5.28E-04	9.19E-04	1.49E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	4.11E-04	2.09E-06	0.00E+00	0.00E+00	1.53E-02	2.07E-01	1.35E-01	9.08E-02	8.25E-02	1.63E-02	2.37E-03	6.03E-04	4.55E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.03E-03	5.86E-01	2.43E-01	2.29E-01	2.06E-01	5.35E-02	2.84E-03	4.13E-05	1.30E-01
Absolute Difference (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.19E-04	-3.10E-02	-1.31E-02	-9.19E-03	-5.65E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-9.43E-04	-1.06E-05	0.00E+00	0.00E+00	-1.36E-02	-1.16E-01	-1.72E-02	-7.53E-03	-1.69E-02	-3.71E-02	-9.99E-03	-3.16E-03	-1.83E-02
	90%	-2.88E-04	0.00E+00	0.00E+00	0.00E+00	-5.59E-02	-2.23E-01	-3.68E-02	-9.49E-03	-2.14E-02	-6.40E-02	-3.00E-02	-1.41E-02	-3.62E-02
Apex River Flow Rate (m^3/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.73%	-6.50%	-3.83%	-2.56%	-94.17%	0.00%	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-12.57%	-3.59%	-0.94%	-0.67%	-1.56%	-10.57%	-119.03%	-2188.32%	-1.79%
	90%	—	0.00%	0.00%	0.00%	-116.41%	-3.32%	-0.96%	-0.43%	-1.03%	-6.74%	-149.77%	—	-1.37%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

Table 56: 2080s 50th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m³/month) - Daily Flow Rate (m³/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-02	2.16E-02	1.61E-02	2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	6.72E-05	0.00E+00	0.00E+00	0.00E+00	6.64E-04	3.64E-01	1.63E-01	8.83E-02	8.17E-02	4.39E-02	6.21E-03	2.51E-04	6.17E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.89E-01	3.24E-01	1.97E-01	1.82E-01	9.78E-02	1.99E-02	3.24E-07	1.54E-01
Unnamed Lake Outflow - Supplementation (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E-02	1.72E-02	2.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Mean	6.67E-05	0.00E+00	0.00E+00	0.00E+00	1.27E-04	2.31E-01	1.34E-01	8.19E-02	6.38E-02	9.57E-03	5.55E-04	1.53E-05	4.30E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.94E-01	2.83E-01	1.92E-01	1.58E-01	2.79E-02	9.29E-05	0.00E+00	1.19E-01
Absolute Difference (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.77E-02	-4.36E-03	-1.41E-02	-2.31E-03	0.00E+00	0.00E+00	0.00E+00
	Mean	-5.69E-07	0.00E+00	0.00E+00	0.00E+00	-5.37E-04	-1.33E-01	-2.86E-02	-6.42E-03	-1.78E-02	-3.43E-02	-5.65E-03	-2.35E-04	-1.87E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.95E-01	-4.18E-02	-4.29E-03	-2.38E-02	-6.99E-02	-1.98E-02	-3.24E-07	-3.51E-02
Apex River Flow Rate (m³/s)	10%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-5.81%	-1.27%	-3.93%	-38.48%	0.00%	0.00%	0.00%
	Mean	—	0.00%	0.00%	0.00%	-0.50%	-4.13%	-1.56%	-0.57%	-1.65%	-9.78%	-67.31%	-163.04%	-1.82%
	90%	0.00%	0.00%	0.00%	0.00%	0.00%	-4.39%	-1.09%	-0.19%	-1.15%	-7.35%	-98.83%	—	-1.33%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m³/s for the corresponding month and statistic.

Table 57: 2080s 90th Percentile Water Year Climate Change Scenario and High Consumption Scenario (115,000 m^3/month) - Daily Flow Rate (m^3/s) from Unnamed Lake Averaged Across Calendar Months with and Without Supplementation to Lake Geraldine

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Unnamed Lake Outflow - No Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.60E-03	3.44E-02	1.62E-02	2.16E-02	2.11E-02	2.22E-04	0.00E+00	0.00E+00
	Mean	9.91E-04	3.35E-05	0.00E+00	0.00E+00	9.19E-03	3.18E-01	1.49E-01	1.02E-01	1.06E-01	8.29E-02	2.86E-02	4.76E-03	6.62E-02
	90%	2.50E-05	0.00E+00	0.00E+00	0.00E+00	6.25E-03	7.41E-01	2.05E-01	2.40E-01	2.39E-01	1.60E-01	6.50E-02	1.36E-02	1.68E-01
Unnamed Lake Outflow - Supplementation (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.43E-04	2.10E-03	9.36E-04	1.30E-02	2.43E-04	0.00E+00	0.00E+00	0.00E+00
	Mean	6.94E-04	3.30E-05	0.00E+00	0.00E+00	4.68E-03	1.98E-01	1.31E-01	9.76E-02	9.71E-02	3.67E-02	5.17E-03	1.28E-03	4.73E-02
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-03	5.38E-01	1.86E-01	2.38E-01	2.28E-01	1.11E-01	1.86E-02	7.93E-05	1.31E-01
Absolute Difference (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.06E-03	-3.23E-02	-1.53E-02	-8.59E-03	-2.08E-02	-2.22E-04	0.00E+00	0.00E+00
	Mean	-2.97E-04	-4.97E-07	0.00E+00	0.00E+00	-4.51E-03	-1.20E-01	-1.80E-02	-4.64E-03	-8.93E-03	-4.62E-02	-2.34E-02	-3.48E-03	-1.88E-02
	90%	-2.50E-05	0.00E+00	0.00E+00	0.00E+00	-2.77E-03	-2.03E-01	-1.88E-02	-2.27E-03	-1.14E-02	-4.86E-02	-4.64E-02	-1.36E-02	-3.75E-02
Apex River Flow Rate (m^3/s)	**10%**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	4.76E-01	3.42E-01	3.59E-01	6.00E-03	0.00E+00	0.00E+00	1.40E-01
	Mean	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-01	3.23E+00	1.83E+00	1.13E+00	1.08E+00	3.51E-01	8.40E-03	1.44E-04	1.02E+00
	90%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-02	6.73E+00	3.85E+00	2.21E+00	2.07E+00	9.50E-01	2.00E-02	0.00E+00	2.65E+00
Estimated % Reduction in Apex River Flows	**10%**	0.00%	0.00%	0.00%	0.00%	0.00%	-16.87%	-6.77%	-4.47%	-2.40%	-347.39%	—	0.00%	0.00%
	Mean	—	—	0.00%	0.00%	-4.16%	-3.71%	-0.98%	-0.41%	-0.82%	-13.17%	-278.79%	-2410.95%	-1.84%
	90%	—	0.00%	0.00%	0.00%	-5.77%	-3.02%	-0.49%	-0.10%	-0.55%	-5.11%	-231.93%	—	-1.41%

Notes:
1. Statistics shown correspond to the 10th, 90th, and mean of the daily values in each calendar month. Statistics are aggregated across consumption and climate scenarios for the 2050s. Additional statistics are provided in Appendix A.
2. Percentage Reduction in Apex River Flows is calculated by dividing the absolute difference in flow rate between No Supplementation and Supplementation values for each statistic indicated.
3. Large percentage change may be caused by small absolute differences and corresponding low Apex River flow rates.
4. Percentage change cannot be calculated as Apex River flow is 0 m^3/s for the corresponding month and statistic.

