APPENDIX C

2022 APEX PUMPING FINAL REPORT

NUNAMI
STANTEC LIMITED

Project Summary Report:

Iqaluit 2022 Lake Geraldine Resupply (Apex River Supplementary Pumping Program): Report of Activities 3AM-IQA1626 and 22-HCAA-02043

March 15, 2023

Prepared for:
City of Iqaluit
Iqaluit, Nunavut

Prepared by:
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Project Number: 144903306

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Executive Summary

This report presents results of monitoring undertaken pursuant to Water License 3AM-IQA1626 Amendment No. 4, Emergency Amendment No. 7 and *Fisheries Act* Authorization 22-HCAA-02043 (DFO 2022: the FAA) issued to the City of Iqaluit. The report addresses the reporting requirements of the Amendment No. 4 and the FAA as they pertain to the 2022 Apex River Supplementary Pumping Program (SPP). Additional supplementation from Unnamed Lake was authorized by Amendment No. 7 but was not undertaken in 2022 and therefore the reporting requirements of Amendment No. 7 were not applicable in 2022.

The 2022 SPP was completed between April 30, 2022 (kickoff meeting) and October 19, 2022 (demobilization). Works and activities completed include:

- Mobilization of equipment and infrastructure to Apex River pumping sites
- Placement of pumps, screens, and connection to manifolds at Apex River
- Completion of fish and fish habitat baseline study, fish and fish habitat monitoring and flow monitoring in Apex River
- Installation and operation of pumps in Apex River
- Conveyance of water from Apex River to Lake Geraldine
- Supporting activities such as power supply, maintenance, refueling, and daily monitoring
- Demobilization of equipment and infrastructure (except semi-permanent pipeline)

Supplementary pumping from the Apex River to the Lake Geraldine Reservoir was completed between June 12 and September 19, 2022. A total of 444,390 m^3 of water were transferred to Lake Geraldine Reservoir. The maximum daily pumped volume was 14,541 m^3 on June 16, 2022. Pumping records were maintained by the contractor at the pumping site and were provided to the City's representative (Nunami Stantec Limited) for review and tabulation throughout the program. The Supplementary Pumping Program was completed in two periods. Pumping Period 1 occurred between June 12 and September 12 and followed guidance outlined in Amendment No. 4. Pumping Period 2 occurred between September 13 to September 19 and followed guidance outlined in Amendment No. 4 and the FAA. No supplementary pumping occurred between July 10 and July 23, 2022 due to low flows in the Apex River. Monitoring completed in Pumping Period 2 indicated that no harmful alteration, disruption, and destruction of fish habitat resulted from Apex River pumping under the conditions of the FAA. Therefore, no fish or fish habitat offsetting requirements are recommended.

Abbreviations

City	City of Iqaluit
DFO	Fisheries and Oceans Canada
FAA	*Fisheries Act* Authorization
GPS	Global Positioning System
km	kilometre
m	metre
m^3	cubic metres
m^3/s	cubic metres per second
MAD	Mean annual discharge
mg/L	milligram per litre
Apex River	Niaqunguk River
SPP	Supplementary Pumping Program
TAL	Tower Arctic Ltd.
UTM	Universal Transverse Mercator
WSC	Water Survey of Canada

1 INTRODUCTION

The City of Iqaluit (City) obtains and distributes potable water from Lake Geraldine, an engineered reservoir located approximately 1 kilometer (km) north of the City center. Owing to the need to supplement the reservoir in 2018 and 2019 on an emergency basis from the nearby Apex River, the City applied to the Nunavut Water Board to amend its Type A Water License 3AM-IQA1626 to permit supplementation of the Lake Geraldine Reservoir from the Niaqunguk (Apex) River during the open water season on an annual basis until 2026 (the term of the license). In September 2019, the City received an amendment (Amendment No. 4) to its Water License. Amendment No. 4 of the City's Type A Water License 3AM-IQA1626, permits an annual maximum of 500,000 cubic metres (m^3) of water to be extracted from Apex River for transfer to the Lake Geraldine Reservoir. The water withdrawals can occur when flows in the river exceed 30% of the mean annual discharge (MAD), and withdrawal rates do not exceed 10% of the instantaneous flow of the river, except if otherwise authorized by Fisheries and Oceans Canada (DFO).

The Supplementary Pumping Program (SPP) was facilitated by a semi-permanent pipeline from the Apex River to Lake Geraldine that was installed in 2019. Temporary pumping infrastructure was required to be installed and operated annually within the Apex River to withdraw water. Supplementary pumping (non-emergency) was previously completed during the 2020 and 2021 open water seasons.

In April 2022, Tower Arctic Ltd. (TAL; the contractor) was retained by the City to complete the SPP during the open water season of 2022. Oversight was provided by Nunami Stantec, also under contract to the City. The objective of the SPP was to increase the volume of water in the reservoir prior to the onset of freezing conditions in compliance with Amendment No. 4. Water levels in the Lake Geraldine Reservoir were monitored throughout the 2022 SPP using data from the WSC Station 10UH013 (Lake Geraldine Near Iqaluit). Lake Geraldine water levels for 2018 – 2022 as well as the historical minimum and maximum are illustrated in Figure 1-1. In Figure 1-1, the 2022 reservoir levels prior to freshet were the lowest observed over the last five years.

On August 12, 2022, the City applied to the Nunavut Water Board to amend its Type A Water License 3AM-IQA1626, on an emergency basis to address the potential potable water shortage in Iqaluit due to low water levels in Lake Geraldine and its tributaries. Figure 1.1shows how freshet was not sufficient to replenish the reservoir as it had in previous years, in fact levels in the reservoir began to decline well short of full reservoir replenishment. On July 10, 2022 based on the observed water levels in the reservoir and hydrologic trends in the Iqaluit area, the City requested authorization to withdraw up to 600,000 m^3 from an additional source – Unnamed Lake and to increase the amount of water authorized to be withdrawn from the Apex River to 900,000 m^3. Amendment No. 7 to the City's Type A Water License 3AM-IQA1626 was issued on August 22, 2022 (Nunavut Water Board 2022) and approved by the Minister of Northern Affairs on August 26, 2022. This amendment was to allow pumping from Unnamed Lake into the Apex River at a location upstream of the current pumping location. The supplemental water introduced into the Apex River, would then be pumped at the existing pumping location. The increase to

the allowable volume of annual pumping from the Apex River was established to account for the additional supplementation to the river from Unnamed Lake.

Concurrently, the City applied to DFO to receive authorization to take between 10% and 80% of the flow of the Apex River at the existing pumping location during open water season, to replenish the water storage at the Lake Geraldine Reservoir in preparation for the winter season. The *Fisheries Act* Authorization – Emergency Circumstances 22-HCAA-02043 (DFO 2022: the FAA) was issued on August 12, 2022.

Nunami Stantec has identified that pumping from the Apex River has an impact on recorded flows at WSC 10UH015, which is immediately upstream of the pump site. The WSC station is under reporting flows compared to real-time measured flows upstream of the pump site.

For purposes of the SPP and to apply conservatism to the protection of fish and fish habitat, Nunami Stantec assumed that flows recorded at WSC 10UH015 were representative of flows directly upstream of the pumping location within the Apex River.

This report includes a summary of the 2022 SPP and details the monitoring undertaken pursuant to Type A Water License 3AM-IQA1626 Amendment No. 4 and the FAA. Supplementation as was authorized by the Amendment No. 7 (supplementation from Unnamed Lake) was not implemented in 2022 and reporting requirements of Amendment No. 7 are not applicable and are not included in this report.

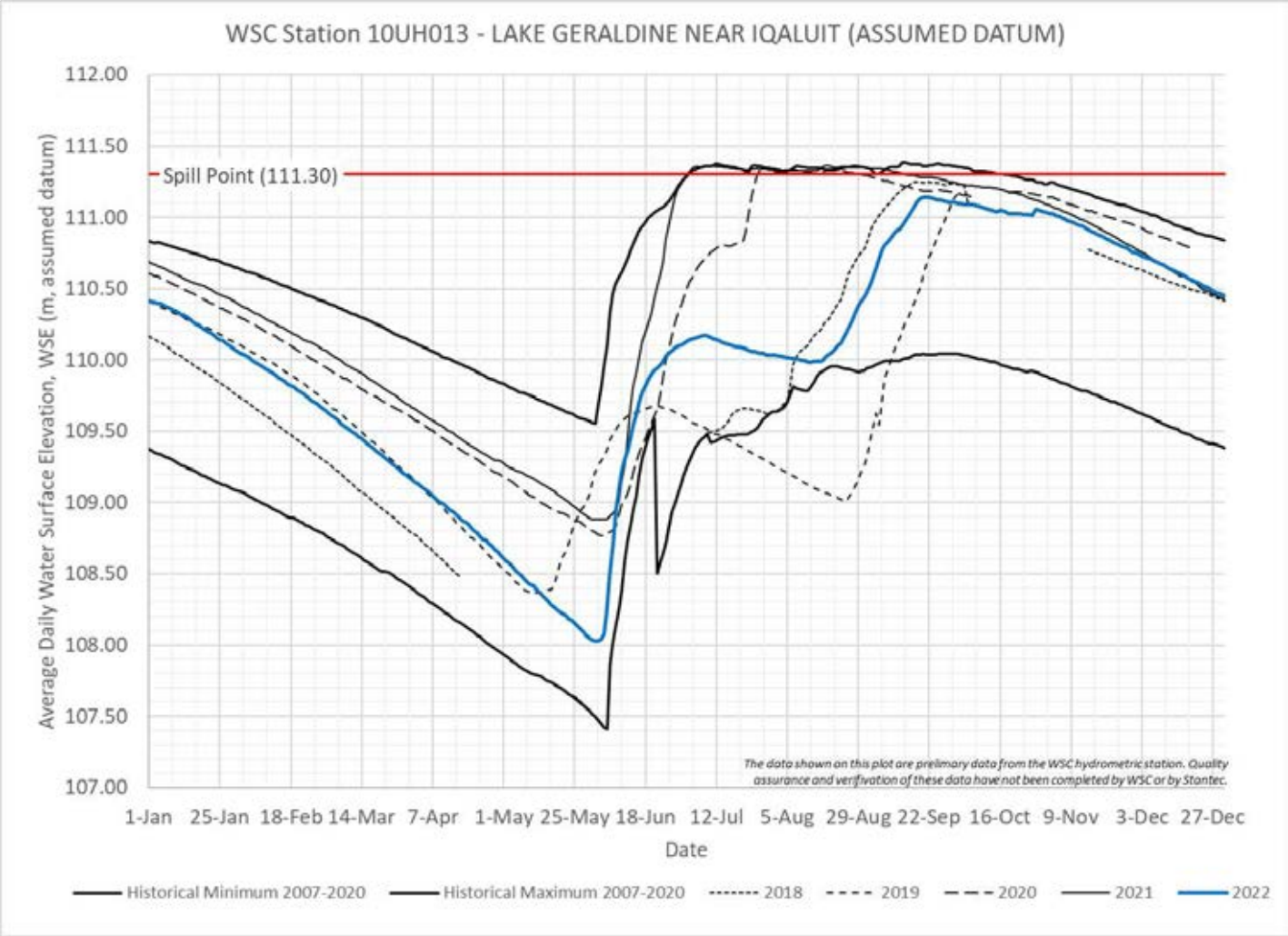


Figure 1.1 WSC Station 10UH013 – Lake Geraldine Near Iqaluit (Assumed Datum)

2 PROJECT WORKS AND ACTIVITIES

The 2022 SPP was completed between April 30, 2022 (kickoff meeting) and October 19, 2022 (demobilization). Pumping activities started on June 12 and continued through to September 19. No pumping occurred between July 10 and July 23, 2022 due to low flow conditions (less than 30% MAD) in the Apex River. Works and activities completed included:

- Mobilization of equipment and infrastructure to Apex River pumping sites
- Placement of pumps, screens, and connection to manifolds at Apex River
- Installation and operation of pumps in Apex River
- Completion of fish and fish habitat baseline study, fish and fish habitat monitoring and flow monitoring in Apex River
- Conveyance of water from Apex River to Lake Geraldine
- Supporting activities such as power supply, maintenance, refueling, and monitoring
- Demobilization of equipment and infrastructure (except semi-permanent pipeline)

The location of works and activities are shown in Figure 2.1. The Apex River pumping site was previously established at this location in 2018, 2019, 2020 and 2021. The location in 2022 was fixed by the need to connect to a semi-permanent pipeline installed in 2019 as well as the location of Water Survey of Canada (WSC) station 10UH015 (Apex River 1km Above Bridge to Nowhere) immediately upstream of the pumping site. The 2022 SPP followed the same protocol and operation as in previous years (2020 and 2021).

Water was pumped from the Apex River using three high-head 94 horsepower (Hp) submersible pumps and conveyed overland to Lake Geraldine. Pumps were housed in a screened cage, where mesh sizes met the DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines (DFO 2020). Pumping took place between June 12, 2022 and September 19, 2022. An access trail and semi-permanent pipeline between the Apex River and Lake Geraldine have remained in place for future pumping requirements.

Unnamed Lake (UNL) was considered as an optional component to the SPP in 2022. The City moved forward with setup of the temporary equipment (trail maintenance, aligning flexible hoses, rental of pumping equipment); however, the 2022 program did not require this system to be placed in service. As such, no water was pumped from UNL. All temporary infrastructure and equipment were demobilized by October 19, 2022 and equipment manifest handover to the City on November 3, 2022.

Stantec

- WSC or SNP Station
- Point of Interest
- Discharge Point
- Pipeline
- Pumping Site

N

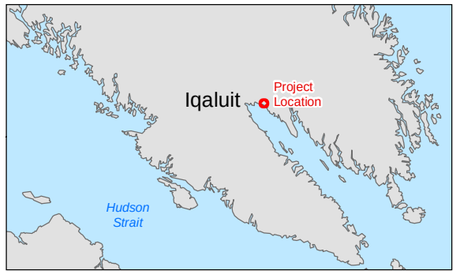
0 160 320 metres

(At original document size of 11x17)
1:8,500

Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 19N

2. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



Project Location

Iqaluit
Nunavut

Client/Project 14490306

Iqaluit Water Supply

Figure No.

2-1

Title

Iqaluit 2022 Apex Pumping Project
Site Overview

3 OPERATIONAL MONITORING PLAN

Two Operational Monitoring Plans were designed for the 2022 SPP. Pumping Period 1 Operational Monitoring Plan (June 12, 2022 to September 12, 2022) was created to maintain compliance with the Type A Water License Amendment No.4. Pumping Period 2 Operational Monitoring Plan (September 13, 2022 to September 19, 2022) was created to maintain compliance with Amendment No. 4 and the requirements for monitoring under the FAA. The Pumping Period 1 and Pumping Period 2 Operational Monitoring Plans are outlined in Section 3.1 and Section 3.2, respectively.

3.1 Pumping Period 1 - Operational Monitoring Plan

The objective of Pumping Period 1 monitoring activities was to observe hydrologic conditions in the Apex River during pumping operations and to inform changes in pumping rates that were required variably throughout the program. In accordance Amendment No. 4, water withdrawals of no greater than 10% of instantaneous flow were permitted when natural flows in the Apex River were above 30% of MAD. Nunami Stantec used WSC Station 10UH015 data to advise TAL on when pumping operations could begin and when pumping rates needed to be changed based on river flows. Each day water levels in Lake Geraldine and flows in Apex River were obtained from WSC stations and were compared to pumping logs provided by TAL. Daily scheduled emails were sent to TAL to advise on the maximum pumping rates to remain within withdrawal limits. Emails were sent more frequently if notable flow changes were observed that necessitated additional communication.

A summary of monitoring locations and activities completed during the program to satisfy the applicable criteria to Pumping Period 1 are presented in Table 3.1 and in Figure 3.1.

Table 3.1 Monitoring Location and Requirements Summary (per Water Licence Requirements)

Monitoring Location ID	UTM Coordinates (Zone 19V)		Monitoring Parameter	Method	Data Source (Nunami Stantec, Contractor, or WSC Location)
	Easting (m)	Northing (m)			
SNP IQA-10	525802	7070474	Pumped Flow and Volume	Volumetric Flow Meter	Contractor
“Apex River at Apex” (station ID: UH10UH002)	527087	7067694	Water level and flow data for Apex River approximately 4 km downstream of pump site	Access data online	WSC
“Apex River 1km Above Bridge to Nowhere” (station ID: 10UH015)	525802	7070531	Water level and flow data for immediately upstream of Apex pump site	Access data online	WSC
“Lake Geraldine Near Iqaluit” (station ID: 10UH013)	524463	7069963	Water level in Lake Geraldine	Access data online	WSC

3.2 Pumping Period 2 - Operational Monitoring Plan

Additional monitoring was required once pumping activities exceeded 10% of instantaneous flow, as authorized in FAA (22-HCAA-02043) per Section 2.2 – 3.2. The purpose of this additional monitoring specified in the FAA was to observe potential changes to fish and fish habitat along the affected reaches of the Apex River prior to, during and after Pumping Period 2 was completed.

A summary of monitoring locations and activities completed during the program to satisfy the FAA are presented in Table 3.2. Monitoring locations are shown in Figure 3.1.

Table 3.2 Monitoring Locations and Requirements Summary (per *Fisheries Act* Authorization Requirements)

Station ID	Station Description	UTM Coordinates (Zone 19V)		Monitoring Parameters	Monitoring Rationale
		Easting (m)	Northing (m)		
AR-06	Immediately upstream (125 m) of pump location	525712	7070535	Wetted width Water level/depth Habitat conditions Fish presence	Monitor natural inflow conditions, immediately upstream of pumping location
SNP IQA-10 (Apex Pump Location)	At pumping location	525820	7070467	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Monitor fish habitat conditions and fish presence at pumping location
AR-07	Immediately downstream (46 m) of pumping location	525850	7070428	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Monitor fish habitat conditions and fish presence immediately downstream of pumping location
A1	Downstream of pumping location, upstream of Road to Nowhere Bridge	526497	7070003	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Monitor fish habitat conditions and fish presence downstream of pumping location Continuity of monitoring location with 2016 fisheries program
A2	Downstream of pumping location, upstream of Swimming Lake	526299	7069247	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Monitor fish habitat conditions and fish presence downstream of pumping location Continuity of monitoring location with 2016 fisheries program (fish previously captured here)
AR-03	Downstream of pumping location, at the downstream end of a pool within the Swimming Lake area	526495	7068724	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Observe fish habitat conditions and fish presence downstream of pumping location and within the Swimming Lake area

Station ID	Station Description	UTM Coordinates (Zone 19V)		Monitoring Parameters	Monitoring Rationale
		Easting (m)	Northing (m)		
AR-02	Downstream of pumping location and downstream of Swimming Lake	526592	7068573	Wetted width Water level/depth Habitat conditions Fish presence Fish stranding Fish mortality	Monitor fish habitat conditions and fish presence downstream of pumping location and immediately downstream of Swimming Lake Continuity of monitoring location with 2016 fisheries program

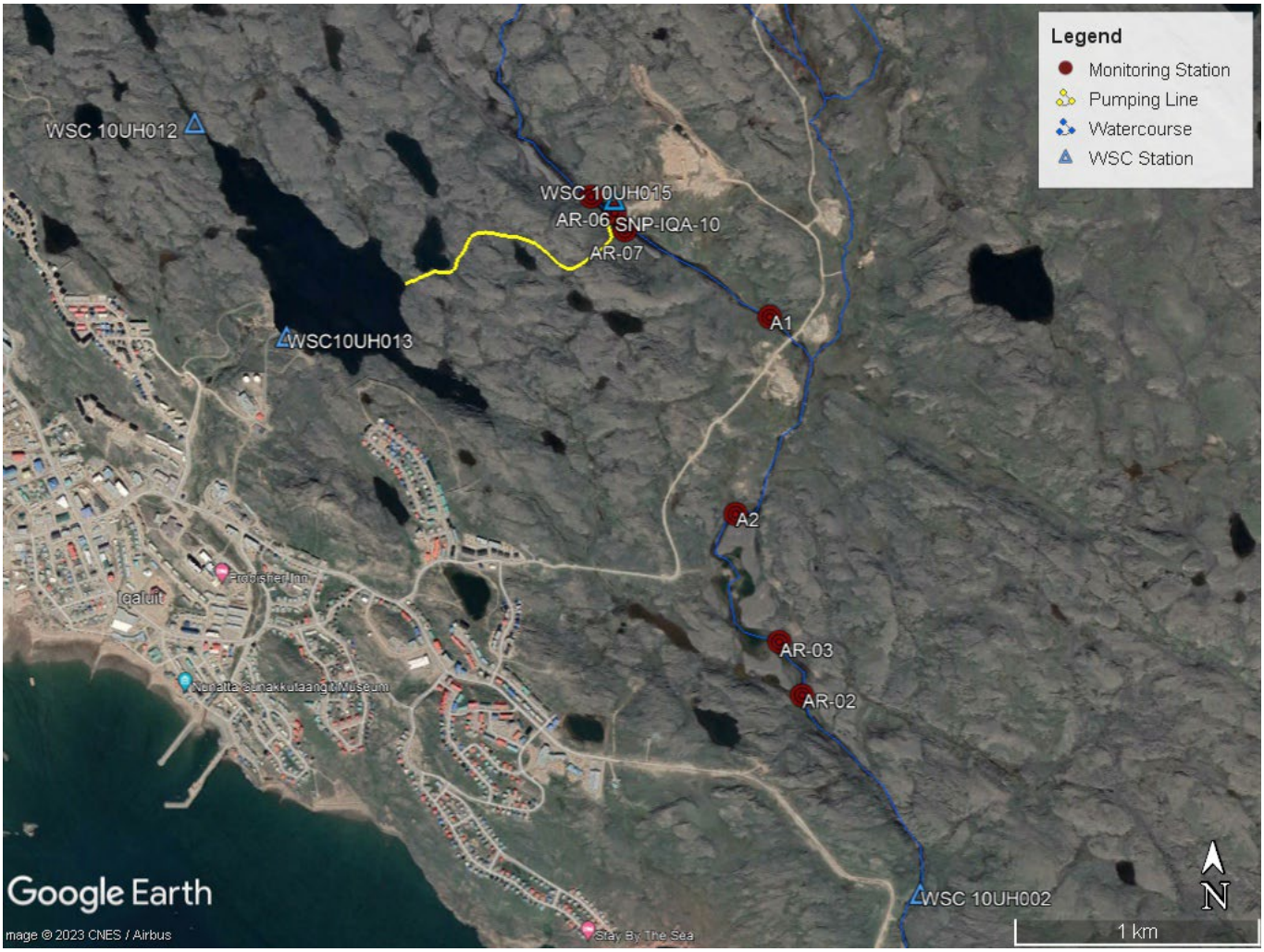


Figure 3.1 Monitoring Locations for Pumping Period 1 and Pumping Period 2

4 2022 SUPPLEMENTAL PUMPING PROGRAM RESULTS

The intent of the 2022 SPP monitoring programs (Pumping Period 1 and Pumping Period 2) was to maintain compliance with the requirements of the water licence (Amendment No. 4 and FAA). Pumping Period 1 took place between June 12, 2022 and September 12, 2022, under the conditions that annual maximum withdrawal from the Apex River was not to exceed 500,000 m^3 and that a maximum withdrawal rate of 10% of instantaneous flow was permitted as long as flows were above 30% MAD. Pumping Period 2 took place between September 13, 2022 and September 19, 2022 and followed the same annual volume restrictions as Pumping Period 1, but allowable withdrawal rates were increased to up to 80% of instantaneous flow (FAA), as long as flows were greater than 30% MAD. Activities completed under the SPP included monitoring, recording, and analyzing the effects of the 2022 SPP on the natural system. The following sections describe the results of SPP (Pumping Period 1 and 2) and its monitoring programs.