APPENDIX B

Stage-Storage Curves

This appendix provides the stage-storage curves used to describe the change in storage with water elevation for Lake Geraldine and Unnamed Lake. In the case of Unnamed Lake, multiple reservoirs are used to define the lake. Values for storage and water level were linearly interpolated from the stage-storage curve in the Goldsim water balance model. The stage-storage curves are provided below in table format.

Table 1: Lake Geraldine Stage Storage Curve

Stage (masl)	Storage (m^3)
98.33	2.03E+03
99.33	1.30E+04
100.33	3.26E+04
101.33	6.58E+04
102.33	1.21E+05
103.33	2.07E+05
104.33	3.16E+05
105.33	4.53E+05
106.33	6.28E+05
107.33	8.36E+05
108.33	1.08E+06
109.33	1.35E+06
109.6	1.43E+06
110.33	1.65E+06
111.33	1.96E+06

Table 2: Unnamed Lake North Pond Stage-Storage Curve

Stage (masl)	Storage (m^3)
202.30	0.00E+00
202.50	7.00E+03
203.39	3.82E+04
203.42	3.92E+04
203.45	4.03E+04
203.48	4.15E+04
203.51	4.26E+04
203.54	4.37E+04
203.57	4.49E+04
203.60	4.61E+04

Stage (masl)	Storage (m^3)
203.63	4.73E+04
203.66	4.85E+04
203.69	4.97E+04
203.72	5.09E+04
203.75	5.22E+04
203.78	5.35E+04
203.81	5.47E+04
203.84	5.60E+04
203.87	5.74E+04
203.90	5.87E+04
203.93	6.00E+04
203.96	6.14E+04
203.99	6.28E+04
204.00	6.32E+04

Table 3: Unnamed Lake North Basin Stage-Storage Curve

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
191.98	1.30E-01	195.07	4.05E+04	198.16	1.75E+05	201.25	4.37E+05
192.01	1.76E+00	195.10	4.13E+04	198.19	1.77E+05	201.28	4.41E+05
192.04	5.70E+00	195.13	4.22E+04	198.22	1.79E+05	201.31	4.44E+05
192.07	1.30E+01	195.16	4.30E+04	198.25	1.81E+05	201.34	4.47E+05
192.10	2.34E+01	195.19	4.39E+04	198.28	1.83E+05	201.37	4.51E+05
192.13	3.66E+01	195.22	4.48E+04	198.31	1.85E+05	201.40	4.54E+05
192.16	5.29E+01	195.25	4.57E+04	198.34	1.87E+05	201.43	4.57E+05
192.19	7.23E+01	195.28	4.66E+04	198.37	1.89E+05	201.46	4.61E+05
192.22	9.47E+01	195.31	4.75E+04	198.40	1.91E+05	201.49	4.64E+05
192.25	1.20E+02	195.34	4.84E+04	198.43	1.93E+05	201.52	4.68E+05
192.28	1.50E+02	195.37	4.93E+04	198.46	1.95E+05	201.55	4.71E+05
192.31	1.82E+02	195.40	5.02E+04	198.49	1.97E+05	201.58	4.75E+05
192.34	2.19E+02	195.43	5.11E+04	198.52	1.99E+05	201.61	4.78E+05
192.37	2.60E+02	195.46	5.20E+04	198.55	2.01E+05	201.64	4.82E+05

Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)
192.40	3.04E+02	195.49	5.30E+04	198.58	2.03E+05	201.67	4.85E+05
192.43	3.53E+02	195.52	5.39E+04	198.61	2.05E+05	201.70	4.89E+05
192.46	4.06E+02	195.55	5.49E+04	198.64	2.07E+05	201.73	4.92E+05
192.49	4.64E+02	195.58	5.58E+04	198.67	2.10E+05	201.76	4.96E+05
192.52	5.27E+02	195.61	5.68E+04	198.70	2.12E+05	201.79	5.00E+05
192.55	5.95E+02	195.64	5.78E+04	198.73	2.14E+05	201.82	5.04E+05
192.58	6.68E+02	195.67	5.88E+04	198.76	2.16E+05	201.85	5.07E+05
192.61	7.48E+02	195.70	5.98E+04	198.79	2.18E+05	201.88	5.11E+05
192.64	8.34E+02	195.73	6.08E+04	198.82	2.20E+05	201.91	5.15E+05
192.67	9.28E+02	195.76	6.18E+04	198.85	2.22E+05	201.94	5.19E+05
192.70	1.03E+03	195.79	6.28E+04	198.88	2.25E+05	201.97	5.23E+05
192.73	1.14E+03	195.82	6.38E+04	198.91	2.27E+05	202.00	5.27E+05
192.76	1.25E+03	195.85	6.48E+04	198.94	2.29E+05	202.03	5.32E+05
192.79	1.38E+03	195.88	6.59E+04	198.97	2.31E+05	202.06	5.36E+05
192.82	1.51E+03	195.91	6.69E+04	199.00	2.34E+05	202.09	5.40E+05
192.85	1.66E+03	195.94	6.80E+04	199.03	2.36E+05	202.12	5.44E+05
192.88	1.81E+03	195.97	6.90E+04	199.06	2.38E+05	202.15	5.49E+05
192.91	1.97E+03	196.00	7.01E+04	199.09	2.40E+05	202.18	5.53E+05
192.94	2.14E+03	196.03	7.12E+04	199.12	2.43E+05	202.21	5.58E+05
192.97	2.33E+03	196.06	7.23E+04	199.15	2.45E+05	202.24	5.62E+05
193.00	2.52E+03	196.09	7.34E+04	199.18	2.47E+05	202.27	5.66E+05
193.03	2.72E+03	196.12	7.45E+04	199.21	2.49E+05	202.30	5.71E+05
193.06	2.94E+03	196.15	7.56E+04	199.24	2.52E+05	202.33	5.76E+05
193.09	3.16E+03	196.18	7.67E+04	199.27	2.54E+05	202.36	5.80E+05
193.12	3.39E+03	196.21	7.78E+04	199.30	2.56E+05	202.39	5.85E+05
193.15	3.63E+03	196.24	7.89E+04	199.33	2.59E+05	202.42	5.89E+05
193.18	3.87E+03	196.27	8.01E+04	199.36	2.61E+05	202.45	5.94E+05
193.21	4.13E+03	196.30	8.12E+04	199.39	2.64E+05	202.48	5.99E+05
193.24	4.40E+03	196.33	8.24E+04	199.42	2.66E+05	202.51	6.04E+05
193.27	4.67E+03	196.36	8.35E+04	199.45	2.68E+05	202.54	6.08E+05
193.30	4.96E+03	196.39	8.47E+04	199.48	2.71E+05	202.57	6.13E+05

Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)
193.33	5.26E+03	196.42	8.59E+04	199.51	2.73E+05	202.60	6.18E+05
193.36	5.57E+03	196.45	8.71E+04	199.54	2.76E+05	202.63	6.23E+05
193.39	5.89E+03	196.48	8.83E+04	199.57	2.78E+05	202.66	6.28E+05
193.42	6.22E+03	196.51	8.94E+04	199.60	2.81E+05	202.69	6.33E+05
193.45	6.56E+03	196.54	9.07E+04	199.63	2.83E+05	202.72	6.38E+05
193.48	6.92E+03	196.57	9.19E+04	199.66	2.86E+05	202.75	6.43E+05
193.51	7.28E+03	196.60	9.31E+04	199.69	2.88E+05	202.78	6.48E+05
193.54	7.66E+03	196.63	9.43E+04	199.72	2.91E+05	202.81	6.53E+05
193.57	8.05E+03	196.66	9.56E+04	199.75	2.93E+05	202.84	6.58E+05
193.60	8.45E+03	196.69	9.68E+04	199.78	2.96E+05	202.87	6.63E+05
193.63	8.86E+03	196.72	9.81E+04	199.81	2.98E+05	202.90	6.69E+05
193.66	9.29E+03	196.75	9.93E+04	199.84	3.01E+05	202.93	6.74E+05
193.69	9.72E+03	196.78	1.01E+05	199.87	3.03E+05	202.96	6.79E+05
193.72	1.02E+04	196.81	1.02E+05	199.90	3.06E+05	202.99	6.84E+05
193.75	1.06E+04	196.84	1.03E+05	199.93	3.09E+05	203.02	6.89E+05
193.78	1.11E+04	196.87	1.04E+05	199.96	3.11E+05	203.05	6.95E+05
193.81	1.16E+04	196.90	1.06E+05	199.99	3.14E+05	203.08	7.00E+05
193.84	1.21E+04	196.93	1.07E+05	200.02	3.16E+05	203.11	7.06E+05
193.87	1.26E+04	196.96	1.09E+05	200.05	3.19E+05	203.14	7.11E+05
193.90	1.31E+04	196.99	1.10E+05	200.08	3.22E+05	203.17	7.16E+05
193.93	1.37E+04	197.02	1.11E+05	200.11	3.24E+05	203.20	7.22E+05
193.96	1.42E+04	197.05	1.13E+05	200.14	3.27E+05	203.23	7.27E+05
193.99	1.48E+04	197.08	1.14E+05	200.17	3.30E+05	203.26	7.33E+05
194.02	1.54E+04	197.11	1.16E+05	200.20	3.33E+05	203.29	7.38E+05
194.05	1.59E+04	197.14	1.17E+05	200.23	3.35E+05	203.32	7.43E+05
194.08	1.65E+04	197.17	1.18E+05	200.26	3.38E+05	203.35	7.49E+05
194.11	1.71E+04	197.20	1.20E+05	200.29	3.41E+05	203.38	7.54E+05
194.14	1.78E+04	197.23	1.21E+05	200.32	3.44E+05	203.41	7.60E+05
194.17	1.84E+04	197.26	1.23E+05	200.35	3.46E+05	203.44	7.66E+05
194.20	1.90E+04	197.29	1.24E+05	200.38	3.49E+05	203.47	7.72E+05
194.23	1.96E+04	197.32	1.26E+05	200.41	3.52E+05	203.50	7.79E+05

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
194.26	2.03E+04	197.35	1.28E+05	200.44	3.55E+05	203.53	7.85E+05
194.29	2.09E+04	197.38	1.29E+05	200.47	3.58E+05	203.56	7.92E+05
194.32	2.16E+04	197.41	1.31E+05	200.50	3.61E+05	203.59	7.98E+05
194.35	2.23E+04	197.44	1.32E+05	200.53	3.63E+05	203.62	8.04E+05
194.38	2.29E+04	197.47	1.34E+05	200.56	3.66E+05	203.65	8.11E+05
194.41	2.36E+04	197.50	1.36E+05	200.59	3.69E+05	203.68	8.17E+05
194.44	2.43E+04	197.53	1.37E+05	200.62	3.72E+05	203.71	8.24E+05
194.47	2.50E+04	197.56	1.39E+05	200.65	3.75E+05	203.74	8.31E+05
194.50	2.57E+04	197.59	1.41E+05	200.68	3.78E+05	203.77	8.37E+05
194.53	2.64E+04	197.62	1.42E+05	200.71	3.81E+05	203.80	8.44E+05
194.56	2.72E+04	197.65	1.44E+05	200.74	3.84E+05	203.83	8.50E+05
194.59	2.79E+04	197.68	1.46E+05	200.77	3.87E+05	203.86	8.57E+05
194.62	2.86E+04	197.71	1.48E+05	200.80	3.90E+05	203.89	8.64E+05
194.65	2.94E+04	197.74	1.49E+05	200.83	3.93E+05	203.92	8.70E+05
194.68	3.01E+04	197.77	1.51E+05	200.86	3.96E+05	203.95	8.77E+05
194.71	3.09E+04	197.80	1.53E+05	200.89	3.99E+05	203.98	8.83E+05
194.74	3.16E+04	197.83	1.55E+05	200.92	4.02E+05	204.01	8.90E+05
194.77	3.24E+04	197.86	1.56E+05	200.95	4.05E+05	204.04	8.96E+05
194.80	3.32E+04	197.89	1.58E+05	200.98	4.08E+05	204.07	9.03E+05
194.83	3.40E+04	197.92	1.60E+05	201.01	4.12E+05	204.10	9.10E+05
194.86	3.48E+04	197.95	1.62E+05	201.04	4.15E+05	204.13	9.16E+05
194.89	3.56E+04	197.98	1.64E+05	201.07	4.18E+05	204.16	9.23E+05
194.92	3.64E+04	198.01	1.66E+05	201.10	4.21E+05	204.19	9.29E+05
194.95	3.72E+04	198.04	1.67E+05	201.13	4.24E+05	204.22	9.36E+05
194.98	3.80E+04	198.07	1.69E+05	201.16	4.27E+05		
195.01	3.88E+04	198.10	1.71E+05	201.19	4.31E+05		
195.04	3.97E+04	198.13	1.73E+05	201.22	4.34E+05		