4.1 Operational Challenges

Operationally, the system performed as per the design. Based upon knowledge from previous years and emergency supplementation programs completed in 2018 and 2019, and the non-emergency operation of the Apex River semi-permanent infrastructure in 2020 and 2021, Nunami Stantec and the City understood the challenges with operation and the importance of daily monitoring for compliance to Amendment No. 4 which included compliance with the DFO Low Risk Criteria (DFO 2013). As in 2020 and 2021, the system began operations during spring melt. The 2022 operations included an emergency operation period in September.

Two challenges were identified earlier in the 2022 SPP.

1. WSC Stations Data Availability

The WSC stations require spring setup by WSC staff every year, including calibration. In 2022, the WSC was delayed in setting up these stations and bringing data online. This setup was not completed before pumping operations began, and as a result, only stage was reported from June 12, 2022 to June 22, 2022. During these 11 days in June, Nunami Stantec provided guidance on permitted pumping rates based on the preliminary rating curve provided by WSC (provided to Nunami Stantec through the City) and the reported stage data.

2. Emergency Planning & Operation

In 2022, there was a large spring deficit in Lake Geraldine. The minimum water level as measured at WSC 10UH013 was 108.027 m on June 1, 2022. This minimum water level was 0.679 m lower than the historical mean water level for June 1 in Lake Geraldine. Furthermore, as shown in Figure 1.1, a short-duration freshet period was observed in 2022. The large spring deficit was influenced by:

a) Flushing by the City of the contaminated water distribution system in late 2021 and early 2022. The system flushing would have contributed to a higher-than-normal demand on Lake Geraldine, especially from the requested household flushing programs.

b) Intentional winter operational bleeds within the City's potable water distribution system to allow for continuous circulation of the potable water loops and unintentional leaks accounted for increased demands (up to 40% over expected). These increased demands were observed outside of the emergency flushing earlier in the winter and were reduced in June.

Based upon the short freshet and Lake Geraldine deficits, the City requested Nunami Stantec provide emergency response support to increase the likelihood of a full reservoir before freeze-up. As part of this and based upon late-season time constraints, two emergency responses were executed in parallel: working with DFO to be able to pump from the Apex River at a rate greater than 10% instantaneous flow while providing additional fisheries monitoring (the FAA); and, obtaining authorization to supplement from Unnamed Lake (Amendment No. 7). Temporary pumping infrastructure was set up at Unnamed Lake in similar configuration to 2019, but was not activated, as the City made the decision to pump from the existing setup in Apex River at an increased rate (as permitted under the FAA).

4.2 Water Withdrawal Pumping Volumes

Permitted extraction volumes and rates for the 2022 SPP were as follows:

- Pumping Period 1: A maximum volume of 500,000 m^3 annually from Apex River and up to 10% of instantaneous flow when the natural flow is at or above 30% MAD in the Apex River (Amendment No. 4).
- Pumping Period 2: A maximum of volume 500,000 m^3 annually from Apex River (Amendment No. 4) and up to 80% of the flow of the Apex River during open water season (FAA).

It should be noted that the maximum volume of water permitted to be withdrawn is cumulative between the two Pumping Periods.

4.2.1 30% MAD Calculation

Nunami Stantec used the available period of record for the WSC Apex River at Apex station 10UH002 from 1973 to 2021 (38-year record, no data recorded from 1996 to 2005) to calculate the 30% MAD at the pumping location in the Apex River. Comparison of concurrent flow records from 2021 at WSC Station 10UH002 (Apex River at Apex) and WSC Station 10UH015 (Apex River 1 km Above Bridge to Nowhere) demonstrated that seasonal scaling factors could be used to convert WSC Station 10UH002 flows to WSC Station 10UH015 flows. The seasonal scaling factors were 0.513 for August and September and 0.746 for the rest of the year. After applying the seasonal scaling factors, a synthetic data set for Station 10UH015 was produced. This synthetic dataset was used to calculate MAD for WSC Station 10UH015

and was estimated to be 0.432 m^3/s. Therefore, 30% MAD was estimated to be 0.130 m^3/s for the Apex River at the pumping station.

4.2.2 Pumping Rates and Volumes

Nunami Stantec provided guidance on permitted pumping rates each day for TAL's pumping operations based on the instantaneous flow recorded at WSC Station 10UH015. At the end of each day, TAL provided Nunami Stantec with the daily pump volumes at SNP IQA-10. Nunami Stantec converted the pump volumes into an average daily pumping rates. Figure 4.1(vertical axis range of 0.0 – 4.0 m^3/s) illustrates the flow in the Apex River throughout the 2022 pumping period, the flow that represents 30% MAD at the pumping station (0.130 m^3/s) is also included on the graph.

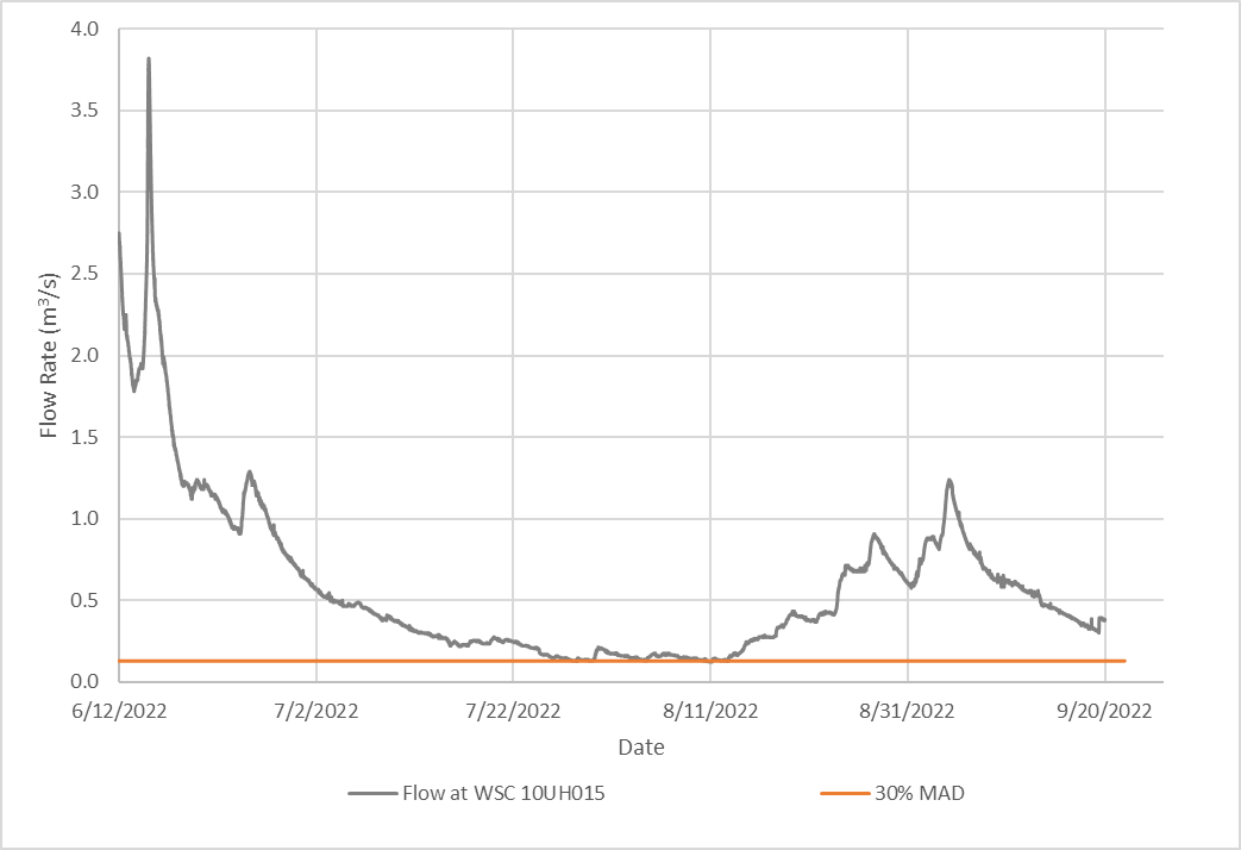


Figure 4.1 Flow at WSC 10UH015 Compared to 30% MAD

4.2.2.1 Pumping Period 1

Between June 12, 2022 and September 12, 2022 (Pumping Period 1) the pumping rate guidance that Nunami Stantec provided to TAL was based on pumping up 10% of the instantaneous flows at the pumping station when flow was greater than 30% MAD (0.130 m^3/s). Flow information used to determine

pumping rates was taken from real-time flows at WSC Station 10UH015, except for the period between June 12 and June 22, 2022 when the station was not reporting real-time discharges (but was reporting stage). During this 11-day period in June, Nunami Stantec used the real-time stage information and a preliminary rating curve from WSC (provided to Nunami Stantec through the City) to determine real-time discharges.

A total of 367,501 m^3 was pumped from the Apex River to Lake Geraldine from June 12 to September 12, 2022. The maximum daily pumped volume was approximately 14,541 m^3 on June 16, 2022.

Figure 4.2 illustrates the average daily pumping rate compared to the 10% instantaneous flow criteria. A summary of daily pumping volumes during the SPP is provided in Appendix A.

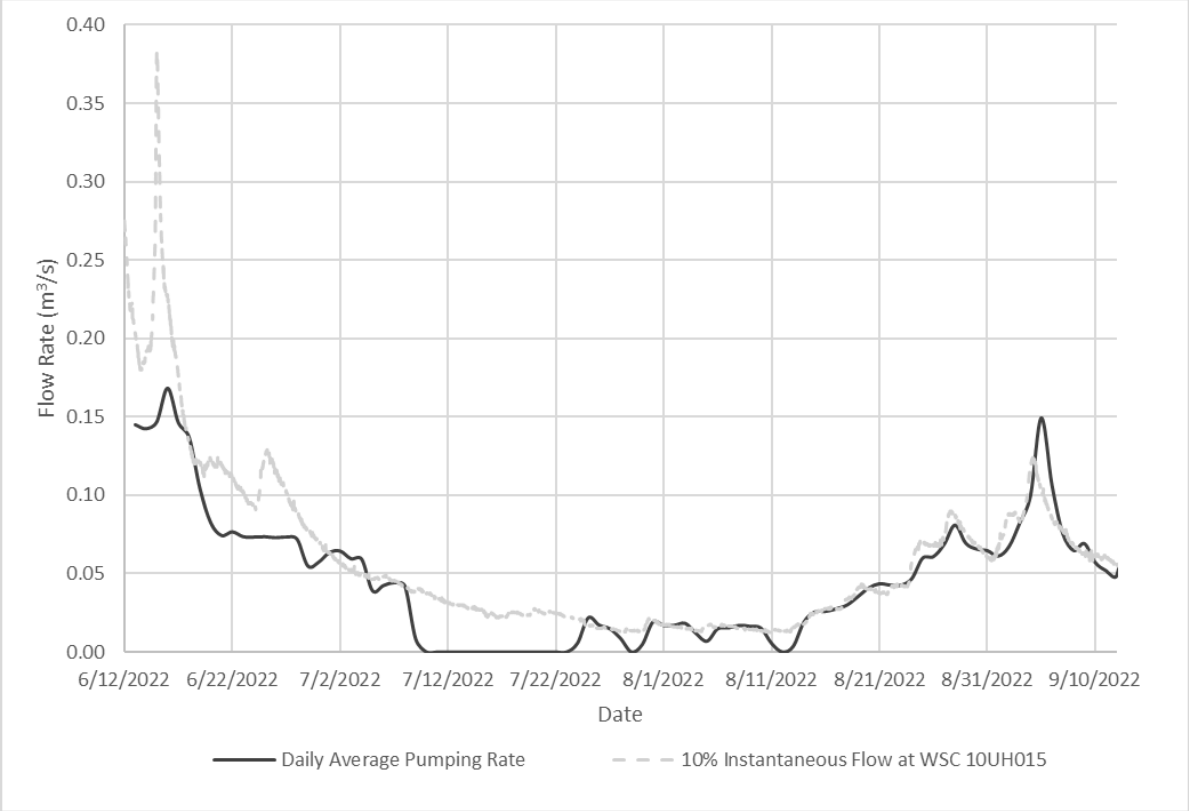


Figure 4.2 Daily Average Flow at WSC 10UH015 and Daily Average Pumping Rate During Pumping Period 1

As shown in Figure 4.2 there were 15 days during Pumping Period 1 (June 12 – September 12) where the daily average pumping rate exceeded 10% of the instantaneous flow at WSC Station 10UH015 at some point during that day. The recorded pumping rate during the days with exceedances were as follows: 16% was the rate for one day, 13% was the rate for two days, 12% was the rate for three days, and 11% was the rate for nine days.

4.2.2.2 Pumping Period 2

Between September 13 and September 19, 2022 (Pumping Period 2) the pumping rate guidance that Nunami Stantec provided to TAL was based on allowing pumping rates up to 80% of the observed flow as long as flows were above 30% MAD, and as limited by the capacity of the pumping infrastructure (designed to pump up to 0.161 m^3/s). The flow values upstream of the pumping station were taken from the real-time flows reported for WSC Station 10UH015.

A total of 76,889 m^3 was pumped from the Apex River to Lake Geraldine from September 13 to September 19, 2022. The maximum daily pumped volume during this time was approximately 12,644 m^3 on September 15, 2022.

Figure 4.3 illustrates flow rates during Pumping Period 2 when the when the upper limit of permitted pump rate was increased per the FAA. A summary of daily pumping volumes during the SPP is provided in Appendix A. The maximum withdrawal (as percent of observed flow) was approximately 42% on September 18, 2022 and the average withdrawal was approximately 31% of flow.

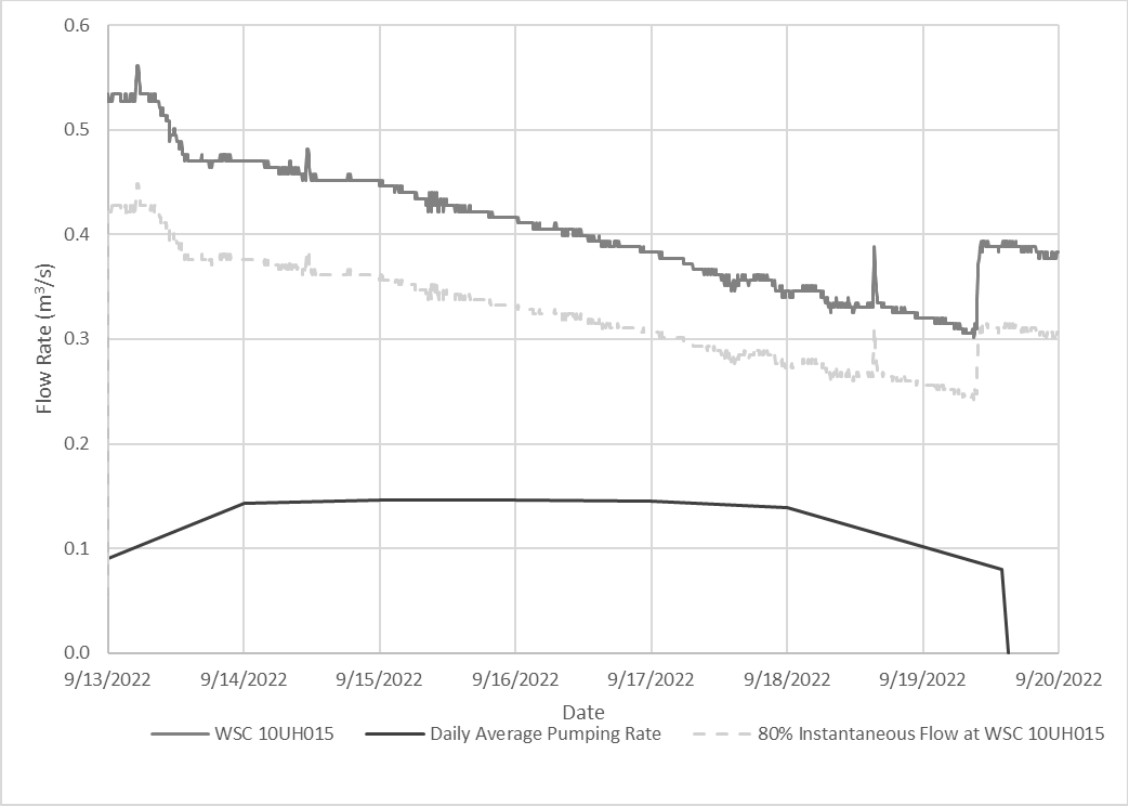


Figure 4.3 Daily Average Flow at WSC 10UH015 and Daily Average Pumping Rate During Pumping Period 2

Figure 4.3 demonstrates the flow at WSC 10UH015 period at the start of Pumping Period 2 when the pumping rate was ramped up by 5% of flow per hour until two pumps were operating at full capacity

(design pump rate of 0.161 m^3/s which resulted in a pump rate of approximately 0.145 m^3/s in actuality). Two pumps were run at full capacity for the remainder of the pumping period until, September 19th when pumps were required to be shut down due to a mechanical component failure with the generator.

4.3 Impacts on Fish and Fish Habitat

Impacts to fish and fish habitat were monitored following the conditions of Amendment No. 4 during Pumping Period 1 and following the FAA during Pumping Period 2. The subsequent sections describe the conditions followed in further detail.

4.3.1 Impacts on Fish and Fish Habitat Pumping Period 1

During Pumping Period 1 the Low-Risk Criteria (DFO 2013) outlined in Amendment No. 4 were followed. The criteria included monitoring of Lake Geraldine water levels, flows in the Apex River, and pumping rates from the Apex River. Monitoring was completed as detailed in Section 3.1.

4.3.2 Impacts on Fish and Fish Habitat Pumping Period 2

Additional monitoring was required during Pumping Period 2 per the FAA conditions. This included monitoring seven stations as described in Section 3.2 for relative water level (m), wetted width (m), habitat conditions and fish presence in addition to the monitoring completed during Pumping Period 1. Daily monitoring reports summarizing in field observations are provided in Appendix B. Condition-by condition commentary to the FAA are provided in Appendix C. The baseline fish habitat report is included in Appendix D.

Table 4.1 summarizes the measured relative water level and wetted width in metres. The percent difference between the presented valued and the previously recorded value is provided below the bolded measured value.

Table 4.1 Relative Water Level and Wetted Width Measured at Monitoring Stations from September 13 to September 19, 2022

		Relative Water Level (m) (% difference from previous observation)							Wetted Width (m) (% difference from previous observation)		
	Date 2022	**Sept 13**	**Sept 14**	**Sept 15**	**Sept 16**	**Sept 17**	**Sept 18**	**Sept 19**	**Sept 13**	**Sept 16**	**Sept 17**
Monitoring Station	**AR-06**	**3.22**	**3.21** -0.3%	NM	**3.2** -0.3%	**3.19** -0.3%	**3.18** -0.3%	**3.17** -0.3%	**50**	**50.6** 1.2%	**50.8** 0.4%
	SNP IQA-10	**0.526**	**0.516** -2%	**0.512** -1%	**0.509** -1%	**0.498** -2%	**0.495** -1%	**0.498** 1%	**32.8**	**33.5** 2%	**33.7** 1%
	AR-07	**4.2**	**4.19** -0.2%	**4.18** -0.2%	**4.18** 0.0%	**4.17** -0.2%	NM	**4.16** -0.2%	**46.7**	**43.1** -7.7%	**45.2** 4.9%
	A1	**2.16**	**2.15** -0.5%	**2.13** -1%	**2.12** -0.5%	**2.11** -0.5%	**2.1** -0.5%	**2.09** -0.5%	**21.54**	**20.7** -3.9%	**21.5** 3.9%
	A2	**1.17**	**1.16** -1%	NM	**1.15** -1%	**1.14** -1%	NM	**1.12** -2%	**10**	**9.95** -1%	**10** 1%
	AR-03	**0.271**	**0.26** -4%	NM	**0.249** -4%	**0.23** -8%	NM	**0.223** -3%	**21.25**	**21.16** 0%	**21.2** 0%
	AR-02	**0.152**	**0.22** 45%	NM	**0.144** -35%	**0.132** -8%	NM	**0.17** 29%	**12.18**	**12.12** 0%	**12.1** 0%

NM – Not Measured

As illustrated in Table 4.1, most percent differences measured for relative water level and wetted width were within 10% of the previous value measured except for relative depths measured at AR-02. As shown in Appendix B, the cross section at AR-02 was uniform and directly downstream of a large pool and was therefore insensitive to hydrological changes. Furthermore AR-02 did not follow the same trend as shown in the upstream stations on the 14 and the 19 (depth increased instead of decreased), therefore the larger percent difference may be a result of measurement error. It is assumed that measurements with less than 10% difference between the previous measurement result in a negligible impact on habitat conditions.

Figure 4.4 illustrates the flow upstream of the pumping location measured at WSC 10UH015 and the flow downstream of the pumping location in comparison to the synthetic average daily minimum, lower quartile and mean. The flow downstream of the pumping location was obtained by taking the flow upstream of the pumping location and subtracting the average daily pumping rate. Synthetic daily averages were used because the period of record at 10UH015 is not long enough to provide historical averages. Therefore, data from WSC 10UH002 downstream of the pumping location was used with a 0.513 scaling factor (as described in section 4.2.1).

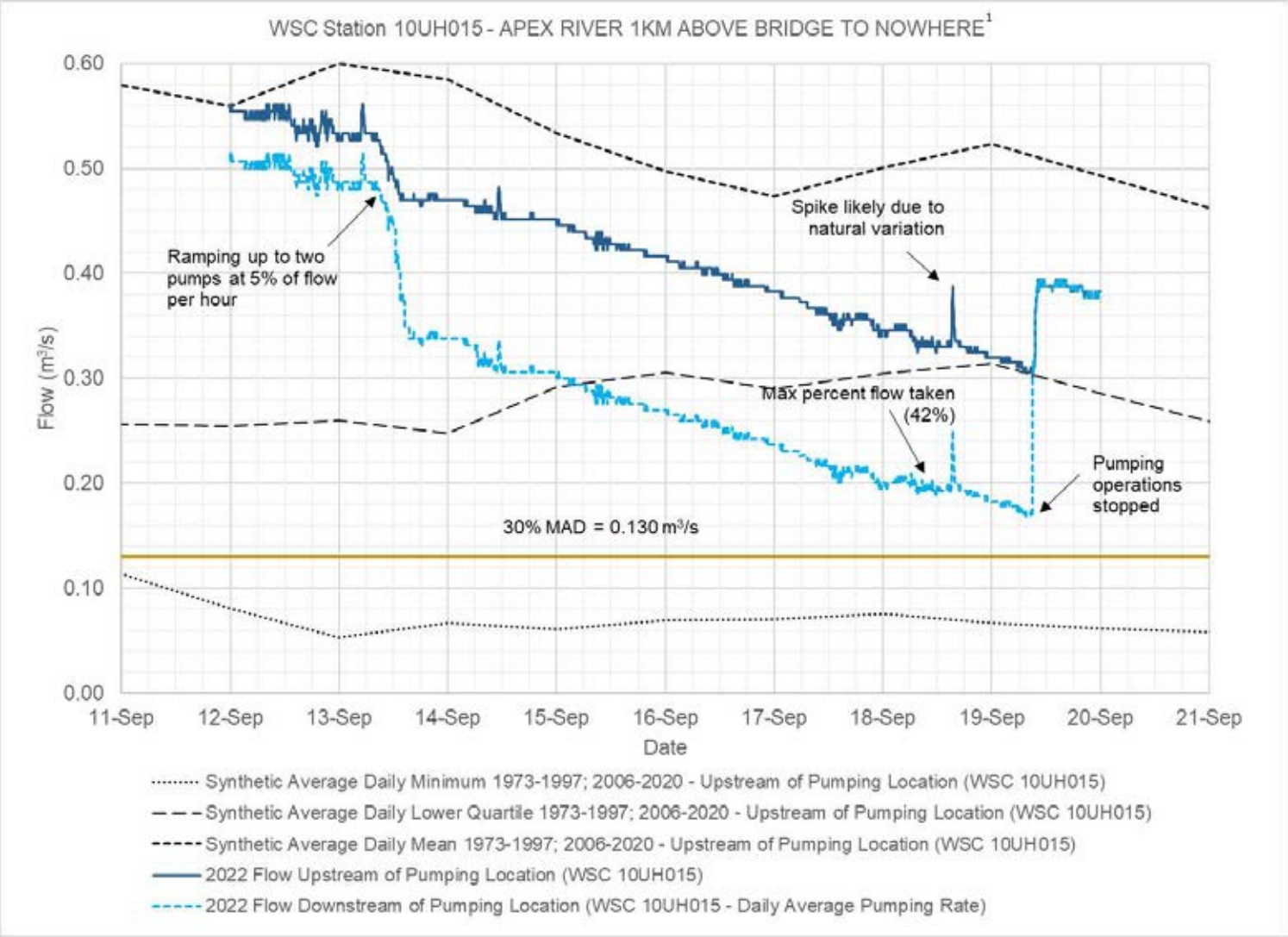


Figure 4.4 Flow Upstream and Downstream of the Pumping Location During Pumping Period 2

1 - The data shown on this plot for 2022 are preliminary data from the WSC hydrometric station. Quality assurance and verification of these data have not been completed by WSC or by Stantec. Synthetic mean, minimum and lower quartile data are from the WSC Station Apex River at Apex (10UH002) with a 0.513 scaling factor applied.

Figure 4.4 illustrates the difference between flows measured upstream of the pumping location (at WSC 10UH015) and affected flows downstream of the pumping location. A consistent pumping rate throughout Pumping Period 2 is shown by the consistent slope of the 2022 flow lines. Since pumping rates were kept consistent throughout this period, variation in flow shown in Figure 4.4 was likely caused by natural variation. The spike that occurred on September 18 occurred during the period of consistent pumping and was therefore likely a result of natural variation. As shown in the figure, once pumping operation stopped on September 19 at 2 pm, the flow upstream and downstream of the pumping location were equal. Furthermore, flow rates downstream of the pumping station (i.e., after withdrawals) were between the synthetic daily average mean and minimum at WSC 10UH015.

Table 4.2 provides a summary of the pumping activities and the average daily flow at WSC 10UH015 throughout Pumping Period 2.

Table 4.2 Summary of Pumping Activities and Average Daily Flow at WSC 10UH015 During Pumping Period 2

Date	Apex River Flow Recorded at WSC 10UH015 (m^3/s)	Daily Pump Rate (m^3/s)	Percent Flow Taken	Average Percent Flow Taken
September 13	0.512	0.091	18%	31%
September 14	0.471	0.132	30%	
September 15	0.442	0.146	33%	
September 16	0.409	0.146	36%	
September 17	0.374	0.145	39%	
September 18	0.335	0.139	42%	
September 19	0.357	0.080	22%	

Table 4.2 indicates that the maximum withdrawal (as percent of observed flow) was approximately 42% on September 18, 2022 and the average withdrawal was approximately 31% of flow. Percent flow taken throughout Pumping Period 2 stayed within the maximum percent flow allowed outlined in the FAA (80%).

Additional monitoring details are provided in the daily reports provided in Appendix B, and condition-by-condition commentary is provided in Appendix C. A summary of the main actions taken during Pumping Period 2 are provided below.

- Prior to the commencement of the emergency authorization, monitoring locations (listed in Table 3.2) were established.
- At each monitoring station, wetted width, depth and habitat condition were recorded on September 13 prior to the activation of the emergency circumstances FAA. Daily monitoring reports can be found in Appendix B.
- At the start of the activation of the FAA, the pumping rate was ramped at 5% of flow per hour until two pumps were operating at full capacity. This approach was selected to reduce the likelihood of

fish stranding and fish mortality. During the ramping up period, the affected reaches were monitored for any presence of fish stranding and/or mortality. No fish stranding and/or mortality was observed, and no fish presence was observed.

- Once two pumps had reached full operating capacity, the pumping rate was held relatively consistently for the remainder of Pumping Period 2.
- The monitoring program outlined in Table 3.2 was followed throughout Pumping Period 2. This included the measurement of wetted width, depth, habitat condition and fish presence at each monitoring station.
- No notable impacts to fish and fish habitat were measured throughout the program as determined by wetted width and depth measurements (Table 4.1).
- No fish stranding and/or mortality was observed, and no fish presence was observed throughout Pumping Period 2.
- Flows were measured upstream of the pumping location each day during the FAA pumping period and the percentage of flow that was pumped was calculated (Table 4.2).
- Pumping stopped abruptly on September 19 due to a mechanical component failure with the generator.

During the pumping program no documented impacts to fish and fish habitat occurred. As presented above, the withdrawals and reductions of flow during the program did not result in flows beyond the range of the historical flow regime during similar historical periods. Based on this, Nunami Stantec's opinion that no harmful alteration, disruption, and destruction of fish habitat resulted from SPP Period 2. Therefore, it is recommended that no fish or fish habitat offsetting requirements are needed per the FAA.

5 DEMOBILIZATION

Pumping operations ended on September 19, 2022. Demobilization followed and included Unnamed Lake pumping equipment and hose return to supplier and Government of Nunavut, respectively. Demobilization also involved return of City-owned equipment to the Coke Plant. The formal equipment handover from TAL to the City on October 19, 2022 with all three parties (Nunami Stantec, City, TAL) signing off on the equipment return on October 25, 2022. On this day, Nunami Stantec, the City (Shane Turner), and TAL (Eric Jacobsen) participated in a formal equipment handover. The manifest from this handover can be found in Appendix E, as well as a final site review memo (dated November 3, 2022).

6 CONCLUSION

Pumping from the Apex River to the Lake Geraldine Reservoir in accordance with Water Licence 3AM-IQA1626 Amendment No. 4 (up to 10% of observed flow when flows are more than 30% MAD) was completed between June 12 to September 12, 2022. A total of 367,501 m^3 were pumped with a maximum daily pumped volume of approximately 14,541 m^3 during this time. Under the emergency *Fisheries Act* authorization (22-HCAA-02043), withdrawals of up to 80% of observed flow were allowed. Pumping was completed between September 13 to September 19, 2022. A total of 76,889 m^3 was pumped during this time, with a maximum daily volume of 12,644 m^3, the maximum withdrawal rate of 42% occurred on September 18. Monitoring completed between September 13 and September 19, 2022 indicated that no harmful alteration, disruption, and destruction of fish habitat was evident from Apex River pumping under the conditions of the FAA. Therefore, no fish or fish habitat offsetting requirements are recommended.

The total volume withdrawn from the Apex River to the Lake Geraldine Reservoir in 2022 was 444,390 m^3. This total volume is less than the maximum allowable pumped volume from the Apex River of 500,000 m^3 as defined in Amendment No. 4.

Pumping records were maintained by the contractor at the pumping site. Pumping was required throughout the entire open water season. The highest water level reached within Lake Geraldine during the 2022 pumping period was 111.141 m (corresponding to an estimated volume of 1,619,154 m^3) recorded on September 21, 2022.

7 LIMITATIONS

This document titled Final Report: Iqaluit 2022 Lake Geraldine Resupply (Apex Pumping): Report of Activities was prepared by Nunami Stantec Ltd. (“Nunami Stantec”) for the account of the City of Iqaluit (the “Client”). This report is intended solely for the use by the Client in accordance with Stantec’s contract with the Client. While the Report may be provided to applicable authorities having jurisdiction and others for whom the Client is responsible, Stantec does not warrant the services to any third party. The report may not be relied upon by any other party without the expressed written consent of Stantec, which may be withheld at Stantec’s discretion. The material in this document reflects Nunami Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Nunami Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Nunami Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Nunami Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

8 CLOSURE

Nunami Stantec Ltd. has prepared this report for the sole benefit of the City of Iqaluit (the City) for the purpose of summarizing the results from water withdrawal and environmental monitoring during the supplementary pumping from the Apex River in 2022. This document was prepared to summarize pumping activities from the 2022 pumping program.

Nunami Stantec trusts the contents of this report meet your expectations at this time. If you have any questions, please do not hesitate to contact the undersigned

Respectfully Submitted,

NUNAMI STANTEC LIMITED

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9 REFERENCES

Fisheries and Oceans Canada (DFO). 2022. Paragraphs 34.4(2)(b) and 35(2)(b) *Fisheries Act* Authorization Emergency Circumstances 22-HCAA-02043. Authorization Issued to the City of Iqaluit.

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Government of Canada (GoC). 2022. Letter from Hon. Daniel Vandal, P.C., M.P. to Lootie Toomasie, Chair, Nunavut Water Board. Ottawa.

Nunavut Water Board. 2022. "NWB Water Licence Type "A" No. 3AM-IQA1626, City of Iqaluit - Request for the Minister's Consent to Process the Application on an Emergency Basis and Attached Reasons for Decision and Amendment No. 7 for the Minister's Consideration." Gjoa Haven.

APPENDIX A

Daily and Monthly Withdrawals from the Apex River

Total Amount Withdrawn from Niaqunguk River in 2022 = 444,390 m^3

Date	Daily (m^3)	Total June (m^3)
6/12/2022	1,885	
6/13/2022	12,524	
6/14/2022	12,309	
6/15/2022	12,691	
6/16/2022	14,541	
6/17/2022	12,635	
6/18/2022	11,814	
6/19/2022	8,996	
6/20/2022	7,119	
6/21/2022	6,423	155,166
6/22/2022	6,625	
6/23/2022	6,358	
6/24/2022	6,334	
6/25/2022	6,356	
6/26/2022	6,304	
6/27/2022	6,337	
6/28/2022	6,219	
6/29/2022	4,741	
6/30/2022	4,953	

Date	Daily (m^3)	Total July (m^3)
7/1/2022	5,481	
7/2/2022	5,566	
7/3/2022	5,142	
7/4/2022	5,111	
7/5/2022	3,374	
7/6/2022	3,664	
7/7/2022	3,822	
7/8/2022	3,630	
7/9/2022	715	
7/10/2022	-	
7/11/2022	-	
7/12/2022	-	
7/13/2022	-	
7/14/2022	-	
7/15/2022	-	
7/16/2022	-	44,466
7/17/2022	-	
7/18/2022	-	
7/19/2022	-	
7/20/2022	-	
7/21/2022	-	
7/22/2022	-	
7/23/2022	-	
7/24/2022	489	
7/25/2022	1,892	
7/26/2022	1,485	
7/27/2022	1,284	
7/28/2022	745	
7/29/2022	-	
7/30/2022	409	
7/31/2022	1,658	

Date	Daily (m^3)	Total August (m^3)
8/1/2022	1,466	
8/2/2022	1,479	
8/3/2022	1,579	
8/4/2022	1,020	
8/5/2022	599	
8/6/2022	1,284	
8/7/2022	1,332	
8/8/2022	1,467	
8/9/2022	1,418	
8/10/2022	1,322	
8/11/2022	478	
8/12/2022	-	
8/13/2022	314	
8/14/2022	1,660	
8/15/2022	2,204	
8/16/2022	2,240	87,252
8/17/2022	2,382	
8/18/2022	2,595	
8/19/2022	3,054	
8/20/2022	3,528	
8/21/2022	3,764	
8/22/2022	3,690	
8/23/2022	3,692	
8/24/2022	4,049	
8/25/2022	5,175	
8/26/2022	5,261	
8/27/2022	5,938	
8/28/2022	6,996	
8/29/2022	6,000	
8/30/2022	5,677	
8/31/2022	5,589	

Date	Daily (m^3)	Total September (m^3)
9/1/2022	5,290	
9/2/2022	5,806	
9/3/2022	7,106	
9/4/2022	8,601	
9/5/2022	12,904	
9/6/2022	9,179	
9/7/2022	6,519	
9/8/2022	5,595	
9/9/2022	5,978	
9/10/2022	4,936	157,507
9/11/2022	4,485	
9/12/2022	4,220	
9/13/2022	7,823	
9/14/2022	12,326	
9/15/2022	12,644	
9/16/2022	12,629	
9/17/2022	12,538	
9/18/2022	12,018	
9/19/2022	6,913	

APPENDIX B

Daily Monitoring Reports

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**1**
Date of Visit:	**September 12th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**7 °C Cloudy, no precipitation, wind gusting up to 52 km/hr from the southeast**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Isaac Freda	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Set up the 7 aquatic monitoring stations outlined in the Fish and Fish Habitat Monitoring Plan

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.049 m^3/s
Discharge (measured at 10UH015)	0.560 m^3/s
Percentage of Instantaneous Flow	9%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level	Wetted Width	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	NM	NM	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	NM	NM	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	NM	NM	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No
A1	NM	NM	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**1**

A2	NM	NM	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	NM	NM	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	NM	NM	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

PHOTO INVENTORY	
AR-06	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**1**

AR-07	
A1	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**1**

A2	
AR-03	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**1**

AR-02	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**2**
Date of Visit:	**September 13th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**7 °C Cloudy, no precipitation, wind 15 km/hr**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Took wetted width measurements and depth measurements at all monitoring stations prior to the commencement of Emergency FAA
1.2	Monitored for fish stranding and fish mortalities during the ramp up to 2 pumps operating at full capacity (increased pumping rate by 25 lps per hour)

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.091 m^3/s
Discharge (measured at 10UH015)	0.512 m^3/s
Percentage of Instantaneous Flow	18%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.22	50	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.526	32.8	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.20	46.70	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

A1	2.16	21.54	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	1.17	10.00	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	0.271	21.25	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	0.152	12.18	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY

AR-06

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**2**

SNP IQA-10	
AR-07	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**2**

A1	
A2	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**2**

AR-03	
AR-02	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**3**
Date of Visit:	**September 14th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**6 °C Cloudy, 0.3 mm precipitation**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.143 m^3/s
Discharge (measured at 10UH015)	0.471 m^3/s
Percentage of Instantaneous Flow	30%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.21 (-0.01)	NM	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.516 (-0.01)	NM	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.19 (-0.01)	NM	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

A1	2.15 (-0.02)	NM	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	1.16 (-0.02)	NM	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	0.260 (-0.011)	NM	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	0.22 (+0.068)	NM	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY

AR-06

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**3**

AR-07	
A1	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**3**

A2	
AR-03	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**4**
Date of Visit:	**September 15th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**6 °C Cloudy**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.146 m^3/s
Discharge (measured at 10UH015)	0.442 m^3/s
Percentage of Instantaneous Flow	33%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	NM	NM	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.512 (-0.004)	NM	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.18 (-0.01)	NM	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**4**

A1	2.13 (-0.02)	NM	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	NM	NM	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	NM	NM	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	NM	NM	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY	
AR-06	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**4**

AR-07	
A1	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**3**

AR-02	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**5**
Date of Visit:	**September 16th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**6 °C Sunny**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.146 m^3/s
Discharge (measured at 10UH015)	0.409 m^3/s
Percentage of Instantaneous Flow	36%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.20 (-0.02)	50.60	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.509 (-0.003)	33.5	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.18 (0.00)	43.10	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

A1	2.12 (-0.01)	20.70	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	1.15 (-0.01)	9.95	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	0.249 (-0.011)	21.16	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	0.144 (-0.076)	12.12	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY

AR-06

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**5**

SNP IQA-10	
AR-07	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**5**

A1	
A2	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**5**

AR-03	
AR-02	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**6**
Date of Visit:	**September 17th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00**	Location:	**Iqaluit, NU**
Weather	**6 °C sun-cloud, wind gusting up to 50 km/hr**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.145 m^3/s
Discharge (measured at 10UH015)	0.374 m^3/s
Percentage of Instantaneous Flow	39%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.19 (-0.01)	50.80	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.498 (-0.011)	33.7	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.17 (-0.01)	45.2	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

A1	2.11 (-0.02)	21.50	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	1.14 (-0.01)	10.00	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	0.230 (-0.019)	21.20	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	0.132 (-0.012)	12.10	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY

AR-06

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**6**

SNP IQA-10	
AR-07	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**6**

A1	
A2	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**6**

AR-03	
AR-02	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**7**
Date of Visit:	**September 18th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 12:00**	Location:	**Iqaluit, NU**
Weather	**6 °C Sunny, wind gusting up to 50 km/hr**		

KEY PERSONAL PRESENT	
Name	Company
Erin Kelly	Stantec
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.139 m^3/s
Discharge (measured at 10UH015)	0.335 m^3/s
Percentage of Instantaneous Flow	42%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.18 (-0.01)	NM	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.495 (-0.003)	NM	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	NM	NM	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No

A1	2.10 (-0.01)	NM	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No
A2	NM	NM	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	NM	NM	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	NM	NM	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

PHOTO INVENTORY	
AR-06	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**7**

SNP IQA-10	
AR-07	

Project:	Apex Supplemental Pumping	Project No.:	144903261	Report No.:	**7**

A1	

Stantec

Apex River Supplemental Pumping: Fish and Fish Habitat Monitoring Plan

Daily Field Report

GENERAL INFORMATION			
Project:	**Apex River Supplemental Pumping**	Report No.:	**8**
Date of Visit:	**September 19th, 2022**	File #:	**144903261**
Site visit time:	**8:00 – 5:00 pm**	Location:	**Iqaluit, NU**
Weather	**6 °C Sunny, wind gusting up to 34 km/hr**		

KEY PERSONAL PRESENT	
Name	Company
Lenny Emiktaut	Stantec

FIELD ACTIVITIES	
Item	**Description**
1.1	Walked reaches, took observations at monitoring stations
1.2	Monitored for fish stranding and fish mortalities, during ramp down of pumps

DAILY AVERAGE WATER WITHDRAWAL	
Daily Withdrawal (measured at SNP IQA-10)	0.080 m^3/s
Discharge (measured at 10UH015)	0.357 m^3/s
Percentage of Instantaneous Flow	22%

EXCEEDANCE OF LOW RISK CRITERIA				
Station	Water Level[1] (difference from previous observation) (m)	Wetted Width (m)	Habitat Conditions	Fish Presence (stranding and mortality)
AR-06	3.17 (-0.01)	NM	The head of the pool from which the supplemental water is being drawn. Water has high clarity, 80% large rounded rocks, 20% large rounded boulders.	No
SNP IQA-10	0.498 (+0.003)	NM	Pumping location, pool, water has high clarity, no vegetation.	No
AR-07	4.16 (-0.01)	NM	The tail end of the pool from which the water is being drawn. Water has high clarity, no indication of sediment from construction or pumping activities.	No
A1	2.09 (-0.01)	NM	Within a riffle directly upstream of bridge to nowhere. Water has clarity, mix of large angular boulders, rounded boulders and large rounded rocks.	No

A2	1.12 (-0.02)	NM	This location is a riffle. Channel slightly embedded at this location. Water has high clarity, mostly rounded rocks.	No
AR-03	0.223 (-0.007)	NM	The tail end of a Swimming Lake pool just upstream of where the river transitions into a run. Water has high clarity, 80% rounded rocks, some rounded cobbles and sand.	No
AR-02	0.17 (+0.038)	NM	Within a riffle, downstream of the tail end of a run. Water has high clarity with 40% rounded boulders, 40% large rounded rocks, 10% cobble.	No

NM= Not Measured

1- Relative height on gauge of monitoring station

APPENDIX C

Conditions that relate to monitoring and reporting of measures and standards to avoid and mitigate impacts to fish and fish habitat

Fisheries Act Authorization Emergency Circumstances - PATH No. 22-HCAA-02043

Conditions of Authorization		
FAA Condition No.	**Action**	**Proof**
1	Activity completed within the given period of August 12, 2022 to October 31, 2022	Pumping Period 2 completed between September 13 - September 19
2	*Conditions that relate to measures and standards to avoid and mitigate impacts to fish and fish habitat*	
2.1	ESC measured installed in compliance with Amendment No. 4	"Apex River Water Withdrawal: Erosion and Sedimentation Control Plan" Dated December 21, 2018
2.2	*List of measures and standards to avoid and mitigate impacts to fish and fish habitat:*	
2.2.1	No fish observed during monitoring program. Environmental professional was on site.	
2.2.2	Screens sized as per DFO's code of practice for the End-of-pipe fish protection screens for small water intakes in freshwater.	Pumps were housed in a screened cage to meet DFO guideline.
2.2.3.	Nunavut Water Board Approved a Spill Contingency Plan under Amendment No. 4	"Apex River Water Withdrawal: Site Specific Spill Contingency Plan" dated December 21, 2018
2.3	Fish and fish habitat monitoring completed by measuring wetted width, depth and habitat condition. In addition to fis presence and mortality.	Monitoring indicated that measures and standards to avoid and mitigate impacts to fish and fish habitat were successful
2.4	Measures and standards to avoid and mitigate impacts to fish and fish habitat completed	
3.1.1	Completed. Please refer to daily reports in Appendix C.	
3.1.1.1	Completed. Please refer to daily reports in Appendix C.	
3.1.1.2	No fish observed during monitoring, therefore no relocation actvities completed.	
3.1.1.3	Contigency measures not needed, not applicable.	
3.2	*Other monitoring and reporting conditions:*	
3.2.1	Completed. Please refer to report in Appendix E.	
3.2.2	Completed. Please refer to daily reports in Appendix C.	
3.2.2.1	From baseline conditions study flows only required upstream of pumping location. Those flows minus the pumped flow is the flow downstream of the pumping location. Baseline study in Appendix E.	
3.2.2.2	Completed, measured wetted width at monitoring sites. Please refer to daily reports in Appendix C.	
3.2.2.3	Completed. Please refer to daily reports in Appendix C.	
3.2.2.4	Completed. Please refer to daily reports in Appendix C.	
3.2.2.5	No fish mortalities observed.	
3.2.2.6	Not applicable, no contingency measures needed.	
All conditions in Section 4	Not applicable. Offsetting not required, as detailed in report.	