Table 4: Unnamed Lake Central Basin Stage Storage Curve

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
180.66	1.26E-03	186.57	1.07E+05	192.48	8.42E+05	198.39	2.36E+06
180.69	2.47E-01	186.6	1.09E+05	192.51	8.48E+05	198.42	2.37E+06
180.72	1.24E+00	186.63	1.10E+05	192.54	8.53E+05	198.45	2.38E+06
180.75	3.64E+00	186.66	1.12E+05	192.57	8.59E+05	198.48	2.39E+06
180.78	7.42E+00	186.69	1.14E+05	192.6	8.64E+05	198.51	2.40E+06
180.81	1.23E+01	186.72	1.16E+05	192.63	8.70E+05	198.54	2.41E+06
180.84	1.82E+01	186.75	1.18E+05	192.66	8.76E+05	198.57	2.42E+06
180.87	2.51E+01	186.78	1.19E+05	192.69	8.81E+05	198.6	2.43E+06
180.9	3.28E+01	186.81	1.21E+05	192.72	8.87E+05	198.63	2.45E+06
180.93	4.15E+01	186.84	1.23E+05	192.75	8.93E+05	198.66	2.46E+06
180.96	5.10E+01	186.87	1.25E+05	192.78	8.98E+05	198.69	2.47E+06
180.99	6.13E+01	186.9	1.27E+05	192.81	9.04E+05	198.72	2.48E+06
181.02	7.25E+01	186.93	1.29E+05	192.84	9.10E+05	198.75	2.49E+06
181.05	8.45E+01	186.96	1.31E+05	192.87	9.16E+05	198.78	2.50E+06
181.08	9.72E+01	186.99	1.33E+05	192.9	9.21E+05	198.81	2.51E+06
181.11	1.11E+02	187.02	1.35E+05	192.93	9.27E+05	198.84	2.52E+06
181.14	1.25E+02	187.05	1.37E+05	192.96	9.33E+05	198.87	2.53E+06
181.17	1.40E+02	187.08	1.39E+05	192.99	9.39E+05	198.9	2.54E+06
181.2	1.56E+02	187.11	1.41E+05	193.02	9.45E+05	198.93	2.55E+06
181.23	1.73E+02	187.14	1.44E+05	193.05	9.51E+05	198.96	2.56E+06
181.26	1.90E+02	187.17	1.46E+05	193.08	9.56E+05	198.99	2.58E+06
181.29	2.08E+02	187.2	1.48E+05	193.11	9.62E+05	199.02	2.59E+06
181.32	2.28E+02	187.23	1.50E+05	193.14	9.68E+05	199.05	2.60E+06
181.35	2.47E+02	187.26	1.52E+05	193.17	9.74E+05	199.08	2.61E+06
181.38	2.68E+02	187.29	1.54E+05	193.2	9.80E+05	199.11	2.62E+06
181.41	2.89E+02	187.32	1.57E+05	193.23	9.86E+05	199.14	2.63E+06
181.44	3.12E+02	187.35	1.59E+05	193.26	9.92E+05	199.17	2.64E+06
181.47	3.35E+02	187.38	1.61E+05	193.29	9.98E+05	199.2	2.65E+06
181.5	3.59E+02	187.41	1.64E+05	193.32	1.00E+06	199.23	2.66E+06
181.53	3.83E+02	187.44	1.66E+05	193.35	1.01E+06	199.26	2.68E+06
181.56	4.09E+02	187.47	1.68E+05	193.38	1.02E+06	199.29	2.69E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
181.59	4.35E+02	187.5	1.70E+05	193.41	1.02E+06	199.32	2.70E+06
181.62	4.62E+02	187.53	1.73E+05	193.44	1.03E+06	199.35	2.71E+06
181.65	4.90E+02	187.56	1.75E+05	193.47	1.03E+06	199.38	2.72E+06
181.68	5.19E+02	187.59	1.78E+05	193.5	1.04E+06	199.41	2.73E+06
181.71	5.48E+02	187.62	1.80E+05	193.53	1.05E+06	199.44	2.74E+06
181.74	5.79E+02	187.65	1.83E+05	193.56	1.05E+06	199.47	2.76E+06
181.77	6.10E+02	187.68	1.85E+05	193.59	1.06E+06	199.5	2.77E+06
181.8	6.42E+02	187.71	1.88E+05	193.62	1.07E+06	199.53	2.78E+06
181.83	6.76E+02	187.74	1.90E+05	193.65	1.07E+06	199.56	2.79E+06
181.86	7.11E+02	187.77	1.93E+05	193.68	1.08E+06	199.59	2.80E+06
181.89	7.48E+02	187.8	1.95E+05	193.71	1.08E+06	199.62	2.81E+06
181.92	7.87E+02	187.83	1.98E+05	193.74	1.09E+06	199.65	2.82E+06
181.95	8.28E+02	187.86	2.00E+05	193.77	1.10E+06	199.68	2.84E+06
181.98	8.70E+02	187.89	2.03E+05	193.8	1.10E+06	199.71	2.85E+06
182.01	9.14E+02	187.92	2.06E+05	193.83	1.11E+06	199.74	2.86E+06
182.04	9.60E+02	187.95	2.08E+05	193.86	1.12E+06	199.77	2.87E+06
182.07	1.01E+03	187.98	2.11E+05	193.89	1.12E+06	199.8	2.88E+06
182.1	1.06E+03	188.01	2.14E+05	193.92	1.13E+06	199.83	2.90E+06
182.13	1.11E+03	188.04	2.17E+05	193.95	1.13E+06	199.86	2.91E+06
182.16	1.17E+03	188.07	2.19E+05	193.98	1.14E+06	199.89	2.92E+06
182.19	1.22E+03	188.1	2.22E+05	194.01	1.15E+06	199.92	2.93E+06
182.22	1.28E+03	188.13	2.25E+05	194.04	1.15E+06	199.95	2.94E+06
182.25	1.35E+03	188.16	2.28E+05	194.07	1.16E+06	199.98	2.95E+06
182.28	1.41E+03	188.19	2.31E+05	194.1	1.17E+06	200.01	2.97E+06
182.31	1.48E+03	188.22	2.34E+05	194.13	1.17E+06	200.04	2.98E+06
182.34	1.55E+03	188.25	2.37E+05	194.16	1.18E+06	200.07	2.99E+06
182.37	1.63E+03	188.28	2.39E+05	194.19	1.19E+06	200.1	3.00E+06
182.4	1.71E+03	188.31	2.42E+05	194.22	1.19E+06	200.13	3.01E+06
182.43	1.79E+03	188.34	2.45E+05	194.25	1.20E+06	200.16	3.03E+06
182.46	1.87E+03	188.37	2.48E+05	194.28	1.21E+06	200.19	3.04E+06
182.49	1.96E+03	188.4	2.51E+05	194.31	1.21E+06	200.22	3.05E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
182.52	2.05E+03	188.43	2.55E+05	194.34	1.22E+06	200.25	3.06E+06
182.55	2.14E+03	188.46	2.58E+05	194.37	1.23E+06	200.28	3.07E+06
182.58	2.24E+03	188.49	2.61E+05	194.4	1.23E+06	200.31	3.09E+06
182.61	2.34E+03	188.52	2.64E+05	194.43	1.24E+06	200.34	3.10E+06
182.64	2.45E+03	188.55	2.67E+05	194.46	1.25E+06	200.37	3.11E+06
182.67	2.56E+03	188.58	2.70E+05	194.49	1.25E+06	200.4	3.12E+06
182.7	2.67E+03	188.61	2.73E+05	194.52	1.26E+06	200.43	3.14E+06
182.73	2.79E+03	188.64	2.77E+05	194.55	1.27E+06	200.46	3.15E+06
182.76	2.91E+03	188.67	2.80E+05	194.58	1.27E+06	200.49	3.16E+06
182.79	3.03E+03	188.7	2.83E+05	194.61	1.28E+06	200.52	3.17E+06
182.82	3.16E+03	188.73	2.86E+05	194.64	1.29E+06	200.55	3.19E+06
182.85	3.30E+03	188.76	2.90E+05	194.67	1.30E+06	200.58	3.20E+06
182.88	3.44E+03	188.79	2.93E+05	194.7	1.30E+06	200.61	3.21E+06
182.91	3.58E+03	188.82	2.96E+05	194.73	1.31E+06	200.64	3.22E+06
182.94	3.73E+03	188.85	3.00E+05	194.76	1.32E+06	200.67	3.24E+06
182.97	3.88E+03	188.88	3.03E+05	194.79	1.32E+06	200.7	3.25E+06
183	4.04E+03	188.91	3.06E+05	194.82	1.33E+06	200.73	3.26E+06
183.03	4.21E+03	188.94	3.10E+05	194.85	1.34E+06	200.76	3.27E+06
183.06	4.38E+03	188.97	3.13E+05	194.88	1.34E+06	200.79	3.29E+06
183.09	4.56E+03	189	3.17E+05	194.91	1.35E+06	200.82	3.30E+06
183.12	4.74E+03	189.03	3.20E+05	194.94	1.36E+06	200.85	3.31E+06
183.15	4.93E+03	189.06	3.24E+05	194.97	1.37E+06	200.88	3.32E+06
183.18	5.13E+03	189.09	3.27E+05	195	1.37E+06	200.91	3.34E+06
183.21	5.33E+03	189.12	3.31E+05	195.03	1.38E+06	200.94	3.35E+06
183.24	5.54E+03	189.15	3.34E+05	195.06	1.39E+06	200.97	3.36E+06
183.27	5.76E+03	189.18	3.38E+05	195.09	1.39E+06	201	3.38E+06
183.3	5.98E+03	189.21	3.41E+05	195.12	1.40E+06	201.03	3.39E+06
183.33	6.22E+03	189.24	3.45E+05	195.15	1.41E+06	201.06	3.40E+06
183.36	6.46E+03	189.27	3.49E+05	195.18	1.42E+06	201.09	3.41E+06
183.39	6.71E+03	189.3	3.52E+05	195.21	1.42E+06	201.12	3.43E+06
183.42	6.96E+03	189.33	3.56E+05	195.24	1.43E+06	201.15	3.44E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
183.45	7.23E+03	189.36	3.59E+05	195.27	1.44E+06	201.18	3.45E+06
183.48	7.50E+03	189.39	3.63E+05	195.3	1.45E+06	201.21	3.47E+06
183.51	7.78E+03	189.42	3.67E+05	195.33	1.45E+06	201.24	3.48E+06
183.54	8.07E+03	189.45	3.71E+05	195.36	1.46E+06	201.27	3.49E+06