APPENDIX D

Fish Habitat Assessment of the Niaqunguk (Apex) River, Nunavut, March 15, 2023

Fish Habitat Assessment of the Niaqunguk (Apex) River, Nunavut

Prepared for:

City of Iqaluit
Iqaluit, Nunavut

Prepared by:

Nunami Stantec Limited

March 15, 2023

Project No.: 144903306

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STANTEC LIMITED

Limitations and Sign-off

This document entitled Fish Habitat Assessment of the Niaqunguk (Apex) River was prepared by Nunami Stantec Limited (“Nunami Stantec”) for the account of City of Iqaluit (the “Client”). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Nunami Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Nunami Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Nunami Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Nunami Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

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Executive Summary

The City of Iqaluit retained Nunami Stantec Ltd. to complete fish habitat assessments along the Niaqunguk (Apex) River, develop a habitat suitability index for Artic char (*Salvelinus alpinus*), and conduct eDNA samples. The sampling was conducted in support of a monitoring program if supplementary water withdrawal for the Lake Geraldine Reservoir exceeds the allowable 10% instantaneous flow. A field survey was conducted between August 16 to August 20, 2022. Ten 100 m reaches were assessed four upstream of the temporary pumping location, the temporary pumping location, and five downstream of the temporary pumping location.

At each sampled reach habitat features were measured and observed, water quality, and flow measures taken. Areas of river between sampling reaches were walked and habitat features observed and recorded. Fish habitat was rated at each reach by the field biologist for the life history requirements of spawning, rearing, fish passage and overwintering.

A habitat suitability index (HSI) model for Arctic char was adapted from an existing model for Dolly Varden char (*S. malma*) and bull trout (*S. confluentus*) as there was insufficient data in the literature on habitat preferences of Arctic char. The HSI model was applied to the reach at the temporary pumping location (PP-01) and downstream assessed reaches as proposed monitoring locations as a comparison of field assessed habitat ratings.

Water samples were collected at one site upstream of the temporary pumping location for the collection of eDNA to determine the potential for Arctic char upstream of the temporary pumping location. Analysis of the water samples indicated the potential presence of Arctic char at or above the sampling site. No other fish species were identified through the eDNA analysis.

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Abbreviations

City ..... City of Iqaluit
DFO ..... Fisheries and Oceans Canada
DNA ..... Deoxyribonucleic acid
eDNA ..... environmental DNA
HSI ..... habitat suitability index
km ..... kilometre
m ..... metre
MAD ..... Mean annual discharge

Glossary

Fish passage	Features used by fish to migrate through a watercourse or waterbody to access different habitats to carry out additional life stages
Adult foraging	Areas used by adult fish for feeding
Metabarcoding	Used for the identification of species assemblages from DNA barcode genes
Overwintering habitat	Habitat used by fish during the winter, typically when watercourses and waterbodies are ice-covered
Rearing habitat	Habitat used by larval and juvenile fish for feeding and shelter
Spawning habitat	Habitat used by adult fish to carry out spawning activities

1 Introduction

The City of Iqaluit (the City) sources its potable water from Lake Geraldine; however, in recent years, low water levels in the reservoir due to lower levels of precipitation than normal have required the City to divert water from other sources in order to supply the community. The City is permitted to divert water as a supplementary water supply from the Niaqunguk (Apex) River to Lake Geraldine when flows in the Apex River are above 30% mean annual discharge (MAD). During HSI time, the City is permitted to divert water at a flow rate equal to or less than 10% of the instantaneous flow of the Apex River. The City has determined that increased diversion rates are required in order to continue to supply the community with potable water.

On August 5, 2022, the City of Iqaluit submitted an application for emergency Authorization under the *Fisheries Act* (22-HCAA-02043) to Fisheries and Oceans Canada (DFO) to withdraw water from the Apex River above the allowable limit of 10% instantaneous flow and when conditions are above 30% of the mean annual discharge, as specified in the City's water licence (3AM-IQA1626). The *Fisheries Act* Emergency Authorization was issued on August 12, 2022. A monitoring plan (Nunami Stantec 2022) was developed for water diversion from the Apex River and would be implemented if water is withdrawn over the 10% instantaneous flow level. This monitoring plan was submitted to DFO as part of the application for emergency Authorization. The initial fish and fish habitat assessment was completed in 2016 (Nunami Stantec 2017) and was submitted with the application for emergency Authorization; however, additional recent fish and fish habitat data is required to support ongoing regulatory reviews.

Nunami Stantec Ltd. (Nunami) was retained by the City in July 2022 to develop a revised fish and fish habitat assessment that included:

- Characterization of pre-water diversion fish habitat conditions at proposed monitoring sites along the Apex River
- Develop a habitat suitability index (HSI) model for Arctic char
- Evaluate potential for Arctic char presence above the temporary pumping location using environmental DNA (eDNA)

1.1 Study Area

The Apex River originates at an unnamed lake north of Iqaluit and flows through a tundra landscape into Koojesse Inlet. The Apex River is approximately 8 kilometres (km) in length. A two metre (m) waterfall at the mouth of the Apex River prevents fish from Koojesse Inlet from entering the river. The study area and sampling locations are presented in Figure 1.1.

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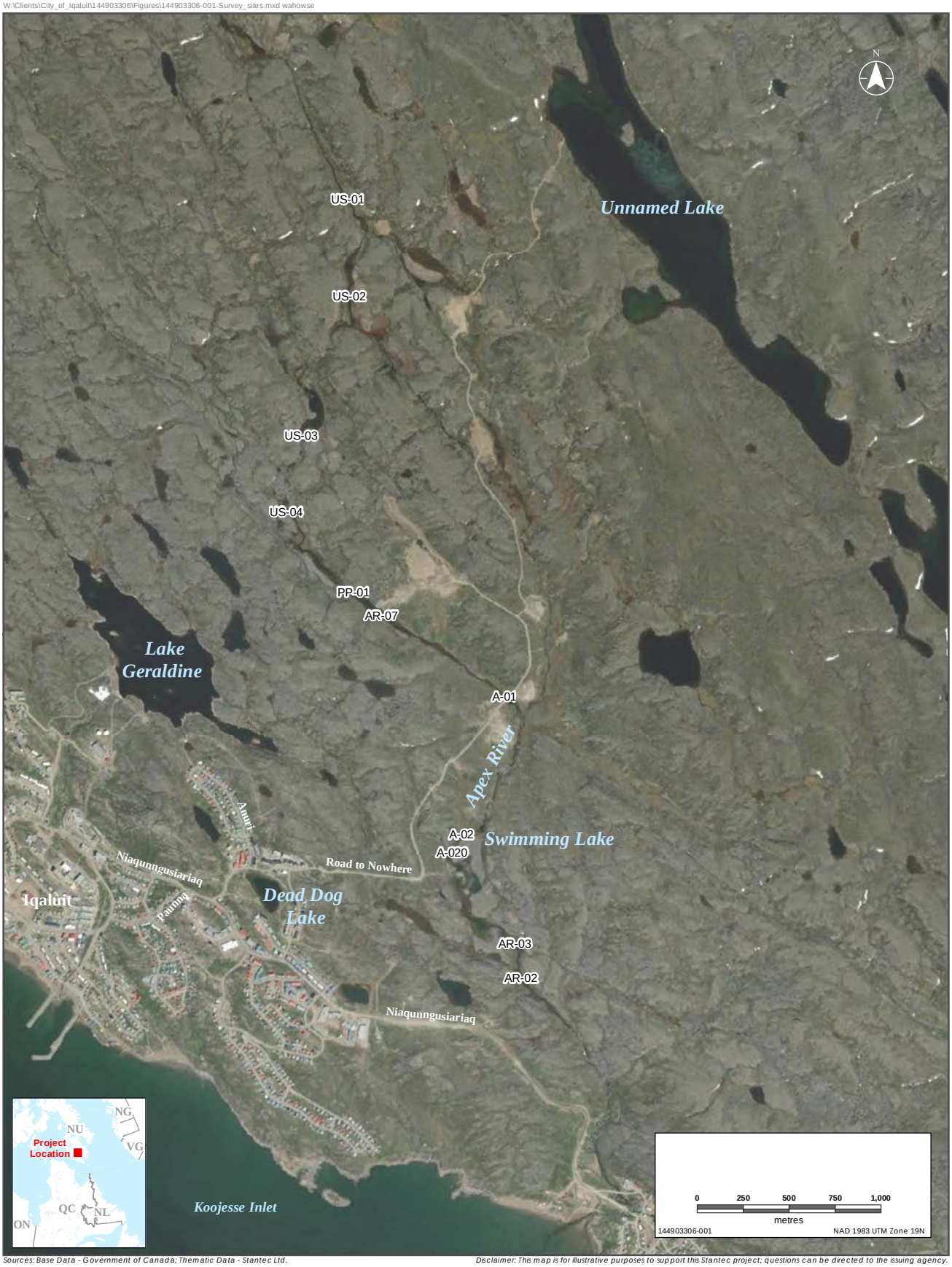

Sources: Base Data - Government of Canada; Thematic Data - Stantec Ltd.

Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

Survey Locations

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FISH AND FISH HABITAT ASSESSMENT STUDY

Figure 1-1

2 Methods

2.1 HSI Model

Habitat suitability indexes (HSI) are used as a tool used to objectively assess the range of environmental conditions that fully, marginally, or do not meet the life history requirements of a species (Wakeley 1988). The HSI provides a numeric measurement of the habitat variable between 0 (does not meet species requirements) and 1 (fully meets the species requirements) (de Kerckhove et al. 2008) (Table 2.1). Habitat suitability metrics (e.g., water velocity, substrate, and water depth) reflect units that are used in an overall HSI numerical index to describe the suitability of habitat to a specific life stage of Arctic char. The HSI provide environmental-variable suitability values ranging between 0 and 1, where a score of 1 is considered most suitable habitat and a score of 0 is considered least suitable habitat for Arctic char.

The HSI model relies heavily on habitat preferences for Dolly Varden char (*Salvelinus malma*) and bull trout (*S. confluentus*) as they share similar habitat preferences as Arctic char and detailed habitat preference data is lacking on Arctic char in the literature.

The HSI for each 100 m reach was calculated by adding the ranks for each parameter for a life history component modelled and dividing by the number of parameters for that life History component. For example for spawning potential, four habitat parameters (P) were used and therefore the HSI for spawning was calculated as $P_1 + P_2 + P_3 + P_4 / 4$ = HSI for spawning.

Table 2.1 Habitat Ranking

Assigned Rank	Habitat Suitability Rating	Description
1.00	Excellent	Available habitat is highly suitable. No limitations to suitability are identified the life stage under consideration
0.75	Above Average	Available habitat has slight limitations for life stage under consideration.
0.50	Average	Available habitat is capable of supporting life stage under consideration, but may not be most desirable habitat
0.25	Below Average	Moderate to severe limitations in habitat suitability are present for the life stage under consideration.
0.00	Least suitable	Habitat suitability is negligible or nonexistent.

2.2 Fish Habitat

The field survey was conducted between August 16 and August 20, 2022 by a qualified aquatic biologist. At each site (Table 2.2; Figure 1.1), fish habitat was assessed along 100 m reaches. Along each 100 m reach, five transects were established to collect fish habitat data; located at 0 m (i.e., reach ID location), and downstream at 25 m, 50 m, 75 m, and 100 m along each reach. At each transect the following data were collected:

- Date and time;

- general channel morphology;
- channel width;
- wetted width;
- water depth at 0.25, 0.5 and 0.75 of wetted width
- water velocity using a Hach FH950 flow meter;
- water quality (e.g., oxygen, conductivity, and pH);
- substrate composition (visually estimated);
- bank description (i.e., height, slope, and stability);
- functional cover type and abundance;
- riparian vegetation composition;
- global positioning system (GPS) recordings and photographs.

River stretches between sampling sites were walked by the aquatic biologist and habitat characteristics observed and recorded. No measurements were taken between sampled reaches.

Habitat characteristics were incorporated into a physical habitat classification system that rates the quality of each macro-habitat type based on physical features (e.g., depth, cover, substrate) with respect to the life requirements of Arctic char (e.g., rearing, spawning, fish passage, overwintering) suspected to occur in the waterbody. Each life history requirement was rated as good, moderate, poor or none, based on the professional judgement of the fish biologist. In addition, the HSI model (Section 3.1) was also applied for the life requirements (spawning, rearing, foraging, and overwintering) of Arctic char for each assessed site.

Table 2.2 Reach Locations (all locations are in UTM Zone 19 V)

Location Number	Easting	Northing
A-01	526548	7069946
A-02	526260	7069180
AR-02	526625	7068410
AR-03	526559	7068632
AR-07	525871	7070396
PP-01	525736	7070513
US-01	525685	7072648
US-02	525666	7072105
US-03	525419	7071445
US-04	525371	7070950

2.3 eDNA

Five eDNA samples were collected from the US-01 Reach. Samples were collected off the left downstream bank to ensure the crew did not enter the water prior to sample collection to prevent contamination. Nitrile gloves were worn when handling sampling equipment and the filters. Each sample was filtered *in-situ* through a 5 µm pore-size Smith-Root self-preserving eDNA filter. Water was pulled through the filters using a drill-operated Masterflex L/S® Easy-Load® peristaltic pump. Two liters of water were filtered per sample. All samples were labelled, bagged and frozen until they were shipped to NatureMetrics for eDNA metabarcoding species analysis. A negative control filter was prepared by filtering two liters of distilled water. Detailed DNA analysis conducted by NatureMetrics is provided in Appendix A.

3 Results

3.1 HSI

Tables 3.1 to 3.4 provides the HSI model adapted for Arctic char from a HSI model developed by AMEX (2012) for Dolly Varden char.

Table 3.1 Spawning/egg Incubation Habitat

Physical Habitat	Spawning/egg Incubation					
	Excellent	**Above Average**	**Average**	**Below Average**	**Unsuitable**	
HSI Value	**1.00**	**0.75**	**0.50**	**0.25**	**0.00**	**References/Notes[1]**
Dominant substrate	gravel	Gravel/cobble	Fine gravel	Cobble/boulder	Rock/bedrock	ADFG 1985 (DV+AC); Griffith 1979 (DV); Leggett 1980 (DV); Kitano and Shimazaki 1995 (DV)
Substrate size (mm)	10-50	50-100	0-10	125-256	≥256	-
Depth-Range (m)	.0.05-0.19	0.19-0.30	0.29-0.40	-	<0.04 >0.40	ADFG 1985 (DV+AC); Armstrong and Morrow 1980 (DV); Griffith 1979 (DV); Hagan and Taylor 2001 (DV); Kitano and Shimazaki 1995 (DV)
Temperature °C	4-12	-	12-15	-	<4, >15	ADFG 1985 (DV+AC); Craig and Poulen 1974 (DV); Griffith 1979 (DV); McPhail 2007 (DV); McPhail and Baxter 1996 (BT)
Water velocity (m/s)	0.1-0.3	0.3-0.6	0.6-1.0	1.0-1.3	>1.3	ADFG 1985(DV+AC); Griffith 1979(DV); Kitano and Shimazaki1995(DV)
Stream morphology	Pool-tails or riffle crests contiguous to holding pools	Riffle-run	Pool-riffle	Runs, pools	-	McCart 1980 (DV)
Additional considerations	Areas of groundwater discharge are considered key habitat spawning					ADFG 1985 (DV+AC); Stewart *et al.* 2007

Notes:

[1] Brackets denote species habitat use information from which HSI was derived from: DV = Dolly Varden; BT = bull trout; AC = Arctic char

"-" no data

Table 3.2 Juvenile Rearing Habitat

Physical Habitat	Juvenile Rearing					References/Notes[1]
	Excellent	Above Average	Average	Below Average	Unsuitable	
HSI Value	1.00	0.75	0.50	0.25	0.00	
Dominant substrate	Gravel-cobble	boulder	-	Fines, debris/organic	Rock/bedrock	Dollof and Reeves 1990 (DV); Griffith 1979 (DV)
Substrate size (mm)	2-256	>256	-	<2, NA	>400	Dollof and Reeves 1990 (DV); Griffith 1979 (DV)
Instream cover	Boulders, undercut banks	Undercut bank	Overhead vegetation + undercut bank	Overhead vegetation, aquatic vegetation, boulder	Cobble	Dollof and Reeves 1990 (DV); Griffith 1979 DV)
Depth-Range (m)	0.16-0.29	0.06-0.10, 0.21-0.39	0.10-0.15	<0.05, 0.40-0.49	≥0.50	Bugert *et al.* 1991 (DV); Dollof and Reeves 1990 (DV)
Gradient (%)	5-7	0-4	8-11	12-18	>18	Bryant *et al.* 2004 (DV)
Water velocity (m/s)	0.06-0.19	0.0-0.09	0.20-0.29	0.30-0.39	>0.40, <0.1	Bugert *et al.* 1991 (DV), Griffith 1979 (DV), Sinnatamby et al. 2012 (AC)
Discharge (m^3/sec)	0.01-0.10	0.10-0.30	0.30-0.50	0.50-0.79	>80	Bryant *et al.* 2009 (DV); Dollof and Reeves 1990 (DV)
Stream morphology	Riffles, riffle/glide, side channels	Run-riffle	Pool	Run-pool	--	Griffith 1979 (DV); McCart 1980 (DV); Smith and Slaney 1980 (DV)

Note:
[1] Brackets denote species habitat use information from which HSI was derived from: DV = Dolly Varden; BT = bull trout; AC = Arctic char

Table 3.3 Adult Foraging

Physical Habitat	Adult Foraging					References/Notes[1]
	Excellent	Above Average	Average	Below Average	Unsuitable	
HSI Value	**1.00**	**0.75**	**0.50**	**0.25**	**0.00**	
Dominant substrate	Cobble-boulder	Gravel	-	Rock	Fines, debris, organic	Stewart *et al.* 2007 (BT)
Cover type	Depth, undercut banks, boulders	Large woody debris, cobble	Overhead vegetation	Aquatic vegetation	Small woody debris	ADFG 1985 (DV+AC); Stewart *et al.* 2007 (BT)
Depth-Range (m)	0.30-0.90	0.20-0.30, 0.90-1.20	>1.2	0.20-0.1	<0.1	Hagan and Taylor 2001 (DV), Stewart *et al.* 2007 (BT)
Temperature °C	4-8	8-12.5	12.5-15	<4, 15-20	>20	McPhail 2007 (DV); McPhail and Baxter 1996 (BT); Stewart *et al.* 2007 (BT)
Water velocity (m/s)	0.22-0.55	-	0-0.22, 0.55-1.46	-	>1.46	Stewart *et al.* 2007 (BT)
Stream morphology	Main channel pools and riffles	Run	Side channel pools-riffles	Flat	Chutes, falls	Hagen 2000 (DV); Murray and Gadboury 2005 (DV+BT)

Note:
[1] Brackets denote species habitat use information from which HSI was derived from: DV = Dolly Varden; BT = bull trout; AC = Arctic char

Table 3.4 Overwintering Habitat

Physical Habitat	Overwintering Habitat					References/Notes[1]
	Excellent	Above Average	Average	Below Average	Unsuitable	
HSI Value	1.00	0.75	0.50	0.25	0.00	
Dominant substrate	Cobble-boulder	Gravel	-	Rock	Fines, debris, organic	Based on rearing substrate use [Stewart *et al.* 2007 (BT)] and use of submerged cover in form of boulders as reported by Heifetz *et al.* 1986 (DV)
Cover	Depth, cobble, boulder	Woody debris,	-	Undercut banks	-	Heifetz *et al.* 1986 (DV)
Depth-Range (m)	0.20-0.60	-	0.05 – 0.20, >0.60	-	<0.05	Derived from data observations of fish in fall or systems where ice cover was not present in winter. Bonneau and Scarnecchia 1998 (BT); Huusko *et al*. 2007 (Salmo spp.); Jakober *et al*. 2000 (BT)
Stream morphology	Deep pools, open areas with groundwater upwelling	Deep Pools	Deep run - glides	Riffles	-	Heifetz *et al.* 1986 (DV); Jakober *et al*. 2000 (BT)

Note:
[1] Brackets denote species habitat use information from which HSI was derived from: DV = Dolly Varden; BT = bull trout; AC = Arctic char

3.2 Fish Habitat

The following provides a summary of the fish habitat at the assessed reaches. Additional habitat details and pictures are provided in Appendix B. Water quality data for all the assessed reaches are provided in Table 3.5 and steam velocities in Table 3.6.

Table 3.5 Water Quality Data by Reach

Reach	Water Clarity	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Specific Conductivity (µs/cm)	pH
A-01	Clear	9.6	10.71	93.9	66.6	7.79
A-02	Clear	7.5	10.66	89.0	67.8	7.78
AR-02	Clear	8.6	10.38	89.0	68.0	7.64
AR-03	Clear	8.7	10.46	89.9	68.0	7.32
AR-07	Clear	7.0	10.61	87.4	66.7	7.22
PP-01	Clear	7.0	10.59	87.1	67.3	7.12
US-01	Clear	7.8	10.65	89.5	63.1	7.07
US-02	Clear	10.9	10.25	92.8	62.4	7.62
US-03	Clear	8.5	10.45	89.4	66.1	7.11
US-04	Clear	9.4	10.35	90.5	65.7	7.16

Table 3.6 Stream Velocities by Reach

Reach	Minimum m/sec	Maximum m/sec	Average m/sec
A-01	0.045	0.429	0.235
A-02	0.003	0.373	0.124
AR-02	0.005	0.487	0.202
AR-03	ND	ND	ND
AR-07	0.018	0.164	0.077
PP-01	ND	ND	ND
US-01	0.018	0.234	0.101
US-02	0.028	0.333	0.163
US-03	0.002	0.248	0.097
US-04	0.043	0.352	0.178

Note:
ND = No data collected

3.2.1 Downstream of AR-02 to Koojesse Inlet

Downstream of AR-02 to the mouth of the Apex River at the Koojesse Inlet, habitat transitions from a riffle to a steeper series of cascades and rapids; however, these features are unlikely to limit fish passage. At the mouth of the Apex there is a 2 m waterfall which is a barrier for fish migrating up the Apex River from Koojesse Inlet. There are no deep pools along the assessed reach between AR-02 and the mouth of the Apex River to provide overwintering habitat. Spawning and rearing habitat is limited or absent.

3.2.2 Reach AR-02

Channel width and wetted width varied from 12.0 m to 33.6 m with the greatest width at the downstream end of the reach and narrowest 25 m downstream from the start of the reach. Maximum depths ranged from 0.49 m at the upstream end of the reach to 2.5 m at the middle of the reach and then decreased to over 1 m in the downstream portion of the reach. Stream gradient ranged from one to four percent with the highest gradient 25 m downstream of the beginning of the reach and then leveling off to one percent for the downstream segment of the reach. The upstream segment of the reach is a mixture of glide and riffle habitat with pools present in the downstream segment of the reach and extend into Swimming Lake. Cobble was the dominant substrate for upstream half of the reach and transitioned to an increased percentage of boulders in the lower half of the reach, with boulder being the dominant substrate at the downstream end of the reach. The remaining substrate was a mixture of sand and large gravel. The banks throughout the reach were stable. Grass was the dominant riparian vegetation and provided little to no overhead cover. Instream cover was provided by boulder and cobble substrate.

Fish habitat was rated in the field as poor for spawning due to a lack of gravel but moderate for rearing due to the presence of boulders and cobble. There is overwintering potential at the lower end of the reach due to the presence of a pool. Fish passage was rated as good as no obstructions to migration were observed.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.7.

Table 3.7 HSI Ratings for AR-02

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.25	0.75	1.0	1.0
Substrate size	ND	ND	ND	ND
Depth range	0	0	0.75	1.0
Instream cover	-	0.25	1.0	1.0
Gradient	-	0.75	-	-
Water velocity (m/s)	0.25	0.5	0.5	-
Stream morphology	0.5	0.75	1.0	1.0
HSI Ranking	0.25 (below average)	0.50 (average)	0.85 (above average)	1.0 (excellent)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.3 Between Reach AR-02 and Reach AR-03

The habitat between reaches AR-02 and AR-03 varies between a series of runs and pools. There is potential for overwintering in a pool (>2 m deep) immediately downstream of AR-03 that has good instream cover afforded by boulders. There are no barriers to migration and sufficient depth to provide good fish passage. Some small patches of large gravels could provide potential spawning areas for Arctic char.

3.2.4 Reach AR-03

Channel width varied from 21.1 m to 44.6 m with the widest section was in the upper portions of the reach and then tapering to the lowest width at the end of the reach. Wetted width ranged from 37.6 m to 21.1 m. Maximum depth ranged from 0.37 m to 0.75 m with the shallowest water depth in the upper section of the reach and deepest at the lower end. Stream gradient ranged from one to 5 percent with the lowest gradient in the upper section of the reach and steepest gradient at the lower end of the reach. The reach was a mixture of riffle and glide habitat. Cobble was the dominant substrate at the upper end of the reach followed by boulders. At 25 m downstream large gravel was the dominant substrate followed by sand but then changing again at 50 m downstream where cobble and boulders were again the dominant substrate. The banks throughout the reach were stable. The dominant riparian vegetation was grass although there were areas on the downstream section which were devoid of vegetation. Marginal overhead cover was provided by undercut banks. Instream cover was provided boulders.

Fish habitat was rated in the field as poor for most of the each but at the 25 m transect with the increased amounts of gravel spawning was rated as moderate. Overwintering potential was rated as low. Rearing habitat was rated as moderate while fish passage was rated as good.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.8.

Table 3.8 HSI Ratings for AR-03

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.25	0.75	1.0	1.0
Substrate size	ND	ND	ND	ND
Depth range	0	0	1.0	0.5
Instream cover	-	0.25	0.75	1.0
Gradient	-	0.75	-	-
Water velocity (m/s)	ND	ND	ND	-
Stream morphology	0.75	0.75	0.75	0.25
HSI Ranking	0.33 (below average)	0.5 (average)	0.88 (above average)	0.69 (average)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.5 Between Reach AR-03 and A-02

There is good overwintering habitat between reaches AR-03 and A-02 which includes Swimming Lake with deep pools and cover provided from boulders. Shallow stretches between pools provide potential spawning habitat. There are no barriers to fish passage in this area. Upstream of Swimming Lake habitat is mostly riffle with a cobble/boulder substrate.

3.2.6 Reach A-02

Channel width varied from 18.4 m to 38.0 m with the narrowest section on the upstream portion of the reach and the widest at the center of the reach. Wetted width varied from 14.3 m to 27.7 m at the center of the reach. Maximum water depth varied from 0.38 m to 1.1 m at the center of the reach. Stream gradient was 4% at the upper section of the reach and then 3% for the remainder of the reach. Cobble was the dominant substrate throughout the reach followed by boulders, with smaller amounts of sand, large gravel and bedrock. Riffles was the dominant habitat type throughout the reach except for the center of the reach was primarily glide. Riverbanks were mainly stable for most of the reach except for the lower quarter of the reach where the banks were mostly unstable. Riparian vegetation was dominated by grasses except for the lower section which had no riparian vegetation. Instream cover was limited and provided predominantly by boulders.

Fish habitat for was rated in the field as poor for spawning and overwintering but moderate to good for rearing and fish passage.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.9.

Table 3.9 HSI Ratings for A-02

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.25	0.75	1	1.0
Substrate size	ND	ND	ND	ND
Depth range	0	0	1	0.5
Instream cover	-	0.75	0.75	1
Gradient	-	0.75	-	-
Water velocity (m/s)	0.5	0.75	0.5	-
Stream morphology	0.5	0.75	1	0.25
HSI Ranking	0.31 (below average)	0.63 (average)	0.85 (above average)	0.69 (average)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.7 Between Reach A-02 and A-01

Immediately upstream of reach A-02 stream habitat alternates between riffle and run. Multiple large pools, some with depths over 2m provide potential over wintering habitat for fish. Sections with cascades and chutes could pose as barriers to fish during different flow periods. Shallow riffle sections could potentially become a passage barrier during low flows. No gravel beds were identified for potential spawning areas.

3.2.8 Reach A-01

Channel width varied from 35.0 m to 6.10 m with the narrowest section of the reach being 25 m downstream of the beginning of the reach and the widest being 75 m downstream of the start of the reach. Wetted width varied from 4.8 m to 29.0 m. Maximum water depth ranged from 0.25 m to an estimated 4.0 m in a pool located at the lower end of the reach. Stream gradient varied from 2% to 5 % throughout the reach. Substrate was dominated by cobble with lesser amounts of boulders, large and small gravel and sand. Dominant habitat is riffles followed by pools and glide. Stream banks were stable throughout the reach. Riparian vegetation was a mixture of grasses or no vegetation, providing no overhead cover. Instream cover available was estimated at 17% provided mainly by boulders.

Fish habitat was rated as poor for spawning, moderate for overwintering due to some small pools, moderate to good for rearing and good for fish passage.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.10.

Table 3.10 HSI Ratings for A-01

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.25	0.75	1	1
Substrate size	ND	ND	ND	ND
Depth range	0	0	0.5	0.5
Instream cover	-	0.25	1.0	1
Gradient	-	0.75	-	-
Water velocity (m/s)	1	0.5	0.5	-
Stream morphology	1	0.75	1	1
HSI Ranking	0.56 (average)	0.50 (average)	0.80 (above average)	0.88 (above average)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.9 Between Reach A-01 and AR-07

There are no barriers to fish passage between reaches A-01 and AR-07. About 170m downstream of AR-07 there is a pool with depths over 1m which may provide overwintering habitat. Most of the section of the stream is composed of riffles and runs. There are some small patches of gravel providing potential spawning sites. Substrate is predominantly cobble and boulder between the two reaches. The section of stream immediately upstream of A-01 has good cover provided from large boulders.

3.2.10 Reach AR-07

Channel width varied from 47.0 m to 61.8 m with the widest section being at the upstream start of the reach. Wetted width varied from 55.1 m to 47.0 m. maximum water depth along the length of the reach was fairly consistent, ranging from 0.61 m to 0.79 m. Stream gradient ranged from 1% at the upper section of the reach increasing to 3% 25 m downstream and then 4% the remainder of the reach. The reach consisted entirely of riffle habitat. Substrate through the reach consisted of boulder and cobble with cobble being the most dominant substrate at the upper end of the reach and boulders being the most dominant for the remainder of the reach. The stream banks were all stable except the left bank at the downstream end of the reach which was moderately stable. Riparian vegetation consisted of grass and provided no overhead cover. Instream cover was limited and provided by the boulder substrate.

Fish habitat for spawning and overwintering was rated as none. Rearing habitat was rated as moderate for both rearing and fish passage.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.11.

Table 3.11 HSI Ratings for AR-07

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.25	0.75	1	1
Substrate size	ND	ND	ND	ND
Depth range	0.5	0.75	1	0.5
Instream cover	-	0.25	0.75	1
Gradient	-	0.75	-	-
Water velocity (m/s)	1	0.75	0.75	-
Stream morphology	0.75	0.75	0.75	0.25
HSI Ranking	0.63 (average)	0.67 (average)	0.85 (above average)	0.69 (average)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.11 Between Reach AR-07 and PP-01

The 80m section between reaches AR-07 and PP-01 is a large pool with depths over 2 m. Overwintering habitat is very good with boulders providing good cover in the area. The bottom of the pool is mostly sand substrate with some cobble, large gravel, and boulders. There are no barriers to fish passage. There are no potential spawning areas in this area.

3.2.12 Reach PP-01

Channel width varied from 35.0 m, at 25 m downstream of the upper start of the reach to 52.0 m at the downstream end of the reach. Wetted width varied from 34.0 m to 50.0 m. Maximum depth ranged from 0.74 m to 1.78 m. Stream gradient was 3% at the upper end of the reach with the gradient being 1% for the remainder of the reach. Riffles is the dominant habitat type at the upstream end of the reach with the dominant habitat type being pool habitat from 25 m downstream and continuing throughout the rest of the reach. Substrate varied considerably from the upstream end of the reach to the downstream end with substrate at the upper end of the reach dominated by boulders (80%). At 25 m downstream large gravel was the dominant substrate type at 60% with a mixture of organics, small gravel, and boulders. At 50 m downstream substrate consisted mainly of cobble and boulders at 40% each, followed by sand and large gravel. At 75 m and 100 m downstream sand becomes the dominant substrate followed by large gravel, cobble and boulders. Stream banks throughout the reach were stable. Instream cover is provided primarily by depth of water and boulders where present. Riparian vegetation consisted of grasses and provided no overhead cover.

Fish habitat for spawning was rated as poor but good for overwintering, rearing and fish passage.

Habitat ratings using the HSI from Section 3.1 is presented in Table 3.12.

Table 3.12 HSI Ratings for PP-01

Physical Habitat Parameter	Spawning/Egg Incubation	Juvenile Rearing	Adult Foraging	Overwintering
Dominant substrate	0.5	0.25	1	1
Substrate size	ND	ND	ND	ND
Depth range	0	0	0.5	0.5
Instream cover	-	0.25	1	1
Gradient	-	0.75	-	-
Water velocity (m/s)	ND	ND	ND	-
Stream morphology	0.5	0.5	1	0.75
HSI Ranking	0.33 (below average)	0.35 (below average)	0.88 (above average)	0.81 (above average)

Notes:
ND = No field data for Apex River
= Not used in HSI calculation

3.2.13 Between Reach PP-01 and US-04

The habitat between reaches PP-01 and US-04 is composed mostly of a riffle with boulder substrate. There are some small glide sections with large and small gravels that provide spawning potential. There are no barriers to fish passage and no deeper pools to provide overwintering habitat.

3.2.14 Reach US-04

Channel width and wetted width varied from 10 m to 25.8 m with the narrowest section of the reach at the downstream end of the reach and the widest section 25 m downstream of the beginning of the reach. Maximum depth ranged from 0.44 m to 0.73 m. Stream gradient ranged from 1% to 2%. Habitat type was predominantly riffle with an area of flat water 25m downstream of the beginning of the reach. Cobble was the dominant substrate throughout the reach with varying amounts of sand large gravel and boulders. Stream banks were stable throughout the reach. Instream cover was limited and mainly provided by boulders and water depth. Riparian vegetation consisted of grasses and there was no overhead cover,

Fish habitat was rated as poor for spawning and overwintering, poor to moderate for rearing and good for fish passage.

3.2.15 Between Reach US-04 and US-03

Between reaches US-04 and US-03 there are several cascades and falls creating potential multiple barriers to fish passage. At the bottom of some of these sections there are deeper pools that provide potential overwintering habitat if fish can access them. No areas with potential spawning gravels were identified.

3.2.16 Reach US-03

Channel width and wetted width varied from 58.0 m at the start of the reach to 7.6 m at the end of the reach. Maximum depth varied from 1.3 m at the beginning of the reach and quicky becoming shallower with the minimum of depth 0.08 m 25 m downstream from the beginning of the reach and then gradually increasing in depth to 0.29 m at the end of the reach. Stream gradient was 1% on the upper sections of the reach and increases to 4% at the end of the reach. A pool was present at the beginning of the reach becoming glide habitat followed by riffles for the remainder of the reach. Boulders followed by sand was the dominant habitat at the beginning of the reach while cobble was dominant or co-dominant throughout the remainder of the reach. Smaller amounts of sand, large gravel and boulders were present throughout the reach. Stream banks were stable throughout the reach. Instream cover was provided by depth at the pool location and boulders throughout the reach. Riparian vegetation consisted of grasses and there was no overhead cover.

Fish habitat was rated as poor to moderate for spawning, overwintering, and rearing and good for fish passage.

3.2.17 Between Reach US-03 and US-02

Habitat immediately upstream of US-03 is a large pool with depths greater than 2m providing good overwintering habitat. Upstream of those pools the stream becomes a very braided section of riffles with cobble and boulder substrate. Upstream of the riffles is a series of cascades and waterfalls that are likely barriers to fish passage. Just downstream of US-02 is a large pool with depths over 1m which may provide overwintering habitat. The pool tail out has some sections of large and small gravels suitable for spawning.

3.2.18 Reach US-02

Channel width and wetted width varied from 9.10 m to 18.2 m with the narrowest sections of the reach being at the end and beginning of the reach and the widest section at the center of the reach. Maximum depth ranged from 0.30 m to 0.75 m with the deepest depth at the beginning of the reach and shallowest depth at 75 m downstream of the beginning of the reach. Stream gradient was 3% for most of the reach except at the end of the reach where is was 5%. The dominant habitat was riffles with varying sections of run, glide and pool habitat. Cobble was the dominant substrate throughout most of the reach except at 25 m downstream of the beginning of the reach where the dominant substrate was sand likely due to a pool at this location. The remaining substrate was a mixture of large gravel and boulders. Stream banks were stable throughout the reach. Instream cover was limited and provided by boulders in this reach. Riparian vegetation consisted of grasses and there was no overhead cover.

Fish habitat for spawning, rearing, and overwintering was rated as poor while fish passage was rated as good.

3.2.19 Between Reach US-02 and US-01

Between reaches US-02 and US-01 there are multiple pools with depths over 2m providing good overwintering habitat. On the pool edges and tail outs there are some gravel patches providing potential spawning areas. There are a series of cascades with step pools that are likely not tall enough to be a barrier to fish passage. Although at the top of this series of cascades and pools is a bedrock chute with water velocities up to 1.9 m/s which may act as a velocity barrier.

3.2.20 Reach US-01

Channel width was the narrowest at the upstream start of the reach and increased a maximum of 32.5 m at the downstream end of the reach. Wetted width varied similarly ranging from 5.8 m to 23.6 m. Maximum depth ranged from 0.96 m at the upstream start of the reach to 0.26 m at the downstream end of the reach. Stream gradient ranged from 3% to 5% with the dominant habitat throughout the reach being riffles. Boulders was the dominant substrate throughout the reach ranging from 60% to 80% of the substrate. Cobble was the next dominant substrate type ranging from 15% to 20% throughout the reach. Large gravel and sand were also present within the reach. The stream banks were stable throughout the reach. Instream cover was provided through the boulder substrate. Riparian vegetation was grass. There was minimal overhead cover (approximately 5%) provided by some undercut banks.

Fish habitat for spawning was rated as poor. Overwintering and rearing habitat were both rated as poor to moderate while fish passage was rated as good.

3.2.21 Comparison of HSI Ratings and Field Ratings by Biologist

A comparison of HSI ratings and field ratings by a qualified aquatic biologist is presented in Table 3.13 for the temporary pumping location (PP-01) and downstream reaches only as these reaches may be used for future monitoring purposes during periods of water diversion. Care must be used in interpreting results from the HSI model as it relies heavily on habitat features of Dolly Varden char and bull trout with only limited information for Arctic char. The model also may also not reflect preferred habitat features of smaller resident Arctic char as compared to larger anadromous Arctic char and Dolly Varden char or the larger bull trout. Much of the reported data used in the model also was for rivers in more southerly locations and may not be fully applicable to rivers in an Arctic tundra environment like the Apex River. Examples of these differences include the reference of root wads and woody debris in the rating criteria for instream cover in the HSI model while there are no root wads or woody debris in the Apex River due to the absence of trees and shrubs along the length of the river. Also, water depths used in the HSI model were lower (< 1.0m) to achieve a higher rating for overwintering than what was used in the field assessed ratings (> 1.0 m). In addition, there are gaps in the HSI model where data is not available thus making it difficult to determine the appropriate rating for those habitat features.

Differences in habitat ratings between the HSI model and field assessed ratings by the aquatic biologist mainly occur for the life history parameters of spawning and egg incubation, and overwintering although these differences were not large. Ratings of both approaches for rearing mainly similar for all reaches.

Table 3.13 Comparison of HSI Ratings and Field Ratings by a Qualified Aquatic Biologist

Reach	Spawning and Egg Incubation		Rearing		Adult Foraging		Fish Passage		Overwintering	
	HSI	Field	HSI	Field	HSI	Field	HSI	Field	HSI	Field
AR-02	Below Average to average	Poor	Average	Moderate	Above Average	NR	NR	Good	Excellent	Good
AR-03	Below average	Poor-moderate	Average	Moderate	Above average	NR	NR	Good	average	Poor
A-02	Below Average	Poor	Average	Moderate - good	Above average	NR	NR	Moderate-good	average	Poor
A-01	Average	Poor	Average	Moderate-good	Excellent	NR	NR	Good	Excellent	Moderate
AR-07	Below average	None	Average	Moderate	Above average	NR	NR	Moderate	Above average	None
PP-01	Average	Poor	Average	Good	Above average	NR	NR	Good	Average	Good

Note:
NR = Not rated

3.3 eDNA

Two of the five samples collected at US-01 detected eDNA from Arctic char which was 100% identical to the global reference database. No other species were detected. Metabarcoding was not successful for the remaining three eDNA samples. No eDNA was detected in the negative control filter. The detection of Arctic char DNA upstream of the pumping location indicated that Arctic char are present upstream of this location at the time of the assessment.