183.57	8.37E+03	189.48	3.74E+05	195.39	1.47E+06	201.3	3.51E+06
183.6	8.68E+03	189.51	3.78E+05	195.42	1.48E+06	201.33	3.52E+06
183.63	9.00E+03	189.54	3.82E+05	195.45	1.48E+06	201.36	3.53E+06
183.66	9.33E+03	189.57	3.86E+05	195.48	1.49E+06	201.39	3.55E+06
183.69	9.67E+03	189.6	3.90E+05	195.51	1.50E+06	201.42	3.56E+06
183.72	1.00E+04	189.63	3.93E+05	195.54	1.51E+06	201.45	3.57E+06
183.75	1.04E+04	189.66	3.97E+05	195.57	1.51E+06	201.48	3.59E+06
183.78	1.08E+04	189.69	4.01E+05	195.6	1.52E+06	201.51	3.60E+06
183.81	1.11E+04	189.72	4.05E+05	195.63	1.53E+06	201.54	3.62E+06
183.84	1.15E+04	189.75	4.09E+05	195.66	1.54E+06	201.57	3.63E+06
183.87	1.20E+04	189.78	4.13E+05	195.69	1.54E+06	201.6	3.64E+06
183.9	1.24E+04	189.81	4.17E+05	195.72	1.55E+06	201.63	3.66E+06
183.93	1.28E+04	189.84	4.21E+05	195.75	1.56E+06	201.66	3.67E+06
183.96	1.33E+04	189.87	4.25E+05	195.78	1.57E+06	201.69	3.69E+06
183.99	1.37E+04	189.9	4.29E+05	195.81	1.57E+06	201.72	3.70E+06
184.02	1.42E+04	189.93	4.33E+05	195.84	1.58E+06	201.75	3.71E+06
184.05	1.47E+04	189.96	4.37E+05	195.87	1.59E+06	201.78	3.73E+06
184.08	1.52E+04	189.99	4.41E+05	195.9	1.60E+06	201.81	3.74E+06
184.11	1.57E+04	190.02	4.45E+05	195.93	1.61E+06	201.84	3.76E+06
184.14	1.63E+04	190.05	4.50E+05	195.96	1.61E+06	201.87	3.77E+06
184.17	1.68E+04	190.08	4.54E+05	195.99	1.62E+06	201.9	3.78E+06
184.2	1.74E+04	190.11	4.58E+05	196.02	1.63E+06	201.93	3.80E+06
184.23	1.80E+04	190.14	4.62E+05	196.05	1.64E+06	201.96	3.81E+06
184.26	1.86E+04	190.17	4.66E+05	196.08	1.65E+06	201.99	3.83E+06
184.29	1.92E+04	190.2	4.70E+05	196.11	1.65E+06	202.02	3.84E+06
184.32	1.98E+04	190.23	4.75E+05	196.14	1.66E+06	202.05	3.86E+06
184.35	2.04E+04	190.26	4.79E+05	196.17	1.67E+06	202.08	3.87E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
184.38	2.10E+04	190.29	4.83E+05	196.2	1.68E+06	202.11	3.89E+06
184.41	2.17E+04	190.32	4.88E+05	196.23	1.69E+06	202.14	3.90E+06
184.44	2.23E+04	190.35	4.92E+05	196.26	1.69E+06	202.17	3.92E+06
184.47	2.30E+04	190.38	4.96E+05	196.29	1.70E+06	202.2	3.93E+06
184.5	2.37E+04	190.41	5.01E+05	196.32	1.71E+06	202.23	3.94E+06
184.53	2.44E+04	190.44	5.05E+05	196.35	1.72E+06	202.26	3.96E+06
184.56	2.51E+04	190.47	5.09E+05	196.38	1.73E+06	202.29	3.97E+06
184.59	2.59E+04	190.5	5.14E+05	196.41	1.74E+06	202.32	3.99E+06
184.62	2.66E+04	190.53	5.18E+05	196.44	1.74E+06	202.35	4.00E+06
184.65	2.74E+04	190.56	5.23E+05	196.47	1.75E+06	202.38	4.02E+06
184.68	2.81E+04	190.59	5.27E+05	196.5	1.76E+06	202.41	4.03E+06
184.71	2.89E+04	190.62	5.32E+05	196.53	1.77E+06	202.44	4.05E+06
184.74	2.97E+04	190.65	5.36E+05	196.56	1.78E+06	202.47	4.06E+06
184.77	3.06E+04	190.68	5.41E+05	196.59	1.79E+06	202.5	4.08E+06
184.8	3.14E+04	190.71	5.45E+05	196.62	1.80E+06	202.53	4.09E+06
184.83	3.22E+04	190.74	5.50E+05	196.65	1.80E+06	202.56	4.11E+06
184.86	3.31E+04	190.77	5.54E+05	196.68	1.81E+06	202.59	4.13E+06
184.89	3.40E+04	190.8	5.59E+05	196.71	1.82E+06	202.62	4.14E+06
184.92	3.49E+04	190.83	5.63E+05	196.74	1.83E+06	202.65	4.16E+06
184.95	3.58E+04	190.86	5.68E+05	196.77	1.84E+06	202.68	4.17E+06
184.98	3.67E+04	190.89	5.73E+05	196.8	1.85E+06	202.71	4.19E+06
185.01	3.77E+04	190.92	5.77E+05	196.83	1.86E+06	202.74	4.20E+06
185.04	3.87E+04	190.95	5.82E+05	196.86	1.87E+06	202.77	4.22E+06
185.07	3.96E+04	190.98	5.87E+05	196.89	1.87E+06	202.8	4.23E+06
185.1	4.06E+04	191.01	5.91E+05	196.92	1.88E+06	202.83	4.25E+06
185.13	4.16E+04	191.04	5.96E+05	196.95	1.89E+06	202.86	4.26E+06
185.16	4.26E+04	191.07	6.01E+05	196.98	1.90E+06	202.89	4.28E+06
185.19	4.37E+04	191.1	6.06E+05	197.01	1.91E+06	202.92	4.30E+06
185.22	4.47E+04	191.13	6.10E+05	197.04	1.92E+06	202.95	4.31E+06
185.25	4.58E+04	191.16	6.15E+05	197.07	1.93E+06	202.98	4.33E+06
185.28	4.68E+04	191.19	6.20E+05	197.1	1.94E+06	203.01	4.34E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
185.31	4.79E+04	191.22	6.25E+05	197.13	1.95E+06	203.04	4.36E+06
185.34	4.90E+04	191.25	6.30E+05	197.16	1.96E+06	203.07	4.37E+06
185.37	5.01E+04	191.28	6.34E+05	197.19	1.97E+06	203.1	4.39E+06
185.4	5.13E+04	191.31	6.39E+05	197.22	1.98E+06	203.13	4.41E+06
185.43	5.24E+04	191.34	6.44E+05	197.25	1.98E+06	203.16	4.42E+06
185.46	5.35E+04	191.37	6.49E+05	197.28	1.99E+06	203.19	4.44E+06
185.49	5.47E+04	191.4	6.54E+05	197.31	2.00E+06	203.22	4.45E+06
185.52	5.59E+04	191.43	6.59E+05	197.34	2.01E+06	203.25	4.47E+06
185.55	5.71E+04	191.46	6.64E+05	197.37	2.02E+06	203.28	4.49E+06
185.58	5.83E+04	191.49	6.69E+05	197.4	2.03E+06	203.31	4.50E+06
185.61	5.95E+04	191.52	6.74E+05	197.43	2.04E+06	203.34	4.52E+06
185.64	6.07E+04	191.55	6.79E+05	197.46	2.05E+06	203.37	4.53E+06
185.67	6.20E+04	191.58	6.84E+05	197.49	2.06E+06	203.4	4.55E+06
185.7	6.32E+04	191.61	6.89E+05	197.52	2.07E+06	203.43	4.57E+06
185.73	6.45E+04	191.64	6.94E+05	197.55	2.08E+06	203.46	4.58E+06
185.76	6.58E+04	191.67	6.99E+05	197.58	2.09E+06	203.49	4.60E+06
185.79	6.71E+04	191.7	7.04E+05	197.61	2.10E+06	203.52	4.61E+06
185.82	6.84E+04	191.73	7.09E+05	197.64	2.11E+06	203.55	4.63E+06
185.85	6.98E+04	191.76	7.14E+05	197.67	2.12E+06	203.58	4.65E+06
185.88	7.11E+04	191.79	7.19E+05	197.7	2.13E+06	203.61	4.66E+06
185.91	7.25E+04	191.82	7.24E+05	197.73	2.14E+06	203.64	4.68E+06
185.94	7.39E+04	191.85	7.30E+05	197.76	2.15E+06	203.67	4.69E+06
185.97	7.53E+04	191.88	7.35E+05	197.79	2.16E+06	203.7	4.71E+06
186	7.67E+04	191.91	7.40E+05	197.82	2.17E+06	203.73	4.73E+06
186.03	7.81E+04	191.94	7.45E+05	197.85	2.18E+06	203.76	4.74E+06
186.06	7.95E+04	191.97	7.50E+05	197.88	2.19E+06	203.79	4.76E+06
186.09	8.10E+04	192	7.56E+05	197.91	2.20E+06	203.82	4.77E+06
186.12	8.25E+04	192.03	7.61E+05	197.94	2.21E+06	203.85	4.79E+06
186.15	8.40E+04	192.06	7.66E+05	197.97	2.22E+06	203.88	4.81E+06
186.18	8.55E+04	192.09	7.71E+05	198	2.23E+06	203.91	4.82E+06
186.21	8.70E+04	192.12	7.77E+05	198.03	2.24E+06	203.94	4.84E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
186.24	8.86E+04	192.15	7.82E+05	198.06	2.25E+06	203.97	4.85E+06
186.27	9.02E+04	192.18	7.87E+05	198.09	2.26E+06	204	4.87E+06
186.3	9.17E+04	192.21	7.93E+05	198.12	2.27E+06	204.03	4.89E+06
186.33	9.33E+04	192.24	7.98E+05	198.15	2.28E+06	204.06	4.90E+06
186.36	9.50E+04	192.27	8.04E+05	198.18	2.29E+06	204.09	4.92E+06
186.39	9.66E+04	192.3	8.09E+05	198.21	2.30E+06	204.12	4.94E+06
186.42	9.82E+04	192.33	8.15E+05	198.24	2.31E+06	204.15	4.95E+06
186.45	9.99E+04	192.36	8.20E+05	198.27	2.32E+06	204.18	4.97E+06
186.48	1.02E+05	192.39	8.25E+05	198.3	2.33E+06	204.21	4.98E+06
186.51	1.03E+05	192.42	8.31E+05	198.33	2.34E+06		
186.54	1.05E+05	192.45	8.36E+05	198.36	2.35E+06		