4 Summary

The Apex River is approximately eight km in length beginning at an unnamed lake to the north of the City of Iqaluit and flowing into Koojesse Inlet (Figure 1.1). The Apex River has a resident population of Arctic char based on a previous study (Nunami Stantec 2017). No other fish species are known to occur in the river. A waterfall at the mouth of the Apex River prevents fish from moving into the river from Koojesse Inlet.

A fish habitat assessment study was conducted in support of a monitoring program if supplementary water withdrawal for the Lake Geraldine Reservoir exceeds the allowable 10% instantaneous flow. A field survey was conducted between August 16 to August 20, 2022. Ten 100 m reaches were assessed four upstream of the temporary pumping location (PP-01), and five downstream of the temporary pumping location.

A HSI model was developed for Arctic char adapted from a HSI model for Dolly Varden char, developed by AMEX (2012). The HSI model for Arctic char relies heavily on data preferences for Dolly Varden char and bull trout due to the limited detailed habitat preferences of Arctic char available in the literature. There are limitations to the validity of the model as it is not specific to the Apex River, utilizes other species habitat preferences and the use of information from other geographic regions. Although there was a general agreement on rankings HSI model rankings were compared with field assessment rankings by an aquatic biologist, there were also some larger discrepancies especially in the ratings of overwintering habitat where the HSI model used lower favourable water depth for overwintering of fish based on requirements in more southerly geographic locations, which do not necessarily reflect requirements at the Apex River.

Water samples were collected at one site upstream of the temporary pumping location for the collection of eDNA to determine the potential for Arctic char upstream of the temporary pumping location. Analysis of the water samples indicated the potential presence of Arctic char at or above the sampling site. No other fish species were identified through the eDNA analysis.

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Appendix A NatureMetrics Report

FISH METABARCODING **RESULTS**

Order number:	NA-SO00135
Report number:	NM-YRX780
Company:	Stantec Consulting Ltd
Contact:	Doug Chiperzak
Project:	I144903261/502.100-CAO2-FishBsIn Study
Sample type:	Smith-Root filter
Date of report:	22-Nov-2022
Number of samples:	6

Thank you for sending your samples for analysis by NatureMetrics. Your samples have been metabarcoded following our eDNA survey - Fish pipeline. **A taxon-by-sample table of your samples is attached to this report (NM-YRX780.NA-SO00135.Fish.xlsx)**. Each row in the table represents one taxon (OTU), shown with the lowest possible taxonomic assignment based on currently available reference data. Each column represents a sample, showing the proportion of sequence reads per detected OTU. Care should be taken in interpreting the numbers in terms of relative species abundance, but a high sequence proportion can be interpreted as lending greater confidence to a detection. This report contains biodiversity information that may be sensitive, particularly with respect to endangered or protected species. It is the responsibility of the client to ensure that due consideration is given to the data and that the information is shared in a responsible way.

Here we present an overview of the key results, followed by a more detailed report that starts with the taxonomic composition of the samples followed by a more detailed look at the steps taken to extract, amplify, sequence, and analyse your DNA. A glossary for terms in bold is provided at the end of the report to define key terms used within the report.

OVERVIEW OF YOUR RESULTS

- A total of 1 taxon was detected.
- Most abundant sequences: Arctic char (*Salvelinus alpinus*).
- Fish sequence data were obtained from 2 of 6 eDNA samples.

FULL REPORT

Sample composition

A total of 1 taxon was detected (**Table 1**). The taxon was 100% identical to a species in the global reference databases, and a species name is suggested.

The relative proportion of the sequences found in each of the samples is shown in **Figure 1** and **Table 1** and the diversity is summarised in **Table 2** and **Table 3**.

Arctic char (*Salvelinus alpinus*), which accounted for 100% of the total sequence reads, was the most abundant in terms of sequences.

High-quality vertebrate sequence data were obtained for 2 of the 6 eDNA samples. eDNA metabarcoding of fish was not successful for the remaining 4 samples, which failed to amplify despite troubleshooting. All negative controls behaved as expected.

Table 1 (attached separately). Taxon-by-sample table.

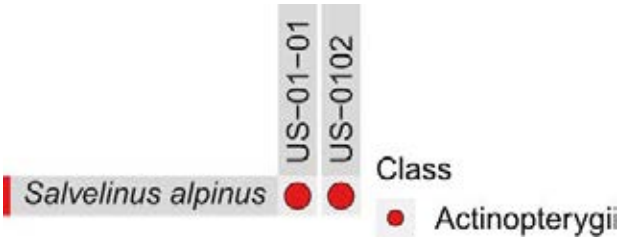


Figure 1. The proportion of the sequencing output allocated to the different species (rows) within each sample (columns). Each bubble per sample represents the proportion of DNA for each species for that sample. The size of the bubble is relative to the number of sequences from all species detected in that sample.

Table 2. Taxon richness among the samples.

Sample ID	Class	Order	Family	Genus	Taxa (Species)
US-01-01	1	1	1	1	1 (1)
US-0102	1	1	1	1	1 (1)

Table 3. The frequency of occurrence of all detected families. Numbers correspond to the number of taxa belonging to those families in those samples.

Class	Order	Family	US-01-01	US-0102	# samples
Actinopterygii	Salmoniformes	Salmonidae	1	1	2

METHODS

DNA from each filter was extracted using a commercial DNA extraction kit with a protocol modified to increase DNA yields. An extraction blank was also processed for the extraction batch. DNA was purified to remove PCR inhibitors using a commercial purification kit.

Comment: DNA yields were as expected.

Purified DNAs were amplified with PCR for a hypervariable region of the 12S rRNA gene to target fish as part of the eDNA survey - Fish pipeline. Our standard analysis includes 12 replicate PCRs per sample.

All PCRs were performed in the presence of both a negative control sample. Amplification success was determined by gel electrophoresis.

Comment: PCR reactions were successful for 2 of 6 samples. Electrophoresis bands were strong and of the expected size. Samples 'NC-01', 'US-01-03', 'US-01-04' and 'US-01-05' failed to amplify despite troubleshooting steps. Overall, 4-8 successful PCRs replicates were obtained for each of the 2 samples submitted for sequencing. No bands were observed on electrophoresis gels for the extraction blank or negative controls.

PCR replicates were pooled and purified, and sequencing adapters were added. Success was determined by gel electrophoresis.

Comment: All samples were successfully indexed, electrophoresis bands were strong and of the expected size. No repeat reactions were necessary.

Amplicons were purified and checked by gel electrophoresis, these were then quantified using a Qubit high sensitivity kit according to the manufacturer's protocol.

Comment: All amplicons were successfully purified.

All purified index PCRs were pooled into a final library with equal concentrations. The final library was sequenced using an Illumina MiSeq V3 kit at 10.5 pM with a 20% PhiX spike in.

Sequence data were processed using a custom bioinformatics pipeline for quality filtering, OTU clustering, and taxonomic assignment.

Comment: Negative controls were as expected. Very few sequences were discarded prior to dereplication, which is indicative of high-quality data with minimal PCR and sequencing errors. A total of 130,422 high-quality sequences, including 130,422 target sequences, were included in the final dataset.

Consensus taxonomic assignments were made for each OTU using sequence similarity searches against the NCBI nt (GenBank) reference database. Assignments were made to the lowest possible taxonomic level where there was consistency in the matches. Conflicts were flagged and resolved manually. Minimum similarity thresholds of 99%, 97%, and 95% were used for species-, genus- and higher-level assignments respectively. In cases where there were equally good matches to multiple species, public records from GBIF were used to assess which were most likely to be present in Canada.

Higher-level taxonomic identifications or multiple potential identifications were reported in cases that could not be resolved in this way.

The OTU table was then filtered to remove low abundance OTUs from each sample (<0.03% or <10 reads, whichever is the greater threshold for the sample). Unidentified, non-target, and common contaminant sequences were then removed.

Note that unidentified or misidentified taxa can result from incomplete or incorrect reference databases, and taxa may be missed due to low quality DNA, environmental contaminants, or the dominance of other species in the sample.

Please note that the abundance of taxa cannot be directly inferred from the proportion of total sequence reads. While the proportion of sequence reads is a consequence of abundance, it is also impacted by biomass, activity, surface area, condition, distance from the physical sample, primer bias, and species-specific variation in the genome.

Table 4. Sample information table.

Kit ID	Sample ID	Volume filtered	Date received
NAS-01-04248	NC-01	2000ml	20-Oct-22
NAS-01-04243	US-01-01	2000ml	20-Oct-22
NAS-01-04245	US-01-03	2000ml	20-Oct-22
NAS-01-04246	US-01-04	2000ml	20-Oct-22
NAS-01-04247	US-01-05	2000ml	20-Oct-22
NAS-01-04244	US-0102	2000ml	20-Oct-22

END OF REPORT

Report issued by: Thomas Shannon

Contact: team@naturemetrics.co.uk

GLOSSARY

adapter	short, artificially synthesised nucleotide sequence which attaches to the ends of the target DNA or RNA sequences prior to sequencing. They are typically used to aid in attachment of the target sequence to other functional molecules/sequences.
amplicon	A DNA sequence which is the product of PCR amplification.
bioinformatics	An interface between genetics, computational biology, statistics, and programming in which DNA or other biological data is processed, analysed and integrated into research or communications.
bioinformatics pipeline	Refers to a data processing pipeline that takes the raw sequence data from high-throughput sequencing (often 20 million sequences or more) and transforms it into usable ecological data. Key steps for metabarcoding pipelines include quality filtering, trimming, merging paired ends, removal of sequencing errors such as chimeras, clustering of similar sequences into molecular Operational Taxonomic Units, and matching one sequence from each cluster against a reference database. The output is a OTU-by-sample table showing how many sequences from each sample were assigned to each OTU.
BMWP	Short for biological monitoring working party, an index that can be used to measure water quality by scoring the presence of aquatic invertebrate indicator taxa. The index is reliant on taxa that are less tolerant of polluted water bodies (e.g. Ephemeroptera, Plecoptera, Trichoptera).
BOLD	Barcode Of Life Database; a specialised database of eukaryote COI reference sequences.
contaminant sequences	The sensitivity of high-throughput sequencing of eDNA means that contamination is always a concern that needs to be minimised. The sources of contamination are threefold: Natural - Examples of natural contaminants include: frequent visitors to site, faecal discharge from predators, livestock, wastewater, and fishing bait. This type of contamination is typically unavoidable and very difficult to quantify. Sequences of this type are typically flagged and conservatively removed from the sequencing output. Typical contaminant species include cow, pig, dog, cat, sheep, etc. Sampling - Human contamination of sampling equipment can reduce the efficiency of the sequencing. This type of

	contamination can be minimised by stringent contamination protocols, such as PPE. Laboratory - Residual DNA can contaminate other samples processed at the same time in other labs. At NatureMetrics this is mitigated by a designated eDNA laboratory, strict decontamination procedures, negative controls, and good laboratory practices.
dereplication	The identification of unique sequences so that only one copy of each sequence is reported.
eBioAtlas	A global partnership between IUCN and NatureMetrics to map the world's biodiversity using DNA from water samples as a foundation for the Global Biodiversity Framework and to enable IUCN Red List Assessments.
eDNA	Short for 'environmental DNA'. Refers to DNA deposited in the environment through excretion, shedding, mucous secretions, saliva etc. This can be collected in environmental samples (e.g. water, sediment) and used to identify the organisms that it originated from. eDNA in water is broken down by environmental processes over a period of days to weeks. It can travel some distance from the point at which it was released from the organism, particularly in running water. eDNA is sampled in low concentrations and can be degraded (i.e. broken into short fragments), which limits the analysis options.
extraction blank	A DNA extraction with no sample added to assess potential contamination during the DNA extraction process.
gel electrophoresis	The process in which DNA is separated according to size and electrical charge via an electric current, while in a gel. The process is used to confirm the successful amplification of a specifically sized fragment of DNA.
high-throughput sequencing	Technology developed in the 2000s that produces millions of sequences in parallel. Enables thousands of different organisms from a mixture of species to be sequenced at once, so community DNA can be sequenced. Various different technologies exist to do this, but the most commonly used platform is Illumina's MiSeq. Also known as Next-Generation Sequencing (NGS) or parallel sequencing.
inhibitors/inhibition	Naturally-occurring chemicals/compounds that cause DNA amplification to fail, potentially resulting in false negative results. Common inhibitors include tannins, humic acids and other organic compounds. Inhibitors can be overcome by either diluting the DNA (and the inhibitors) or by additional cleaning of the DNA, but

dilution carries the risk of reducing the DNA concentration below the limits of detection. At NatureMetrics, inhibition is removed using a commercial purification kit.

invasive

Invasive species are defined using GRIIS (Global Register of Introduced and Invasive Species) which is a checklist of Introduced and Invasive species for each country. The IUCN describes an Introduced species as a species outside of its natural range and dispersal potential, and an Invasive species as an introduced species which becomes established in a habitat, is an agent of change or threatens native biological diversity.

IUCN Red List

The IUCN (International Union for the Conservation of Nature) is a global union of government and civil organisations that disseminates information to assist conservation. The IUCN Red List of Threatened Species is an inventory of the conservation status of over 100,000 species worldwide. The Red List evaluates data such as population trends, geographic range and the number of mature individuals in order to categorise species based on their extinction risk:

Extinct (EX) - No individual of this species remains alive.

Extinct in the Wild (EW) - Surviving individuals are only found in captivity.

Critically Endangered (CE) - species faces an extremely high risk of extinction in the wild. e.g. Population size estimated at fewer than 50 mature individuals.

Endangered (EN) - species faces a very high risk of extinction in the wild. e.g. Population size estimated at fewer than 250 mature individuals.

Vulnerable (VU) - species faces a high risk of extinction in the wild. e.g. Population size estimated at fewer than 10,000 mature individuals and declining.

Near Threatened (NT) - species is below the threshold for any of the threatened categories (CE, E, V) but is close to this threshold or is expected to pass it in the near future.

Least Concern (LC) - species is not currently close to qualifying for any of the other categories. This includes widespread and abundant species.

Data Deficient (DD) - There is currently insufficient data available to make an assessment of extinction risk. This is not a threat category - when more data becomes available the species may be recategorised as threatened.

Jaccard similarity index

This index is a calculation that compares two samples to see which taxa are shared and which are distinct. The higher the percentage,

	the more similar two samples are in their community composition.
metabarcoding	Refers to identification of species assemblages from community DNA using barcode genes. PCR is carried out with non-specific primers, followed by high-throughput sequencing and bioinformatics processing. Can identify hundreds of species in each sample, and 100+ different samples can be processed in parallel to reduce sequencing cost.
NCBI nt	National Centre for Biotechnology Information nucleotide database; a general reference database.
negative control	Used to determine whether PCR reactions are contaminated.
NMDS	Non-metric multidimensional scaling (NMDS) is a method that allows visualisation of the similarity of each sample to one another. The dissimilarity between each sample is calculated, taking into account shared taxa (Jaccard similarity index), and then configured into a 2D ordinal space that allows the similarity-based relationship between each sample to be plotted. Samples which are closer together are more similar to one another in terms of community composition, while samples which are further apart are less similar. This type of clustering analysis allows you to see if certain types of samples, for example, those from a particular habitat type, are more clustered together and therefore more similar to one another compared to other groups.
nucleotide	An individual unit of genetic material which, when strung together constitutes a DNA (or RNA) strand/sequence.
OTU	Operational Taxonomic Unit; similar sequences are clustered into OTUs at a defined similarity threshold. OTUs are approximately equivalent to species and are treated as such in our analyses. Species-level taxonomic assignments may or may not be possible, depending on the availability of reference sequences and the similarity between closely related species in the amplified marker. It may be possible to refine the taxonomic assignment for an OTU later as more sequences are added to reference databases.
PCR	Polymerase Chain Reaction; a process by which millions of copies of a particular DNA segment are produced through a series of heating and cooling steps. Known as an 'amplification' process. One of the most common processes in molecular biology and a precursor to most sequencing-based analyses.

positive control	Used to determine whether the PCR is working correctly.
primers	Short sections of synthesised DNA that bind to either end of the DNA segment to be amplified by PCR. Can be designed to be totally specific to a particular species (so that only that species' DNA will be amplified from a community DNA sample), or to be very general so that a wide range of species' DNA will be amplified. Good design of primers is one of the critical factors in DNA-based monitoring.
rarefaction curve	A plot showing the number of taxa as a function of the sequencing depth (number of reads). Rarefaction curves grow rapidly at first as common species are found then reach a plateau as only the rarest species remain to be detected. Rarefaction curves can provide an indication as to whether the species being studied have been comprehensively sampled.
rarefy	A normalisation technique which transforms the data to remove biases associated with uneven sampling depth (number of reads) across samples. The sampling depth of each sample is standardised to a specified number of reads (usually that of the sample with the lowest depth) by random resampling.
reference databases	Over time, the DNA sequences of many species have been compiled into publicly accessible databases by scientists from around the world. These databases serve as a reference against which unknown sequences can be queried to obtain a species identification. The most commonly accessed database is NCBI, which is maintained by the US National Institute of Health. Anyone can search for DNA sequences at https://www.ncbi.nlm.nih.gov.
richness	The total number of taxa within a sample.
rRNA	Ribosomal RNA.
SAC species	Typically the presence of these species potentially elevates the conservation status of a site to a Special Area of Conservation (SAC). Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive.
sequence(s)	A DNA sequence is made up of four nucleotide bases represented by the letters A, T, C & G. The precise order of these letters is used to compare genetic similarity among individuals or species and to identify species using reference databases. In high-throughput sequencing analyses (e.g. metabarcoding), many identical copies of the same sequence are obtained for each species in the sample. The number of copies obtained per species is known as the number of sequence reads, and this is often -

	although not always - related to the relative abundance of the species.
SILVA	SILVA is a database of small (16S/18S, SSU) and large subunit (23S/28S, LSU) ribosomal RNA sequences for all three domains of life (Bacteria, Archaea and Eukarya).
taxon (s.) / taxa (pl.)	Strictly, a taxonomic group. Here we use the term to describe groups of DNA sequences (OTUs) that are equivalent to species. We do not use the term species because we are unable to assign complete identifications to all of the groups at this time due to gaps in the available reference databases.
taxonomy	The branch of science concerned with classification of organisms. species (s./pl.) - A group of genetically similar organisms that show a high degree of overall similarity in many independent characteristics. Related species are grouped together into progressively larger taxonomic units, from genus to kingdom. Homo sapiens (human) is an example of a species. genus (s.) / genera (pl.) - A group of closely related species. Each genus can include one or more species. Homo is an example of a genus. family (s.) / families (pl.) - A group of closely related genera. Homo sapiens is in the Family Hominidae (great apes). order (s.) / orders (pl.) - A group of closely related families. Homo sapiens is in the Order Primates. class (s.) / classes (pl.) - A group of closely related orders. Homo sapiens is in the Class Mammalia. phylum (s.) / phyla (pl.) - A group of closely related classes. Homo sapiens is in the Phylum Chordata.
UKBAP species	UK Biodiversity Action Plan species have been identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan.
UNITE	A ribosomal RNA database for identification of fungi.

Appendix B Site Summary Cards

Nunami Stantec Limited - Apex River Study 2022

Site AR-02: Apex River

UTM Location: 19V 526625 7068410 **Survey Date:** August 17, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

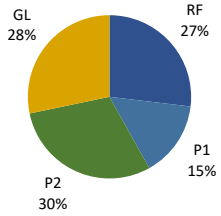
Transect # (Location)	0	25	50	75	100
Channel Width (m)	17.6	12.0	27	18.6	33.6
Wetted Width (m)	16.3	12.0	26.9	18.6	33.6
Depth at LDB + 25% (m)	0.24	0.05	2.10	0.49	0.55
Depth at LDB + 50% (m)	0.12	0.14	0.65	0.86	0.05
Depth at LDB + 75% (m)	0.07	0.15	0.35	0.53	0.15
Max. Depth (m)	0.49	0.87	2.5	1.14	1.08
Gradient (%)	2	4	1	1	1
Dominant Habitat Unit	GL	RF	GL	P1	P2
Stream Bed					
Substrate (% of Transect Area) – Organics	0	0	0	0	0
Sand	20	10	15	10	5
Small Gravel	0	0	0	0	0
Large Gravel	10	5	10	10	5
Cobble	60	80	65	40	20
Boulder	10	5	10	40	70
Bedrock	0	0	0	0	0
Embeddedness	L	L	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.23	0.25	0.37	0.20	0.19	0.43	0.28	0.25	0.53	0.25
Bank Slope (°)	80	80	70	80	60	70	80	80	80	80
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	O	O	O	O	O	O	O	O	BL
Dom. Riparian Veg.	G	G	G	G	N	G	G	G	G	G
Subdom. Riparian Veg.					G					N

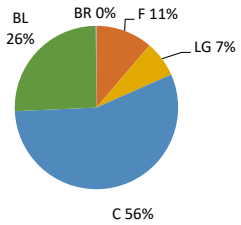
Habitat Inventory / Reach Data

Instream Cover (%):	6	Overhead Cover (%):	0
Dom. Instream Cover:	DC	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	BL	Subdom. Overhead Cover:	
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	07:26
Water Temperature (°C):	8.6
Dissolved Oxygen (mg/L):	10.38
Sp. Conductivity (µs/cm):	68.0
pH:	7.64
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	SI
Islands:	N
Bars:	SP
Coupling:	PC
Confinement:	FC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Good
Rearing:	None	None	Moderate
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site AR-03: Apex River

UTM Location: 19V 526559 7068632 **Survey Date:** August 17, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

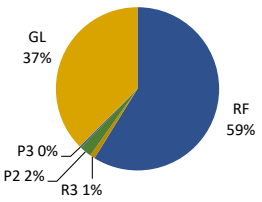
Transect # (Location)		0	25	50	75	100
Channel Width (m)		37.6	44.6	32	27.1	21.1
Wetted Width (m)		37.6	37.5	24.3	21.4	21.1
Depth at LDB + 25% (m)		0.21	0.10	0.37	0.30	0.27
Depth at LDB + 50% (m)		0.19	0.35	0.43	0.21	0.10
Depth at LDB + 75% (m)		0.16	0.08	0.38	0.16	0.11
Max. Depth (m)		0.37	0.63	0.63	0.58	0.75
Gradient (%)		1	2	2	3	5
Dominant Habitat Unit		RF	GL	GL	RF	RF
Stream Bed						
Substrate (% of Transect Area)	Organics	0	0	0	0	0
	Sand	10	20	5	5	5
	Small Gravel	0	10	0	0	0
	Large Gravel	10	60	5	5	10
	Cobble	60	10	75	45	65
	Boulder	20	0	15	45	20
	Bedrock	0	0	0	0	0
Embeddedness		L	L	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.16	0.16	0.28	0.10	0.20	0.19	0.37	0.37	0.21	0.48
Bank Slope (°)	80	70	80	30	90	90	70	90	80	90
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	BL	F	BD	F
Subdom. Bank Material	O	O	O	O	O	O	F	O	BL	O
Dom. Riparian Veg.	G	G	G	G	G	N	G	G	N	G
Subdom. Riparian Veg.							N	N	G	

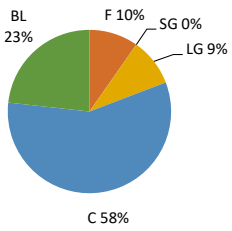
Habitat Inventory / Reach Data

Instream Cover (%):	11	Overhead Cover (%):	0
Dom. Instream Cover:	BL	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	-	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	12:07
Water Temperature (°C):	8.7
Dissolved Oxygen (mg/L):	10.46
Sp. Conductivity (µs/cm):	68.0
pH:	7.32
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	IR
Islands:	N
Bars:	SP
Coupling:	PC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor-moderate
Overwintering:	None	None	Poor
Rearing:	None	None	Moderate
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site A-02: Apex River

UTM Location: 19 V 526260 7069180 **Survey Date:** August 16, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

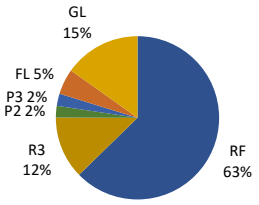
Transect # (Location)	0	25	50	75	100
Channel Width (m)	18.4	32.0	38	26.0	30.0
Wetted Width (m)	14.3	21.0	27.7	20.0	21.0
Depth at LDB + 25% (m)	0.24	0.36	0.79	0.31	0.33
Depth at LDB + 50% (m)	0.37	0.21	0.32	0.00	0.00
Depth at LDB + 75% (m)	0.40	0.18	0.11	0.19	0.37
Max. Depth (m)	0.71	0.38	1.1	0.69	0.77
Gradient (%)	4	3	3	3	3
Dominant Habitat Unit	RF	RF	GL	RF	RF
Stream Bed					
Substrate (% of Transect Area) – Organics	0	0	0	0	0
Sand	5	5	20	10	5
Small Gravel	0	0	0	0	0
Large Gravel	10	5	15	10	5
Cobble	60	40	30	60	40
Boulder	25	30	20	20	40
Bedrock	0	5	5	0	10
Embeddedness	L	L	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.31	0.10	0.32	0.30	0.34	0.17	0.38	0.30	0.40	0.35
Bank Slope (°)	70	30	80	70	90	60	90	70	45	30
Bank Stability	S	S	S	S	MS	S	US	S	US	US
Dom. Bank Material	F	BL	F	BL	F	F	F	F	F	F
Subdom. Bank Material	O	F	O	F	O	BD	O	BD	C	BD
Dom. Riparian Veg.	G	G	G	G	G	G	G	G	N	N
Subdom. Riparian Veg.	N	N	N	N	N	N	N	N	G	G

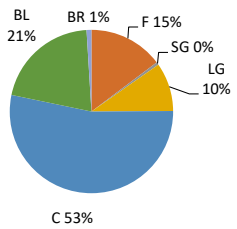
Habitat Inventory / Reach Data

Instream Cover (%):	2	Overhead Cover (%):	1
Dom. Instream Cover:	BL	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	-	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	08:03
Water Temperature (°C):	7.5
Dissolved Oxygen (mg/L):	10.66
Sp. Conductivity (µs/cm):	67.8
pH:	7.78
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	ST
Islands:	O
Bars:	SP
Coupling:	PC
Confinement:	FC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Poor
Rearing:	None	None	Moderate-Good
Passage:	None	None	Moderate-Good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site A-01: Apex River

UTM Location: 19V 526548 7069946 **Survey Date:** August 16, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

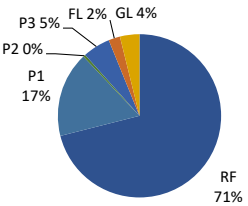
Transect # (Location)	0	25	50	75	100
Channel Width (m)	26.0	6.10	22	35.0	20.0
Wetted Width (m)	20.5	4.80	17.0	29.0	20.0
Depth at LDB + 25% (m)	0.60	0.42	0.60	0.14	0.48
Depth at LDB + 50% (m)	0.58	0.43	1.01	0.43	0.38
Depth at LDB + 75% (m)	0.32	0.25	1.46	0.37	0.43
Max. Depth (m)	0.98	1.15	1.6	0.66	4.00
Gradient (%)	2	5	3	3	4
Dominant Habitat Unit	P3	RF	P1	RF	RF
Stream Bed					
Substrate (% of Transect Area) Organics	0	0	0	0	0
Sand	30	0	30	20	10
Small Gravel	10	0	0	5	0
Large Gravel	10	5	0	30	5
Cobble	20	90	50	20	5
Boulder	30	5	20	25	80
Bedrock	0	0	0	0	0
Embeddedness	L	N	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.38	0.09	0.72	0.72	0.14	0.18	0.13	0.23	0.32	0.41
Bank Slope (°)	80	15	90	45	20	45	20	70	70	70
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	BL	C	C	F	F	F	F	F
Subdom. Bank Material	BL	BL	C	BL	F	O	SG	BL	BL	BL
Dom. Riparian Veg.	G	N	N	N	N	G	N	G	G	G
Subdom. Riparian Veg.		G			G		G			N

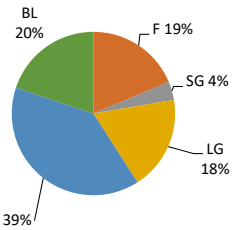
Habitat Inventory / Reach Data

Instream Cover (%):	17	Overhead Cover (%):	-
Dom. Instream Cover:	BL	Dom. Overhead Cover:	-
Subdom. Instream Cover:	DC	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	12:17
Water Temperature (°C):	9.6
Dissolved Oxygen (mg/L):	10.71
Sp. Conductivity (µs/cm):	66.6
pH:	7.79
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	IR
Islands:	I
Bars:	SP
Coupling:	DC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Moderate
Rearing:	None	None	Moderate-Good
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site AR-07: Apex River

UTM Location: 19V 525871 7070396 **Survey Date:** August 18, 2022

Legal Location: 00-00-000-00W4M **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

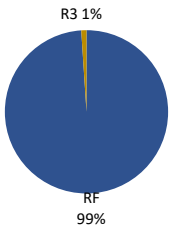
Transect # (Location)	0	25	50	75	100
Channel Width (m)	61.8	53.0	58	47.0	50.5
Wetted Width (m)	55.1	48.7	53.0	43.7	47.5
Depth at LDB + 25% (m)	0.34	0.25	0.16	0.36	0.21
Depth at LDB + 50% (m)	0.24	0.30	0.47	0.30	0.33
Depth at LDB + 75% (m)	0.27	0.52	0.30	0.27	0.22
Max. Depth (m)	0.62	0.79	0.74	0.61	0.72
Gradient (%)	1	3	4	4	4
Dominant Habitat Unit	RF	RF	RF	RF	RF
Stream Bed					
Substrate (% of Transect Area): Organics	0	0	0	0	0
Sand	0	0	0	0	0
Small Gravel	0	0	0	0	0
Large Gravel	0	0	5	0	0
Cobble	60	30	15	10	20
Boulder	40	70	80	90	80
Bedrock	0	0	0	0	0
Embeddedness	N	N	N	N	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.18	0.28	0.27	0.18	0.27	0.10	0.25	0.21	0.22	0.17
Bank Slope (°)	60	45	50	70	70	60	90	45	60	80
Bank Stability	S	S	S	S	S	S	S	S	MS	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	BL	O	BL	O	O	O	O	O	O
Dom. Riparian Veg.	G	G	G	G	G	G	G	G	G	G
Subdom. Riparian Veg.		N		N				N	N	

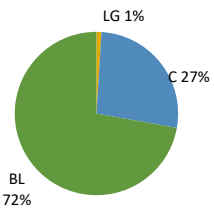
Habitat Inventory / Reach Data

Instream Cover (%):	6	Overhead Cover (%):	-
Dom. Instream Cover:	BL	Dom. Overhead Cover:	-
Subdom. Instream Cover:	-	Subdom. Overhead Cover:	-
Maximum Depth (m)		Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	07:19
Water Temperature (°C):	7.0
Dissolved Oxygen (mg/L):	10.61
Sp. Conductivity (µs/cm):	66.7
pH:	7.22
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	ST
Islands:	N
Bars:	SP
Coupling:	PC
Confinement:	FC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	None
Overwintering:	None	None	None
Rearing:	None	None	Moderate
Passage:	None	None	Moderate

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site PP-01: Apex River

UTM Location: 19V 525736 7070513 **Survey Date:** August 18, 2022

Legal Location: 00-00-000-00W4M **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

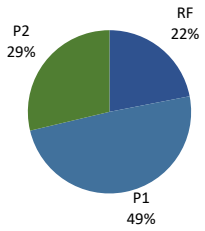
Transect # (Location)	0	25	50	75	100
Channel Width (m)	50.5	35.0	40	51.0	52.0
Wetted Width (m)	47.5	34.0	39.0	50.0	50.0
Depth at LDB + 25% (m)	0.43	0.43	0.78	1.00	1.20
Depth at LDB + 50% (m)	0.47	0.57	1.10	-	-
Depth at LDB + 75% (m)	0.39	0.70	1.33	1.55	1.17
Max. Depth (m)	1.43	0.74	1.6	1.78	1.38
Gradient (%)	3	1	1	1	1
Dominant Habitat Unit	RF	P2	P1	P1	P1
Stream Bed					
Substrate (% of Transect Area) – Organics	0	10	0	0	0
Sand	0	0	20	70	55
Small Gravel	0	10	0	0	0
Large Gravel	0	60	10	10	10
Cobble	20	20	40	10	20
Boulder	80	0	30	10	15
Bedrock	0	0	0	0	0
Embeddedness	N	L	L	M	M

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.22	0.96	0.14	0.17	0.18	0.25	0.23	0.2	0.18	0.14
Bank Slope (°)	45	60	30	45	70	-	45	45	45	45
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	BL	O	BL	BL	BL	BL	O	O	O
Dom. Riparian Veg.	G	G	G	G	G	G	G	G	G	G
Subdom. Riparian Veg.	N	N	N	N		N	N	N	N	N

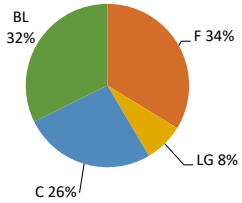
Habitat Inventory / Reach Data

Instream Cover (%):	61	Overhead Cover (%):	0
Dom. Instream Cover:	DC	Dom. Overhead Cover:	-
Subdom. Instream Cover:	BL	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	07:52
Water Temperature (°C):	7.0
Dissolved Oxygen (mg/L):	10.59
Sp. Conductivity (µs/cm):	67.3
pH:	7.12
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	SI
Islands:	N
Bars:	SP
Coupling:	DC
Confinement:	FC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	poor
Overwintering:	None	None	good
Rearing:	None	None	good
Passage:	None	None	good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site US-04: Apex River

UTM Location: 19V 525371 7070950 **Survey Date:** August 20, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

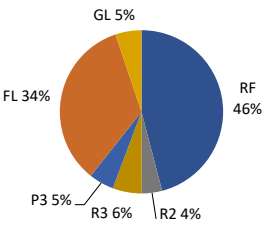
Transect # (Location)	0	25	50	75	100
Channel Width (m)	18.1	25.8	13	14.4	10.0
Wetted Width (m)	18.1	25.8	12.3	13.6	10.0
Depth at LDB + 25% (m)	0.55	0.10	0.27	0.12	0.32
Depth at LDB + 50% (m)	0.14	0.13	0.26	0.35	0.14
Depth at LDB + 75% (m)	0.15	0.25	0.17	0.10	0.20
Max. Depth (m)	0.71	0.53	0.44	0.73	0.71
Gradient (%)	2	1	2	2	2
Dominant Habitat Unit	RF	FL	RF	RF	RF
Stream Bed					
Substrate (% of Transect Area) Organics	0	0	0	0	0
Sand	20	20	10	10	10
Small Gravel	0	10	0	0	0
Large Gravel	10	25	10	10	10
Cobble	65	40	60	65	65
Boulder	5	5	20	15	15
Bedrock	0	0	0	0	0
Embeddedness	M	M	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.16	0.15	0.03	0.28	0.16	0.09	0.17	0.38	0.26	0.23
Bank Slope (°)	90	80	90	90	90	60	90	70	90	90
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	O	O	O	O	O	O	O	O	O
Dom. Riparian Veg.	G	G	G	G	G	G	G	G	G	G
Subdom. Riparian Veg.										

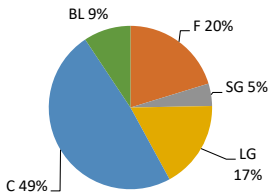
Habitat Inventory / Reach Data

Instream Cover (%):	2	Overhead Cover (%):	0
Dom. Instream Cover:	BL	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	DC	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	11:54
Water Temperature (°C):	9.4
Dissolved Oxygen (mg/L):	10.35
Sp. Conductivity (µs/cm):	65.7
pH:	7.16
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	IR
Islands:	O
Bars:	MD
Coupling:	DC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Poor
Rearing:	None	None	Poor-moderate
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site US-03: Apex River

UTM Location: 19V 525419 7071445 **Survey Date:** August 20, 2022

Legal Location: 00-00-000-00W4M **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

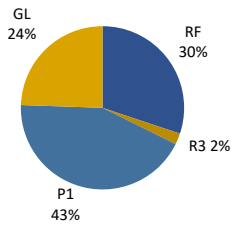
Transect # (Location)	0	25	50	75	100
Channel Width (m)	58.0	54.5	27	24.2	7.60
Wetted Width (m)	58.0	54.5	27.4	21.3	7.60
Depth at LDB + 25% (m)	1.3	0.08	0.17	0.16	0.29
Depth at LDB + 50% (m)	-	0.22	0.14	0.11	0.28
Depth at LDB + 75% (m)	1.1	0.27	0.13	0.20	0.30
Max. Depth (m)	1.59	0.58	0.34	0.43	0.92
Gradient (%)	1	1	2	2	4
Dominant Habitat Unit	P1	GL	RF	RF	RF
Stream Bed					
Substrate (% of Transect Area) – Organics	0	0	0	0	0
Sand	30	20	10	20	10
Small Gravel	0	0	0	0	0
Large Gravel	10	10	10	20	10
Cobble	10	40	40	40	40
Boulder	50	30	40	20	40
Bedrock	0	0	0	0	0
Embeddedness	M	L	L		L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.29	0.06	0.31	0.13	0.17	0.08	0.23	0.11	0.62	0.51
Bank Slope (°)	80	45	80	80	90	45	90	20	80	60
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	O	O	O	O	O	O	O	BL	BL
Dom. Riparian Veg.	G	G	G	G	G	N	G	G	G	G
Subdom. Riparian Veg.		N		N					N	N

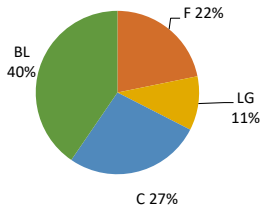
Habitat Inventory / Reach Data

Instream Cover (%):	42	Overhead Cover (%):	-
Dom. Instream Cover:	DC	Dom. Overhead Cover:	-
Subdom. Instream Cover:	BL	Subdom. Overhead Cover:	-
Maximum Depth (m)		Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	08:56
Water Temperature (°C):	8.5
Dissolved Oxygen (mg/L):	10.45
Sp. Conductivity (µs/cm):	66.1
pH:	7.11
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	IR
Islands:	N
Bars:	SD
Coupling:	DC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	poor-moderate
Overwintering:	None	None	Poor-Moderate
Rearing:	None	None	Poor-moderate
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited - Apex River Study 2022

Site US-02: Apex River

UTM Location: 19V 525666 7072105 **Survey Date:** August 19, 2022

Legal Location: 00-00-000-00W4M **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

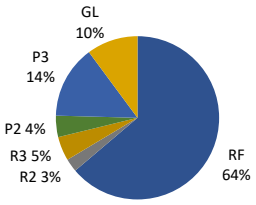
Transect # (Location)	0	25	50	75	100
Channel Width (m)	9.60	13.9	18	14.5	9.10
Wetted Width (m)	9.60	13.9	18.2	14.3	9.10
Depth at LDB + 25% (m)	0.40	0.39	0.13	0.16	0.14
Depth at LDB + 50% (m)	0.22	0.29	0.17	0.30	0.33
Depth at LDB + 75% (m)	0.16	0.35	0.36	0.25	0.11
Max. Depth (m)	0.75	0.52	0.50	0.30	0.56
Gradient (%)	3	3	3	3	5
Dominant Habitat Unit	R3	P3	GL	RF	RF
Stream Bed					
Substrate (% of Transect Area) Organics	0	0	0	0	0
Sand	10	40	20	10	20
Small Gravel	0	0	0	0	0
Large Gravel	20	20	10	20	10
Cobble	65	30	65	60	75
Boulder	5	10	5	10	5
Bedrock	0	0	0	0	0
Embeddedness	L	M	L	L	L

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.35	0.14	0.13	0.10	0.14	0.10	0.14	0.09	0.23	0.22
Bank Slope (°)	90	80	90	90	90	30	90	60	90	90
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	O	O	O	O	O	O	O	O	O
Dom. Riparian Veg.	G	N	G	G	G	N	G	G	G	G
Subdom. Riparian Veg.										

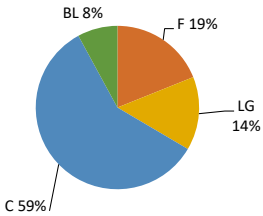
Habitat Inventory / Reach Data

Instream Cover (%):	1	Overhead Cover (%):	0
Dom. Instream Cover:	BL	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	-	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	12:56
Water Temperature (°C):	10.9
Dissolved Oxygen (mg/L):	10.25
Sp. Conductivity (µs/cm):	62.4
pH:	7.62
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	ST
Islands:	N
Bars:	SP
Coupling:	DC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Poor
Rearing:	None	None	Poor
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

General Comments

Prepared by: CB Reviewed by: LA

Nunami Stantec Limited -Apex River Study 2022

Site US-01: Apex River

UTM Location: 19V 525685 7072648 **Survey Date:** August 19, 2022

Legal Location: **Watercourse Class:**

Crew Initials: AB, CM **Restricted Activity Period:**

Physical Channel Transect Data

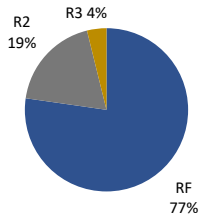
Transect # (Location)	0	25	50	75	100
Channel Width (m)	5.80	10.9	6.9	16.0	32.5
Wetted Width (m)	5.80	10.9	6.80	16.0	23.6
Depth at LDB + 25% (m)	0.42	0.32	0.54	0.34	0.26
Depth at LDB + 50% (m)	0.60	0.25	0.44	0.54	0.25
Depth at LDB + 75% (m)	0.38	0.38	0.37	0.26	0.19
Max. Depth (m)	0.96	0.69	0.87	0.91	0.26
Gradient (%)	3	5	4	2	3
Dominant Habitat Unit	RF	RF	R2	R2	RF
Stream Bed					
Substrate (% of Transect Area) Organics	0	0	0	0	0
Sand	10	10	10	10	0
Small Gravel	0	0	0	0	0
Large Gravel	0	10	5	0	0
Cobble	15	20	15	20	20
Boulder	75	60	70	70	80
Bedrock	0	0	0	0	0
Embeddedness	L	L	L	L	N

Bank Measurements	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Bank Height (m)	0.30	0.36	0.31	0.18	0.20	0.33	0.38	0.31	0.41	0.20
Bank Slope (°)	90	90	80	90	90	80	80	80	90	45
Bank Stability	S	S	S	S	S	S	S	S	S	S
Dom. Bank Material	F	F	F	F	F	F	F	F	F	F
Subdom. Bank Material	O	O	O	O	O	O	O	O	O	O
Dom. Riparian Veg.	G	G	G	G	G	G	G	G	G	G
Subdom. Riparian Veg.									N	N

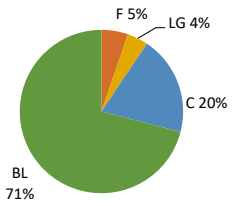
Habitat Inventory / Reach Data

Instream Cover (%):	21	Overhead Cover (%):	5
Dom. Instream Cover:	BL	Dom. Overhead Cover:	UC
Subdom. Instream Cover:	-	Subdom. Overhead Cover:	-
Maximum Depth (m)	-	Dom. Aquatic Veg. Type:	-

Habitat Distribution



Substrate Composition



Water Quality Data

Time of Day (HH:MM):	08:40
Water Temperature (°C):	7.8
Dissolved Oxygen (mg/L):	10.65
Sp. Conductivity (µs/cm):	63.1
pH:	7.07
Turbidity (NTU):	0.00

Channel Characteristics

Pattern:	SI
Islands:	I
Bars:	SP
Coupling:	DC
Confinement:	OC
Flow Stage:	Moderate

Fish Habitat Assessment Ratings

	Forage Fish	Coarse Fish	Sport Fish
Spawning:	None	None	Poor
Overwintering:	None	None	Poor-moderate
Rearing:	None	None	Poor-moderate
Passage:	None	None	Good

P

Fish Sampling Data

Method	Effort

Electrofisher Settings

Volts	Freq. (Hz)	Duty Cycle (%)	Dist. (m)

Species	Efish Catch (n)	Trap Catch (n)	Efish CPUE (#fish/100s)	Trap CPUE (#fish/hr)	Rel. Abundance (% of total)

General Comments

Prepared by: CB Reviewed by: LA

APPENDIX E

Lake Geraldine Resupply 2022 Final Site Review November 3, 2022

NUNAMI

Equipment Manifest (Pre-Mobilization)

To:	Shane Turner Superintendent of Public Works/Water Works City of Iqaluit	From:	Matt Follett, M.A.Sc., P.Eng. Associate Civil Engineer Nunami Stantec Ltd.
	Eric Jacobsen President Tower Arctic Ltd.		
File:	Lake Geraldine Emergency Resupply 2022	Date:	October 19, 2022

Reference: Lake Geraldine Emergency Resupply 2022 _ Equipment Manifest & Project Closeout

The following list summarizes the equipment returned following the project demobilization. If any items have been missed from this list, please make note of them in the rows provided at the end of the table and have all parties sign.