Table 5: Unnamed Lake South Basin Stage-Storage Curve

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
188.03	0.00E+00	191.87	4.74E+04	195.71	2.90E+05	199.55	7.15E+05
188.06	4.94E-02	191.9	4.85E+04	195.74	2.92E+05	199.58	7.19E+05
188.09	6.56E-01	191.93	4.95E+04	195.77	2.95E+05	199.61	7.23E+05
188.12	2.44E+00	191.96	5.05E+04	195.8	2.98E+05	199.64	7.27E+05
188.15	7.24E+00	191.99	5.16E+04	195.83	3.01E+05	199.67	7.31E+05
188.18	1.90E+01	192.02	5.27E+04	195.86	3.03E+05	199.7	7.35E+05
188.21	4.05E+01	192.05	5.38E+04	195.89	3.06E+05	199.73	7.39E+05
188.24	7.16E+01	192.08	5.49E+04	195.92	3.09E+05	199.76	7.43E+05
188.27	1.12E+02	192.11	5.60E+04	195.95	3.12E+05	199.79	7.47E+05
188.3	1.63E+02	192.14	5.71E+04	195.98	3.14E+05	199.82	7.51E+05
188.33	2.21E+02	192.17	5.83E+04	196.01	3.17E+05	199.85	7.55E+05
188.36	2.83E+02	192.2	5.95E+04	196.04	3.20E+05	199.88	7.59E+05
188.39	3.51E+02	192.23	6.06E+04	196.07	3.23E+05	199.91	7.63E+05
188.42	4.22E+02	192.26	6.18E+04	196.1	3.25E+05	199.94	7.68E+05
188.45	4.98E+02	192.29	6.30E+04	196.13	3.28E+05	199.97	7.72E+05
188.48	5.76E+02	192.32	6.43E+04	196.16	3.31E+05	200	7.76E+05

Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)	Stage (masl)	Storage (m³)
188.51	6.59E+02	192.35	6.55E+04	196.19	3.34E+05	200.03	7.80E+05
188.54	7.45E+02	192.38	6.68E+04	196.22	3.37E+05	200.06	7.84E+05
188.57	8.33E+02	192.41	6.81E+04	196.25	3.40E+05	200.09	7.88E+05
188.6	9.25E+02	192.44	6.93E+04	196.28	3.43E+05	200.12	7.92E+05
188.63	1.02E+03	192.47	7.06E+04	196.31	3.45E+05	200.15	7.97E+05
188.66	1.12E+03	192.5	7.20E+04	196.34	3.48E+05	200.18	8.01E+05
188.69	1.22E+03	192.53	7.33E+04	196.37	3.51E+05	200.21	8.05E+05
188.72	1.33E+03	192.56	7.46E+04	196.4	3.54E+05	200.24	8.09E+05
188.75	1.43E+03	192.59	7.60E+04	196.43	3.57E+05	200.27	8.13E+05
188.78	1.54E+03	192.62	7.74E+04	196.46	3.60E+05	200.3	8.18E+05
188.81	1.66E+03	192.65	7.88E+04	196.49	3.63E+05	200.33	8.22E+05
188.84	1.78E+03	192.68	8.02E+04	196.52	3.66E+05	200.36	8.26E+05
188.87	1.90E+03	192.71	8.16E+04	196.55	3.69E+05	200.39	8.30E+05
188.9	2.02E+03	192.74	8.30E+04	196.58	3.72E+05	200.42	8.35E+05
188.93	2.15E+03	192.77	8.45E+04	196.61	3.75E+05	200.45	8.39E+05
188.96	2.28E+03	192.8	8.60E+04	196.64	3.78E+05	200.48	8.43E+05
188.99	2.41E+03	192.83	8.75E+04	196.67	3.81E+05	200.51	8.48E+05
189.02	2.55E+03	192.86	8.90E+04	196.7	3.84E+05	200.54	8.52E+05
189.05	2.68E+03	192.89	9.05E+04	196.73	3.87E+05	200.57	8.56E+05
189.08	2.83E+03	192.92	9.20E+04	196.76	3.90E+05	200.6	8.61E+05
189.11	2.97E+03	192.95	9.36E+04	196.79	3.93E+05	200.63	8.65E+05
189.14	3.12E+03	192.98	9.51E+04	196.82	3.96E+05	200.66	8.69E+05
189.17	3.27E+03	193.01	9.67E+04	196.85	3.99E+05	200.69	8.74E+05
189.2	3.42E+03	193.04	9.83E+04	196.88	4.02E+05	200.72	8.78E+05
189.23	3.58E+03	193.07	9.99E+04	196.91	4.05E+05	200.75	8.83E+05
189.26	3.74E+03	193.1	1.02E+05	196.94	4.08E+05	200.78	8.87E+05
189.29	3.90E+03	193.13	1.03E+05	196.97	4.11E+05	200.81	8.92E+05
189.32	4.06E+03	193.16	1.05E+05	197	4.14E+05	200.84	8.96E+05
189.35	4.23E+03	193.19	1.07E+05	197.03	4.17E+05	200.87	9.00E+05
189.38	4.40E+03	193.22	1.08E+05	197.06	4.20E+05	200.9	9.05E+05
189.41	4.57E+03	193.25	1.10E+05	197.09	4.23E+05	200.93	9.09E+05

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
189.44	4.75E+03	193.28	1.12E+05	197.12	4.27E+05	200.96	9.14E+05
189.47	4.92E+03	193.31	1.13E+05	197.15	4.30E+05	200.99	9.18E+05
189.5	5.11E+03	193.34	1.15E+05	197.18	4.33E+05	201.02	9.23E+05
189.53	5.29E+03	193.37	1.17E+05	197.21	4.36E+05	201.05	9.28E+05
189.56	5.48E+03	193.4	1.19E+05	197.24	4.39E+05	201.08	9.32E+05
189.59	5.67E+03	193.43	1.20E+05	197.27	4.42E+05	201.11	9.37E+05
189.62	5.86E+03	193.46	1.22E+05	197.3	4.46E+05	201.14	9.41E+05
189.65	6.07E+03	193.49	1.24E+05	197.33	4.49E+05	201.17	9.46E+05
189.68	6.28E+03	193.52	1.26E+05	197.36	4.52E+05	201.2	9.50E+05
189.71	6.49E+03	193.55	1.28E+05	197.39	4.55E+05	201.23	9.55E+05
189.74	6.71E+03	193.58	1.30E+05	197.42	4.58E+05	201.26	9.60E+05
189.77	6.94E+03	193.61	1.31E+05	197.45	4.62E+05	201.29	9.64E+05
189.8	7.17E+03	193.64	1.33E+05	197.48	4.65E+05	201.32	9.69E+05
189.83	7.41E+03	193.67	1.35E+05	197.51	4.68E+05	201.35	9.74E+05
189.86	7.65E+03	193.7	1.37E+05	197.54	4.71E+05	201.38	9.78E+05
189.89	7.91E+03	193.73	1.39E+05	197.57	4.75E+05	201.41	9.83E+05
189.92	8.16E+03	193.76	1.41E+05	197.6	4.78E+05	201.44	9.88E+05
189.95	8.43E+03	193.79	1.43E+05	197.63	4.81E+05	201.47	9.93E+05
189.98	8.71E+03	193.82	1.45E+05	197.66	4.85E+05	201.5	9.97E+05
190.01	8.99E+03	193.85	1.47E+05	197.69	4.88E+05	201.53	1.00E+06
190.04	9.29E+03	193.88	1.49E+05	197.72	4.91E+05	201.56	1.01E+06
190.07	9.59E+03	193.91	1.51E+05	197.75	4.95E+05	201.59	1.01E+06
190.1	9.91E+03	193.94	1.53E+05	197.78	4.98E+05	201.62	1.02E+06
190.13	1.02E+04	193.97	1.55E+05	197.81	5.01E+05	201.65	1.02E+06
190.16	1.06E+04	194	1.57E+05	197.84	5.05E+05	201.68	1.03E+06
190.19	1.09E+04	194.03	1.59E+05	197.87	5.08E+05	201.71	1.03E+06
190.22	1.12E+04	194.06	1.61E+05	197.9	5.12E+05	201.74	1.04E+06
190.25	1.16E+04	194.09	1.63E+05	197.93	5.15E+05	201.77	1.04E+06
190.28	1.20E+04	194.12	1.65E+05	197.96	5.18E+05	201.8	1.05E+06
190.31	1.23E+04	194.15	1.67E+05	197.99	5.22E+05	201.83	1.05E+06
190.34	1.27E+04	194.18	1.69E+05	198.02	5.25E+05	201.86	1.06E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
190.37	1.31E+04	194.21	1.71E+05	198.05	5.29E+05	201.89	1.06E+06
190.4	1.35E+04	194.24	1.73E+05	198.08	5.32E+05	201.92	1.07E+06
190.43	1.39E+04	194.27	1.75E+05	198.11	5.36E+05	201.95	1.07E+06
190.46	1.43E+04	194.3	1.77E+05	198.14	5.39E+05	201.98	1.08E+06
190.49	1.48E+04	194.33	1.79E+05	198.17	5.43E+05	202.01	1.08E+06
190.52	1.52E+04	194.36	1.81E+05	198.2	5.46E+05	202.04	1.09E+06
190.55	1.57E+04	194.39	1.84E+05	198.23	5.50E+05	202.07	1.09E+06
190.58	1.61E+04	194.42	1.86E+05	198.26	5.53E+05	202.1	1.10E+06
190.61	1.66E+04	194.45	1.88E+05	198.29	5.57E+05	202.13	1.10E+06
190.64	1.71E+04	194.48	1.90E+05	198.32	5.61E+05	202.16	1.11E+06
190.67	1.76E+04	194.51	1.92E+05	198.35	5.64E+05	202.19	1.11E+06
190.7	1.80E+04	194.54	1.94E+05	198.38	5.68E+05	202.22	1.12E+06
190.73	1.86E+04	194.57	1.97E+05	198.41	5.71E+05	202.25	1.12E+06
190.76	1.91E+04	194.6	1.99E+05	198.44	5.75E+05	202.28	1.13E+06
190.79	1.96E+04	194.63	2.01E+05	198.47	5.78E+05	202.31	1.13E+06
190.82	2.02E+04	194.66	2.03E+05	198.5	5.82E+05	202.34	1.14E+06
190.85	2.07E+04	194.69	2.06E+05	198.53	5.86E+05	202.37	1.14E+06
190.88	2.13E+04	194.72	2.08E+05	198.56	5.89E+05	202.4	1.15E+06
190.91	2.19E+04	194.75	2.10E+05	198.59	5.93E+05	202.43	1.15E+06
190.94	2.24E+04	194.78	2.12E+05	198.62	5.97E+05	202.46	1.16E+06
190.97	2.30E+04	194.81	2.15E+05	198.65	6.00E+05	202.49	1.16E+06
191	2.37E+04	194.84	2.17E+05	198.68	6.04E+05	202.52	1.17E+06
191.03	2.43E+04	194.87	2.19E+05	198.71	6.08E+05	202.55	1.17E+06
191.06	2.49E+04	194.9	2.22E+05	198.74	6.11E+05	202.58	1.18E+06
191.09	2.56E+04	194.93	2.24E+05	198.77	6.15E+05	202.61	1.18E+06
191.12	2.63E+04	194.96	2.26E+05	198.8	6.19E+05	202.64	1.19E+06
191.15	2.69E+04	194.99	2.29E+05	198.83	6.23E+05	202.67	1.19E+06
191.18	2.76E+04	195.02	2.31E+05	198.86	6.26E+05	202.7	1.20E+06
191.21	2.84E+04	195.05	2.34E+05	198.89	6.30E+05	202.73	1.20E+06
191.24	2.91E+04	195.08	2.36E+05	198.92	6.34E+05	202.76	1.21E+06
191.27	2.98E+04	195.11	2.38E+05	198.95	6.38E+05	202.79	1.22E+06

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
191.3	3.06E+04	195.14	2.41E+05	198.98	6.41E+05	202.82	1.22E+06
191.33	3.13E+04	195.17	2.43E+05	199.01	6.45E+05	202.85	1.23E+06
191.36	3.21E+04	195.2	2.46E+05	199.04	6.49E+05	202.88	1.23E+06
191.39	3.29E+04	195.23	2.48E+05	199.07	6.53E+05	202.91	1.24E+06
191.42	3.37E+04	195.26	2.51E+05	199.1	6.57E+05	202.94	1.24E+06
191.45	3.46E+04	195.29	2.53E+05	199.13	6.60E+05	202.97	1.25E+06
191.48	3.54E+04	195.32	2.56E+05	199.16	6.64E+05	203	1.25E+06
191.51	3.62E+04	195.35	2.58E+05	199.19	6.68E+05	203.03	1.26E+06
191.54	3.71E+04	195.38	2.61E+05	199.22	6.72E+05	203.06	1.26E+06
191.57	3.80E+04	195.41	2.64E+05	199.25	6.76E+05	203.09	1.27E+06
191.6	3.89E+04	195.44	2.66E+05	199.28	6.80E+05	203.12	1.27E+06
191.63	3.98E+04	195.47	2.69E+05	199.31	6.84E+05	203.15	1.28E+06
191.66	4.07E+04	195.5	2.71E+05	199.34	6.87E+05	203.18	1.29E+06
191.69	4.16E+04	195.53	2.74E+05	199.37	6.91E+05	203.21	1.29E+06
191.72	4.25E+04	195.56	2.77E+05	199.4	6.95E+05	203.24	1.30E+06
191.75	4.35E+04	195.59	2.79E+05	199.43	6.99E+05	203.27	1.30E+06
191.78	4.45E+04	195.62	2.82E+05	199.46	7.03E+05	203.3	1.31E+06
191.81	4.54E+04	195.65	2.84E+05	199.49	7.07E+05	203.33	1.31E+06
191.84	4.64E+04	195.68	2.87E+05	199.52	7.11E+05		

Table 6: Unnamed Lake Outlet Basin Stage-Storage Curve

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
201.6	0.00E+00	203.5	5.94E+04	205.4	1.28E+05	207.3	1.99E+05
201.7	3.00E+03	203.6	6.30E+04	205.5	1.32E+05	207.4	2.02E+05
201.8	6.00E+03	203.7	6.65E+04	205.6	1.36E+05	207.5	2.06E+05
201.9	9.00E+03	203.8	7.01E+04	205.7	1.40E+05	207.6	2.10E+05
202	1.20E+04	203.9	7.37E+04	205.8	1.43E+05	207.7	2.13E+05
202.1	1.50E+04	204	7.73E+04	205.9	1.47E+05	207.8	2.17E+05
202.2	1.81E+04	204.1	8.10E+04	206	1.51E+05	207.9	2.21E+05
202.3	2.13E+04	204.2	8.46E+04	206.1	1.54E+05	208	2.25E+05
202.4	2.44E+04	204.3	8.82E+04	206.2	1.58E+05	208.1	2.28E+05

Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)	Stage (masl)	Storage (m^3)
202.5	2.76E+04	204.4	9.18E+04	206.3	1.62E+05	208.2	2.32E+05
202.6	3.07E+04	204.5	9.55E+04	206.4	1.65E+05	208.3	2.36E+05
202.7	3.39E+04	204.6	9.91E+04	206.5	1.69E+05	208.4	2.39E+05
202.8	3.70E+04	204.7	1.03E+05	206.6	1.73E+05	208.5	2.43E+05
202.9	4.02E+04	204.8	1.06E+05	206.7	1.76E+05	208.6	2.47E+05
203	4.33E+04	204.9	1.10E+05	206.8	1.80E+05	208.7	2.51E+05
203.1	4.65E+04	205	1.14E+05	206.9	1.84E+05	208.8	2.54E+05
203.2	4.96E+04	205.1	1.17E+05	207	1.88E+05	208.9	2.58E+05
203.3	5.28E+04	205.2	1.21E+05	207.1	1.91E+05	209	2.62E+05
203.4	5.60E+04	205.3	1.25E+05	207.2	1.95E+05		

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