Item	Notes	Signoff (Initials)		
		City of Iqaluit	Nunami Stantec	TAL
Floating Pump Docks	These were used for the UNL pumping system and were purchased by the city. It is understood that these are located at the back of the Coke Plant.			
Operator Shack & Pump Control Room	UNL Shack & secondary building for pump controls. Controls, transformer, electrical components returned. Please confirm these have been placed outside the Coke Plant.		Isaac Freda	
3 Apex pumps & associated fish screens	It is understood that these are at the Coke Plant		Isaac Freda	
Manifolds	Apex river manifold. Outside of Coke Plant		Isaac Freda	
Flow Meters	3 x Apex are still attached to the Apex manifold outside of the Coke Plant.		Isaac Freda	
Hoses	The city owns 2 km of 4" flexible hose. It is understood that all hoses are in the green seacan outside of the Coke Plant.		Isaac Freda	
Apex Generator	The city-owned generator and associated seacan containment has been returned to outside of the Coke Plant.		Isaac Freda	

Reference: **Lake Geraldine Emergency Resupply 2022 _ Equipment Manifest & Project Closeout**

400mm HDPE	The uninsulated 400 mm HDPE used for the UNL portion of the project has been left on site near UNL.		Isaac Freda	
4" Flexible Hoses (GN-Owned)	TAL to pickup, layout, re-coil, and return flexible hoses from the GN to outside of the Apex warehouse. Hoses to be returned in good condition.		Isaac Freda	
Fuel Tanks	Apex Generator Fuel tanks (2) have been returned to outside of the Coke Plant.		Isaac Freda	
Add any additional equipment below				

This is a working document with expected updates as the project progresses.

Nunami Stantec Ltd.

Matt Follett, M.A.Sc., P.Eng.
Associate Civil Engineer - Nunavut

Phone: 613-223-1569
Matt.Follett@stantec.com

NUNAMI
STANTEC LIMITED

Final Site Review

To:	Amy Elgersma	From:	Erica Bonhomme
	City of Iqaluit		Yellowknife, NT
File:	Lake Geraldine Emergency Resupply 2022	Date:	November 3, 2022

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

1. General

I. This report will cover the work completed during the construction closeout phase/demobilization.

II. A site review was completed on Oct.03. At this time there was still material and equipment on site to be demobilized.

- **i.** The GN owned 4" hose was coiled up at set on pallets in one spot for the most part however it was still up the road very close to Unnamed Lake and would have to be brought back to the Apex warehouse. (Figure 1)
- **ii.** The seacans (staff room, generator, electrical/controls), as well as the fuel tanks for the generator at the Apex River were still on site. (Figure 5)
- **iii.** The 3 submersible pumps along with their associated fish screens were still in the Apex River. (Figure 3)
- **iv.** The Apex River pump manifold had been demobilized and brought to the coke plant. (Figure 7)
- **v.** There was still a large Caterpillar loader parked at Unnamed Lake as well as one at the Apex River site. (Figures 5, and 8)
- **vi.** The HDPE line at unnamed lake had yet to be capped. (Figure 9)
- **vii.** Some miscellaneous materials scraps, pallets, etc. are to be removed from site. (Figure 10)
- **viii.** The broken chain at the new road's gate had been fixed and locked

III. Once the required outstanding demobilization work was completed, we were unable to get out to site before a large snowfall had occurred in Iqaluit. This meant that the site was inaccessible, and a final review was not able to be completed safely.

IV. Fortunately, a representative from the City of Iqaluit was able to get out to site with a representative from Tower Ltd. To ensure the aforementioned outstanding items had been demobilized from site. The representative from the City of Iqaluit confirmed with Nunami Stantec that the tasks had been completed and that they were satisfied.

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

V. A representative from the City of Iqaluit, Nunami Stantec, and Tower confirmed all materials and equipment had been returned to its proper place for winter storage while completing the demobilization manifests forms that all 3 parties signed-off on Oct.25, 2022.

VI. A representative from the GN (Emergency Preparedness Department) was notified of the return of the GN owned hoses to the Apex warehouse. A separate project closeout manifest form was presented to them regarding the placement and condition of the hoses upon return. The representative was satisfied with the return of the hoses.

2. Photos

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 1: GN hoses rolled up and stacked on Pallets, still near Unnamed Lake site (Oct. 3)

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 2: GN hoses placed at the Apex warehouse (Oct.19)

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 3: Apex River site on Oct.3. Pumps still in the water.

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 4: 3 Apex River pumps at the Coke Plant (Oct.19).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 5: Apex River site (Oct. 3). Three seacans still on-site.

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 6: Apex River seacans outside the Coke Plant (Oct.19).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 7: Apex River pumps manifold outside the Coke Plant (Oct.19).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 8: Unnamed Lake site on (Oct.3).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 9: HDPE line at Unnamed Lake to be capped (Oct.3).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Figure 10: Example of 1 of a few miscellaneous/scrap material piles to be removed from site (Oct.3).

Reference: Lake Geraldine Emergency Resupply 2022_Final Site Review

Nunami Stantec

Isaac Freda
P. Eng
Phone: Sender's Phone
Fax: Sender's Fax
Sender's Email

Attachment: Attachment

c. C.C.

APPENDIX F
Water Quality Results

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)

2781 Lancaster Road, Suite 101
Ottawa, ON K2C 3G4
Attn: Matt Follett

Client PO:
Project: 144903261
Custody:

Report Date: 6-Sep-2022
Order Date: 30-Aug-2022

Order #: 2236155

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2236155-01	Unnamed Lake UNL-01
2236155-02	Unnamed Lake UNL-02
2236155-03	Apex River APEX-01
2236155-04	Lake Geraldine LG-01

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Client: Stantec Consulting Ltd. (Ottawa)

Client PO:

Report Date: 06-Sep-2022

Order Date: 30-Aug-2022

Project Description: 144903261

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Ammonia, as N	EPA 351.2 - Auto Colour	1-Sep-22	1-Sep-22
Anions	EPA 300.1 - IC	31-Aug-22	31-Aug-22
E. coli	MOE E3407	31-Aug-22	31-Aug-22
Hardness	Hardness as CaCO3	31-Aug-22	31-Aug-22
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	31-Aug-22	31-Aug-22
Metals, ICP-MS	EPA 200.8 - ICP-MS	31-Aug-22	31-Aug-22
pH	EPA 150.1 - pH probe @25 °C	31-Aug-22	31-Aug-22
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	31-Aug-22	6-Sep-22
Total Suspended Solids	SM 2540D - Gravimetric	31-Aug-22	1-Sep-22
Turbidity	SM 2130B - Turbidity meter	31-Aug-22	31-Aug-22

Certificate of Analysis

Report Date: 06-Sep-2022

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 30-Aug-2022

Client PO:

Project Description: 144903261

	Client ID:	Unnamed Lake UNL-01	Unnamed Lake UNL-02	Apex River APEX-01	Lake Geraldine LG-01
	Sample Date:	29-Aug-22 10:00	29-Aug-22 10:15	29-Aug-22 10:30	29-Aug-22 11:00
	Sample ID:	2236155-01	2236155-02	2236155-03	2236155-04
	MDL/Units	Water	Water	Water	Water
Microbiological Parameters					
E. coli	1 CFU/100mL	ND [1]	ND [1]	ND [1]	1
General Inorganics					
Ammonia as N	0.01 mg/L	<0.01	<0.01	<0.01	<0.01
Hardness	mg/L	21.0	21.4	33.7	15.3
pH	0.1 pH Units	7.5	7.5	7.6	7.3
Total Suspended Solids	2 mg/L	<2	<2	<2	<2
Total Kjeldahl Nitrogen	0.1 mg/L	0.1	0.1	0.1	0.2
Turbidity	0.1 NTU	0.2	0.2	0.1	0.5
Anions					
Bromide	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Chloride	1.0 mg/L	<1.0	<1.0	<1.0	<1.0
Fluoride	0.1 mg/L	<0.1	<0.1	0.1	<0.1
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Phosphate as P	0.2 mg/L	<0.2	<0.2	<0.2	<0.2
Sulphate	1.0 mg/L	3.3	3.3	8.3	2.0
Metals					
Mercury	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Aluminum	1 ug/L	7	6	54	12
Antimony	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Arsenic	1 ug/L	<1	<1	<1	<1
Barium	1 ug/L	2	2	2	1
Beryllium	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Boron	10 ug/L	<10	<10	<10	<10
Cadmium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Calcium	100 ug/L	7080	7210	10900	4730
Chromium	1 ug/L	<1	<1	<1	<1
Cobalt	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Copper	0.5 ug/L	0.6	<0.5	0.7	0.9
Iron	100 ug/L	<100	<100	<100	<100
Lead	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Magnesium	200 ug/L	802	827	1570	859
Manganese	5 ug/L	<5	<5	<5	11
Molybdenum	0.5 ug/L	<0.5	<0.5	<0.5	<0.5

Certificate of Analysis

Report Date: 06-Sep-2022

Client: Stantec Consulting Ltd. (Ottawa)

Order Date: 30-Aug-2022

Client PO:

Project Description: 144903261

	Client ID:	Unnamed Lake UNL-01	Unnamed Lake UNL-02	Apex River APEX-01	Lake Geraldine LG-01
	Sample Date:	29-Aug-22 10:00	29-Aug-22 10:15	29-Aug-22 10:30	29-Aug-22 11:00
	Sample ID:	2236155-01	2236155-02	2236155-03	2236155-04
	MDL/Units	Water	Water	Water	Water
Nickel	1 ug/L	<1	<1	<1	<1
Potassium	100 ug/L	197	201	199	172
Selenium	1 ug/L	<1	<1	<1	<1
Silver	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Sodium	200 ug/L	751	744	980	724
Strontium	10 ug/L	11	11	19	11
Thallium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Tin	5 ug/L	<5	<5	<5	<5
Titanium	5 ug/L	<5	<5	<5	<5
Tungsten	10 ug/L	<10	<10	<10	<10
Uranium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Vanadium	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Zinc	5 ug/L	<5	<5	<5	<5

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Bromide	ND	0.1	mg/L						
Chloride	ND	1.0	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Phosphate as P	ND	0.2	mg/L						
Sulphate	ND	1.0	mg/L						
General Inorganics									
Ammonia as N	ND	0.01	mg/L						
Total Suspended Solids	ND	2	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Mercury	ND	0.1	ug/L						
Aluminum	ND	1	ug/L						
Antimony	ND	0.5	ug/L						
Arsenic	ND	1	ug/L						
Barium	ND	1	ug/L						
Beryllium	ND	0.5	ug/L						
Boron	ND	10	ug/L						
Cadmium	ND	0.1	ug/L						
Calcium	ND	100	ug/L						
Chromium	ND	1	ug/L						
Cobalt	ND	0.5	ug/L						
Copper	ND	0.5	ug/L						
Iron	ND	100	ug/L						
Lead	ND	0.1	ug/L						
Magnesium	ND	200	ug/L						
Manganese	ND	5	ug/L						
Molybdenum	ND	0.5	ug/L						
Nickel	ND	1	ug/L						
Potassium	ND	100	ug/L						
Selenium	ND	1	ug/L						
Silver	ND	0.1	ug/L						
Sodium	ND	200	ug/L						
Strontium	ND	10	ug/L						
Thallium	ND	0.1	ug/L						
Tin	ND	5	ug/L						
Titanium	ND	5	ug/L						
Tungsten	ND	10	ug/L						
Uranium	ND	0.1	ug/L						
Vanadium	ND	0.5	ug/L						
Zinc	ND	5	ug/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100mL						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Bromide	0.11	0.1	mg/L	0.26			NC	10	
Chloride	ND	1.0	mg/L	ND			NC	10	
Fluoride	ND	0.1	mg/L	ND			NC	10	
Nitrate as N	ND	0.1	mg/L	ND			NC	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Phosphate as P	ND	0.2	mg/L	ND			NC	10	
Sulphate	ND	1.0	mg/L	324			NC	10	
General Inorganics									
Ammonia as N	ND	0.01	mg/L	ND			NC	18	
pH	7.3	0.1	pH Units	7.3			0.5	3.3	
Total Suspended Solids	2.0	2	mg/L	2.0			0.0	10	
Total Kjeldahl Nitrogen	ND	0.1	mg/L	0.33			NC	16	
Turbidity	0.2	0.1	NTU	0.2			0.0	10	
Metals									
Mercury	ND	0.1	ug/L	ND			NC	20	
Antimony	ND	0.5	ug/L	ND			NC	20	
Arsenic	ND	1	ug/L	ND			NC	20	
Barium	1.6	1	ug/L	1.8			14.0	20	
Beryllium	ND	0.5	ug/L	ND			NC	20	
Boron	ND	10	ug/L	ND			NC	20	
Cadmium	ND	0.1	ug/L	ND			NC	20	
Calcium	7050	100	ug/L	7080			0.5	20	
Chromium	ND	1	ug/L	ND			NC	20	
Cobalt	ND	0.5	ug/L	ND			NC	20	
Copper	0.51	0.5	ug/L	0.55			7.6	20	
Iron	ND	100	ug/L	ND			NC	20	
Lead	ND	0.1	ug/L	ND			NC	20	
Magnesium	831	200	ug/L	802			3.6	20	
Manganese	ND	5	ug/L	ND			NC	20	
Molybdenum	ND	0.5	ug/L	ND			NC	20	
Nickel	ND	1	ug/L	ND			NC	20	
Potassium	213	100	ug/L	197			8.0	20	
Selenium	ND	1	ug/L	ND			NC	20	
Silver	ND	0.1	ug/L	ND			NC	20	
Sodium	867	200	ug/L	751			14.3	20	
Strontium	11	10	ug/L	11			2.9	20	
Thallium	ND	0.1	ug/L	ND			NC	20	
Tin	ND	5	ug/L	ND			NC	20	
Titanium	ND	5	ug/L	ND			NC	20	
Tungsten	ND	10	ug/L	ND			NC	20	
Uranium	ND	0.1	ug/L	ND			NC	20	
Vanadium	ND	0.5	ug/L	ND			NC	20	
Zinc	ND	5	ug/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100mL	ND			NC	30	BAC14

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Bromide	1.24	0.1	mg/L	0.26	98.6	80-120			
Chloride	10.3	1.0	mg/L	ND	103	80-120			
Fluoride	1.08	0.1	mg/L	ND	108	80-120			
Nitrate as N	1.03	0.1	mg/L	ND	103	80-120			
Nitrite as N	1.09	0.05	mg/L	ND	109	80-120			
Phosphate as P	5.15	0.2	mg/L	ND	103	70-130			
Sulphate	9.91	1.0	mg/L	ND	99.1	75-125			
General Inorganics									
Ammonia as N	0.203	0.01	mg/L	ND	81.3	81-124			
Total Suspended Solids	22.0	2	mg/L	ND	110	75-125			
Total Kjeldahl Nitrogen	1.88	0.1	mg/L	ND	93.8	81-126			
Metals									
Mercury	2.53	0.1	ug/L	ND	84.3	70-130			
Aluminum	62.2	1	ug/L	6.8	111	80-120			
Arsenic	42.7	1	ug/L	ND	85.2	80-120			
Barium	44.3	1	ug/L	1.8	85.1	80-120			
Beryllium	46.8	0.5	ug/L	ND	93.6	80-120			
Boron	47	10	ug/L	ND	91.3	80-120			
Cadmium	47.0	0.1	ug/L	ND	94.1	80-120			
Calcium	16900	100	ug/L	7080	97.7	80-120			
Chromium	52.6	1	ug/L	ND	104	80-120			
Cobalt	54.1	0.5	ug/L	ND	108	80-120			
Copper	48.4	0.5	ug/L	0.55	95.6	80-120			
Iron	2510	100	ug/L	ND	99.3	80-120			
Lead	47.0	0.1	ug/L	ND	93.9	80-120			
Magnesium	11500	200	ug/L	802	107	80-120			
Manganese	52.9	5	ug/L	ND	102	80-120			
Molybdenum	49.1	0.5	ug/L	ND	97.9	80-120			
Nickel	49.8	1	ug/L	ND	99.3	80-120			
Potassium	11200	100	ug/L	197	110	80-120			
Selenium	50.5	1	ug/L	ND	101	80-120			
Silver	45.4	0.1	ug/L	ND	90.7	80-120			
Sodium	11500	200	ug/L	751	107	80-120			
Strontium	59	10	ug/L	11	96.9	80-120			
Thallium	45.6	0.1	ug/L	ND	91.2	80-120			
Tin	45.0	5	ug/L	ND	89.4	80-120			
Titanium	59.2	5	ug/L	ND	118	80-120			
Tungsten	50.5	10	ug/L	ND	101	80-120			
Uranium	51.8	0.1	ug/L	ND	104	80-120			
Vanadium	52.4	0.5	ug/L	ND	105	80-120			
Zinc	49	5	ug/L	ND	97.9	80-120			

Qualifier Notes:

Sample Qualifiers :

1 : A2C - Background counts greater than 200

QC Qualifiers :

BAC14 A2C - Background counts greater than 200

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Paracel ID: 2236155

PARACEL LABORATORIES LTD

Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2236155	

Client Name: Stantec / City of Iqaluit	Project Ref: 144903261	Page __ of __
Contact Name: Matt Follett	Quote #: Stantec MSA 2020-2023-DW	Turnaround Time
Address: ~~108-C Noble House, Iqaluit~~ Ottawa, ON	PO #:	☐ 1 day ☐ 3 day ☑ Regular ☐ 2 day
Telephone: 613-223-1569	E-mail: matt.follett@stantec.com erica.bonhomme@stantec.com	Date Required: 2022-09-02

☐ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table
For RSC: ☐ Yes ☐ No

Other Regulation: ☐ REG 558 ☐ PWQO ☐ CCME ☐ MISA ☐ SU - Sani ☐ SU - Storm
Mun: Northern Health
☑ Other Public Health Prot

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analysis: Ammonia as N; Anions full scan; CBOD; Chloride; E. Coli; General Water Quality; Hardness; Mercury; Metals - full scan; pH; Total K-N; TSS; Turbidity

	Sample ID/Location Name		Matrix	Air Volume	# of Containers	Sample Taken: Date	Sample Taken: Time	Ammonia as N	Anions full scan	CBOD	Chloride	E. Coli	General Water Quality	Hardness	Mercury	Metals - full scan	pH	Total K-N	TSS	Turbidity
1	Unnamed Lake	UNL-01	SW		7	08/29/22	10:00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Unnamed Lake	UNL-02	SW		7	08/29/22	10:15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Apex River	APEX-01	SW		7	08/29/22	10:30	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Lake Geraldine	LG-01	SW		7	08/29/22	11:00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5																				
6																				
7																				
8																				
9																				
10																				

Comments: Revised CoC

Method of Delivery: Canadian North

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): Matt Follett, M.A.Sc., P.Eng.	Date/Time:	Date/Time: Aug 30 2022 1440	Date/Time: Aug 30 2022 1500
Date/Time: August 29, 2022	Temperature: °C	Temperature:	pH Verified: ☑ By:

PARAC LABORATORIES

Paracel ID: 2236155

Laurent Blvd.
io K1G 4J8
1947
aracellabs.com
abs.com

Paracel Order Number	Chain Of Custody Ontario Drinking Water Samples
22 36155	№ 17189

Client Name:	Stantec	Project Ref:	1449	Waterworks Name:	City of Iqaluit	Samples Taken By:	
Contact Name:	Matt follett	Quote #:		Waterworks Number:		Name:	matt follett
Address:	Iqaluit, NU	PO #:		Address:		Signature:	
After Hours Contact:	Matt	E-mail:	matt.follett@stantec.com			Page ___ of ___	
Telephone:	613-223-1569	Fax:		Public Health Unit:		Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☐ 4 day	

Samples Submitted Under: (Indicate **ONLY one**)
☐ ON REG 170/03 ☐ ON REG 319/08 ☐ Private Well
☐ ON REG 243/07 ☑ Other:

Have LSN forms been submitted to MOE/MOHLTC?: ☐ Yes ☐ No ☑ N/A

Are these samples for human consumption?: ☑ Yes ☐ No

All information must be completed before samples will be processed.

Sample Type: R = Raw ; T = Treated ; D = Distribution; P = Plumbing
Source Type: G = Ground Water; S = Surface Water
Reportable: Requires AWQI reporting as per Regulation - Y = Yes; N = No

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G / S	Reportable: Y / N	Resample	SAMPLE COLLECTED DATE	SAMPLE COLLECTED TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S / F (REG 243)	Required Analyses: Total Coliform/E. Coli	HPC	Lead	THM				
1	~~UNL-01~~ Unnamed Lake	UNL-01	R	S	N	N	08/29/22	10 AM	7										
2	Apex River	APEX-01	R	S	N	N	08/29/22	10:30AM	7										
3	Lake Geraldine	LG-01	R	S	N	N	08/29/22	11:00 AM	7										
4	Unnamed Lake	UNL-02	R	S	N	N	08/29/22	10:15 AM	7										
5																			
6																			
7																			
8																			
9																			
10																			

Comments: Call matt follett @ 1-613-223-1569 prior to processing

Method of Delivery: Canadian North

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print):	Date/Time:	Date/Time: Aug 30 2022 14:40	Date/Time: Aug 30 2022 1506
Date/Time:	Temperature: °C	Temperature: 6.9 °C	pH Verified: ☐ By: