FINAL

Great Pond Water Supply
Project Description

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IMPORTANT NOTICE

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1.0 INTRODUCTION

The Town of Torbay is planning on developing Great Pond as a municipal water supply. The town has been one of the fastest growing towns in the region and is currently limited by access to additional town supplied drinking water. This document describes the proposed project and summarizes the biophysical and socio-economic environments and potential interactions.

1.1 Project Related Documents

A conceptional design of the project and several environmental studies have been conducted to assess the existing environment and are appended to this document. The studies include:

- Great Pond WTP Conceptional Design – Draft for Town Review (Wood 2022), Appendix A
- Great Pond Fish and Fish Habitat (Wood 2021), Appendix B
- Great Pond Study (Draft) (Wood 2021), Appendix C

2.0 THE UNDERTAKING

Project Name: Great Pond Water Supply

2.1 Nature of the Undertaking

The Town of Torbay is proposing to develop Great Pond as a municipal water supply. The Project will include development of water withdrawal and treatment facilities (water control structure, intake pipe, treatment plant and storage tank) and associated access roads. A fishway is planned to mitigate against potential effects on fish passage due to water withdrawal.

2.2 Purpose, Rationale and Need

The municipal planning area of the Town of Torbay includes three watersheds designated for municipal water supply: North Pond, South Pond, and Great Pond. Only North Pond is currently in use as a municipal water supply (Town of Torbay 2017); however, it is at its maximum usage capacity. Due to contamination of South Pond from operations at St. John's International Airport, South Pond was repealed from watershed protection (under Minister French) in the spring of 2012. The town has been one of the fastest growing towns in the region and is currently limited by access to additional town supplied drinking water.

2.3 Project Planning and Alternatives

Great Pond has been identified, and zoned, as an alternate drinking water supply for the Town of Torbay since the 1970s, and has maintained that zoning and status throughout all council changes since. The Town has identified the only viable alternative to developing Great Pond is to utilize the Regional Supply. This has presented numerous challenges due to the current external restraints and demands on the regional supply.

3.0 PROJECT DESCRIPTION

3.1 Geographical Location

Great Pond will be the proposed water supply to develop within the Town of Torbay. The proposed infrastructure will be mainly located on the northern side of Great Pond on land zoned as watershed or rural. The proposed treatment plant is proposed to be located northwest of Great Pond and will be accessible via Bauline Line. A new water storage tower may be located northeast of Great Pond and is proposed to be connected to the treatment plant via transmission line along existing rights-of-way.

3.2 Project Components and Layout

The proposed project consists of water supply, treatment, and distribution system. A summary of the major physical features is below. A proposed, high level, site layout and bathymetric map are presented in Figure 4-1. Engineering design is conceptual in nature and physical feature dimensions are approximations only. The Town of Torbay is budgeting for detailed design work to progress in 2023.

Water Control Structure: A water control structure is proposed to be placed at the outflow of Great Pond and head of Big River. The structure would be approximately 10 m in length and 2 m in height and consist of concrete and earth fill. The average width of the structure would be 2 m at the base. The control structure would be designed to hold the water level at existing high water mark levels.

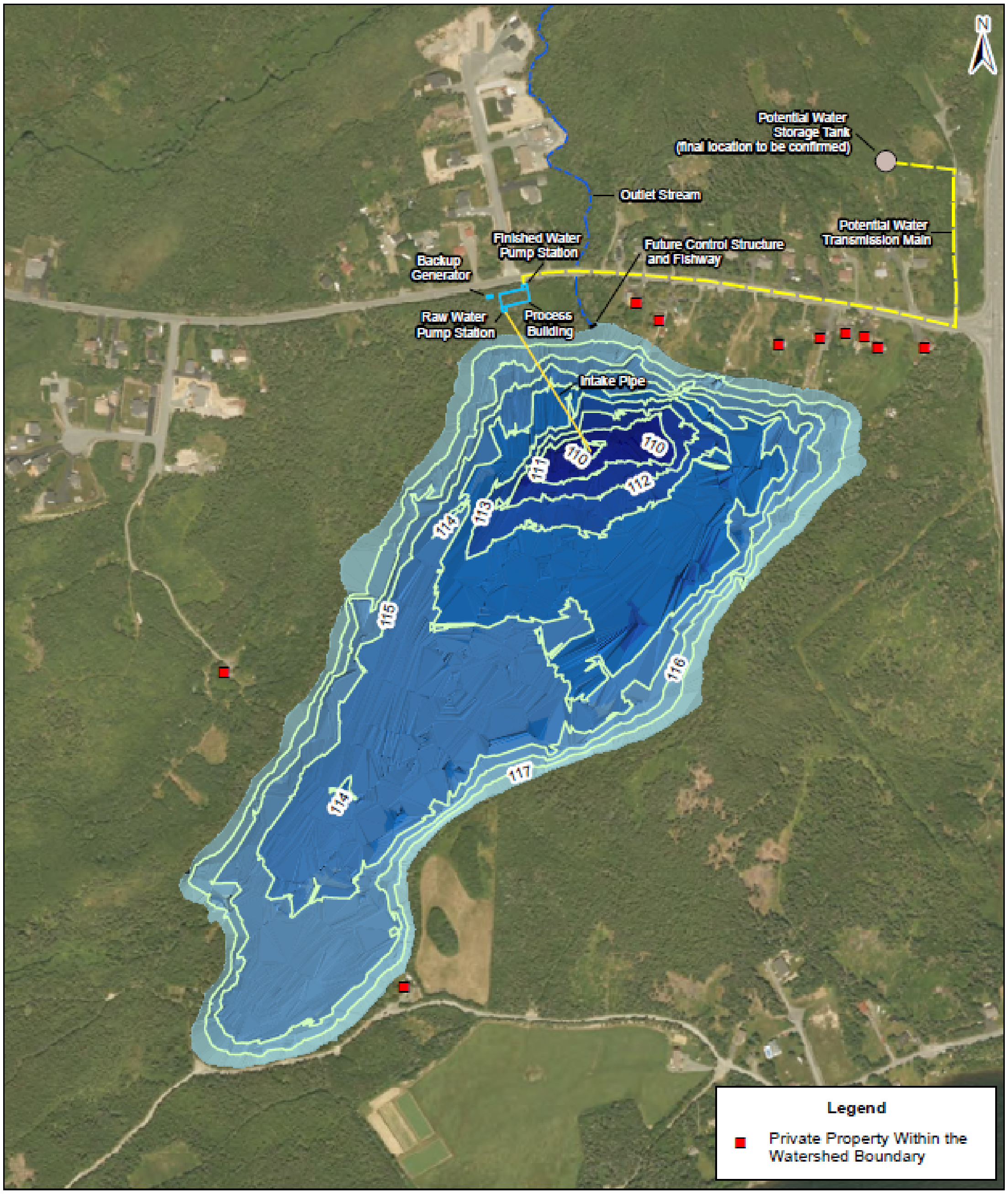
Water Intake Pipe: The intake line is expected to be 400 mm diameter HDPE and will extend from the deepest area of Great Pond to the process building. The intake pipe will be approximately 150 m long.

Water Treatment Plant: The treatment plant building is planned to have concrete foundations and wood or steel frame construction. It is expected to be located on the northwest side of Great Pond within the watershed area. The facility is divided into several process areas including coarse filtration, membrane, disinfection (primary & secondary) and garage/maintenance (Figure 4-2). Washrooms, office and electrical room would also be in the treatment plant. The process building would include, at its southern extreme, an influent pump station to draw water from Great Pond. A second pump station to the north of the building would direct finished water to the elevated finished water storage tank. The backup generator would be sized to provide full electrical power to the plant in case of power loss and is proposed to be on an exterior pad mounted system with a 24-hour supply of diesel fuel. It has been assumed that the waste streams generated by the process will be returned to the environment using a rock sump system. The building has a footprint of approximately 33m x 15m.

Water Storage Tank: A water storage tank may be needed to provide enough treated water to supply the system during high demand periods. The storage tank may be located northeast of Great Pond, though final location is to be confirmed. Water will be sent to the storage tank through the finished water pump station with the transmission main, approximately 700 m in length, placed along existing available corridors (e.g., roads).

Fishway: The fishway will be constructed with concrete and rebar. This fishway will be constructed in conjunction with the water control structure and will maintain flows for fish passage. The structure will be constructed at the outflow of Great Pond and head of Big River. Approximate dimensions of the fish passage structure will be 10 m length and 1.5 m height, and average width of 1 m.

Roads: Approximately 250 m of access roads will be constructed or upgraded to access the proposed siting for the infrastructure including the water treatment plant, water storage tank, and water control structure and fishways. A permanent access road will be constructed to access the water treatment facility.



wood. Wood 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: SEPTEMBER 2022
	CHKD BY: S. HICKEY		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 75 150 Meters	PROJECT TITLE: PROPOSED GREAT POND WATER SUPPLY INFRASTRUCTURE	DRAWING No. 1

Figure 3-1: Bathymetric map of Great Pond and proposed infrastructure layout

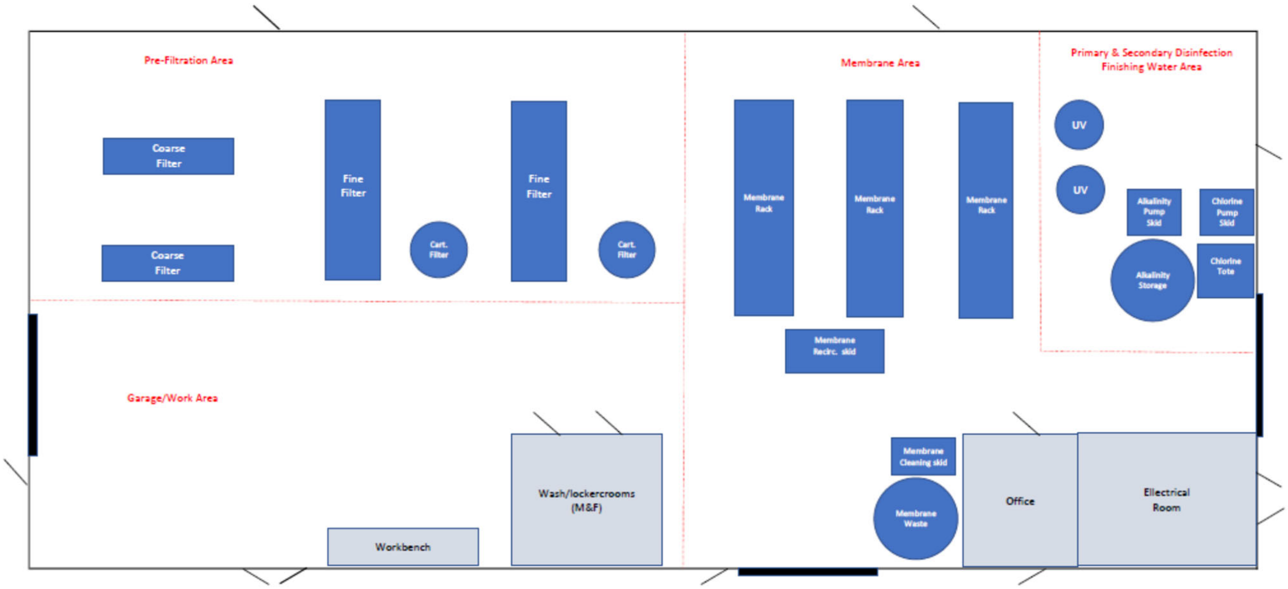


Figure 3-2: Great Pond Water Treatment Plant Process Layout

3.3 Construction

Construction will be completed in two major phases over two years;

- Site Clearing and Earthworks
- Infrastructure and Utilities Construction

Site preparation activities include vegetation clearing, excavation, and grading. Timber removed during site preparation activities will be salvaged where possible. Site preparation will also include installation of mitigative controls for sedimentation and erosion. Big River, at the outlet of Great Pond, will need to be temporarily diverted to construct the water control structure and fishway. Temporary access roads may be constructed to reach proposed sites. Construction of the Great Pond water treatment plant, intake line, water control structure, water storage tank, and fishway and associated components will follow standard construction methods.

It is anticipated that site preparation and infrastructure construction phase will involve the presence of heavy machinery and generators. Potential sources of pollutants during the construction phase include air exhaust from equipment and machinery and from handling of fuels and oils. It is not anticipated that petroleum products will be stored on site during the construction phase. The handling of petroleum products will comply with the Storage and

Handling of Gasoline and Associated Products Regulations. During construction, sewage will be handled by approved potable facilities with tanks pumped as needed by licenced companies. Any domestic wastes generated during construction will be collected and disposed at an approved disposal site. Construction works near Great Pond indicates there is also potential for siltation and erosion from construction activities. Water will be applied to control dust as needed. Potential negative effects from the construction phase would be localized and short term with standard mitigative measures. The construction phase will locally increase noise levels, though not above typical construction works that occur in the region. The noise will also be in accordance with local noise ordinances. All work will be completed in adherence to requirements of permits and approvals from applicable regulatory agencies and environmental protection guidelines.

3.4 Operations and Maintenance

Operations of the water withdrawal and treatment facilities will include daily monitoring of the water quality and treatment process and water disinfection. Personnel on site will also be responsible for receipt and storage of water treatment chemicals. Facility operations will be year-round with periodic maintenance to facilities.

It is planned that the primary disinfection will be achieved by Ultra Violet (UV) light disinfection and secondary disinfection will be achieved by adding chlorine (liquid sodium hypochlorite) following UV disinfection. Liquid sodium hypochlorite will be stored on site, though storage quantities are not known at this time. Holding tanks for the liquid sodium hypochlorite will have secondary storage such that spills or pollution would be unlikely.

3.5 Decommissioning

Decommissioning of this project is not anticipated.

3.6 Project Schedule

Construction will begin once all regulatory approvals are acquired. It is anticipated that construction will take two years to complete (two construction seasons).

3.7 Environmental Management and Protection

Construction of the Great Pond water treatment plant, intake line, water control structure and fishway and associated components will follow standard construction methods. All work will be completed in adherence to requirements of permits and approvals from applicable regulatory agencies and environmental protection guidelines.

3.8 Environmental Permits and Authorizations

A list of anticipated permits and issuing Governmental departments are presented in Table 3.1. Unforeseen permits beyond those presented in Table 3.1 will be applied for as they become applicable.

Table 3.1: Listing of anticipated approvals, licences and Permits for the Great Pond Water Supply Project

Approval/Licence/Permit	Legislation	Authority
Municipal		
Municipal Approval in Principle	Torbay Municipal Planning and Development Regulations 2012-2025	Town of Torbay
Building Permit	Torbay Municipal Planning and Development Regulations 2012-2025	Town of Torbay
Provincial		
Approval of the Undertaking	*Environmental Protection Act*	Department of Environment and Climate Change
Certificate of Approval for Site Drainage	*Water Resources Act*	Department of Environment and Climate Change
Environmental Approval for Water Supply and Distribution	*Water Resources Act*	Department of Environment and Climate Change
Water Use Licence	*Water Resources Act*	Department of Environment and Climate Change
Storage and Handling of Gasoline and Associated Products Regulation	*Environmental Protection Act*	Department of Environment and Climate Change
National Building Code Approval	National Building Code	Digital Government and Service NL
National Fire Code Approval	National Fire Code	Digital Government and Service NL
Building Accessibility Exemption Registration	*Building Accessibility Act*	Digital Government and Service NL
Protected Road Zoning and Development and Control Regulations	*Urban and Rural Planning Act*	Digital Government and Service NL
Certificate of Approval for a Water Supply System	*Water Resources Act*	Digital Government and Service NL
Certificate of Approval for Septic System	*Water Resources Act*	Digital Government and Service NL
Operating Permit	*Forestry Act*	Department of Fisheries, Forestry and Agriculture
Permit to Burn	*Forestry Act*	Department of Fisheries, Forestry and Agriculture
Commercial Cutting Permit	*Forestry Act*	Department of Fisheries, Forestry and Agriculture
Licence to Occupy Crown Lands	*Lands Act*	Department of Fisheries, Forestry and Agriculture
Federal		
Approval for Works and Undertakings affecting Fish Habitat	*Fisheries Act*	Fisheries and Oceans Canada

3.9 Occupations

The number of employees associated with the development of the Great Pond Water Supply for each phase is described below.

3.9.1 Construction

It is estimated that 28 people will be employed for the duration of the construction phase (Table 3.2). As noted in Section 3.3, the construction phase is estimated to be two years.

Table 3.2: National Occupational Classification Codes for employees during the Construction Phase

Occupational Title Code	Title	Number of Anticipated Positions
20010	Engineering Manager	1
22231	Engineering Inspectors and Regulatory Officers	1
21300	Civil Engineer	1
22300	Civil Engineering Technologists and Technicians	1
22303	Construction Estimator/Surveyor	1
22233	Construction Inspector	1
72012	Contractors and Supervisors, pipefitting trades	3
72013	Contractors and Supervisors, carpentry trades	3
72014	Contractors and Supervisors, Other Construction Trades, Installers, Repairers and Servicers	3
72021	Contractors and supervisors, heavy equipment operator crews	1
73400	Heavy Equipment Operators (except crane)	4
75110	Construction trades helpers and labourers	4
75119	Other Trades Helpers and Labourers	4
Total		28

3.9.2 Operation

It is estimated that two will be employed at any time for the duration of the operational phase (Table 4.3).

Table 3.3: National Occupational Classification Codes for employees during the Construction Phase

NOC Occupational Title Code	Title	Number of Anticipated Positions
20010	Engineering Manager	1
92101	Water and Waste Treatment Plant Operators	1
	Total	2

4.0 ENVIRONMENTAL SETTING AND CONTEXT

4.1 The Natural Environment

The Project itself is located within the town limits of the Town of Torbay, with much of the immediate surrounding area being a mix of rural and urban, primarily residential development. Typical vegetation, fish and wildlife within the area are discussed below. It is noted that the Great Pond watershed itself is located with the municipal boundaries of the Town of Torbay and the Town of Portugal Cove-St. Philips, while the project location is limited to the Town of Torbay.

4.1.1 Vegetation and Soils

The project area is located within the Maritime Barrens ecoregion, Southeastern Barrens subregion (Town of Torbay 2015). This region is characterized as having significant exposed bedrock, and thin, poorly drained soils, while detailed vegetation surveys have not been completed, it is anticipated that vegetation assemblage would be made up of a combination of boreal forest and urban/disturbed plant species. This is likely to include, but not limited to:

- Balsam fir (*Abies balsamea*)
- Birch (*Betula papyrifera*)
- Black spruce (*Picea mariana*)
- Bunchberry (*Cornus* canadensis)
- Creeping snowberry (*Gaultheria hispidula*)
- Feathermoss (Order: Hypnales)
- Green alder (*Alnus alnobetula*)
- Lowbush blueberry (*Vaccinium angustifolium*)
- Meadowsweet (*Filipendula ulmaria*)
- Mountain ash (*Sorbus americana*)
- Mountain holly (*Ilex mucronate*)
- Pin cherry (*Prunus pensylvanica*)
- Service berry (*Amelanchier arborea*)
- Sheep laurel (*Kalmia angustifolia*)
- Sweet gale (*Myrica gale*)

4.1.2 Hydrology and Water

The Project is located within the Big River watershed, with the primary project interactions limited to Great Pond and Great Pond Outflow. The Big River watershed is approximately 33.2 km^2 and flows in a general northeast direction where is empties into the North Atlantic through the Town of Flatrock. Discharge for Big River and Great Pond Outflow have been prorated using available data from Northeast Pond River, located in Portugal Cove-St. Philips (Station # 02ZM006). Mean annual flow (MAF; m^3/s) for each location is presented in Figure 5.1. Since 1953, Big River has had a MAF of $1.25 m^3/s$, with Great Pond contributing approximately 10% of that with a MAF of $0.12 m^3/s$ over the same time period. Discharge has been measured in the Great Pond Outflow since December 2019 using barometric pressure loggers and standard hydrology transects (DFO 2012). Between 2020 and 2022, MAF ranged from 0.09 to 0.11 m^3/s (Figure 4-1).

Water chemistry for Great Pond was evaluated from 2019-2022 for general chemistry, metals, hydrocarbons, pesticides and herbicides (Appendix A). These parameters were largely within Guidelines for Canadian Drinking Water Quality (GCDWQ). Parameters that exceed the GCDWQ are presented in Table 4.1 and will mainly be controlled through the water treatment process. Magnesium levels are well below the Maximum Acceptable Concentration (MAC) value of 120 ug/L and is not considered a priority for removal. Total Organic Carbon (TOC) does not have a regulatory limit, however, to control Disinfection By-Product (DBP) formation, it will need to be controlled.

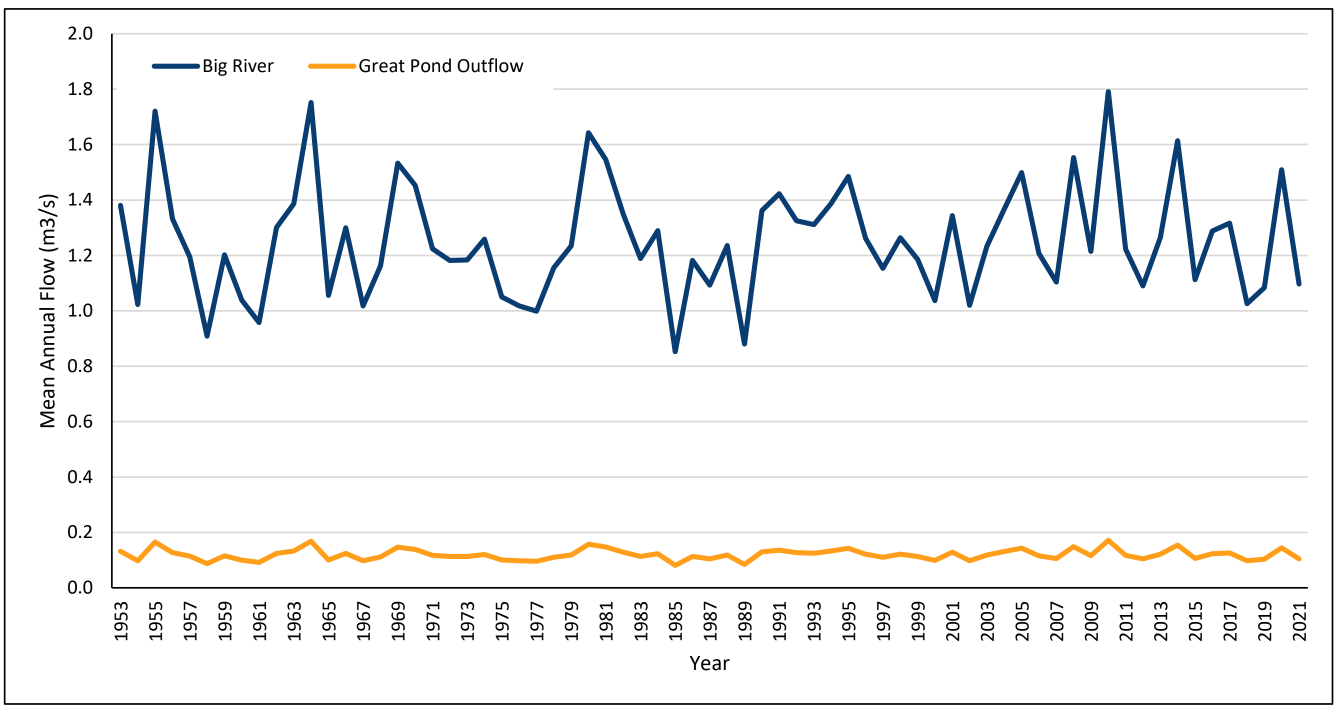


Figure 4-1: Prorated mean annual flow (m^3/s) for Big River and Great Pond Outflow, 1953-2021

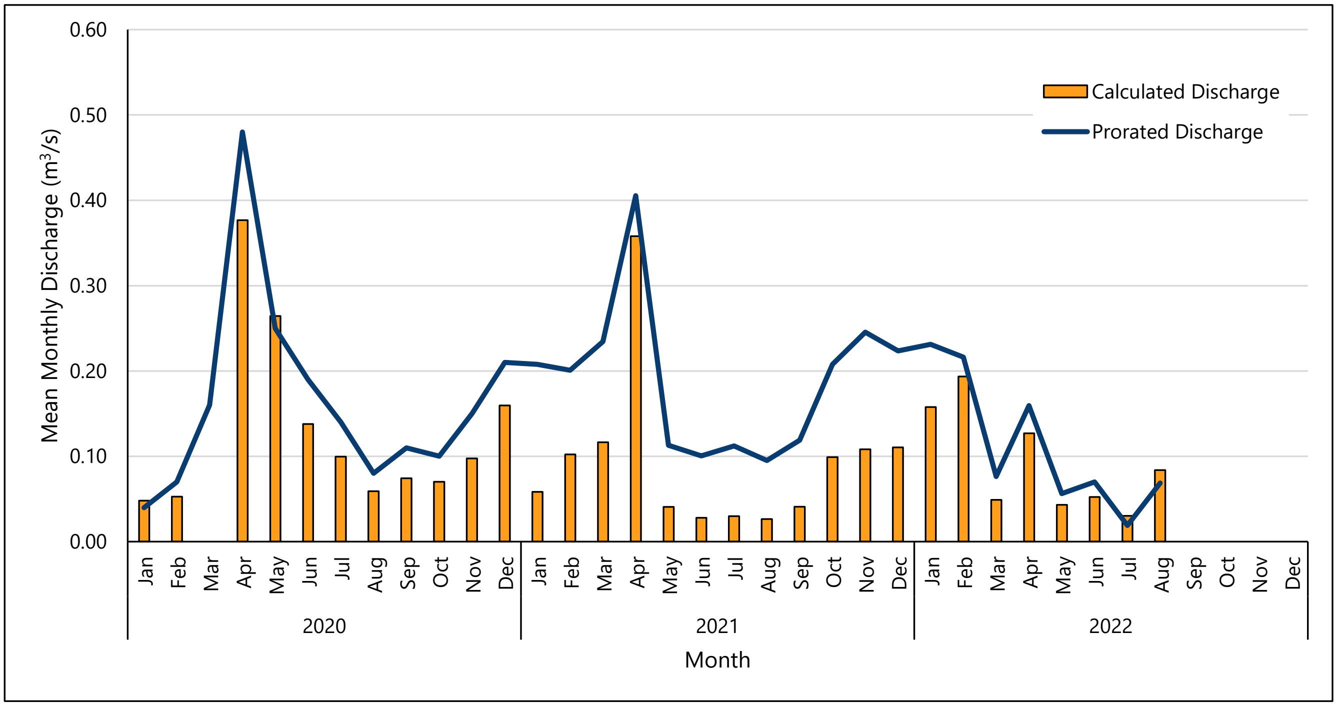


Figure 4-2: Calculated and prorated discharge (m^3/s) for Great Pond Outflow, 2020-2022

Table 4.1: Great Pond – Historical Raw Water Quality (Outliers), 2019-2022.

Parameter	Units	Guideline	Samples Collected	Range	Average
pH	-	GCDWQ: 7-10.5 Provincial: 6.5-8.5	10	5.87 – 6.48	6.21
True Colour	TCU	GCDWQ: <15 (AO)	10	9.02 – 39.4	19.5
Turbidity	NTU	GCDWQ: 0.3/<1/<0.1 Provincial: <1.0	10	0.9 – 4.5	2.1
Magnesium	µg/L	GCDWQ: 120 (MAC) / 20 (AO)	10	12 - 65	32
Aluminium	µg/L	100 (OG)	10	30 - 163	71
TOC	mg/L	-	10	3.5 – 8.0	4.6
Notes: Aesthetic objective (AO), operating guideline (OG), maximum acceptable concentration (MAC).					

4.1.3 Fish and Fish Habitat

Fish and fish habitat of Great Pond and the Great Pond Outflow was investigated to better understand potential effects on these resources from the Project. Data collected throughout the Fish and Fish Habitat surveys has been incorporated in a Request for Project Review from

Fisheries and Oceans Canada (DFO), which was submitted to DFO in September 2022. The outcome of the Request for Review is pending.

Lacustrine Habitat

A bathymetric survey of Great Pond was completed by Wood on June 5, 2020 (Figure 5.3). At the time of the bathymetric survey, the measured water surface elevation was 117.75 m. The lowest measured elevation at the bottom of the pond was 109.6 m, resulting in a maximum water depth at the time of survey of approximately 8.2 m. The deepest portion of the pond is in the northwest corner, which will be beneficial if any future intake is to be sited near the outlet of the pond.

Brook Trout (*Salvelinus fontinalis*) and Threespine Stickleback (*Gasterosteus aculeatus*) were the only species captured, with Stickleback accounting for most of the total catch and total biomass (Table 3.2). Due to the quantities of Stickleback captured, total catch was estimated based on total biomass and mean weight per individual. All Brook Trout captured were marked with a small fin clip on the top caudal fin to identify any recaptured fish. Throughout the netting, there were no recaptures observed. Therefore, to calculate a population estimate, a single recapture was assumed, yielding a population estimate of 575 Brook Trout (95% Confidence Interval 175-1,122).

Table 4.2: Summary of catch-per-unit-effort in Great Pond, August 2021

Species	Abundance		Biomass	
	Total Catch	CPUE (fish/net-night)	Total Catch	CPUE (grams/net-night)
Brook Trout	62	4.13	9,397.6	626.51
Threespine Stickleback	34,190[1]	2,279.33	70,608.6	4,707.24

Brook Trout had a mean length of 218mm and a mean weight of 161.8g. Following the removal of outliers, 59 Brook Trout were included in condition analysis, and had a mean condition of 1.29. All Brook Trout included in the analysis had condition factors greater than 1.00, indicating they are in good condition.

The 2021 Fish and Fish Habitat Study has been attached to this document (Appendix B).

Riverine Habitat

A detailed habitat survey was completed in the Great Pond outflow during the summer of 2021. At that time, a total of 17.4 habitat units (100m^2) were characterized, the majority of which were riffle, which is typically suitable spawning habitat for salmonids (Grant and Lee 2004). Salmonid spawning was observed within the outflow during October 2021. Cobble and bedrock were the most dominant substrate present (Table 5.3). At the time of survey, the outflow was primarily shallow, with most depths below 0.30m, with slow to moderate water velocity, typically less than 0.50m/s.

Table 4.3: Summary of riverine habitat characterization for Great Pond outflow, 2021

Transect #	Section Length (m)	Wetted Width (m)	Channel Width (m)	Area (Units)	Depth (m)		Veolocity (m/s)		Substrate Composition (%)*												Habitat Classification	Dominant Riparian Vegetation
					Average	Maximum	Average	Maximum	B	LgB	SmB	R	C	G	S	St	Cl	D	M	AqV		
1	-	2.9	3.8	-	0.08	0.13	0.06	0.11	0	0	10	40	40	10	0	0	0	0	0	0	Riffle	Grass
2	**31**	**3.8**	**5.6**	**1.18**	**0.05**	**0.10**	**0.10**	**0.35**	**0**	**0**	**10**	**30**	**50**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Grass**
3	33	3.4	4.6	1.12	0.08	0.16	0.02	0.09	0	0	15	35	40	10	0	0	0	0	0	0	Riffle	Grass
4	**25**	**3.5**	**4.1**	**0.88**	**0.10**	**0.13**	**0.05**	**0.16**	**0**	**0**	**5**	**35**	**50**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Shrub**
5	**25**	**3.7**	**5.5**	**0.93**	**0.06**	**0.10**	**0.07**	**0.22**	**0**	**0**	**5**	**10**	**35**	**50**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Conifer**
6	45	5.5	6.2	2.48	0.15	0.22	0.00	0.00	0	0	10	15	40	35	0	0	0	0	0	0	Riffle	Shrub
7	40	2.4	3.2	0.96	0.06	0.14	0.20	0.38	25	10	15	20	25	5	0	0	0	0	0	0	Riffle	Conifer
8	25	3.7	4.8	0.93	0.23	0.44	0.00	0.00	5	0	5	20	40	20	5	5	0	0	0	0	Pool	Conifer
9	3	-	-	-	-	-	-	-	100	0	0	0	0	0	0	0	0	0	0	0	Cascade	-
10	65	3.3	4.2	2.15	0.06	0.12	0.11	0.60	10	15	25	30	20	0	0	0	0	0	0	0	Rapids	Conifer
11	17	3.4	4.7	0.58	0.10	0.24	0.06	0.28	80	5	10	5	0	0	0	0	0	0	0	0	Cascade	Conifer
12	10	5.4	5.9	0.54	0.31	0.80	0.00	0.00	65	0	10	10	0	10	0	0	0	5	0	0	Run	Grass
13	30	4.0	4.7	1.20	0.13	0.23	0.01	0.05	75	0	5	10	10	0	0	0	0	0	0	0	Cascade	Conifer
14	**95**	**3.7**	**5.0**	**3.52**	**0.09**	**0.15**	**0.04**	**0.09**	**0**	**5**	**20**	**20**	**40**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Conifer**
15	25	3.5	4.0	0.88	0.30	0.48	0.01	0.05	0	0	0	0	35	25	0	20	0	20	0	0	Run	Grass

Note Bolder lines indicate transects selected for Wetted Perimeter Modelling

Substrate

B	Bedrock	C	Cobble	Cl	Clay
LgB	Larger Boulder	G	Gravel	D	Detritus
SmB	Small Boulder	S	Sand	M	Mud
R	Rubble	St	Silt	AqV	Aquatic Vegetation

Two quantitative electrofishing stations were completed in Great Pond Outflow and Big River, downstream of Great Pond Outflow, during August 2021. Brook Trout, Rainbow Trout (*Oncorhynchus mykiss*) and Threespine Stickleback were captured in each location, with Brook Trout being the most abundant (Table 4.4) within the Great Pond Outflow, while Rainbow Trout were the most dominant within Big River.

Table 4.4: Summary of population and biomass estimates in the Great Pond Outflow and Big River, August 2021

Location	Species	Population Estimate (fish/habitat unit)			Biomass Estimate (grams/habitat unit)		
		Station #1	Station #2	Mean	Station #1	Station #2	Mean
Great Pond Outflow	Brook Trout	59.5	25.3	42.4	207.7	117.4	162.6
	Rainbow Trout	2.6	14.2	8.4	4.3	70.9	37.7
	Threespine Stickleback	38.8	35.5	37.2	37.1	85.2	61.2
Big River	Brook Trout	12.1	14.5	13.3	190.3	321.3	255.8
	Rainbow Trout	26.8	24.2	25.5	382.9	609.8	496.4
	Threespine Stickleback	14.7	14.5	14.6	7.5	8.2	7.8

Overall, Brook Trout and Rainbow Trout were larger in Big River than Great Pond Outflow (Table 5.5). On average, salmonids in each sampling location were in good condition ($K \geq 1.00$). Rainbow Trout had similar condition in each location ($p = 0.90$), while Brook Trout had higher condition in Great Pond Outflow ($p<0.05$). The majority of the Brook Trout captured in Great Pond Outflow were young-of-year (YOY) indicating that this area may primarily be used for spawning and rearing.

Table 4.5: Summary of biometrics in Great Pond Outflow and Big River, August 2021

Location	Species	Mean Length (mm)	Mean Weight (g)	Mean Condition (K)
Great Pond Outflow	Brook Trout	61.0	3.8	1.29 (9)
	Rainbow Trout	66.4	4.6	1.27 (3)
	Threespine Stickleback	63.0	1.6	-
Big River	Brook Trout	111.7	19.5	1.10 (24)
	Rainbow Trout	102.1	19.6	1.16 (33)
	Threespine Stickleback	32.8	0.6	-

Note Number of fish included in condition factor summaries presented in brackets.

The 2021 Fish and Fish Habitat Study has been attached to this document (Appendix B).

4.1.4 Wildlife

As mentioned, the project area is located within the town limits of Torbay, with much of the immediately surrounding areas being a mix of rural and urban development. Potential wildlife that occurs in the region includes moose, snowshoe hare, red squirrel, muskrat, and green frog. A variety of resident and migratory birds also inhabit the region including loons, geese, ducks, herons, ospreys, shorebirds, gulls, terns and passerine birds (Town of Torbay 2015).

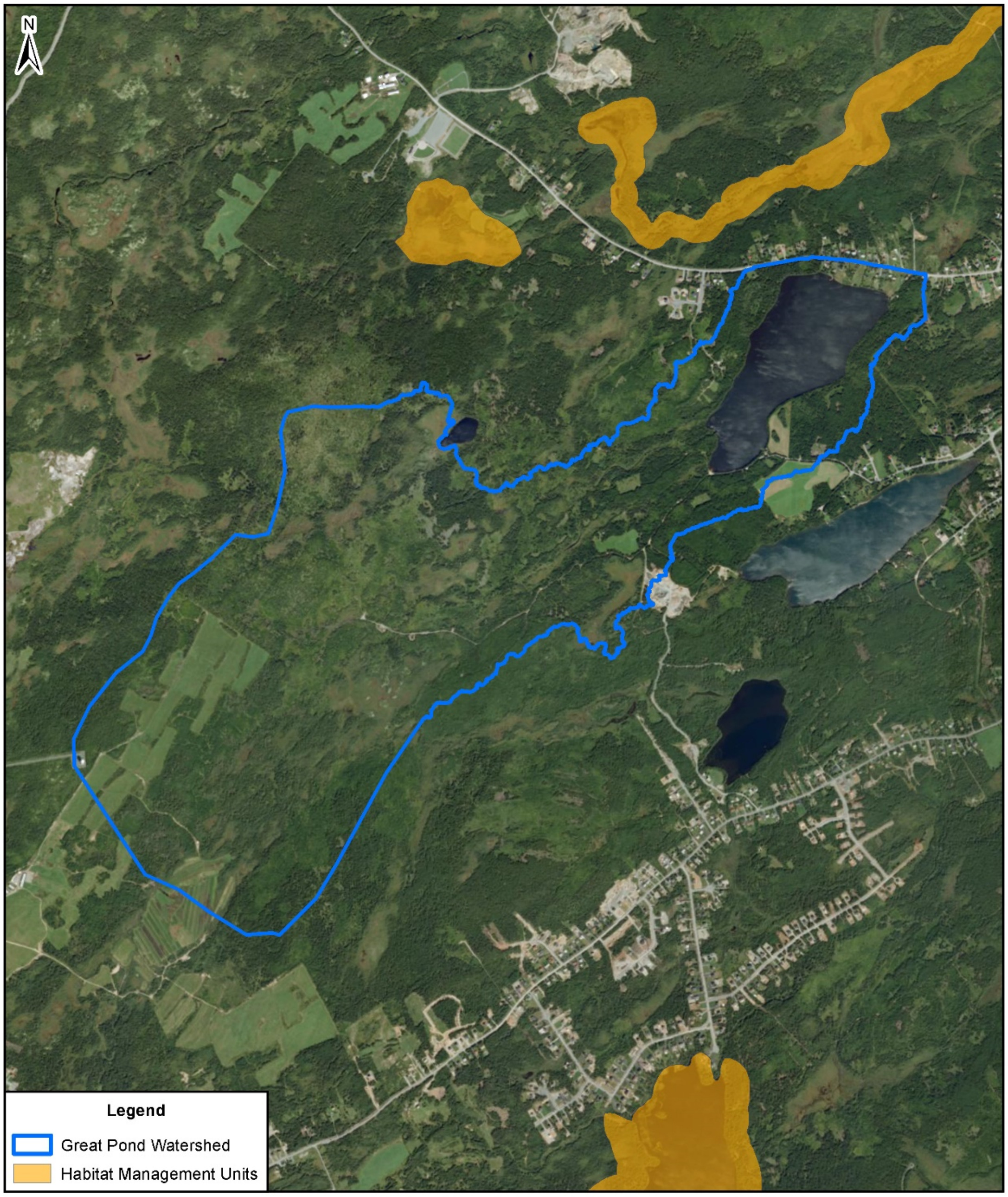
4.1.5 Special Areas

In 1997, the Town of Torbay signed a Municipal Wetland Stewardship Agreement with the Stewardship Association of Municipalities (SAM). A Stewardship Zone, which covers more than half of the Municipal Boundary area, encompasses most of the major wetlands and waterfowl habitat within the Town (Figure 4-3). Within the Stewardship Zone, conservation areas (significant waterfowl habitats) have been identified at Western Island Pond, Gosse's Pond (also known as Goose Pond), Upper Three Corner Pond, Jones Pond Riparian Zone, The Gully and the Shoreline Conservation Area (Town of Torbay 2015, Wood 2021).

The Habitat Conservation Plan for Torbay allows canoeing, hiking, photography, bird watching and opportunities to learn about wetlands and waterfowl conservation. Applications for development located within the Stewardship Zone and conservation areas are reviewed by Council, which also refers these development proposals to Wildlife Division, Department of Municipal Affairs and Environment for review and comment. Council may use mitigating measures to reduce habitat degradation that may result from development within the Stewardship Zone (Town of Torbay 2015, Wood 2021).

The Stewardship Zone encompasses Great Pond, but all Management Units are outside the Great Pond watershed (2020). Gosse's Pond is directly downstream of Great Pond and the management unit (MU) is approximately 200 m by 2.5 km. Gosse's Pond MU is shallow with mud substrate. Key vegetation in the wetland includes sphagnum moss, horse tail, bur-reeds and bullhead lilies. The wetland perimeter is primarily swamp-like with further areas heavily forested (balsam fir and black spruce mainly).

Along with the SAM Conservation Areas, the Torbay Municipal Plan identifies environmentally sensitive areas as steep slopes, wetlands, areas prone to landslides and rockfalls, and a 30 m buffer along the sea wall. These areas are identified in the Future Land Use Map as Conservation Areas (Town of Torbay 2015). No Conservation Areas were identified within the Great Pond watershed.



wood. Wood, 133 Crosbie Road, St. John's, NL, A1B 4A5, (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: FEBRUARY 2021
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 250 500 Meters	PROJECT TITLE: HABITAT MANAGEMENT UNITS	DRAWING No. 7

Figure 4-3: Habitat Management Units

4.2 Land and Resource Use

4.2.1 Existing Land Use in the Great Pond Watershed

While much of the land within the Great Pond watershed in Torbay is undeveloped, various land uses currently exist within the watershed. The following list describes these areas based on a desktop study using the Town of Torbay's EagleView system. Field reconnaissance was used to clarify some of the observations.

- A portion of Bauline Line passes through the Great Pond watershed (2022).
- Residential and / or seasonal properties are located within the Great Pond Watershed (2022). One property is located on an extension of Pondside Lane and another on Great Pond Road / Whiteway Pond Road. Whole, or portions of, 10 to 15 properties on either side of Bauline Line are within the watershed (Drawing 9; Appendix A). Properties within the watershed appear to include houses or cabins and outbuildings, cleared areas (e.g., lawns and potentially hobby farms), hard surfaces such as roads and driveways, boat launches and stored automobiles and / or recreational vehicles.
- Agricultural development(s), possibly one or more sod farms with residences and outbuildings, are located on Great Pond Road / Whiteway Pond Road within the Great Pond watershed (2022).
- Several roads (paved and unpaved), dirt tracks and ATV trails begin at the terminus of Great Pond Road / Whiteway Pond Road extending to cleared areas (e.g., domestic cutting, agriculture areas) and an inactive gravel pit (accessed from Indian Meal Line). ATV trails extend to a pond that is within the Torbay WAT Zone but outside of the Great Pond watershed (2022). This trail crosses a stream that runs into Great Pond. This stream appears to have been forded.
- An easement runs from a power substation at the Torbay Bypass Road and Whiteway Pond Road through the Great Pond watershed (2022) on its way to Flatrock.
- Several areas north of Great Pond Road / Whiteway Pond Road have trails and domestic cutting.
- A stream that runs beneath Bauline Line via a culvert empties into Great Pond. The stream connects to Big River, which runs adjacent to an agricultural area off Three Island Pond Road.

4.2.2 Agriculture

Based on satellite imagery and field investigation, it appears that agricultural activity occurs in the Great Pond watershed (2022). It is likely that one or more sod farms with residences and outbuildings, are located on Great Pond Road / Whiteway Pond Road (Figure 4-4).

4.2.3 Forestry

In Newfoundland and Labrador, a permit is required for domestic cutting, which occurs mainly in fall and winter using ATVs or snowmobiles. Each permit allows harvesting of 7-9 m3. Torbay is within the Provincial Zone 1 Forestry Management District, which has a current operations plan for the period of 2017-2021. Domestic cutting blocks are located throughout the District including in Torbay (Figure 4-5). Operating Unit Area No. CC01603 Patrick's Path (369.7 ha) overlaps with the Great Pond Watershed (2022). The estimated annual domestic harvest in CC01603 is approximately 16,742 m3 and recent cutting is evident off Great Pond Road / Whiteway Pond Road (Forest Service 2016). Forest access roads are located within the watershed connecting to Great Pond Road / Whiteway Pond Road and Woodfine's Lane (GNL, 2020a). Domestic harvesting increased in Zone 1 in the last planning period. Demand for fuel wood is particularly high and anticipated to grow given the rising cost of other heating methods and decreased availability of fuel wood sources. No commercial cutting, silviculture blocks or planned forestry road construction are identified for Torbay (Forest Service, 2016). Twenty (20) m No-Cut Buffers are located around most of the edge of Great Pond and streams leading into the Pond. Wider buffers are established where a waterbody is a protected water supply area; the guidelines are attached to any cutting permits issued in the area and compliance is monitored. The Forest Service must receive annual approval under the Water Resources Act for harvesting within a protected watershed. Great Pond watershed is not identified as a protected water supply in the forestry plan. District Ecosystem Managers and planning teams may widen buffer widths to protect sensitive areas such as salmon spawning habitat, cabin areas or for aesthetic purposes (Forest Service, 2016).

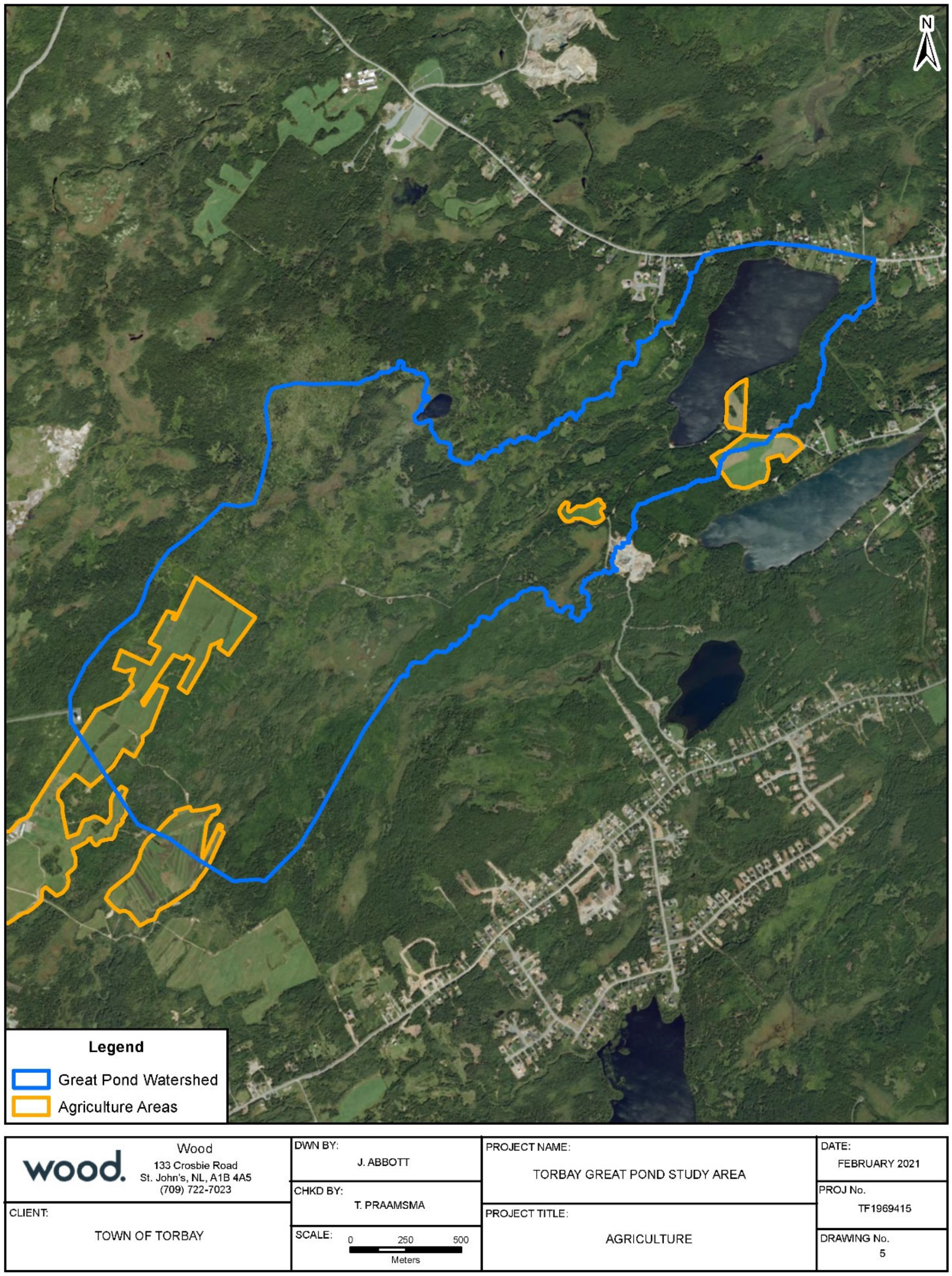


Figure 4-4: Agricultural Areas

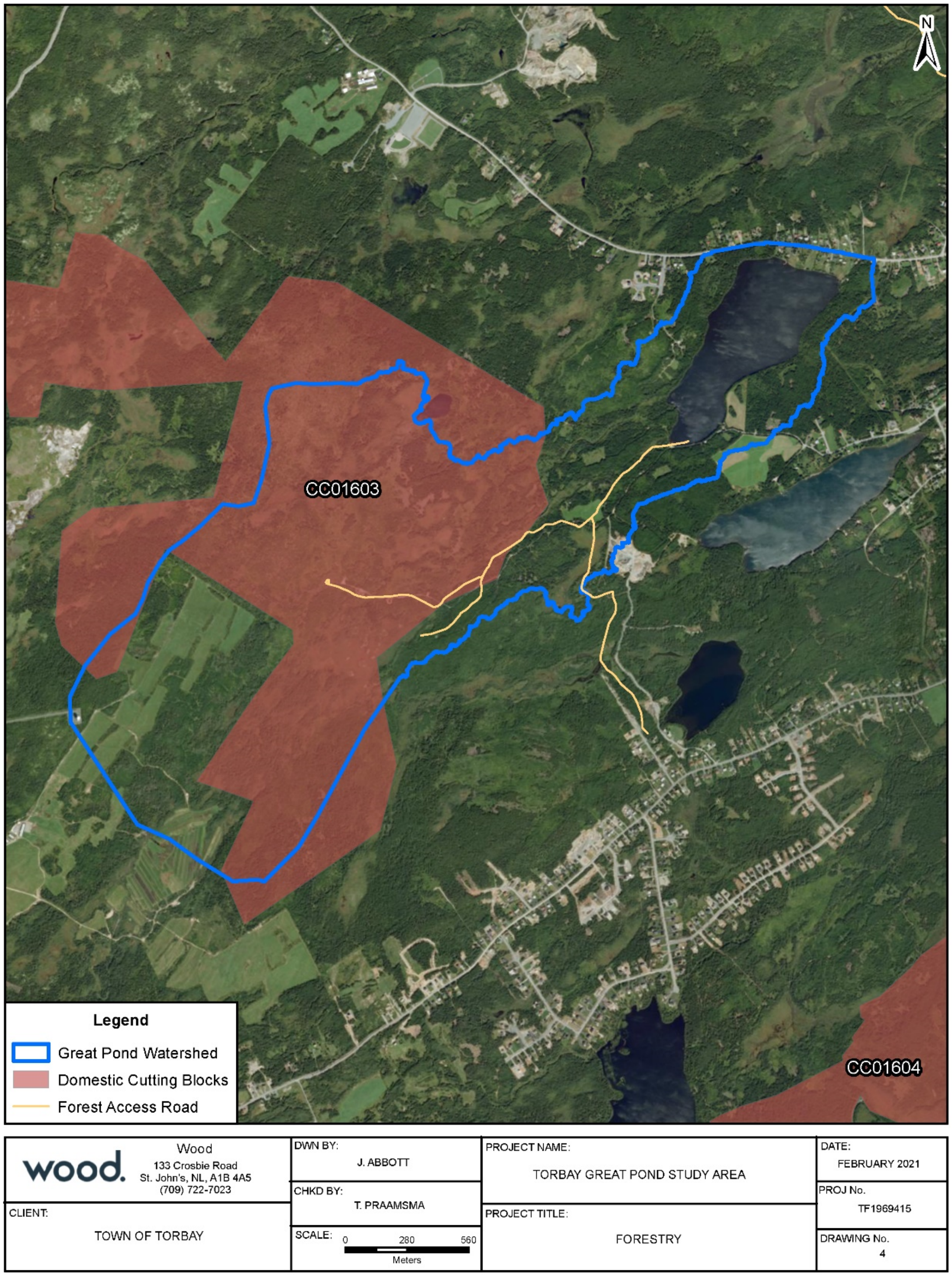


Figure 4-5: Domestic Cutting Blocks

4.2.4 Mining

There is no known exploration licenses or mining leases within the Great Pond watershed. A quarry was noted near the watershed, however it appears to be inactive and the permit for operations expired in 2014 (Figure 4-6; GNL, 2020a).

4.2.5 Hunting and Trapping

Torbay is within various hunting zones. Permitted activities include moose (*Alces alces*) hunting, which occurs usually from September to December and small game (willow (*Lagopus lagopus*) and rock ptarmigan (*Lagopus muta*), ruffed (*Bonasa umbellus*) and spruce grouse (*Falcipennis canadensis*) and snowshoe hare (*Lepus americanus*)) hunting generally from September to March each year. Caribou (*Rangifer tarandus*) and black bear (*Ursus americanus*) management areas surrounding Torbay are closed to hunting. Torbay is in trapping Zone B, where various species may be harvested (Government of NL 2020b). Trapping generally occurs in winter when fur quality is optimal. While this information is not detailed enough to confirm the level of activities in Torbay, hunting and trapping may occur within the Great Pond watershed.

4.2.6 Recreation

The Eastern Avalon has extensive trail systems including the East Coast Trail and Grand Concourse, which are both partly located in Torbay. The Father Troy Path, a 5 km section of the East Coast Trail, connects Torbay to Flatrock. The Silver Mine Head Path connects to Middle Cove also along the coast (Town of Torbay 2020). None of these trails are within the Great Pond watershed (2022).

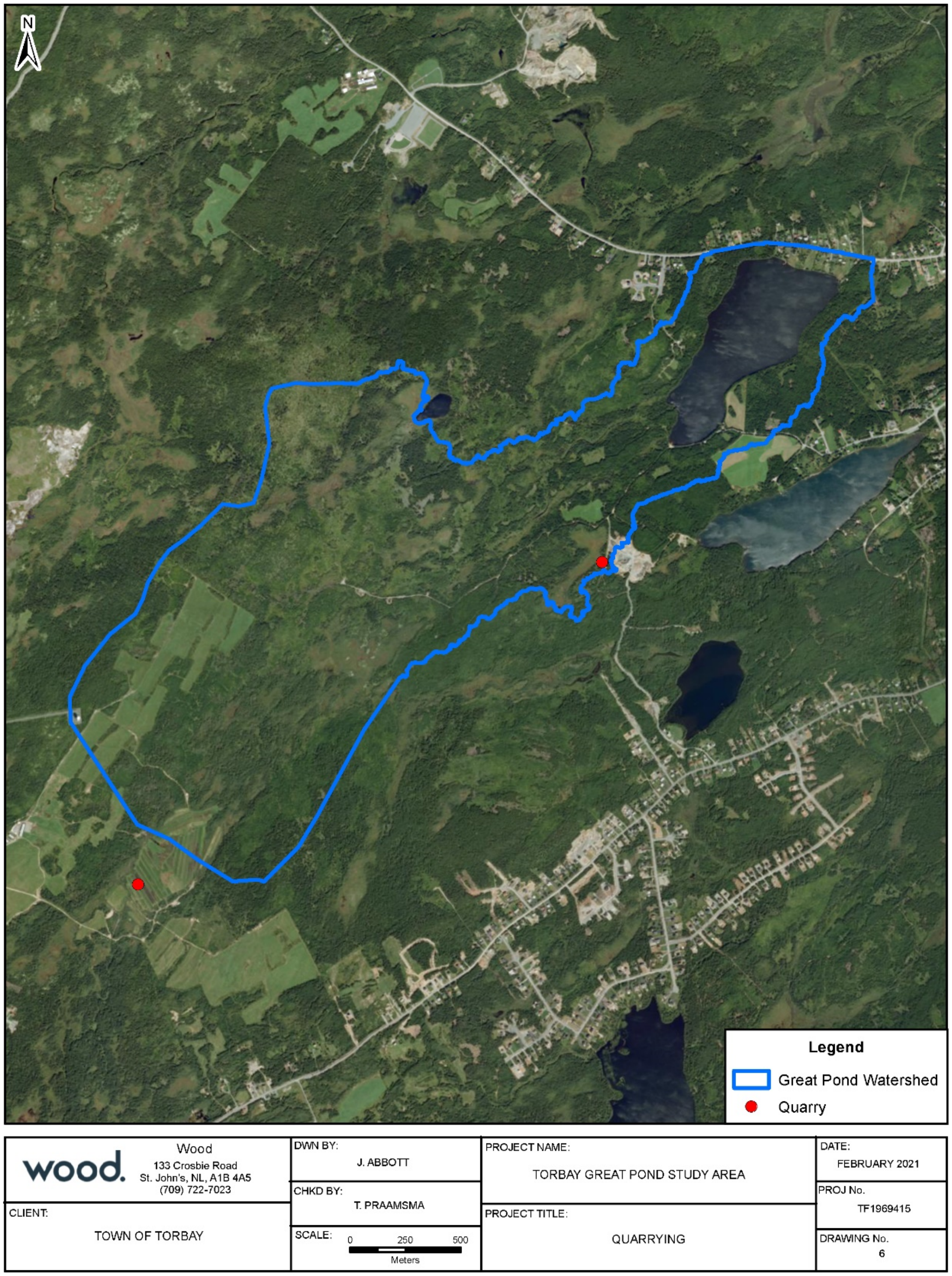


Figure 4-6: Quarries

5.0 CONSULTATION AND ISSUES SCOPING

The Town of Torbay has been open with the public about the constraints it is facing with its current municipal water supply (North Pond), and past and ongoing studies of North Pond and Great Pond to be able to meet potable water and development demands. This matter has been part of the public discussion in the public realm for more than 10 years. Most recently, WSP's (as Wood) 2021 combined capacity assessment, as well as planning and land use study of Great Pond (completed on February 25, 2021) has been posted for public viewing on the Town's website at www.torbay.ca. Also being posted is the associated power point presentation presented to Council by WSP to Council in 2021, as well as the subsequent Aquatic (Fish Habitat) Study (completed by WSP in 10 December 2021).

With the Environmental Assessment Review now commencing, the Town is posting an Information Bulletin to the public via an advertisement in the local newspaper (Northeast Avalon Times), on the Town's website and via social media to keep residents informed about the status of the ongoing Great Pond Study and environmental assessment process. The Town is planning on proceeding with a full public engagement process, once potential environmental implications have been assessed, so Council can consider how to proceed from there in terms of engineering and cost implications, as well as land use considerations. It is noted that this will include consultations with the Town of Portugal Cove-St. Philips and the provincial Department of Municipal and Provincial Affairs as it relates to zoning and land use implications for the watershed, associated boundary definition and required amendments. Most importantly, the Town will consult with Torbay residents and property owners.

6.0 FUNDING

It is anticipated that this project will cost between $8-10 million, and is hoped to be funded equally through one third federal, one third provincial and one third municipal funding.

7.0 REFERENCES

DFO (Fisheries and Oceans Canada). 2012. Standard Methods Guide for the Classification and Quantification of Fish Habitat in Rivers of Newfoundland and Labrador for the Determination of Harmful Alteration, Disruption or Destruction of Fish Habitat (Draft).

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APPENDIX A: Great pond Water Treatment Plant Conceptual Design

Great Pond WTP Conceptual Design – DRAFT FOR TOWN REVIEW

Town of Torbay Water Supply
Great Pond
Project # TF1969415

Prepared for:

Town of Torbay
1288 Torbay Road; PO Box 1160, Torbay, NL, A1K1K4

Prepared by:

Wood Environment and Infrastructure Solutions
a Division of Wood Canada Limited
36 Pippy Place
PO Box 13216
St. John's, NL
A1B 4A5

24 August 2021

wood.

Great Pond WTP Conceptual Design

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24 August 2021

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List of Acronyms and Abbreviations

Al	Aluminum
AO	Aesthetic Objective
DAF	Dissolved Air Floatation
DBP	Disinfection By-Product
DOC	Dissolved Organic Carbon
GCDWQ	Guidelines for Canadian Drinking Water Quality
HAA5	Haloacetic acid group (total of 5)
MAC	Maximum Acceptable Concentration
Mn	Manganese
NTU	Nephelometric Turbidity Units
OG	Operational Guideline
TOC	Total Organic Carbon
TCU	True Colour Units

TTHM	Total Trihalomethanes
UV	Ultra Violet
UVT	Ultra Violet Transmittance

1.0 Introduction

This document is in support of the Town of Torbay's submission to the Newfoundland and Labrador Department of Environment and Conservation for Environmental Assessment registration and the Department of Fisheries and Oceans Canada (DFO) regarding the utilization of Great Pond as a drinking water source. Great Pond is located approximately 2.5 km north of North Pond, the current water supply for Torbay, and if registered as a designated water supply and a treatment system constructed, will augment the current water supply for Torbay.

Previous work completed for Great Pond includes, watershed identification, bathymetry, water balance and source water characterization. The objective of this report is to review collected information and develop a conceptual design for providing potable water using Great Pond as the raw water source.

This report is divided into the following sections:

- Great Pond raw water characteristics
- Treatment requirements
- Potential treatment technologies
- Typical system layout
- Facility siting.

Each of the above are described separately in the sections that follow.

2.0 Great Pond Characteristics

2.1 Source Water Flow and Treated Flow

As part of the Wood Environment and Infrastructure, a division of Wood Canada Limited (Wood) report dated February 25, 2021, a bathymetric survey, flow monitoring and water balance was conducted for Great Pond. This report identified the need for further study regarding the inflection point in the discharge stream from the Pond. That is, the point of steep transition in the relationship between the discharge stream wetted perimeter versus flow. This inflection point represents the minimum flow that ensures that fish habitat is maintained in the stream.

Between the two above noted bodies of work, the following information is summarized:

- Minimum required discharge from Great Pond is 0.02 m^3/s
- The top 2m of Great Pond has a water storage capacity of 508,515 m^3 (884,192 – 375,677 m^3)
- Average yearly fill rate to Great Pond is 0.09 m^3/s
- Average dry weather fill rate to Great Pond is 0.05 m^3/s.

Based on Great Pond using the top 2m as storage volume during an assumed 120 day dry weather period from June to September, the storage volume corresponds to a daily flow of 4,237 m^3/d (0.049 m^3/s). This value is less than the yearly average fill rate of 0.09 m^3/s so the volume can be replenished outside the dry period.

Without utilizing storage within Great Pond, the maximum withdrawal while maintaining an effluent flow of 0.02 m^3/s is the difference between the dry fill period (0.05 m^3/s) and the minimum effluent flow to maintain fish habitat (0.02 m^3/s) or 0.03 m^3/s (0.05 – 0.02 m^3/s; 2,592 m^3/d.). Utilizing storage, will allow higher flows to the removed for potable water processing. The Wood February 25, 2021 report proposed average day flows of 2,000 m^3/d and peak flows of 4,000 m^3/d. Considering a 20% waste stream generation during water treatment, the maximum draw from Great Pond would be required to be 5,000 m^3/d. This value is considered to be able to be supported by Great Pond and is proposed to be the maximum feed flow for the treatment system.

2.2 Raw Water Quality

A Great Pond sampling program was conducted during the period 2019 to 2022. The samples collected were analyzed for the following categories:

- General chemistry and metals
- BTEX (Benzene, Toluene, Ethylbenzene, Xylenes) and THP (Total Petroleum Hydrocarbons)
- PAHs (Poly Aromatic Hydrocarbons)
- Pesticides and herbicides

All of the sample results are provided in **Appendix A**. Parameters that exceed the Guidelines for Canadian Drinking Water Quality (GCDWQ) for any one sample are summarized in **Table 2-1**. The table includes the number of samples collected (10), the range for all samples and the average. In addition to the Federal Guidelines, provincial values where different than the Federal are also provided.

The raw water low pH can be adjusted using a number of chemicals which may also increase the low carbonate alkalinity of the raw water. True colour and turbidity, are often controlled through filtration following coagulant addition or by membrane filtration. The average manganese concentration is higher than the Aesthetic Objective (AO) of 20 ug/L; however, it is well below the Maximum Acceptable Concentration (MAC) value of 120 ug/L and is not considered a priority for removal.

Aluminum in Great Pond can reach values above the Operating Guideline value of 100 ug/L; however, this value represents a target when aluminum-based coagulants are used and is based on the assumption of near zero raw water concentrations. Based on no MAC value for aluminum, it is proposed that aluminum will not be actively controlled.

Total Organic Carbon (TOC) does not have a regulatory limit, however, to control Disinfection By-Product (DBP) formation, it will need to be controlled. The Province provides guidance on the Dissolved Organic Carbon (DOC) as noted in the sections that follow. TOC/DOC can be reduced by coagulation/filtration and membrane filtration.

Table 2-1: Great Pond – Historical Raw Water Quality (Outliers)

Parameter	GCDWQ	2019-2022		
		Samples Collected	Range	Average
pH	7-10.5 (Provincial: 6.5-8.5)	10	5.87 – 6.48	6.21
True Colour	15 TCU (AO)	10	9.02 – 39.4	19.5
Turbidity	0.3/<1/<0.1 NTU (Provincial <1.0)	10	0.9 – 4.5	2.1

Mn	120 (MAC)/20 ug/L (AO)	10	12 - 65	32
Al	100 ug/L (OG)	10	30 - 163	71
TOC	--	10	3.5 – 8.0	4.6

3.0 Disinfection Treatment Requirements

As a surface raw water source, some key components for the treatment system must include:

- Primary disinfection
- Secondary disinfection.

Primary disinfection is the process or series of processes to remove/inactivate viruses, bacteria and protozoa. Secondary disinfection is the addition of a chemical that provides a residual in the distribution system to protect from pathogen re-inactivation and biofilm growth.

For this work, it has been assumed that the primary disinfection will be achieved by Ultra Violet (UV) light disinfection (minimum dose 40 mJ/cm^2) and secondary disinfection will be achieved by adding chlorine (liquid sodium hypochlorite) following UV disinfection. Since UV disinfection is not effective for virus inactivation, Provincial treatment standards allow for the secondary disinfection (chlorination) to provide for full disinfection of viruses (2021, Drinking Water Treatment Standards, p.5). Based on the USEPA guidance for the USA surface water treatment rule, a UV dose of 40 mJ/cm^2 can achieve a 0.5 log removal for viruses. UV is very effective at controlling Giardia and Cryptosporidium.

The key Provincial standards for drinking water plants (2021, Drinking Water Treatment Standards) are provided below in **Table 3-1**. Based on the conservative assumption that all of the raw water TOC in **Table 2-1** (average 4.6 mg/L) is in the form of DOC, the effluent DOC from the facility must be less than or equal to 2.0 mg/L (see below in **Table 3-1**). Based on this low TOC, effluent Disinfection By-Product (DBP) Formation of Total Trihalomethanes (TTHM) and the 5 Haloacetic Acids (HAA5) are anticipated to meet provincial requirements. This is especially true given the water has low boron concentrations (precursor to some HAA and THM compounds).

Table 3-1: Disinfection/Inactivation Requirements

Parameter	Standard Removal Rate or Effluent Value Limit	Comments
Giardia	3-log reduction/inactivation	Conventional filtration provides 3.0 log removal
Cryptosporidium	3-log reduction/inactivation	Conventional filtration provides 2.5 log removal
Viruses	4-log reduction/inactivation	
DOC	Raw ≤5.0 mg/L; Effluent ≤2.0 mg/L Raw 5-8 mg/L; Effluent ≤2.5 mg/L	

	Raw ≥8.0 mg/L; Effluent ≤3 mg/L	

4.0 Treatment Technologies

4.1 Pre-Disinfection

Prior to primary disinfection, raw water is treated ensure that the treated water will meet quality requirements. Based on the Great Pond raw water quality, this pre-disinfection step will include the following:

- Coarse filtration
- Precursors removal through a treatment process

To protect downstream processes, raw water is proposed to flow through a series of coarse filtration steps. A roughing filter (60 to 100um effective pore size) followed by a fine filter (2 to 5 um effective pore size) will remove the larger material prior to the systems that will remove small and in-solution dissolved material. These coarse filtration processes will likely be self-cleaning and will generate waste streams. An optional, disposable cartridge filter system may in addition be provided to capture material that passes through the upstream filtration system. The cartridge filter is designed to protect downstream treatment processes (esp. membrane systems).

Following coarse filtration, further treatment of the raw water will be provided. One of the two commonly used technologies in the province that may be integrated into the treatment process include:

- Dissolved air flotation (DAF)
- Membrane filtration.

The objective of the above are to remove pre-cursors prior to primary and secondary disinfection that, as noted previously, will reduce raw water:

- Colour
- Turbidity
- TOC.

In addition, by improving the above, the UV Transmittance (UVT) of the water will increase which will improve the efficacy of the UV system.

<u>DAF System</u>

The DAF system would be an off-the-shelf system that would add coagulant to a mixing chamber, followed by a flocculation and then filtration through the DAF process. The objective of the coagulant is to generate particulates by reacting water constituents (e.g. DOC) with the flocculant. Rather than having the solids generated during the flocculation period settle by gravity, air saturated into water under pressure is released into the DAF unit, forming fine air bubbles. These bubbles rise and carry the solids to the top of the tank where they are they collect and are skimmed off for solids handling. A typical flow schematic for a DAF is provided in **Figure 4-1** below.

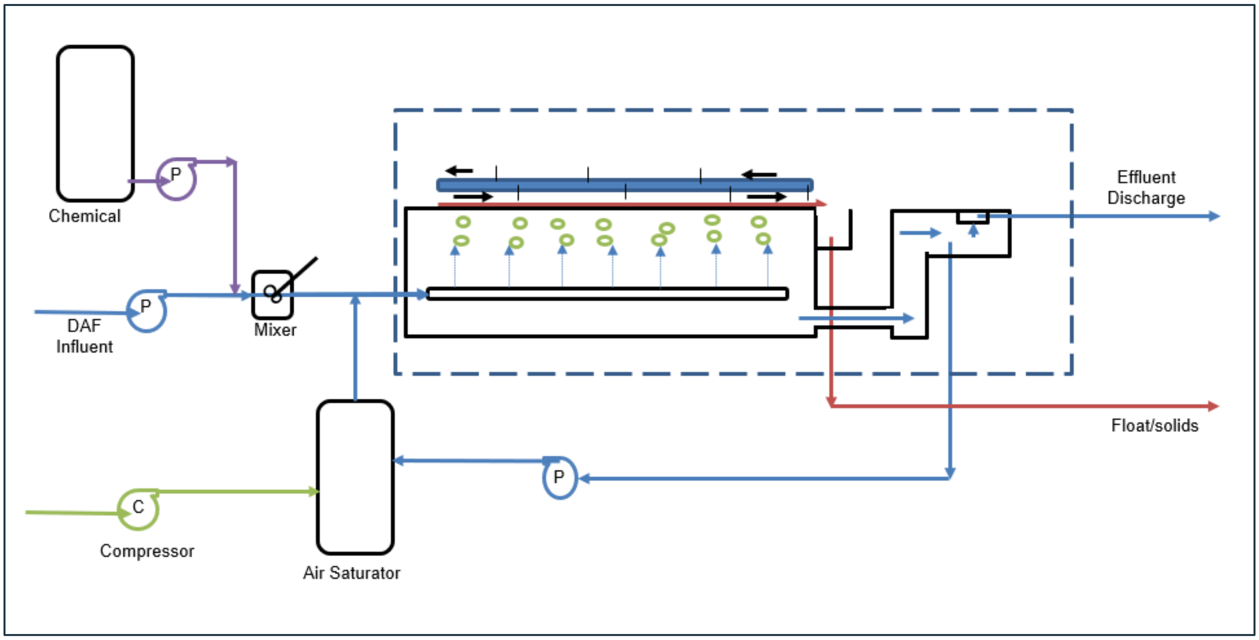


Figure 4-1: Typical DAF Configuration

<u>Membrane Filtration</u>

The membrane process utilizes very small pores to improve raw water quality with four categories of pore size identified as micro, ultra, nano and reverse osmosis. The nominal port size for each is provided below in **Table 4-1**. For potable water systems, the most commonly used membranes are nano and reverse osmosis.

Table 4-1: Membrane Pore Size

Membrane Type	Nominal Pore Size (um)
Micro (MF)	0.1 – 10
Ultra (UF)	0.01 – 0.1
Nano (NF)	0.001 – 0.01
Reverse Osmosis (RO)	<0.001

In the membrane process, pressurized water is passed over the membrane with most of the water passing through while some is not (reject water). The material rejected by the membranes remains in the reject water and concentrates as the more reject particles are scoured from the membrane. To maintain an adequate scouring velocity and improve the system efficiency with respect to reject generation, recirculation through the membrane system is often utilized. An alternative is to use a stage configuration where, the second membrane stage has fewer elements. By reducing the number of elements in the second stage, the scouring velocity can be maintained. A simplified schematic of a typical membrane system is provided below in **Figure 4-2**.

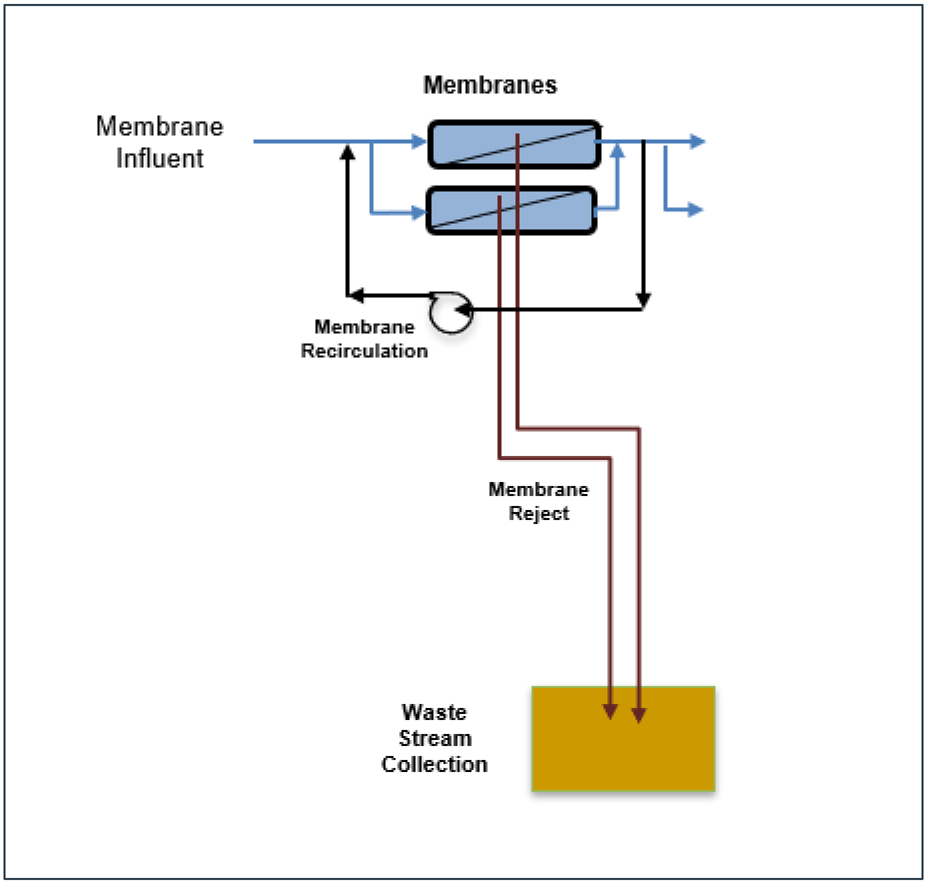


Figure 4-2: Typical Membrane Configuration

4.2 Disinfection

As noted previously, the primary and secondary disinfection processes are proposed to be UV and chlorine, respectively.

5.0 Typical System Process Flow Schematic

Utilizing the processes described previously and the membrane process as the pre-disinfection process, a facility process flow schematic for the Great Pond WTP is provided below in **Figure 5-1**.

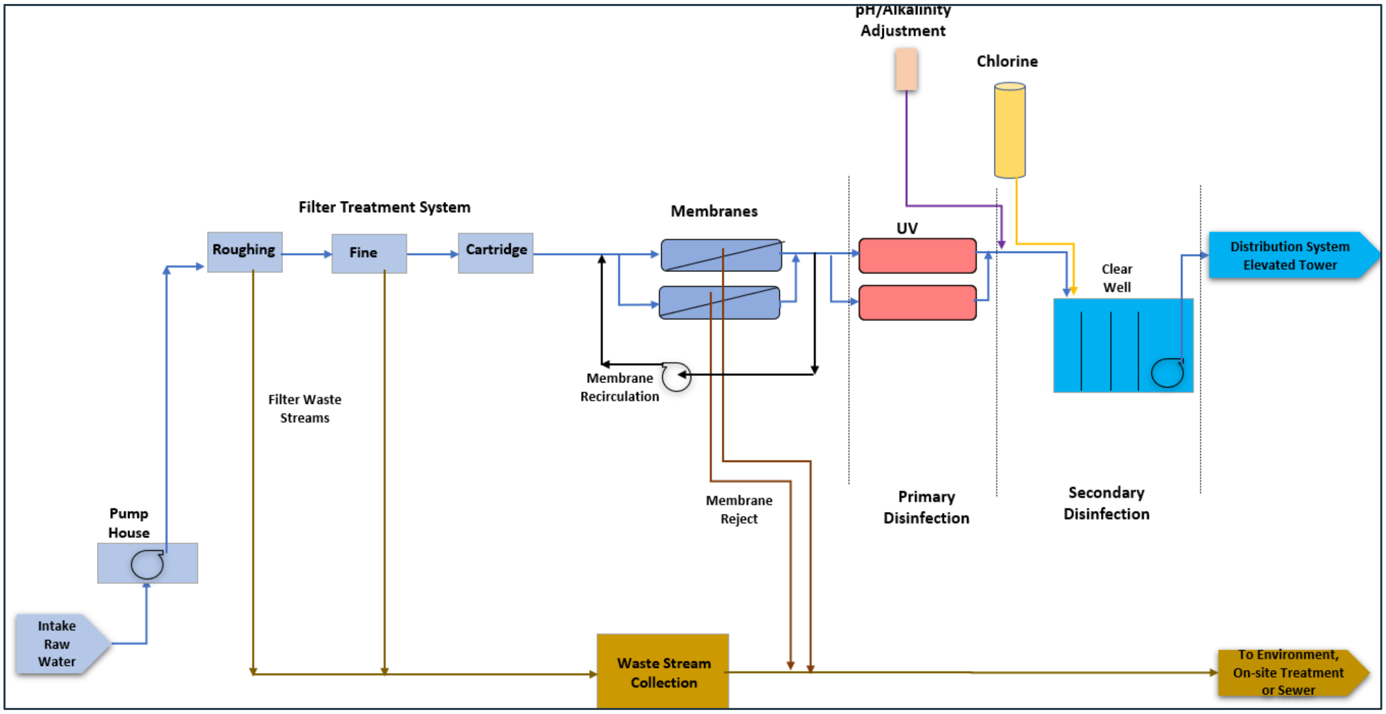


Figure 5-1: Great Pond WTP - Process Flow Diagram

6.0 Typical Facility Layout

The Great Pond WTP facility is composed of the following may components:

- Process area
- Clear well
- Electrical room
- Office/SCADA and/or Laboratory room
- Washroom/locker room (M&F)
- Shop/storage (garage)
- Waste stream discharge
- Back-up generator
- Finished water storage

Utilizing the membrane technology, a potential Great Pond WTP equipment layout is provided below in **Figure 6-1**. The facility is divided into several process areas including coarse filtration, membrane, disinfection (primary & secondary) and garage/maintenance. Potential locations for the washrooms, office and electrical room are also provided. The building has a footprint of approximately 33m x 15m. The items located outside of the treatment building (e.g. back-up generator) are shown in the facility siting section that follows.

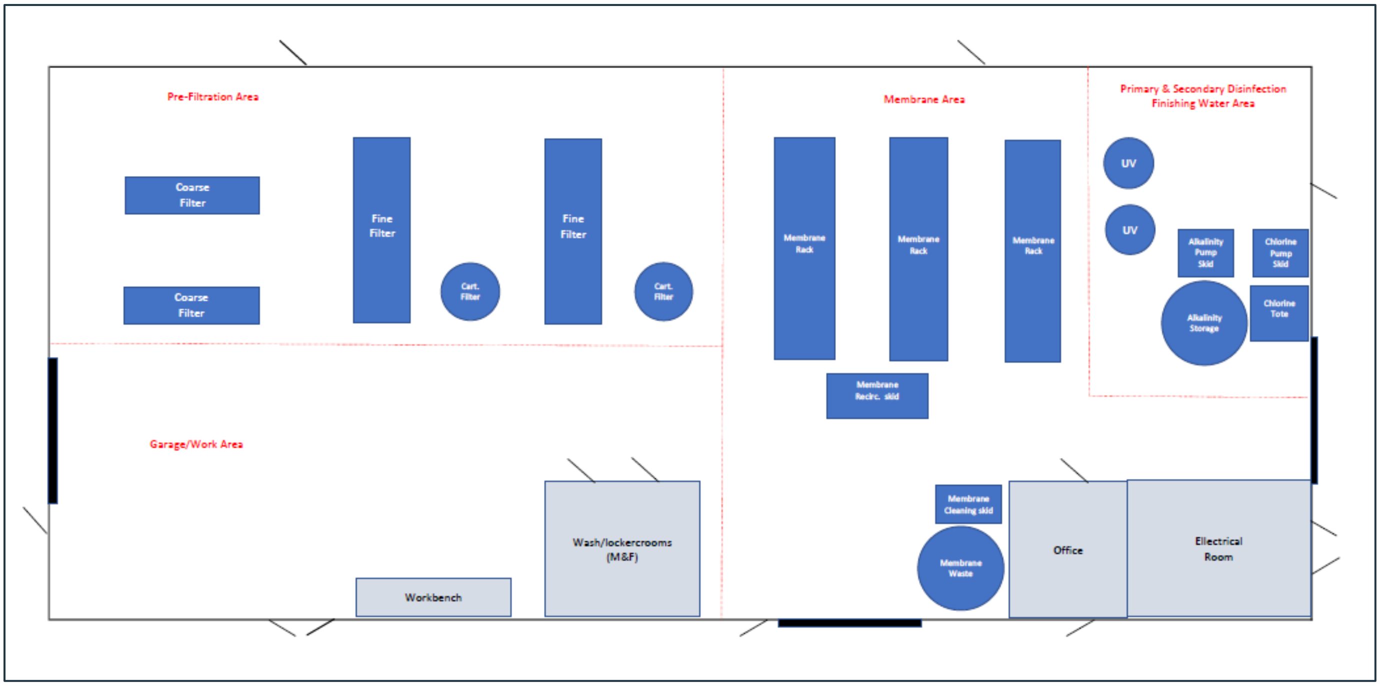


Figure 6-1: Great Pond WTP – Process Layout

7.0 Facility Siting

The Great Pond WTP is proposed to be located at the north end of the Pond. The facility location and features are provided in **Appendix B**. The site includes features including:

- Intake pipe (deepest part of pond)
- Treatment building
- Backup generator
- Great Pond discharge stream
- Pond overflow control structure and fishway
- Proposed elevated finished water storage tank north and east of plant

The process building would include at its southern extreme, an influent pump station to draw water from Great Pond. A second pump station to the north of the building would direct finished water to the elevated finished water storage tank. The backup generator would be sized to provide full electrical power to the plant in case of power loss and is proposed to be an exterior pad mounted system with a 24-hour supply of diesel fuel. It has been assumed that the waste streams generated by the process will be returned to the environment using a rock sump system

8.0 References

2021, "Drinking Water Treatment Standards for Newfoundland & Labrador", Department of Environment and Climate hange Water Resources Management Division, April 19, 2021.

9.0 Closure

Great Pond can add significant capacity to the Town of Torbay's potable water supply. A facility layout utilizing the membrane technology will be able to meet Provincial water quality standards and is proposed to be located at the north end of Great Pond.

Sincerely,

Wood Environment and Infrastructure Solutions
a Division of Wood Canada Limited

Prepared by:

DRAFT (no signatures provided)

Lars Sterne, P.Eng.
Senior Engineer

Reviewed by:

Susann Hickey, P.Eng.
Senior Engineer - Municipal

Appendix A – Great Pond Raw Water Sample Results (2019-2022)

wood.

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
pH		7-10.5	-	**6.48**	**6.31**	**6.08**	**6.14**
Reactive Silica as SiO2	mg/L	-	0.5	<0.5	2.2	1.6	1.7
Chloride	mg/L	250 [2]	1	14	12	11	12
Fluoride	mg/L	1.5 [1]	0.12	<0.12	<0.12	<0.12	<0.12
Sulphate	mg/L	500 [2]	2	3	2	2	<2
Alkalinity	mg/L	-	5	<5	<5	<5	<5
True Color	TCU	15 [2]	5	10	**21**	**25**	**21**
Turbidity	NTU	<0.3/<1/<0.1	0.1	**3.3**	**1.5**	**0.9**	**0.9**
Electrical Conductivity	umho/cm	-	1	66	60	60	56
Nitrate + Nitrite as N	mg/L	-	0.05	<0.05	<0.05	<0.05	0.17
Nitrate as N	mg/L	10 [1]	0.05	<0.05	<0.05	<0.05	0.17
Nitrite as N	mg/L	1 [1]	0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	-	0.03	0.10	0.10	0.08	<0.03
Total Organic Carbon	mg/L	-	0.5	3.6	4.3	3.5	5.3
Ortho-Phosphate as P	mg/L	-	0.01	<0.01	<0.01	<0.01	0.01
Total Sodium	mg/L	200 [2]	0.1	11.0	8.4	9.3	7.1
Total Potassium	mg/L	-	0.1	0.6	0.5	0.4	0.4
Total Calcium	mg/L	-	0.1	1.8	1.3	1.9	1.1
Total Magnesium	mg/L	-	0.1	1.0	0.9	0.9	0.7
Bicarb. Alkalinity (as CaCO3)	mg/L	-	5	<5	<5	<5	<5
Carb. Alkalinity (as CaCO3)	mg/L	-	10	<10	<10	<10	<10
Hydroxide	mg/L	-	5	<5	<5	<5	<5
Calculated TDS	mg/L	-	1	32	25	26	22
Hardness	mg/L	-	-	8.6	7.0	8.5	5.6
Langelier Index (@20C)	NA	-	-	-4.11	-4.41	-4.48	-4.65
Langelier Index (@ 4C)	NA	-	-	-4.43	-4.73	-4.80	-4.97
Saturation pH (@ 20C)	NA	-	-	10.6	10.7	10.6	10.8
Saturation pH (@ 4C)	NA	-	-	10.9	11.0	10.9	11.1
Anion Sum	me/L	-	-	0.46	0.38	0.35	0.35
Cation sum	me/L	-	-	0.68	0.53	0.60	0.45
% Difference/ Ion Balance	%	-	-	19.8	16.7	26.3	12.4
Total Aluminum	ug/L	100 [3]	5	39	65	48	84
Total Antimony	ug/L	6 [1]	2	<2	<2	<2	<2
Total Arsenic	ug/L	1000 [1]	2	3	<2	<2	<2
Total Barium	ug/L	2000 [1]	5	<5	<5	<5	<5

wood.

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS							
Parameter	**Unit**	**GCDWQ**	**RDL**	**Great Pond**			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
Total Beryllium	ug/L	-	2	<2	<2	<2	<2
Total Bismuth	ug/L	-	2	<2	<2	<2	<2
Total Boron	ug/L	5000 [1]	5	16	6	8	7
Total Cadmium	ug/L	7 [1]	0.09	<0.09	<0.017	<0.017	<0.017
Total Chromium	ug/L	50 [1]	1	<1	<1	<1	<1
Total Cobalt	ug/L	-	1	<1	<1	<1	<1
Total Copper	ug/L	2000 [1]/1 [2]	1	<1	<1	<1	<1
Total Iron	ug/L	300 [2]	50	122	<50	186	209
Total Lead	ug/L	5 [1]	0.5	<0.5	<0.5	<0.5	<0.5
Total Manganese	ug/L	120 [1]/20 [2]	2	**39**	**23**	**39**	**41**
Total Molybdenum	ug/L	-	2	<2	<2	<2	<2
Total Nickel	ug/L	-	2	<2	<2	<2	<2
Total Phosphorous	mg/L	-	0.02	0.03	0.05	0.35	<0.1
Total Selenium	ug/L	50 [1]	1	<1	<1	<1	<1
Total Silver	ug/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L	7000 [1]	5	9	6	10	6
Total Thallium	ug/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Total Tin	ug/L	-	2	<2	<2	<2	<2
Total Titanium	ug/L	-	2	<2	<2	<2	2
Total Uranium	ug/L	20 [1]	0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium	ug/L	-	2	7	<2	<2	<2
Total Zinc	ug/L	5000 [2]	5	<5	<5	<5	<5

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

[3] OG: Operational Guideline

The cation and anion sums are at, or below, 1 me/L, therefore the acceptable criteria is a difference of less than 0.3me/L.

wood.

TABLE 4: GREAT POND HYDROCARBONS							
Parameter	**Unit**	**GCDWQ**	**RDL**	**Great Pond**			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
Benzene	mg/L	0.005 [1]	0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	0.06 [1]/0.024 [2]	0.001	<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.14 [1]/0.0016 [2]	0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	0.09 [1]/0.02 [2]	0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	mg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L	-	0.10	<0.10	<0.10	<0.10	<0.10
>C21-C32 Hydrocarbons	mg/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH (Tier 1)	mg/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Resemblance Comment		-	-	NR	NR	NR	NR
Return to Baseline at C32		-	-	Y	Y	Y	Y
Isobutylbenzene - EPH	%	-	-	85	93	88	101
Isobutylbenzene - VPH	%	-	-	98	113	113	93
n-Dotriacontane - EPH	%	-	-	90	99	88	104

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

Resemblance Comment Key: GF - Gasoline Fraction, WGF - Weathered Gasoline Fraction, GR - Product in Gasoline Range, FOF - Fuel Oil Fraction, WFOF - Weathered Fuel Oil Fraction, FR - Product in Fuel Oil Range, LOF - Lube Oil Fraction, LR - Lube Range, UC - Unidentified Compounds, NR - No Ressemblance, NA - Not Applicable

wood.

TABLE 6: GREAT POND POLYAROMATIC HYDROCARBONS							
Parameter	**Unit**	**GCDWQ**	**RDL**	**Great Pond**			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
1-Methylnaphthalene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Acridine	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	ug/L	-	0.012	<0.012	<0.012	<0.012	<0.012
Benzo(a)anthracene	ug/L	-	0.018	<0.018	<0.018	<0.018	<0.018
Benzo(a)pyrene	ug/L	0.04	0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Perylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Nitrobenzene-d5	%	-	-	116	58	80	122
2-Fluorobiphenyl	%	-	-	114	62	78	64
Terphenyl-d14	%	-	-	85	51	96	83

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

TABLE 8: GREAT POND PESTICIDES AND HERBICIDES

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
Pesticides							
Gamma-Hexachlorocyclohexane	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
Chlordane	µg/L	-	0.04	<0.04	<0.04	<0.04	<0.04
DDE	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
DDD	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
DDT	µg/L	-	0.04	<0.04	<0.04	<0.04	<0.04
Dieldrin	µg/L	-	0.02	<0.02	<0.02	<0.02	<0.02
Endrin	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	µg/L	-	0.04	<0.04	<0.04	<0.04	<0.04
Hexachlorobenzene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Hexachlorobutadiene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Hexachloroethane	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
TCMX	%	-	-	81	68	83	88
Decachlorobiphenyl	%	-	-	82	79	84	95
Phorate	µg/L	2	0.5	<0.5	<0.5	<0.5	<0.5
Dimethoate	µg/L	-	2.5	<2.5	<2.5	<2.5	<2.5
Terbufos	µg/L	1	0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	µg/L	-	1	<1	<1	<1	<1
Malathion	µg/L	190	5	<5	<5	<5	<5
Chlorpyrifos	µg/L	-	1	<1	<1	<1	<1
Parathion	µg/L	-	1	<1	<1	<1	<1
Azinphos-methyl	µg/L	20	2	<2	<2	<2	<2
Herbicides							
2,4-D	µg/L	100	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-T	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-TP	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Dicamba	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5

TABLE 8: GREAT POND PESTICIDES AND HERBICIDES							
Parameter	**Unit**	**GCDWQ**	**RDL**	**Great Pond**			
Sample Date (DD/MM/YYYY)				**26/06/2019**	**18/07/2019**	**08/06/2020**	**15/10/2020**
Dichlorprop	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Dinoseb	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Picloram	µg/L	190	0.5	<0.5	<0.5	<0.5	<0.5
Diclofop-methyl	µg/L	9	0.5	<0.5	<0.5	<0.5	<0.5
2,3,4,6-Tetrachlorophenol	µg/L	100	0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dichlorophenol	µg/L	900	0.2	<0.2	<0.2	<0.2	<0.2
2,4,5-Trichlorophenol	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol	µg/L	5	0.5	<0.5	<0.5	<0.5	<0.5
Bromoxynil	µg/L	5	0.3	<0.3	<0.3	<0.3	<0.3
MCPA	ug/L	100	5.0	<5.0	<5.0	<5.0	<5.0
MCPP	µg/L	-	5.0	<5.0	<5.0	<5.0	<5.0
Pentachlorophenol	µg/L	60	0.1	<0.1	<0.1	<0.1	<0.1
DCAA	%	-	-	85	108	114	80

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.

DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.

DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.

Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.

Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane.

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/23/2021**	**7/6/2021**	**10/14/2021**	**12/20/2021**
Laboratory Sample ID				**2378544**	**2708864**	**3092897**	**3380837**
pH		7-10.5	-	**5.87**	**6.25**	**6.31**	**6.36**
Reactive Silica as SiO2	mg/L	-	0.5	2.3	<0.5	1.1	3.8
Chloride	mg/L	250 [2]	1	9	13	12	13
Fluoride	mg/L	1.5 [1]	0.12	<0.12	<0.12	<0.12	<0.12
Sulphate	mg/L	500 [2]	2	2	17	2	2
Alkalinity	mg/L	-	5	<5	<5	<5	<5
True Color	TCU	15 [2]	5	**32.7**	9.02	12.2	39.4
Turbidity	NTU	<0.3/<1/<0.1	varies	**1.1**	**3.4**	**1.4**	**1.7**
Electrical Conductivity	umho/cm	-	1	48	57	59	68
Nitrate + Nitrite as N	mg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
Nitrate as N	mg/L	10 [1]	0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as N	mg/L	1 [1]	0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	-	0.03	<0.03	<0.03	1.12	<0.03
Total Organic Carbon	mg/L	-	1	5.0	3.5	3.8	8.0
Ortho-Phosphate as P	mg/L	-	0.01	0.02	<0.01	<0.01	<0.01
Total Sodium	mg/L	200 [2]	varies	7.6	7.7	7.8	9.8
Total Potassium	mg/L	-	varies	0.5	0.5	0.4	<1.15
Total Calcium	mg/L	-	varies	1.7	1.3	1.2	1.8
Total Magnesium	mg/L	-	varies	0.7	0.7	0.8	1.4
Bicarb. Alkalinity (as CaCO3)	mg/L	-	5	<5	<5	<5	<5
Carb. Alkalinity (as CaCO3)	mg/L	-	10	<10	<10	<10	<10
Hydroxide	mg/L	-	5	<5	<5	<5	<5
Calculated TDS	mg/L	-	1	22	41	26	28
Hardness	mg/L	-	-	7.1	6.1	6.3	10.1
Langelier Index (@20C)	NA	-	-	-4.73	-4.49	-4.45	-4.23
Langelier Index (@ 4C)	NA	-	-	-5.05	-4.81	-4.77	-4.55
Saturation pH (@ 20C)	NA	-	-	10.6	10.7	10.8	10.6
Saturation pH (@ 4C)	NA	-	-	10.9	11.1	11.1	10.9
Anion Sum	me/L	-	-	0.30	0.72	0.38	0.41
Cation sum	me/L	-	-	0.51	0.49	0.56	0.64
% Difference/ Ion Balance	%	-	-	26.9	19.3	19.4	22.3
Total Aluminum	ug/L	100 [3]	varies	**163**	70	30	**103**
Total Antimony	ug/L	6 [1]	varies	<2	<2	<2	<3.0
Total Arsenic	ug/L	1000 [1]	varies	<2	<2	<2	<3.0
Total Barium	ug/L	2000 [1]	varies	<5	<5	<5	2.9
Total Beryllium	ug/L	-	varies	<2	<2	<2	<0.50
Total Bismuth	ug/L	-	2	<2	<2	<2	<2.0
Total Boron	ug/L	5000 [1]	varies	6	5	5	11
Total Cadmium	ug/L	7 [1]	varies	<0.09	<0.09	<0.09	<0.10
Total Chromium	ug/L	50 [1]	varies	<1	<1	<1	<3.0
Total Cobalt	ug/L	-	varies	<1	<1	<1	<0.50
Total Copper	ug/L	2000 [1]/1 [2]	1	<1	<1	1	<1.0
Total Iron	ug/L	300 [2]	50	195	184	89	154
Total Lead	ug/L	5 [1]	varies	<0.5	<0.5	<0.5	<1.0
Total Manganese	ug/L	120 [1]/20 [2]	2	**31**	**65**	**22**	16.3
Total Molybdenum	ug/L	-	2	<2	<2	<2	<2.0
Total Nickel	ug/L	-	varies	<2	<2	<2	<3.0
Total Phosphorous	mg/L	-	varies	0.05	0.04	0.03	<0.10
Total Selenium	ug/L	50 [1]	1	<1	<1	<1	<1.0
Total Silver	ug/L	-	0.1	<0.1	<0.1	<0.1	<0.10

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/23/2021**	**7/6/2021**	**10/14/2021**	**12/20/2021**
Total Strontium	ug/L	7000 [1]	5	9	5	5	9.1
Total Thallium	ug/L	-	varies	<0.1	<0.1	<0.1	<0.30
Total Tin	ug/L	-	2	<2	<2	<2	<2.0
Total Titanium	ug/L	-	varies	4	<2	<2	<10.0
Total Uranium	ug/L	20 [1]	varies	<0.2	<0.2	<0.2	<0.50
Total Vanadium	ug/L	-	2	<2	<2	<2	<2.0
Total Zinc	ug/L	5000 [2]	varies	8	<5	<5	<20

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

[3] OG: Operational Guideline

The cation and anion sums are at, or below, 1 me/L, therefore the acceptable criteria is a difference of less than 0.3me/L.

TABLE 4: GREAT POND HYDROCARBONS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				4/23/2021	4/23/2021	10/14/2021	12/20/2021
Benzene	mg/L	0.005 [1]	0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	0.06 [1]/0.024 [2]	0.001	<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.14 [1]/0.0016 [2]	0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	0.09 [1]/0.02 [2]	0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	mg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L	-	0.10	<0.05	<0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH (Tier 1)	mg/L	-	0.1	<0.1	<0.1	<0.1	<0.1
Resemblance Comment		-	-	NR	NR	NR	NR
Return to Baseline at C32		-	-	Y	Y	Y	Y
Isobutylbenzene - EPH	%	-	-	109	76	118	108
Isobutylbenzene - VPH	%	-	-	84	99	96	86
n-Dotriacontane - EPH	%	-	-	113	72	119	104

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

Resemblance Comment Key: GF - Gasoline Fraction, WGF - Weathered Gasoline Fraction, GR - Product in Gasoline Range, FOF - Fuel Oil Fraction, WFOF - Weathered Fuel Oil Fraction, FR - Product in Fuel Oil Range, LOF - Lube Oil Fraction, LR - Lube Range, UC - Unidentified Compounds, NR - No Ressemblance, NA - Not Applicable

TABLE 6: GREAT POND POLYAROMATIC HYDROCARBONS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				4/23/2021	7/6/2021	10/14/2021	12/20/2021
1-Methylnaphthalene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	ug/L	-	0.01	<0.01	0.01	<0.01	<0.01
Acenaphthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Acridine	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	ug/L	-	0.012	<0.012	<0.012	<0.012	<0.012
Benzo(a)anthracene	ug/L	-	0.018	<0.018	<0.018	<0.018	<0.018
Benzo(a)pyrene	ug/L	0.04	0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(j+k)fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Perylene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene-d8	%	-	1	81	82	69	90
Terphenyl-d14	%	-	1	84	93	77	96
Pyrene-d10	%	-	1	88	107	73	89

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Benzo(j+k)fluoranthene is not an accredited parameter.

TABLE 8: GREAT POND PESTICIDES AND HERBICIDES

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				4/23/2021	7/6/2021	10/14/2021	12/20/2021
Pesticides							
Gamma-Hexachlorocyclohexane	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	µg/L	-	0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan	µg/L	-	0.002	<0.002	<0.002	<0.002	<0.002
Chlordane	µg/L	-	0.1	<0.1	<0.1	<0.1	<0.1
DDE	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
DDD	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
DDT	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	µg/L	-	0.02	<0.02	<0.02	<0.02	<0.02
Endrin	µg/L	-	0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	µg/L	-	0.04	<0.04	<0.04	<0.04	<0.04
Hexachlorobenzene	ug/L	-	0.01	<0.01	<0.01	<0.01	<0.01
TCMX	%	-	-	80	106	73	85
Decachlorobiphenyl	%	-	-	82	113	97	84
Phorate	µg/L	2	0.5	<0.5	<0.5	<0.5	<0.5
Dimethoate	µg/L	-	2.5	<2.5	<2.5	<2.5	<2.5
Terbufos	µg/L	1	0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	µg/L	-	1	<1	<1	<1	<1
Malathion	µg/L	190	5	<5	<5	<5	<5
Chlorpyrifos	µg/L	-	1	<1	<1	<1	<1
Parathion	µg/L	-	1	<1	<1	<1	<1
Azinphos-methyl	µg/L	20	2	<2	<2	<2	<2
Herbicides							
2,4-D	µg/L	100	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-T	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-TP	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Dicamba	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Dichlorprop	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Dinoseb	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
Picloram	µg/L	190	0.5	<0.5	<0.5	<0.5	<0.5
Diclofop-methyl	µg/L	9	0.5	<0.5	<0.5	<0.5	<0.5
2,3,4,6-Tetrachlorophenol	µg/L	100	0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dichlorophenol	µg/L	900	0.2	<0.2	<0.2	<0.2	<0.2
2,4,5-Trichlorophenol	µg/L	-	0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol	µg/L	5	0.5	<0.5	<0.5	<0.5	<0.5
Bromoxynil	µg/L	5	0.3	<0.3	<0.3	<0.3	<0.3
MCPA	ug/L	100	5.0	<5.0	<5.0	<5.0	<5.0
MCPP	µg/L	-	5.0	<5.0	<5.0	<5.0	<5.0
Pentachlorophenol	µg/L	60	0.1	<0.1	<0.1	<0.1	<0.1
DCAA	%	-	-	110	80	109	88

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.

DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.

DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.

Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.

Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane.

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/21/2022**	**6/22/2022**		
Laboratory Sample ID				**3769719**	**4011375**		
pH		7-10.5	-	**5.87**	**6.42**		
Reactive Silica as SiO_2	mg/L	-	0.5	1.9	0.9		
Chloride	mg/L	250 [2]	1	13	12		
Fluoride	mg/L	1.5 [1]	0.12	<0.12	<0.12		
Sulphate	mg/L	500 [2]	2	2	<2		
Alkalinity	mg/L	-	5	<5	<5		
True Color	TCU	15 [2]	5.00	**15**	9.71		
Turbidity	NTU	<0.3/<1/<0.1	0.5	**2.2**	**4.5**		
Electrical Conductivity	umho/cm	-	1	63	63		
Nitrate + Nitrite as N	mg/L	-	0.05	0.06	<0.05		
Nitrate as N	mg/L	10 [1]	0.05	0.06	<0.05		
Nitrite as N	mg/L	1 [1]	0.05	<0.05	<0.05		
Ammonia as N	mg/L	-	0.03	<0.03	<0.03		
Total Organic Carbon	mg/L	-	0.5	3.9	4.8		
Ortho-Phosphate as P	mg/L	-	0.01	<0.01	0.01		
Total Sodium	mg/L	200 [2]	0.1	9.8	8.8		
Total Potassium	mg/L	-	0.1	0.4	0.4		
Total Calcium	mg/L	-	0.1	1.3	1.6		
Total Magnesium	mg/L	-	0.1	0.8	0.9		
Bicarb. Alkalinity (as $CaCO_3$)	mg/L	-	5	<5	<5		
Carb. Alkalinity (as $CaCO_3$)	mg/L	-	10	<10	<10		
Hydroxide	mg/L	-	5	<5	<5		
Calculated TDS	mg/L	-	1	28	24		
Hardness	mg/L	-	-	6.5	7.7		
Langelier Index (@20C)	NA	-	-	-4.85	-4.21		
Langelier Index (@ 4C)	NA	-	-	-5.17	-4.53		
Saturation pH (@ 20C)	NA	-	-	10.7	10.6		
Saturation pH (@ 4C)	NA	-	-	11.0	11.0		
Anion Sum	me/L	-	-	0.41	0.34		
Cation sum	me/L	-	-	0.58	0.55		
% Difference/ Ion Balance	%	-	-	16.8	24.2		
Total Aluminum	ug/L	100 [3]	5	68	44		
Total Antimony	ug/L	6 [1]	2	<2	<2		
Total Arsenic	ug/L	1000 [1]	2	<2	<2		
Total Barium	ug/L	2000 [1]	5	<5	<5		
Total Beryllium	ug/L	-	2	<2	<2		
Total Bismuth	ug/L	-	2	<2	<2		
Total Boron	ug/L	5000 [1]	5	5	<5		
Total Cadmium	ug/L	7 [1]	0.09	<0.09	<0.09		
Total Chromium	ug/L	50 [1]	1	<1	<1		
Total Cobalt	ug/L	-	1	<1	<1		
Total Copper	ug/L	2000 [1]/1 [2]	1	<1	<1		
Total Iron	ug/L	300 [2]	50	74	57		
Total Lead	ug/L	5 [1]	0.5	<0.5	<0.5		
Total Manganese	ug/L	120 [1]/20 [2]	3	12	**28**		
Total Molybdenum	ug/L	-	2	<2	<2		
Total Nickel	ug/L	-	2	<2	<2		
Total Phosphorous	mg/L	-	0.02	0.03	<0.02		
Total Selenium	ug/L	50 [1]	1.0	<1	<1.0		
Total Silver	ug/L	-	0.1	<0.1	<0.1		

TABLE 2: GREAT POND GENERAL CHEMISTRY AND METALS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/21/2022**	**6/22/2022**		
Total Strontium	ug/L	7000 [1]	5	6	7		
Total Thallium	ug/L	-	0.2	<0.1	<0.2		
Total Tin	ug/L	-	3	<2	<3		
Total Titanium	ug/L	-	3	<2	<3		
Total Uranium	ug/L	20 [1]	0.2	<0.2	<0.2		
Total Vanadium	ug/L	-	2	<2	<2		
Total Zinc	ug/L	5000 [2]	5	<5	<5		

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

[3] OG: Operational Guideline

The cation and anion sums are at, or below, 1 me/L, therefore the acceptable criteria is a difference of less than 0.3me/L.

TABLE 4: GREAT POND HYDROCARBONS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/21/2022**	**6/22/2022**		
Benzene	mg/L	0.005 [1]	0.001	<0.001	<0.001		
Toluene	mg/L	0.06 [1]/0.024 [2]	0.001	<0.001	<0.001		
Ethylbenzene	mg/L	0.14 [1]/0.0016 [2]	0.001	<0.001	<0.001		
Xylene (Total)	mg/L	0.09 [1]/0.02 [2]	0.002	<0.002	<0.002		
C6-C10 (less BTEX)	mg/L	-	0.01	<0.01	<0.01		
>C10-C16 Hydrocarbons	mg/L	-	0.05	<0.05	<0.05		
>C16-C21 Hydrocarbons	mg/L	-	0.10	<0.05	<0.05		
>C21-C32 Hydrocarbons	mg/L	-	0.1	<0.1	<0.1		
Modified TPH (Tier 1)	mg/L	-	0.1	<0.1	<0.1		
Resemblance Comment		-	-	NR	NR		
Return to Baseline at C32		-	-	Y	Y		
Isobutylbenzene - EPH	%	-	-	108	107		
Isobutylbenzene - VPH	%	-	-	78	100		
n-Dotriacontane - EPH	%	-	-	110	106		

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

[1] MAC: Maximum Acceptable Concentration

[2] AO: Aesthetic Objective

Resemblance Comment Key: GF - Gasoline Fraction, WGF - Weathered Gasoline Fraction, GR - Product in Gasoline Range, FOF - Fuel Oil Fraction, WFOF - Weathered Fuel Oil Fraction, FR - Product in Fuel Oil Range, LOF - Lube Oil Fraction, LR - Lube Range, UC - Unidentified Compounds, NR - No Ressemblance, NA - Not Applicable

TABLE 6: GREAT POND POLYAROMATIC HYDROCARBONS

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				**4/21/2022**	**6/22/2022**		
1-Methylnaphthalene	ug/L	-	0.01	<0.01	<0.01		
2-Methylnaphthalene	ug/L	-	0.01	<0.01	0.01		
Acenaphthene	ug/L	-	0.01	<0.01	<0.01		
Acenaphthylene	ug/L	-	0.01	<0.01	<0.01		
Acridine	ug/L	-	0.01	<0.01	<0.01		
Anthracene	ug/L	-	0.012	<0.012	<0.012		
Benzo(a)anthracene	ug/L	-	0.018	<0.018	<0.018		
Benzo(a)pyrene	ug/L	0.04	0.010	<0.010	<0.010		
Benzo(b)fluoranthene	ug/L	-	0.01	<0.01	<0.01		
Benzo(e)pyrene	ug/L	-	0.01	<0.01	<0.01		
Benzo(ghi)perylene	ug/L	-	0.01	<0.01	<0.01		
Benzo(j+k)fluoranthene	ug/L	-	0.01	<0.01	<0.01		
Chrysene	ug/L	-	0.01	<0.01	<0.01		
Dibenzo(a,h)anthracene	ug/L	-	0.01	<0.01	<0.01		
Fluoranthene	ug/L	-	0.01	<0.01	<0.01		
Fluorene	ug/L	-	0.01	<0.01	<0.01		
Indeno(1,2,3-cd)pyrene	ug/L	-	0.01	<0.01	<0.01		
Naphthalene	ug/L	-	0.01	<0.01	<0.01		
Perylene	ug/L	-	0.01	<0.01	<0.01		
Phenanthrene	ug/L	-	0.01	<0.01	<0.01		
Pyrene	ug/L	-	0.01	<0.01	<0.01		
Quinoline	ug/L	-	0.01	<0.01	<0.01		
Naphthalene-d8	%	-	1	94	87		
Terphenyl-d14	%	-	1	78	93		
Pyrene-d10	%	-	1	78	101		

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Benzo(j+k)fluoranthene is not an accredited parameter.

TABLE 8: GREAT POND PESTICIDES AND HERBICIDES

Parameter	Unit	GCDWQ	RDL	Great Pond			
Sample Date (YYYY-MM-DD)				4/21/2022	6/22/2022		
Pesticides							
Gamma-Hexachlorocyclohexane	µg/L	-	0.01	<0.01	<0.01		
Heptachlor	µg/L	-	0.01	<0.01	<0.01		
Aldrin	µg/L	-	0.01	<0.01	<0.01		
Heptachlor Epoxide	µg/L	-	0.01	<0.01	<0.01		
Endosulfan	µg/L	-	0.002	<0.002	<0.002		
Chlordane	µg/L	-	0.1	<0.1	<0.1		
DDE	µg/L	-	0.05	<0.05	<0.05		
DDD	µg/L	-	0.05	<0.05	<0.05		
DDT	µg/L	-	0.05	<0.05	<0.05		
Dieldrin	µg/L	-	0.02	<0.02	<0.02		
Endrin	µg/L	-	0.05	<0.05	<0.05		
Methoxychlor	µg/L	-	0.04	<0.04	<0.04		
Hexachlorobenzene	ug/L	-	0.01	<0.01	<0.01		
TCMX	%	-	-	98	86		
Decachlorobiphenyl	%	-	-	86	92		
Phorate	µg/L	2	0.5	<0.5	<0.5		
Dimethoate	µg/L	-	2.5	<2.5	<2.5		
Terbufos	µg/L	1	0.5	<0.5	<0.5		
Diazinon	µg/L	-	1	<1	<1		
Malathion	µg/L	190	5	<5	<5		
Chlorpyrifos	µg/L	-	1	<1	<1		
Parathion	µg/L	-	1	<1	<1		
Azinphos-methyl	µg/L	20	2	<2	<2		
Herbicides							
2,4-D	µg/L	100	0.5	<0.5	<0.5		
2,4,5-T	µg/L	-	0.5	<0.5	<0.5		
2,4,5-TP	µg/L	-	0.5	<0.5	<0.5		
Dicamba	µg/L	-	0.5	<0.5	<0.5		
Dichlorprop	µg/L	-	0.5	<0.5	<0.5		
Dinoseb	µg/L	-	0.5	<0.5	<0.5		
Picloram	µg/L	190	0.5	<0.5	<0.5		
Diclofop-methyl	µg/L	9	0.5	<0.5	<0.5		
2,3,4,6-Tetrachlorophenol	µg/L	100	0.5	<0.5	<0.5		
2,4-Dichlorophenol	µg/L	900	0.2	<0.2	<0.2		
2,4,5-Trichlorophenol	µg/L	-	0.5	<0.5	<0.5		
2,4,6-Trichlorophenol	µg/L	5	0.5	<0.5	<0.5		
Bromoxynil	µg/L	5	0.3	<0.3	<0.3		
MCPA	ug/L	100	5.0	<5.0	<5.0		
MCPP	µg/L	-	5.0	<5.0	<5.0		
Pentachlorophenol	µg/L	60	0.1	<0.1	<0.1		
DCAA	%	-	-	88	114		

Notes:

denotes exceedance

RDL: Reportable Detection Limit

-: Value not established or not calculated

GCDWQ: Guidelines for Canadian Drinking Water Quality

DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.

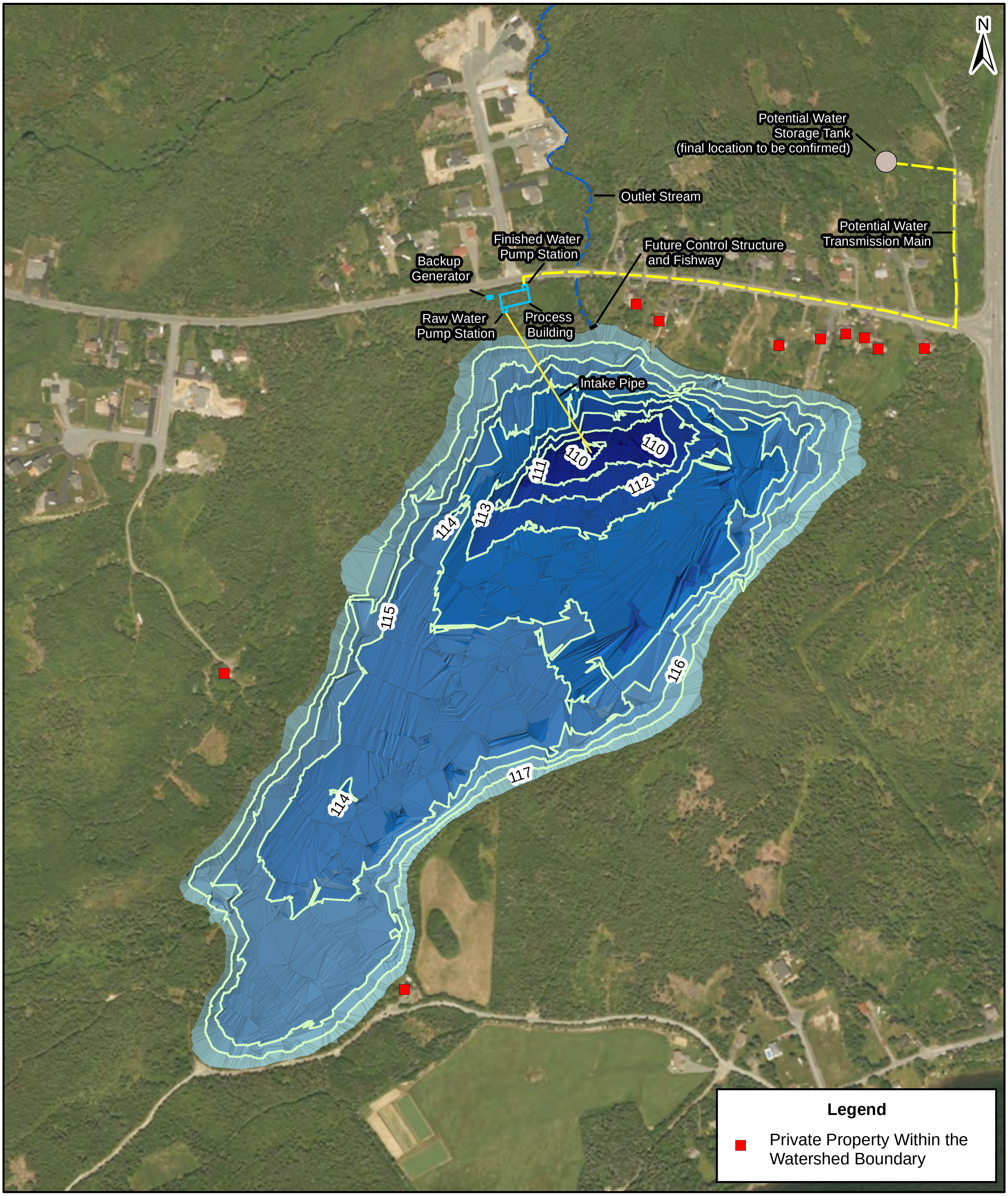
DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.

DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.

Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.

Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane.

Appendix B – Facility Siting



Wood 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: SEPTEMBER 2022
	CHKD BY: S. HICKEY		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 75 150 Meters	PROJECT TITLE: PROPOSED GREAT POND WATER SUPPLY INFRASTRUCTURE	DRAWING No. 1

APPENDIX B: Great Pond Fish and Fish Habitat

TOWN OF TORBAY
Great Pond Fish and Fish Habitat

Town of Torbay
1288 Torbay Road
P.O. Box 1160
Torbay, NL A1K 1K4

December 10, 2021
Project Number: TF1969415.2000

BASELINE REPORT

DRAFT

Great Pond Fish and Fish Habitat

Submitted to:

Town of Torbay

1288 Torbay Road

P.O. Box 1160

Torbay, NL

Submitted by:

Wood Environment & Infrastructure Solutions,

a Division of Wood Canada Limited

133 Crosbie Road

PO Box 13216

St. John's, NL A1B 4A5

10 December 2021

Wood Project #: TF1969415.2000

IMPORTANT NOTICE

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1.0 INTRODUCTION

The Town of Torbay is currently investigating the possibility of using Great Pond as a future water supply to accommodate increased demand for potable water. Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood) has been aiding in the investigations since 2019, when water level monitoring began. Water level has been monitored for over two years in the outflow of Great Pond with the objective of determining the long term capacity of Great Pond as a drinking water supply.

Figure 1-1: Western shoreline of Great Pond, October 2021

One of the possible public and regulatory issues with developing Great Pond as a water supply is the potential effect on fish and fish habitat. To better quantify the fish and fish habitat in the system, field surveys were completed during August 2021. Data collected throughout the Fish and Fish Habitat surveys will be incorporated into a Request for Project Review from Fisheries and Oceans Canada (DFO), which is part of the permitting phase for the Project. The Request for Project Review is anticipated to be prepared and submitted to DFO in early 2022.

2.0 METHODOLOGY

Presented below is a summary of the methodologies employed throughout the Great Pond fish and fish habitat sampling program. All field surveys were completed as per generally accepted techniques in the province of Newfoundland and Labrador (Scruton and Gibson 1995, Sooley et al. 1998, DFO 2012) and Wood Standard Operating Procedures (SOPs). All field staff involved in this program have been conducting similar programs throughout Newfoundland and Labrador for over 15 years.

2.1 Sample Areas

Field surveys completed in August 2021 were concentrated in Great Pond, the Great Pond Outflow and Big River downstream of Great Pond (Figure 2-1).

2.2 Riverine Habitat Assessment

Riverine habitat was surveyed in 2021 for physical habitat quantification, fish populations and benthic macroinvertebrate abundance and diversity. A summary of the methods used to measure each parameter is presented below.

2.2.1 Stream Surveys

Stream surveys were conducted as part of electrofishing and stream habitat compensation monitoring. The methods used to classify and quantify the aquatic habitat were based on standardized DFO methodologies such as Scruton and Gibson (1995), Sooley et al. (1998) and DFO (2012). Survey data collection consisted of a series of measurements for each habitat reach including:

- Channel dimensions (channel width, wetted width, ice scour height);
- Substrate composition (percentage of each class of substrate found within the stream bed, e.g., cobble, gravel);
- Instream features (discharge, water depths and velocity);
- Riparian vegetation (dominant species, percent cover, instream woody debris); and
- Upstream and downstream photos at each transect.
- A general habitat description was also used to classify each section of stream with similar habitat features (e.g., pool, riffle, run) and the quantity of each in the surveyed section of the stream.

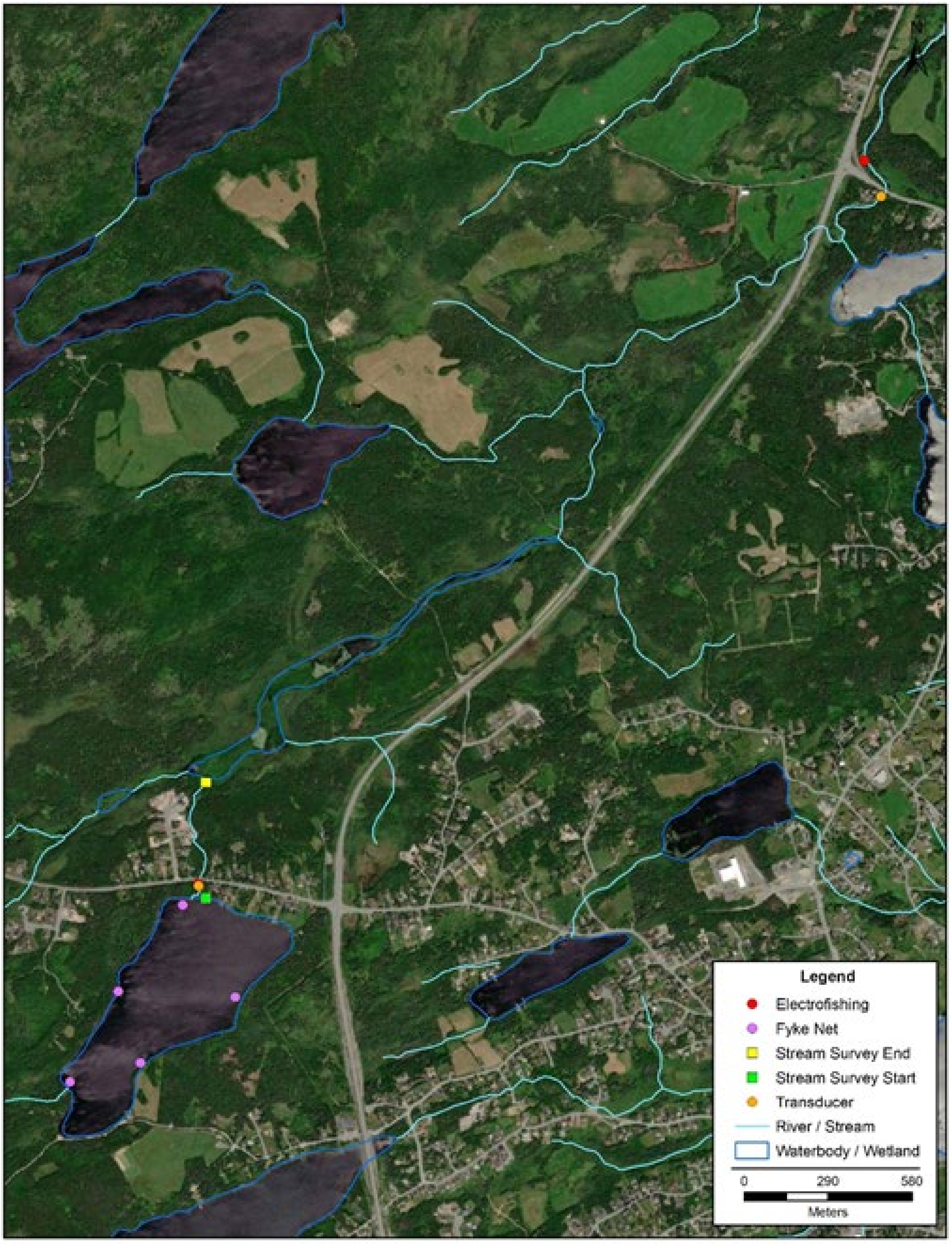


Figure 2-1: Great Pond Fish and Fish Habitat Assessment sampling locations

2.2.1 Instream Flow Monitoring

Habitat surveys at the outflow of Great Pond included an elevation survey that can be tied to existing LiDAR data. The elevation survey included a cross section of the base of the outlet river. Measurements were conducted using standard procedures as outlined in Sooley et al. (1998) and McCarthy et al. (2007). Standard measurements such as wetted width, water depth and mean water velocity were recorded across each transect. Depth was recorded using a metre stick while mean velocity will be recorded using a Global Flow Probe (Model 101a). Wood's standard flow equipment provides instantaneous calculation of mean water velocity at an accuracy of +0.01m/s. This data was also be used to calculate discharge rates for each survey transect.

A datalogger was installed at the outlet of Great Pond to conduct continuous flow monitoring. The elevation data collected from the datalogger was calibrated with flow data to create a flow curve.

2.2.2 Wetted Perimeter Modelling

The Wetted Perimeter Method (WPM) is a fixed flow hydraulic rating method based on the hydraulic relationship between flow (i.e. discharge) and wetted river perimeter at selected transect(s) (Stalnaker et al. 1995). Using the relationship, the flow corresponding to the wetted perimeter (wetted width of the stream transect), which is needed to minimally protect all habitats, can be estimated. Figure 2-2presents a schematic of a wetted perimeter/flow relationship and indicates the point of inflection for that relationship. The point of inflection is taken as the flow below which dewatering would take place rapidly for the represented habitat. Field surveys typically cover the range of natural flows. Where this is not achievable, Manning's equation can be applied to estimate extreme values. Manning's equation is given by:

$$V = \frac{R^{\frac{2}{3}} \times S^{\frac{1}{2}}}{n}$$

V	Velocity (m/s)
R	Hydraulic Radius (area/wetted perimeter)
S	Slope
n	Manning's n (roughness)

The cross-sections, or transects, selected to determine the minimum flow for habitat protection is very important in this technique. The selected transects for assessment must stand as an index habitat for the rest of the river or river section being assessed (Stalnaker et al. 1995). Riffles are typically selected because cross sections in these areas exhibit sensitivity of width, depth and velocity to changes in flow. They are usually the shallowest habitat type found and as such, would indicate adequate water levels needed to protect all habitats. Therefore, once a minimum level of flow is estimated for a riffle, it is assumed that other habitat areas, such as pools and runs, are also satisfactorily protected. Because the shape of the channel can influence the results of the analysis, transects are usually located in areas that are wide, shallow, and rectangular.

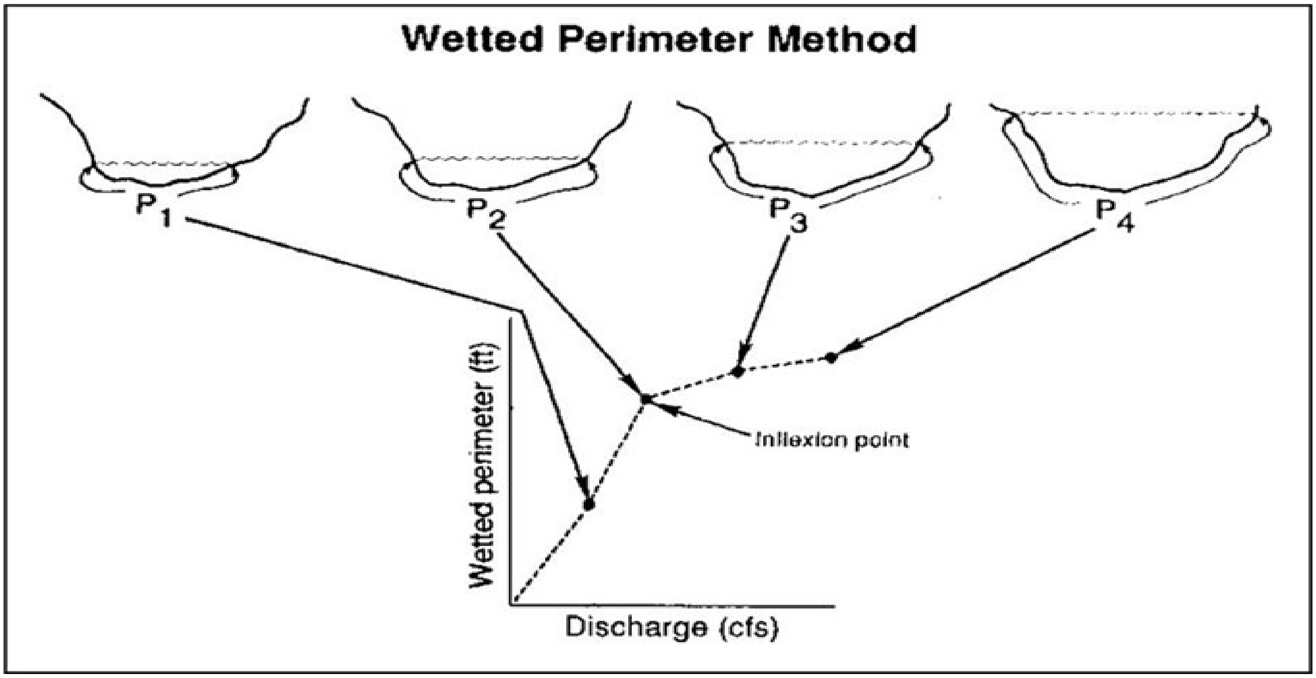


Figure 2-2: Example of wetted perimeter model to estimate instream flows (Nelson 1980)

2.2.3 Fish Population Assessment

Riverine fish populations were sampled using quantitative electrofishing in Great Pond Outflow and Big River (Figure 2-1). Each electrofishing station was blocked off using barrier nets at the upstream and downstream boundaries. The isolated area was then electrofished with a minimum of four sweeps, or until the last sweep had a total catch of less than half of the previous sweep.

Population Estimates

Abundance and biomass estimates were calculated using the Zippen removal method using the FSA package (Ogle et al. 2019) for R (R Core Team 2019). This approach was applied to abundance and biomass of all species combined, and then estimates were calculated based on the proportion of the total catch for each species. This approach helps to overcome any issues associated with low catch rates of some species.

Fish Biometrics

Each fish captured during electrofishing was processed following the completion of each sweep. Processing included:

- Identification to species;
- Measuring to nearest millimeter; and,

- Weighing to nearest 0.1 gram.

Length (L) and weight (W) data was then used to calculated Fulton's Condition Factor (K; Peterson and Harmon 2005), which is length-weight relationship:

$$K = \frac{(W \times 10^5)}{L^3}$$

Smaller fish often have errors associated with the calculation of condition factors. Likewise, instrument error can also affect the data. In order to account for this, two conditions were considered;

- Fish smaller than 80mm in length were removed from estimates of fish condition as slight errors in the weights of these individuals could skew the estimates.
- Ranges were calculated using three standard deviations of the mean for each species and values outside of the calculated range were removed from further analysis as they most likely included errors in length and/or weight measures. This was completed separately for each species in order to account for varying body types.

Figure 2-3: Sonar Equipment used in Great Pond, June 2020

2.3 Lacustrine Habitat Assessment

All sampling was completed using standard fish and fish habitat monitoring methods (DFO n.d., Bradbury et al. 2001), and followed Wood SOPs.

2.3.1 Bathymetric Surveys

The bathymetric survey was conducted using a differential GPS sonar unit attached to a Zodiac style inflatable boat (Figure 2-3). The unit links GPS and sonar technology in a digital environment so that depths and location (differential GPS) are digitally mapped.

The Lowrance sonar/GPS unit was set up in the field to collect combined positional and depth data once every second. The boat was generally moving at a rate of less than 2 metres per second (m/s) for optimal coverage. The unit has been tested using known survey pin locations for positional accuracy and has been recorded at being less than one metre. The error associated with sonar depth detection has been given as 1 centimetre (cm); however, weather conditions such as wave height and variable water temperatures can also affect this slightly.

Quality assurance/quality control (QA/QC) was conducted on all data collected with respect to validity (e.g., positional data and/or depth data acquired) prior to contour generation. Water surface elevation was recorded before and after surveys to better tie generated contours to elevation datum. Final contours were completed and assessed using GIS to provide a bathymetric contour of the study area.

2.3.2 Fish Population Assessment

A total of 15 fyke net-nights were completed in the Great Pond between August 11-13, 2021. Fyke nets were fished for a minimum of 16 hours, which covered the dawn and dusk periods when fish are most active. All fish captured were marked with a small clip on the top of the caudal fin to identify recaptures. All fish were live released near the capture area, and during subsequent net checks, any recaptures were weighed, measured and noted as a recapture (see Section 2.2.4). Population estimates and confidence intervals were calculated using the Schnabel multiple mark-recapture method (Ricker 1977, Ogle 2016).

3.0 RESULTS

Fish and fish habitat was assessed in Great Pond, Great Pond Outflow and Big River during the summer of 2021.

3.1 Riverine Habitat Assessment

Habitat surveys, instream flow monitoring and fish populations were monitored in riverine habitats downstream of Great Pond. A summary is of the results is provided below.

3.1.1 Stream Surveys

In total, Great Pond Outflow was 484 m in length, with 17.4 habitat units (one unit = 100 m^2). A summary of the habitat throughout Great Pond Outflow is presented in Table 3-1. The majority of the habitat present is classified as riffle (eight of 15 reaches), which is typically considered good salmonid rearing habitat (Grant and Lee 2004). There was also migratory habitat present in the form of cascades (three reaches) and rapids (one reach). Run (two reaches) and pool (one reach) made up the remaining habitat types. Overall, cobble, bedrock and rubble made up the majority of the substrate present throughout Great Pond Outflow. Gravel, used for Brook Trout spawning, was observed in low quantities, typically less than 20% coverage, with the exceptions of Reaches 5, 6 and 15, which had coverages ranging from 25% to 50%.

Stream survey data is presented in Appendix A, while representative photographs of each reach are presented in Appendix B.

3.1.1 Instream Flow Monitoring

Pressure transducers were installed at the outflow of Great Pond (Figure 3-1), immediately downstream of Great Pond, and have been collecting data continuously since December 2019. One transducer is located in the stream, and measures water temperature and pressure, while a second sensor is located nearby to measure air pressure. This is used to calculate the depth of the transducer. During regular downloads, discharge transects (that measure flow rates in the stream) are also completed in order to develop a regression to estimate discharge based on water depth (Figure 3-2).

Using the water level-discharge relationship, discharge was calculated throughout the period December 2019 to early January 2021 (Figure 3-3 and Table 3-2). Figure 3-3 also presents the prorated discharge based on the gauging station in Northeast Pond River (Station # 02ZM006). Both methods of discharge estimation produced similar mean annual discharges.

Figure 3-1: Pressure transducer installed in Great Pond Outflow

Table 3-1: Summary of habitat surveys completed in Great Pond Outflow, August 2021

Transect #	Section Length (m)	Wetted Width (m)	Channel Width (m)	Area (Units)	Depth (m)		Veolocity (m/s)		Substrate Composition (%)*												Habitat Classification	Dominant Riparian Vegetation
					Average	Maximum	Average	Maximum	B	LgB	SmB	R	C	G	S	St	Cl	D	M	AqV		
1	-	2.9	3.8	-	0.08	0.13	0.06	0.11	0	0	10	40	40	10	0	0	0	0	0	0	Riffle	Grass
2	**31**	**3.8**	**5.6**	**1.18**	**0.05**	**0.10**	**0.10**	**0.35**	**0**	**0**	**10**	**30**	**50**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Grass**
3	33	3.4	4.6	1.12	0.08	0.16	0.02	0.09	0	0	15	35	40	10	0	0	0	0	0	0	Riffle	Grass
4	**25**	**3.5**	**4.1**	**0.88**	**0.10**	**0.13**	**0.05**	**0.16**	**0**	**0**	**5**	**35**	**50**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Shrub**
5	**25**	**3.7**	**5.5**	**0.93**	**0.06**	**0.10**	**0.07**	**0.22**	**0**	**0**	**5**	**10**	**35**	**50**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Conifer**
6	45	5.5	6.2	2.48	0.15	0.22	0.00	0.00	0	0	10	15	40	35	0	0	0	0	0	0	Riffle	Shrub
7	40	2.4	3.2	0.96	0.06	0.14	0.20	0.38	25	10	15	20	25	5	0	0	0	0	0	0	Riffle	Conifer
8	25	3.7	4.8	0.93	0.23	0.44	0.00	0.00	5	0	5	20	40	20	5	5	0	0	0	0	Pool	Conifer
9	3	-	-	-	-	0.00	-	0.00	100	0	0	0	0	0	0	0	0	0	0	0	Cascade	-
10	65	3.3	4.2	2.15	0.06	0.12	0.11	0.60	10	15	25	30	20	0	0	0	0	0	0	0	Rapids	Conifer
11	17	3.4	4.7	0.58	0.10	0.24	0.06	0.28	80	5	10	5	0	0	0	0	0	0	0	0	Cascade	Conifer
12	10	5.4	5.9	0.54	0.31	0.80	0.00	0.00	65	0	10	10	0	10	0	0	0	5	0	0	Run	Grass
13	30	4.0	4.7	1.20	0.13	0.23	0.01	0.05	75	0	5	10	10	0	0	0	0	0	0	0	Cascade	Conifer
14	**95**	**3.7**	**5.0**	**3.52**	**0.09**	**0.15**	**0.04**	**0.09**	**0**	**5**	**20**	**20**	**40**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**Riffle**	**Conifer**
15	25	3.5	4.0	0.88	0.30	0.48	0.01	0.05	0	0	0	0	35	25	0	20	0	20	0	0	Run	Grass

Note Bolder lines indicate transects selected for Wetted Perimeter Modelling

Substrate

B	Bedrock	C	Cobble	Cl	Clay
LgB	Larger Boulder	G	Gravel	D	Detritus
SmB	Small Boulder	S	Sand	M	Mud
R	Rubble	St	Silt	AqV	Aquatic Vegetation

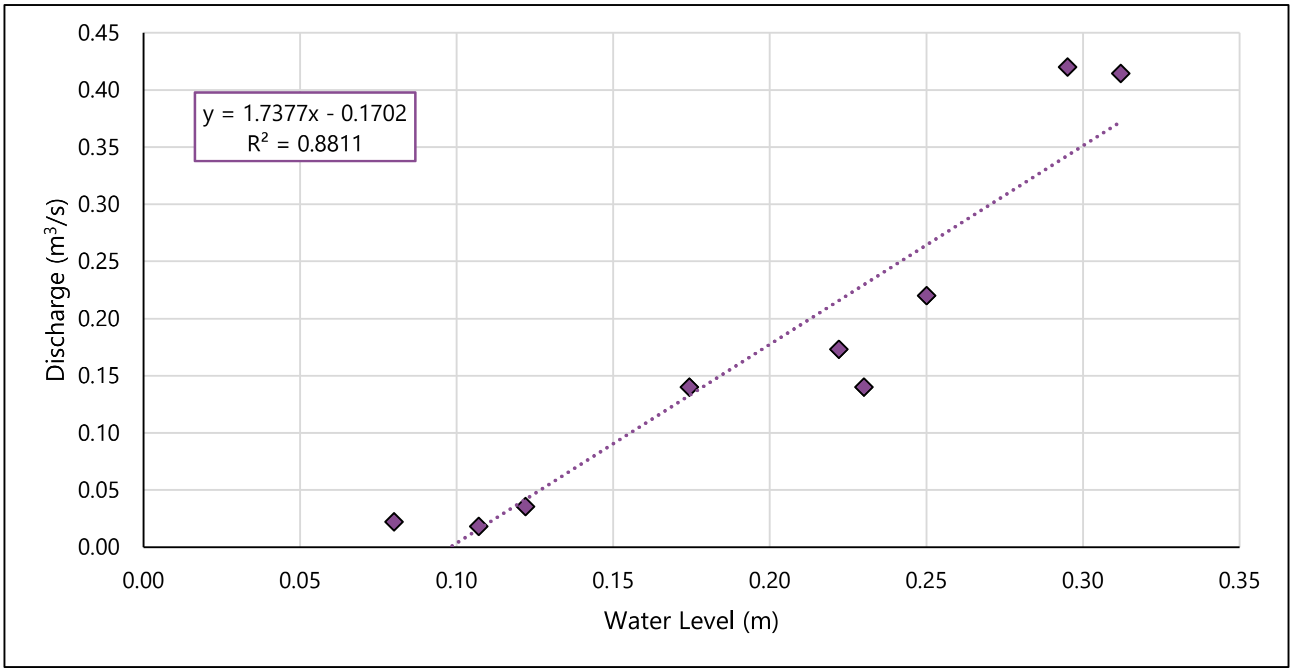


Figure 3-2: Discharge-water level relationship for Great Pond Outflow

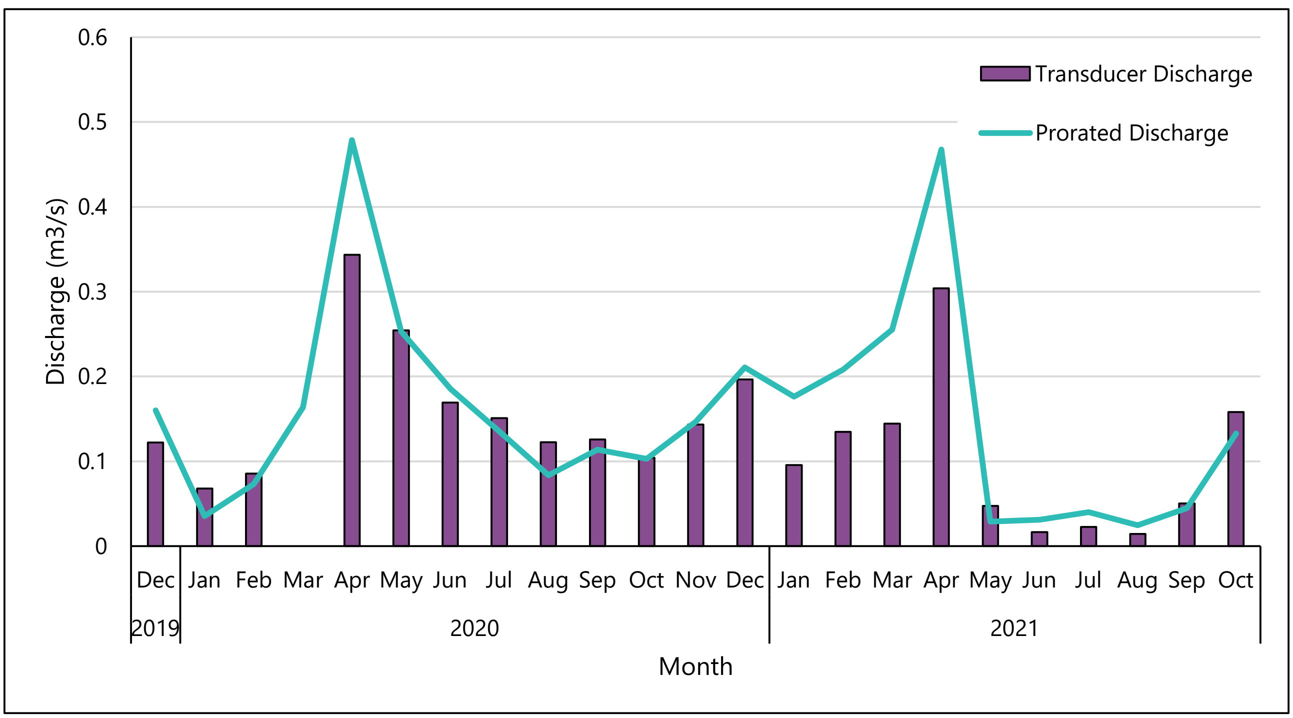


Figure 3-3: Hydrograph for Great Pond Outflow, December 2019-October 2021

Table 3-2: Summary of estimated discharge from Great Pond, 2020-2021

Month	2020		2021	
	Transducer	Prorated Hydrology	Transducer	Prorated Hydrology
January	0.07	0.04	0.10	0.18
February	0.09	0.07	0.13	0.21
March	-	0.16	0.14	0.26
April	0.34	0.48	0.30	0.47
May	0.25	0.25	0.05	0.03
June	0.17	0.19	0.02	0.03
July	0.15	0.14	0.02	0.04
August	0.12	0.08	0.01	0.02
September	0.13	0.11	0.05	0.04
October	0.10	0.10	0.16	0.13
November	0.14	0.15	-	-
December	0.20	0.21	-	-
Mean Annual Flow	0.15	0.17	0.10	0.14

Note At time of preparation, only data up to October 22, 2021 was available

3.1.2 Wetted Perimeter Modelling

Wetted Perimeter Models (WPM) were completed for four representative transects; T2, T4, T5 and T14 (Table 3-3 and Figures 3-4 through 3-7). A model was also developed for T12, however, it was deemed to be an unsuitable location (i.e. channel shape and measured conditions did not result in an inflection point being determined). This location has not been included in any further summaries. Inflection point discharges ranged from 0.003-0.043 m^3/s, with a mean inflection point discharge of 0.020m^3/s (Table 3-3).

Table 3-3: Summary of wetted perimeter models from Great Pond Outflow

Transect #	Measured		Inflection Point	
	Perimeter	Discharge (m^3/s)	Perimeter	Discharge (m^3/s)
2	3.82	0.022	3.82	0.022
4	3.71	0.017	3.59	0.003
5	3.75	0.017	4.67	0.043
14	3.77	0.015	3.73	0.010
Mean	-	0.018	-	0.020

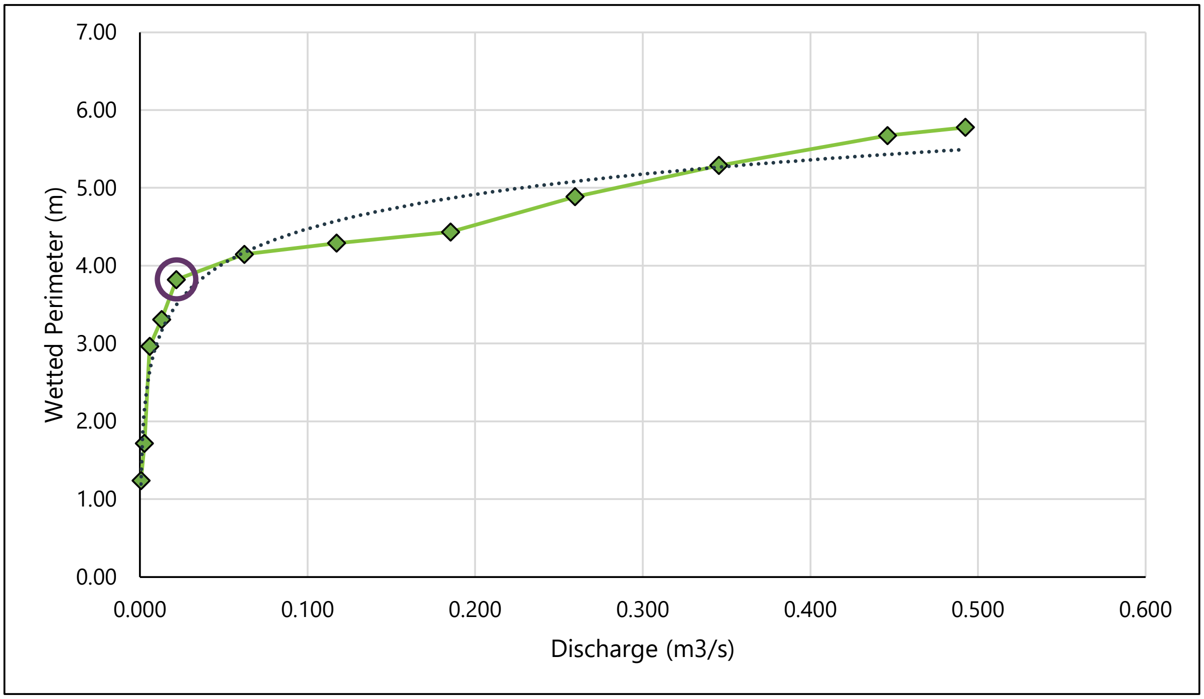


Figure 3-4: Wetted perimeter model for T2, inflection point circled

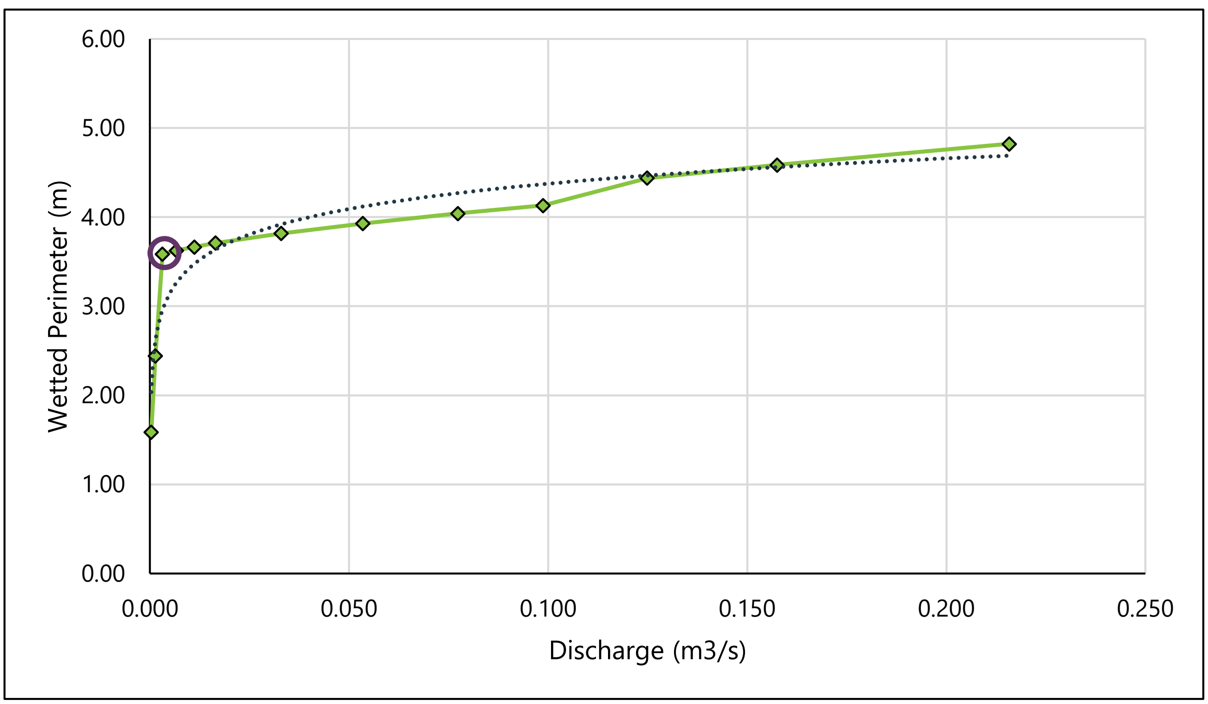


Figure 3-5: Wetted perimeter model for T4, inflection point circled

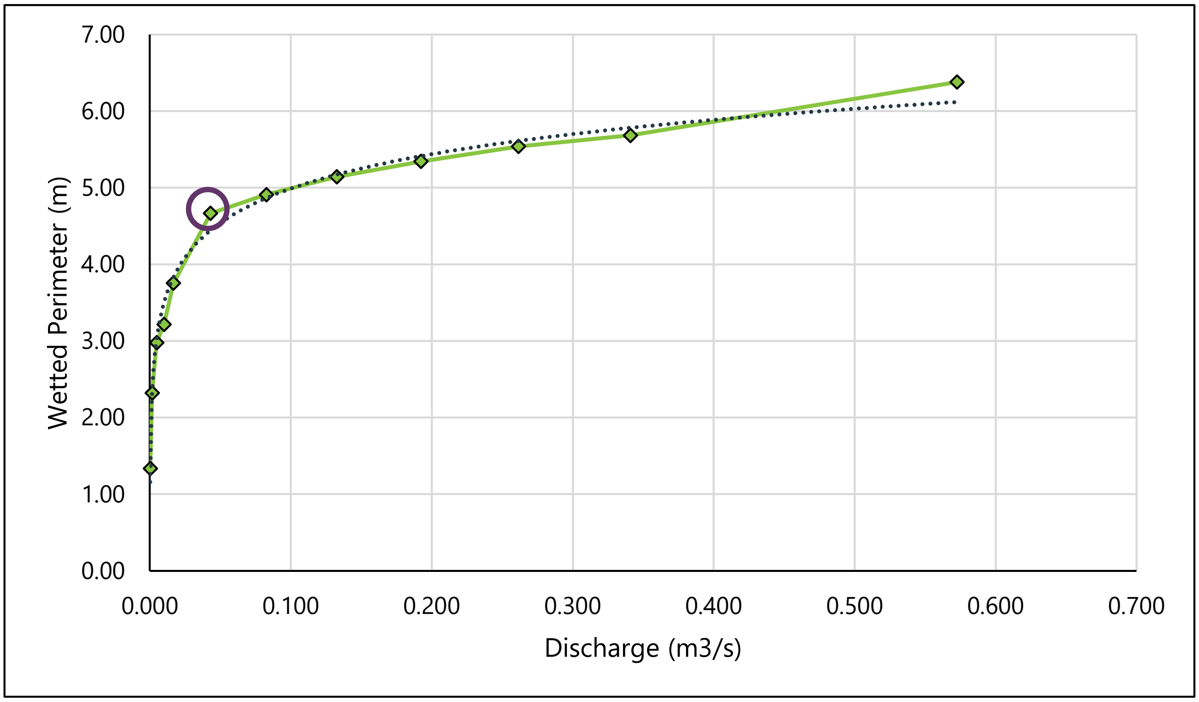


Figure 3-6: Wetted perimeter model for T5, inflection point circled

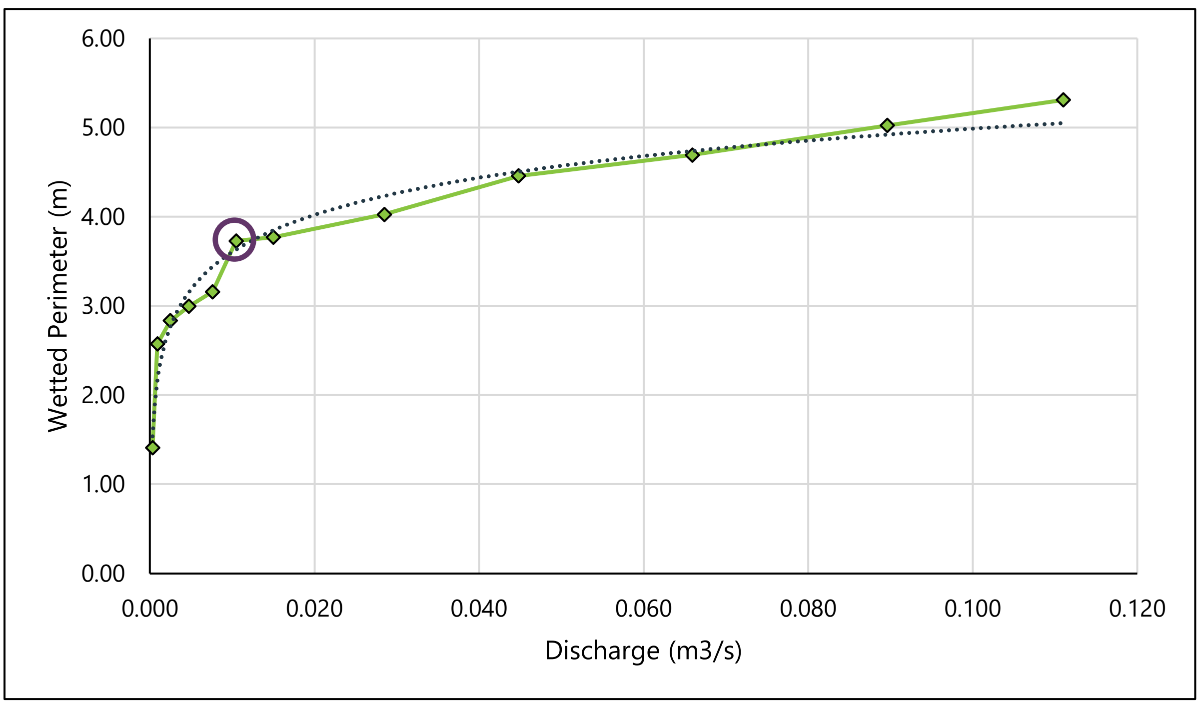


Figure 3-7: Wetted perimeter model for T14, inflection point circled

3.1.3 Fish Population Assessment

Two quantitative electrofishing stations were completed in Great Pond Outflow and Big River, downstream of Great Pond Outflow, during August 2021. Brook Trout (*Salvelinus fontinalis*), Rainbow Trout (*Oncorhynchus mykiss*) and Threespine Stickleback (*Gasterosteus aculeatus*) were captured in each location, with Brook Trout being the most abundant (Table 3-4).

Table 3-4: Summary of population and biomass estimates in the Great Pond Outflow and Big River, August 2021

Location	Species	Population Estimate (fish/habitat unit)			Biomass Estimate (grams/habitat unit)		
		Station #1	Station #2	Mean	Station #1	Station #2	Mean
Great Pond Outflow	Brook Trout	59.5	25.3	42.4	207.7	117.4	162.6
	Rainbow Trout	2.6	14.2	8.4	4.3	70.9	37.7
	Threespine Stickleback	38.8	35.5	37.2	37.1	85.2	61.2
Big River	Brook Trout	12.1	14.5	13.3	190.3	321.3	255.8
	Rainbow Trout	26.8	24.2	25.5	382.9	609.8	496.4
	Threespine Stickleback	14.7	14.5	14.6	7.5	8.2	7.8

Overall, Brook Trout and Rainbow Trout were larger in Big River than Great Pond Outflow (Table 3-5). On average, salmonids in each sampling location were in good condition ($K \geq 1.00$). Rainbow Trout had similar condition in each location ($p = 0.90$), while Brook Trout had higher condition in Great Pond Outflow ($p<0.05$). The majority of the Brook Trout captured in Great Pond Outflow were young-of-year (YOY; Figure 3-8) indicating that this area may primarily be used for spawning and rearing. Brook Trout spawning behaviour was observed in Great Pond Outflow, primarily downstream of Bauline Line during field surveys in October 2021.

Electrofishing data is presented in Appendix C.

Table 3-5: Summary of biometrics in Great Pond Outflow and Big River, August 2021

Location	Species	Mean Length (mm)	Mean Weight (g)	Mean Condition (K)
Great Pond Outflow	Brook Trout	61.0	3.8	1.29 (9)
	Rainbow Trout	66.4	4.6	1.27 (3)
	Threespine Stickleback	63.0	1.6	-
Big River	Brook Trout	111.7	19.5	1.10 (24)
	Rainbow Trout	102.1	19.6	1.16 (33)
	Threespine Stickleback	32.8	0.6	-

Note Number of fish included in condition factor (as per section 2.2.4) summaries presented in brackets.

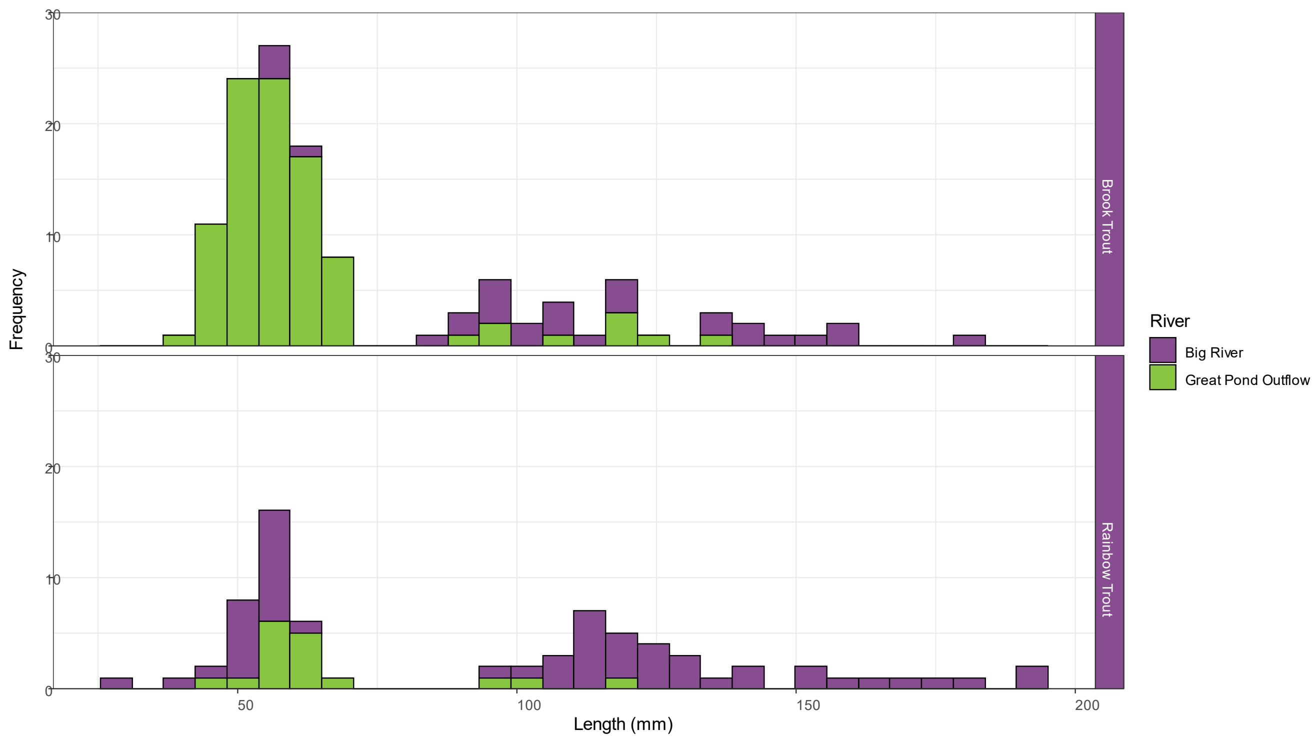


Figure 3-8: Length distributions of salmonids from Great Pond Outflow and Big River, August 2021

3.2 Lacustrine Habitat Assessment

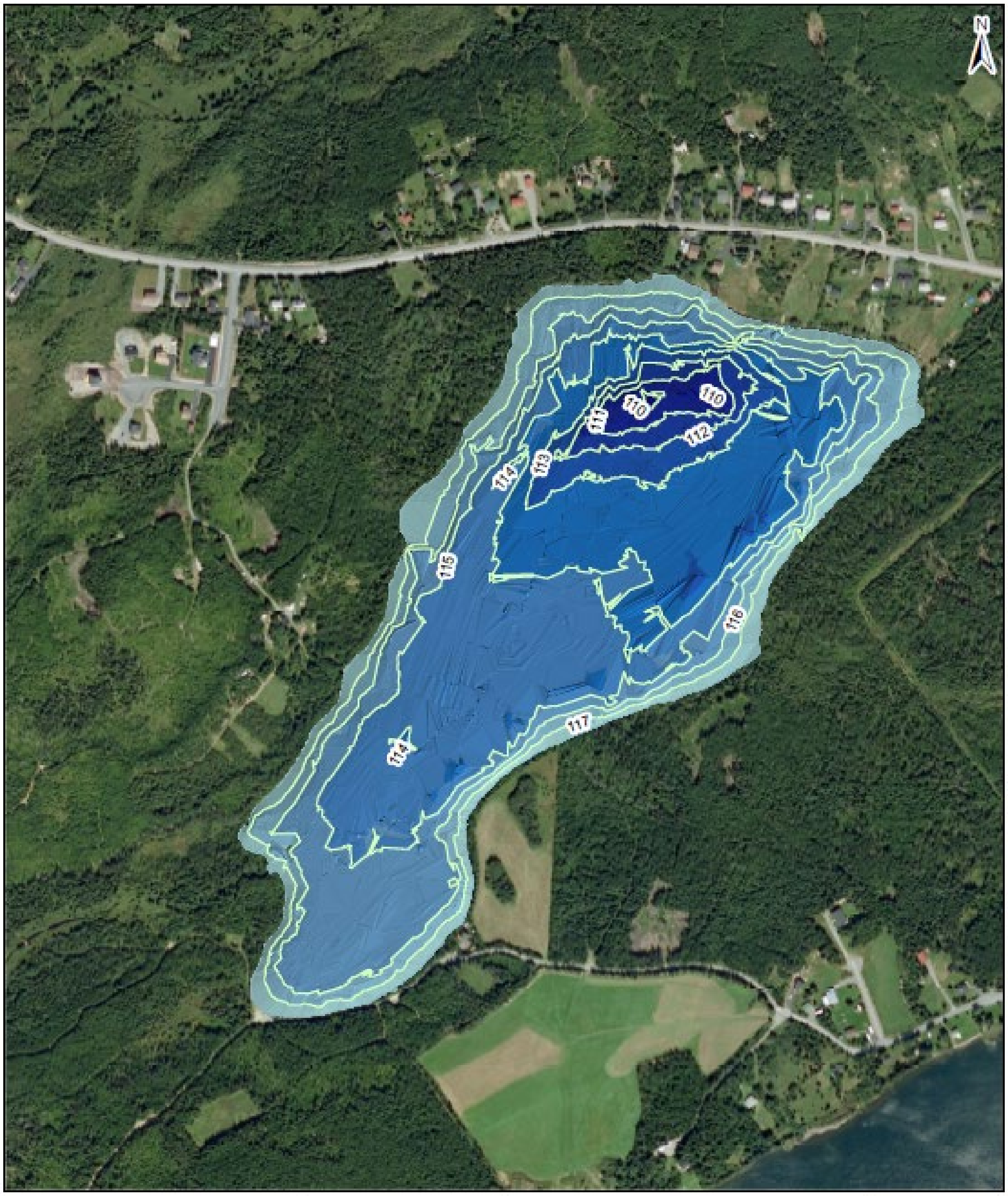
Lacustrine habitats surveys were completed in Great Pond with bathymetric surveys being completed in June 2020, and fish surveys completed in August 2021. A summary of the results is presented below.

3.2.1 Bathymetric Surveys

A bathymetric survey of Great Pond was completed by Wood staff on June 5, 2020 (Figure 3-9) to support the development of a geo-referenced bathymetric contour map of the water supply. At the time of the bathymetric survey (June 5, 2020), the measured water surface elevation was 117.75 m. The lowest measured elevation at the bottom of the pond was 109.6 m, resulting in a maximum water depth at the time of survey of approximately 8.2 m. The deepest portion of the pond is in the northwest corner, which will be beneficial if any future intake is to be sited near the outlet of the pond.

3.2.1 Fish Population Assessment

Brook Trout and Threespine Stickleback were the only species captured, with Stickleback accounting for most of the total catch and total biomass (Table 3-6). Due to the quantities of Stickleback captured, total catch was estimated based on total biomass and mean weight per individual. All Brook Trout captured were marked with a small fin clip on the top caudal fin to identify any recaptured fish. Throughout the netting, there were no recaptures observed. Therefore, to calculate a population estimate, a single recapture was assumed, yielding a population estimate of 575 Brook Trout (95% Confidence Interval 175-1,122).



Wood 133 Crosbie Road St John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: FEBRUARY 2021
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 75 150 Meters	PROJECT TITLE: BATHYMETRY	DRAWING No. 3

Figure 3-9: Bathymetric map of Great Pond

Table 3-6: Summary of catch-per-unit-effort in Great Pond, August 2021

Species	Abundance		Biomass	
	Total Catch	CPUE (fish/net-night)	Total Catch	CPUE (grams/net-night)
Brook Trout	62	4.13	9,397.6	626.51
Threespine Stickleback	34,190[1]	2,279.33	70,608.6	4,707.24

Brook Trout had a mean length of 218mm and a mean weight of 161.8g. Following the removal of outliers, 59 Brook Trout were included in condition analysis, and had a mean condition of 1.29. All Brook Trout included in the analysis had condition factors greater than 1.00, indicating they are in good condition.

Fyke netting data is presented in Appendix D.

4.0 SUMMARY

There were 17.4 habitat units surveyed in Great Pond Outflow during August 2021, the majority of which have been characterized as riffle habitat. Riffle habitat is typically suitable for salmonid spawning and rearing. Electrofishing was completed in Great Pond Outflow and Big River, downstream of Great Pond. Brook Trout, Rainbow Trout and Threespine Stickleback were present in all electrofishing stations, with Brook Trout being the most abundant in both locations. Population estimates were higher for Brook Trout in Great Pond Outflow, while biomass estimates were higher in Big River. The majority of the Brook Trout captured in Great Pond Outflow were YOY, indicating that the area is suitable for spawning and juvenile rearing.

Within Great Pond, Brook Trout and Threespine Stickleback were the only species present, with Threespine Stickleback being significantly more abundant. Brook Trout captured in Great Pond were larger on average than those in Great Pond Outflow, with no YOY being observed, indicating Great Pond is primarily utilized by juvenile and adult Brook Trout.

4.1 Recommendations and Future Works

As part of the environmental assessment and permitting process for any project potentially affecting fish and fish habitat, the project may require provincial environmental assessment registration and a federal Fisheries and Oceans Request for Project Review. Field data collected during 2021 can be used to further quantify fish habitat should it be required. Habitat quantification would be used by DFO to determine potential HADD and possible offset requirements. Additional effort will be required to identify and design suitable design/offsets, if DFO determines offsets are required. Also note, any habitat offsets as part of a *Fisheries Act* authorization will also require public consultation and well as monitoring of habitat stability and suitability.

5.0 CLOSURE

We trust that you will find the information within this document satisfactory in meeting requirements and expectations. Should you have any questions or concerns regarding the information presented in this document, please do not hesitate to contact us at your convenience.

Sincerely
Wood Environment & Infrastructure Solutions

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APPENDIX A
STREAM SURVEY DATA

Stream Survey Data

Transect #	GPS Coordinates			Section Length (m)	Wetted Width (m)	Channel Width (m)	Bank Heights (m)					
	Zone	Easting	Northing				L→					
1	22T	367594	5280857	0	2.9	3.8	0.00	0.08	0.10	0.24		0.00
2	22T	367570	5280878	31	3.8	5.6	0.00	0.10	0.08	0.19	0.15	0.00
3	22T	367569	5280908	33	3.4	4.6	0.00	0.10	0.09	0.10	0.02	0.00
4	22T	367578	5280932	25	3.5	4.1	0.24					0.00
5	22T	367587	5280954	25	3.7	5.5	0.00	0.07	0.12	0.42	0.43	0.00
6	22T	367594	5281011	45	5.5	6.2	0.00	0.11	0.31	0.34		0.00
7	22T	367576	5281039	40	2.4	3.2	0.00	0.12	0.26	0.45	0.40	0.00
8	22T	367553	5281040	25	3.7	4.8	0.00	0.10	0.18	0.31		0.00
9	22T	367549	5281048	3								
10	22T	367553	5281106	65	3.3	4.2	0.00	0.09	0.21	0.35		0.00
11	22T	367544	5281124	17	3.4	4.7	0.00	0.04	0.33	0.25	0.38	0.00
12	22T	367538	5281135	10	5.4	5.9	0.32					0.00
13	22T	367541	5281164	30	4.0	4.7	0.00	0.07	0.30	0.47		0.00
14	22T	367576	5281420	95	3.7	5.0	0.00	0.06	0.10	0.24		0.00
15	22T	367605	5281257	25	3.5	4.0	0.00	0.17				0.00

Stream Survey Data

Transect #	←R				L→							
					Bank Lengths (m)							
1	0.10	0.05	0.12		0.00	0.25	0.37	0.44			0.00	0.19
2	0.06	0.09	0.36	0.34	0.00	0.17	0.36	0.52	0.74	0.88	0.00	0.19
3	0.10	0.08	0.15	0.22	0.00	0.12	0.31	0.49	0.53		0.00	0.20
4	0.13	0.14	0.18	0.37	0.00						0.00	0.22
5	0.07	0.13	0.14		0.00	0.32	0.46	0.67	1.00		0.00	0.24
6	0.13	0.23	0.38		0.00	0.09	0.15	0.36			0.00	0.13
7	0.15	0.41			0.00	0.14	0.29	0.41	0.57		0.00	0.10
8	0.06	0.18	0.25		0.00	0.21	0.40	0.46			0.00	0.23
9												
10	0.17	0.25	0.37		0.00	0.23	0.45	0.50			0.00	0.16
11	0.09	0.24	0.27		0.00	0.15	0.35	0.73	1.00		0.00	0.10
12	0.10	0.09	0.19		0.00						0.00	0.12
13	0.13	0.24	0.40		0.00	0.15	0.25	0.44			0.00	0.14
14	0.25	0.36	0.56	0.81	0.00	0.25	0.38	0.52			0.00	0.25
15	0.20				0.00	0.27					0.00	0.20

Stream Survey Data

Transect #				Length (m)								
	←R			1	2	3	4	5	6	7	8	9
1	0.35	0.45		0.00	0.50	1.00	1.50	2.00	2.50	2.90		
2	0.41	0.74	0.89	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	3.80
3	0.37	0.52	0.66	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.40	
4	0.34	0.47	0.61	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	
5	0.46	0.84		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	3.70
6	0.27	0.31		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
7	0.22			0.00	0.50	1.00	1.50	2.00	2.40			
8	0.40	0.60		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	3.70
9												
10	0.27	0.39		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.30	
11	0.19	0.25		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.40	
12	0.37	0.50		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
13	0.26	0.27		0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
14	0.36	0.56	0.81	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	3.70
15				0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	

Stream Survey Data

Transect #				Depth (m)								
	10	11	12	1	2	3	4	5	6	7	8	9
1				0.02	0.09	0.13	0.13	0.11	0.09	0.01		
2				0.00	0.05	0.04	0.06	0.09	0.10	0.09	0.02	0.01
3				0.00	0.03	0.10	0.11	0.10	0.16	0.09	0.02	
4				0.09	0.13	0.12	0.07	0.06	0.08	0.10	0.11	
5				0.02	0.02	0.08	0.05	0.07	0.10	0.09	0.08	0.02
6	4.50	5.00	5.50	0.02	0.12	0.12	0.15	0.18	0.17	0.14	0.18	0.19
7				0.05	0.05	0.14	0.04	0.04	0.05			
8				0.10	0.23	0.44	0.37	0.42	0.28	0.15	0.07	0.02
9												
10				0.02	0.04	0.12	0.09	0.09	0.05	0.02	0.03	
11				0.00	0.07	0.06	0.24	0.24	0.11	0.09	0.02	
12	4.50	5.00	5.40	0.00	0.16	0.12	0.21	0.38	0.42	0.60	0.80	0.70
13				0.11	0.17	0.21	0.23	0.17	0.15	0.04	0.07	0.02
14				0.02	0.04	0.15	0.10	0.10	0.15	0.14	0.08	0.02
15				0.12	0.38	0.47	0.46	0.48	0.38	0.09	0.02	

Stream Survey Data

Transcect #	10	11	12	Average Depth (m)	Velocity (m/s) 1	2	3	4	5	6	7	8
1				0.08	0.000	0.090	0.110	0.11	0.08	0.00	0.00	
2				0.05	0.000	0.000	0.000	0.06	0.35	0.34	0.13	0.00
3				0.08	0.000	0.000	0.000	0.09	0.04	0.00	0.00	0.00
4				0.10	0.000	0.030	0.090	0.08	0.00	0.16	0.00	0.00
5				0.06	0.000	0.000	0.110	0.00	0.09	0.22	0.10	0.12
6	0.22	0.19	0.09	0.15	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
7				0.06	0.000	0.250	0.210	0.32	0.38	0.05		
8				0.23	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
9												
10				0.06	0.00	0.00	0.60	0.08	0.18	0.00	0.00	0.00
11				0.10	0.00	0.00	0.00	0.00	0.00	0.17	0.28	0.00
12	0.19	0.05	0.04	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13				0.13	0.00	0.05	0.03	0.00	0.04	0.00	0.00	0.00
14				0.09	0.00	0.00	0.09	0.09	0.08	0.00	0.07	0.06
15				0.30	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00

Stream Survey Data

Transect #					Average Velocity (m/s)	Substrate (%						
	9	10	11	12		Bedrock	LgB	SmB	Rubble	Cobble	Gravel	Sand
1					0.06	0	0	10	40	40	10	0
2	0.00				0.10	0	0	10	30	50	10	0
3					0.02	0	0	15	35	40	10	0
4					0.05	0	0	5	35	50	10	0
5	0.00				0.07	0	0	5	10	35	50	0
6	0.00	0.00	0.00	0.00	0.00	0	0	10	15	40	35	0
7					0.20	25	10	15	20	25	5	0
8	0.00				0.00	5	0	5	20	40	20	5
9						100	0	0	0	0	0	0
10					0.11	10	15	25	30	20	0	0
11					0.06	80	5	10	5	0	0	0
12	0.00	0.00	0.00	0.00	0.00	65	0	10	10	0	10	0
13	0.00				0.01	75	0	5	10	10	0	0
14	0.00				0.04	0	5	20	20	40	15	0
15					0.01	0	0	0	0	35	25	0

Stream Survey Data

Transect #	)						Bank			Cover (%)		
	Silt	Clay	Detritus	Muck	Aq Veg	Total	Undercut L	Undercut R	Bank Stability	Instream	Overhang	Canopy
1	0	0	0	0	0	100	0	0	Good	20	30	40
2	0	0	0	0	0	100	0	10	Good	20	30	20
3	0	0	0	0	0	100	10	10	Good	15	10	10
4	0	0	0	0	0	100	0	0	Good	20	40	40
5	0	0	0	0	0	100	0	0	Good	20	30	40
6	0	0	0	0	0	100	0	0	Good	30	25	15
7	0	0	0	0	0	100	0	10	Good	15	40	25
8	5	0	0	0	0	100	0	0	Good	20	20	20
9	0	0	0	0	0	100	0	0	Good	10	10	10
10	0	0	0	0	0	100	5	0	Good	20	35	20
11	0	0	0	0	0	100	0	0	Good	10	50	10
12	0	0	5	0	0	100	10	10	Good	25	25	25
13	0	0	0	0	0	100	0	0	Good	10	20	40
14	0	0	0	0	0	100	5	5	Good	20	30	40
15	20	0	20	0	0	100	0	0	Good	15	35	0

Stream Survey Data

Transcect #		Riparian Vegetation LHS (%)							Riparian Vegetation RHS (			
	Total	Conifer	Deciduous	Shrub	Grass	Bog	No Veg	Total	Conifer	Deciduous	Shrub	Grass
1	90	15	40	15	30	0	0	100	10	30	15	45
2	70	10	30	20	40	0	0	100	20	20	20	40
3	35	10	45	15	30	0	0	100	5	10	35	50
4	100	35	5	40	20	0	0	100	25	10	25	40
5	90	40	10	35	15	0	0	100	30	5	15	50
6	70	25	10	40	25	0	0	100	25	15	35	25
7	80	40	0	30	30	0	0	100	45	0	20	35
8	60	30	10	35	25	0	0	100	40	10	20	20
9	30	0	0	0	0	0	0	0	0	0	0	0
10	75	45	5	20	30	0	0	100	35	5	10	40
11	70	45	10	15	30	0	0	100	20	5	45	30
12	75	30	10	20	40	0	0	100	25	25	20	30
13	70	40	10	30	20	0	0	100	35	0	30	35
14	90	50	10	20	20	0	0	100	30	0	45	25
15	50	5	5	50	40	0	0	100	10	0	30	60

Stream Survey Data

Transect #	%)		Total	Comments
	Bog	No Veg		
1	0	0	100	
2	0	0	100	
3	0	0	100	
4	0	0	100	
5	0	0	100	
6	0	0	100	
7	0	0	100	
8	0	10	100	
9	0	0	0	
10	0	0	90	
11	0	0	100	Series of small cascades and falls
12	0	0	100	Pool between two cascades
13	0	0	100	
14	0	0	100	
15	0	0	100	

APPENDIX B
REPRESENTATIVE PHOTOGRAPHS

Representative Photos – Great Pond Outflow

Photo 1: Great Pond Outflow Transect 1

Photo 2:   Great Pond Outflow Transect 2

Representative Photos – Great Pond Outflow

Photo 3: Great Pond Outflow Transect 3

Photo 4: Great Pond Outflow Transect 4

Representative Photos – Great Pond Outflow

Photo 5: Great Pond Outflow Transect 5

Photo 6: Great Pond Outflow Transect 6

Representative Photos – Great Pond Outflow

Photo 7: Great Pond Outflow Transect 7

Photo 8: Great Pond Outflow Transect 8

Representative Photos – Great Pond Outflow

Photo 9: Great Pond Outflow Transect 9

Photo 10: Great Pond Outflow Transect 10

Representative Photos – Great Pond Outflow

Photo 11: Great Pond Outflow Transect 11

Photo 12: Great Pond Outflow Transect 12

Representative Photos – Great Pond Outflow

Photo 13: Great Pond Outflow Transect 13

Photo 14: Great Pond Outflow Transect 14

Representative Photos – Great Pond Outflow

Photo 15: Great Pond Outflow Transect 15

APPENDIX A
ELECTROFISHING DATA

River Name	Station #	Station Type	Sweep	Station Area (m^2)	Electrofisher Time	Species	Count	Length (mm)	Weight (g)	Condition
Big River	1	Quantitative	1	123	442	RB	1	122	21.8	1.20
Big River	1	Quantitative	1	123	442	RB	1	134	27.1	1.13
Big River	1	Quantitative	1	123	442	SB	1	28	0.5	2.28
Big River	1	Quantitative	1	123	442	RB	1	123	22.3	1.20
Big River	1	Quantitative	1	123	442	RB	1	113	17.3	1.20
Big River	1	Quantitative	1	123	442	BK	1	95	8.4	0.98
Big River	1	Quantitative	1	123	442	BK	1	145	38.2	1.25
Big River	1	Quantitative	1	123	442	RB	1	113	16.7	1.16
Big River	1	Quantitative	1	123	442	BK	1	158	47.6	1.21
Big River	1	Quantitative	1	123	442	RB	1	117	18.6	1.16
Big River	1	Quantitative	1	123	442	SB	1	30	0.3	1.11
Big River	1	Quantitative	1	123	442	BK	1	109	13.6	1.05
Big River	1	Quantitative	1	123	442	RB	1	56	1.9	1.08
Big River	1	Quantitative	1	123	442	BK	1	87	6.8	1.03
Big River	1	Quantitative	1	123	442	RB	1	176	64.4	1.18
Big River	1	Quantitative	1	123	442	BK	1	63	2.8	1.12
Big River	1	Quantitative	1	123	442	BK	1	118	19.6	1.19
Big River	1	Quantitative	1	123	442	BK	1	103	11.4	1.04
Big River	1	Quantitative	1	123	442	RB	1	56	2	1.14
Big River	1	Quantitative	1	123	442	SB	1	34	0.5	1.27
Big River	1	Quantitative	1	123	442	RB	1	56	1.9	1.08
Big River	1	Quantitative	1	123	442	RB	1	128	25.6	1.22
Big River	1	Quantitative	1	123	442	RB	1	58	2.2	1.13
Big River	1	Quantitative	1	123	442	RB	1	65	2.6	0.95
Big River	1	Quantitative	1	123	442	RB	1	108	15.2	1.21
Big River	1	Quantitative	1	123	442	RB	1	55	1.9	1.14
Big River	1	Quantitative	1	123	442	BK	1	119	19	1.13
Big River	1	Quantitative	1	123	442	BK	1	96	9.5	1.07
Big River	1	Quantitative	1	123	442	RB	1	123	21.2	1.14
Big River	1	Quantitative	1	123	442	RB	1	127	24.2	1.18
Big River	1	Quantitative	2	123	454	SB	1	24	0.1	0.72
Big River	1	Quantitative	2	123	454	SB	1	31	0.2	0.67
Big River	1	Quantitative	2	123	454	SB	1	43	0.6	0.75
Big River	1	Quantitative	2	123	454	SB	1	28	0.3	1.37
Big River	1	Quantitative	2	123	454	RB	1	166	56.7	1.24
Big River	1	Quantitative	2	123	454	SB	1	32	0.6	1.83
Big River	1	Quantitative	2	123	454	SB	1	24	0.1	0.72
Big River	1	Quantitative	2	123	454	SB	1	26	0.1	0.57
Big River	1	Quantitative	2	123	454	SB	1	36	0.4	0.86
Big River	1	Quantitative	2	123	454	SB	1	56	2.1	1.20
Big River	1	Quantitative	2	123	454	RB	1	121	21.1	1.19
Big River	1	Quantitative	2	123	454	RB	1	113	18.3	1.27
Big River	1	Quantitative	2	123	454	RB	1	154	42.2	1.16
Big River	1	Quantitative	2	123	454	RB	1	55	1.8	1.08
Big River	1	Quantitative	2	123	454	RB	1	28	0.1	0.46
Big River	1	Quantitative	2	123	454	SB	1	29	0.2	0.82
Big River	1	Quantitative	2	123	454	BK	1	90	8.6	1.18
Big River	1	Quantitative	2	123	454	BK	1	143	32.7	1.12
Big River	1	Quantitative	3	123	505	SB	1	56	1.1	0.63
Big River	1	Quantitative	3	123	505	SB	1	22	0.1	0.94
Big River	1	Quantitative	3	123	505	SB	1	48	1.8	1.63
Big River	1	Quantitative	3	123	505	RB	1	49	1.3	1.10
Big River	1	Quantitative	3	123	505	RB	1	54	1.9	1.21
Big River	1	Quantitative	3	123	505	BK	1	101	11.4	1.11
Big River	1	Quantitative	3	123	505	BK	1	56	1.8	1.02
Big River	1	Quantitative	3	123	505	RB	1	109	15.4	1.19
Big River	1	Quantitative	3	123	505	RB	1	51	1.6	1.21
Big River	1	Quantitative	3	123	505	RB	1	49	1.7	1.44
Big River	1	Quantitative	3	123	505	RB	1	49	1	0.85
Big River	1	Quantitative	3	123	505	SB	1	26	0.1	0.57
Big River	1	Quantitative	4	123	367	RB	1	51	1.3	0.98
Big River	1	Quantitative	4	123	367	RB	1	114	14.4	0.97
Big River	2	Quantitative	1	105	505	RB	1	151	36.4	1.06
Big River	2	Quantitative	1	105	505	BK	1	182	64.7	1.07
Big River	2	Quantitative	1	105	505	SB	1	22	0.1	0.94
Big River	2	Quantitative	1	105	505	RB	1	99	19.2	1.98
Big River	2	Quantitative	1	105	505	BK	1	110	13.9	1.04
Big River	2	Quantitative	1	105	505	RB	1	50	1	0.80
Big River	2	Quantitative	1	105	505	BK	1	110	14.5	1.09
Big River	2	Quantitative	1	105	505	RB	1	46	1.2	1.23
Big River	2	Quantitative	1	105	505	RB	1	112	26.1	1.86
Big River	2	Quantitative	1	105	505	RB	1	96	10.6	1.20
Big River	2	Quantitative	1	105	505	BK	1	114	12.4	0.84
Big River	2	Quantitative	1	105	505	SB	1	38	0.6	1.09
Big River	2	Quantitative	1	105	505	BK	1	89	7.6	1.08
Big River	2	Quantitative	1	105	505	SB	1	23	0	0.00
Big River	2	Quantitative	1	105	505	SB	1	32	0.4	1.22
Big River	2	Quantitative	1	105	505	BK	1	143	34.6	1.18
Big River	2	Quantitative	1	105	505	BK	1	154	42.2	1.16
Big River	2	Quantitative	1	105	505	RB	1	182	65.5	1.09
Big River	2	Quantitative	1	105	505	RB	1	59	2.2	1.07
Big River	2	Quantitative	1	105	505	RB	1	168	56	1.18
Big River	2	Quantitative	1	105	505	RB	1	112	16	1.14
Big River	2	Quantitative	1	105	505	RB	1	108	14.7	1.17
Big River	2	Quantitative	1	105	505	BK	1	160	46.4	1.13
Big River	2	Quantitative	1	105	505	RB	1	58	1.4	0.72

River Name	Station #	Station Type	Sweep	Station Area (m^2)	Electrofisher Time	Species	Count	Length (mm)	Weight (g)	Condition
Big River	2	Quantitative	1	105	505	SB	1	23	0.1	0.82
Big River	2	Quantitative	1	105	505	BK	1	136	27.3	1.09
Big River	2	Quantitative	1	105	505	SB	1	26	0	0.00
Big River	2	Quantitative	1	105	505	SB	1	26	0	0.00
Big River	2	Quantitative	1	105	505	SB	1	23	0	0.00
Big River	2	Quantitative	1	105	505	SB	1	68	2.8	0.89
Big River	2	Quantitative	1	105	505	SB	1	27	0.1	0.51
Big River	2	Quantitative	1	105	505	RB	1	132	24.7	1.07
Big River	2	Quantitative	1	105	505	RB	1	132	26.4	1.15
Big River	2	Quantitative	1	105	505	RB	1	116	17.6	1.13
Big River	2	Quantitative	1	105	505	RB	1	139	34.9	1.30
Big River	2	Quantitative	1	105	505	BK	1	119	17.4	1.03
Big River	2	Quantitative	1	105	505	SB	1	59	1.9	0.93
Big River	2	Quantitative	2	105	416	BK	1	95	8.9	1.04
Big River	2	Quantitative	2	105	416	RB	1	143	32	1.09
Big River	2	Quantitative	2	105	416	SB	1	23	0.1	0.82
Big River	2	Quantitative	2	105	416	BK	1	58	2.2	1.13
Big River	2	Quantitative	2	105	416	SB	1	31	0.2	0.67
Big River	2	Quantitative	2	105	416	RB	1	192	81.7	1.15
Big River	2	Quantitative	2	105	416	RB	1	157	47	1.21
Big River	2	Quantitative	2	105	416	RB	1	116	16.3	1.04
Big River	2	Quantitative	2	105	416	BK	1	95	9.6	1.12
Big River	2	Quantitative	2	105	416	RB	1	42	0.9	1.21
Big River	2	Quantitative	2	105	416	SB	1	26	0.1	0.57
Big River	2	Quantitative	2	105	416	SB	1	28	0.1	0.46
Big River	2	Quantitative	3	105	462	RB	1	52	1.3	0.92
Big River	2	Quantitative	3	105	462	RB	1	113	18.5	1.28
Big River	2	Quantitative	3	105	462	RB	1	192	77.3	1.09
Big River	2	Quantitative	3	105	462	BK	1	138	29.1	1.11
Big River	2	Quantitative	3	105	462	RB	1	59	2.3	1.12
Big River	2	Quantitative	4	105	387	BK	1	55	1.8	1.08
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	58	1.9	0.97
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	57	2.2	1.19
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	59	2.5	1.22
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	51	1.5	1.13
Great Pond Outflow	1	Quantitative	1	119	595	SB	8		1.9	
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	120	21.3	1.23
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	55	2	1.20
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	48	1.2	1.09
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	44	0.9	1.06
Great Pond Outflow	1	Quantitative	1	119	595	SB	3		4.4	
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	65	3	1.09
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	65	3.2	1.17
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	52	1.8	1.28
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	55	2.1	1.26
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	60	2.7	1.25
Great Pond Outflow	1	Quantitative	1	119	595	SB	9		3.2	
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	63	2.7	1.08
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	58	1.7	0.87
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	52	1.7	1.21
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	60	2.4	1.11
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	49	1.2	1.02
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	54	1.5	0.95
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	66	3.8	1.32
Great Pond Outflow	1	Quantitative	1	119	595	SB	3		1.1	
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	68	3.2	1.02
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	49	1.6	1.36
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	59	2.4	1.17
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	50	1.5	1.20
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	52	1.9	1.35
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	58	2.2	1.13
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	64	3.8	1.45
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	135	35.2	1.43
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	60	2.9	1.34
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	58	2.2	1.13
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	64	3.3	1.26
Great Pond Outflow	1	Quantitative	1	119	595	SB	5		2	
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	52	1.6	1.14
Great Pond Outflow	1	Quantitative	1	119	595	RB	1	52	1.6	1.14
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	60	2.5	1.16
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	50	1.4	1.12
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	52	1.6	1.14
Great Pond Outflow	1	Quantitative	1	119	595	RB	1	60	2.3	1.06
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	50	2	1.60
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	60	2.3	1.06
Great Pond Outflow	1	Quantitative	1	119	595	RB	1	45	1.2	1.32
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	45	1.5	1.65
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	46	1	1.03
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	53	1.5	1.01
Great Pond Outflow	1	Quantitative	1	119	595	BK	1	48	1.2	1.09
Great Pond Outflow	1	Quantitative	1	119	595	SB	2		1	
Great Pond Outflow	1	Quantitative	2	119	425	BK	1	68	4.2	1.34
Great Pond Outflow	1	Quantitative	2	119	425	BK	1	51	1.6	1.21
Great Pond Outflow	1	Quantitative	2	119	425	SB	1	65	2.1	0.76
Great Pond Outflow	1	Quantitative	2	119	425	BK	1	51	1.4	1.06
Great Pond Outflow	1	Quantitative	2	119	425	BK	1	45	1.2	1.32

River Name	Station #	Station Type	Sweep	Station Area (m^2)	Electrofisher Time	Species	Count	Length (mm)	Weight (g)	Condition
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	50	1.6	1.28
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	50	1.6	1.28
Great Pond Outflow	1	Quantatitive	2	119	425	SB	1	48	1.8	1.63
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	57	2.4	1.30
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	55	2.3	1.38
Great Pond Outflow	1	Quantatitive	2	119	425	SB	1	76	4.5	1.03
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	48	1.3	1.18
Great Pond Outflow	1	Quantatitive	2	119	425	SB	5		4.7	
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	119	25.9	1.54
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	50	1.4	1.12
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	95	8.9	1.04
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	65	3.8	1.38
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	48	1.2	1.09
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	63	3	1.20
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	56	2.2	1.25
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	68	4.1	1.30
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	58	2	1.03
Great Pond Outflow	1	Quantatitive	2	119	425	BK	1	54	1.9	1.21
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	66	3.5	1.22
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	67	4	1.33
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	51	1.7	1.28
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	54	1.7	1.08
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	59	2.1	1.02
Great Pond Outflow	1	Quantatitive	3	119	301	SB	6		13.3	
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	70	4.6	1.34
Great Pond Outflow	1	Quantatitive	3	119	301	BK	1	50	1.3	1.04
Great Pond Outflow	1	Quantatitive	3	119	301	SB	4		2.5	
Great Pond Outflow	1	Quantatitive	4	119	275	BK	1	92	7.7	0.99
Great Pond Outflow	1	Quantatitive	4	119	275	BK	1	50	1.3	1.04
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	124	24.7	1.30
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	45	1.1	1.21
Great Pond Outflow	2	Quantatitive	1	104	306	SB	5		9.4	
Great Pond Outflow	2	Quantatitive	1	104	306	RB	1	95	10.2	1.19
Great Pond Outflow	2	Quantatitive	1	104	306	SB	2		7.7	
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	60	2.5	1.16
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	62	2.7	1.13
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	52	1.8	1.28
Great Pond Outflow	2	Quantatitive	1	104	306	SB	8		19.5	
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	69	4.5	1.37
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	49	1.5	1.27
Great Pond Outflow	2	Quantatitive	1	104	306	SB	2		5.2	
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	120	23.1	1.34
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	65	3.5	1.27
Great Pond Outflow	2	Quantatitive	1	104	306	RB	1	120	24.7	1.43
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	110	17.3	1.30
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	94	12	1.44
Great Pond Outflow	2	Quantatitive	1	104	306	RB	1	65	3.1	1.13
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	57	2	1.08
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	50	1.4	1.12
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	54	1.7	1.08
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	54	1.2	0.76
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	63	3	1.20
Great Pond Outflow	2	Quantatitive	1	104	306	RB	1	68	3.2	1.02
Great Pond Outflow	2	Quantatitive	1	104	306	BK	1	59	2.4	1.17
Great Pond Outflow	2	Quantatitive	1	104	306	RB	1	58	2.1	1.08
Great Pond Outflow	2	Quantatitive	1	104	306	SB	4		10.1	
Great Pond Outflow	2	Quantatitive	1	104	275	RB	1	56	1.9	1.08
Great Pond Outflow	2	Quantatitive	2	104	275	BK	1	45	1	1.10
Great Pond Outflow	2	Quantatitive	2	104	275	RB	1	60	2.1	0.97
Great Pond Outflow	2	Quantatitive	2	104	275	BK	1	42	1.2	1.62
Great Pond Outflow	2	Quantatitive	2	104	275	RB	1	55	1.3	0.78
Great Pond Outflow	2	Quantatitive	2	104	275	SB	5		14.1	
Great Pond Outflow	2	Quantatitive	2	104	275	RB	1	61	2.4	1.06
Great Pond Outflow	2	Quantatitive	3	104	286	RB	1	65	3.3	1.20
Great Pond Outflow	2	Quantatitive	3	104	286	RB	1	55	2	1.20
Great Pond Outflow	2	Quantatitive	3	104	286	BK	1	62	2.7	1.13
Great Pond Outflow	2	Quantatitive	3	104	286	RB	1	57	2.2	1.19
Great Pond Outflow	2	Quantatitive	3	104	286	BK	1	58	2.1	1.08
Great Pond Outflow	2	Quantatitive	3	104	286	BK	1	55	2	1.20
Great Pond Outflow	2	Quantatitive	3	104	286	SB	8		14.4	
Great Pond Outflow	2	Quantatitive	3	104	286	RB	1	57	2.3	1.24
Great Pond Outflow	2	Quantatitive	3	104	286	BK	1	55	2	1.20
Great Pond Outflow	2	Quantatitive	3	104	286	SB	4		6.7	
Great Pond Outflow	2	Quantatitive	4	104	269	RB	1	99	11.6	1.20
Great Pond Outflow	2	Quantatitive	4	104	269	BK	1	47	1.2	1.16
Great Pond Outflow	2	Quantatitive	4	104	269	BK	1	52	1.4	1.00

APPENDIX A
FYKE NETTING DATA

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK01	1	162	46.4	1.09
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	207		427.6	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	187		387.0	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	334		690.6	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	353		729.6	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	268		552.8	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	224		461.8	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	183		377.0	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	110		226.6	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	120		248.8	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	90		185.7	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	62		128.9	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	3		8.1	
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK02	1	236	175.7	1.34
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK03	1	208	117.7	1.31
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK04	1	252	233.8	1.46
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK05	1	284	351.1	1.53
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK06	1	156	47.7	1.26
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK07	1	245	214.0	1.46
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK08	1	212	132.0	1.39
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK09	1	162	55.7	1.31
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK10	1	212	126.2	1.32
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK11	1	236	165.4	1.26
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK12	1	164	101.1	2.29
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK13	1	172	65.0	1.28
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK14	1	153	47.3	1.32
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK15	1	162	52.6	1.24
11-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	SB01	1	80	4.6	0.90
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	3574		7380	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	142		293.8	

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	188		387.2	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	129		266.1	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	122		252.6	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	96		198	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	58		118.8	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	45		93.7	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	44		90.5	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	19		38.6	
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK16	1	189	89.3	1.32
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK17	1	240	186.6	1.35
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK18	1	230	169.8	1.40
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK19	1	212	96.7	1.01
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	SB02	1	69	3.4	1.03
11-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK20	1	123	20.2	1.09
11-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	Batch	6455		13330.0	
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK21	1	219	130.9	1.25
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK22	1	165	51.7	1.15
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK23	1	144	33.9	1.14
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK24	1	232	160.7	1.29
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	SB	Batch	1139		2352.0	
11-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK25	1	216	144.0	1.43
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	3564		7360.0	
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK26	1	226	138.3	1.20
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK27	1	301	383.8	1.41
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK28	1	243	196.7	1.37
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK29	1	236	197.8	1.50
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK30	1	218	131.0	1.26
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK31	1	258	220.6	1.28
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	727		1502.0	
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK32	1	221	135.7	1.26

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK33	1	276	263.7	1.25
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK34	1	267	239.4	1.26
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK35	1	282	264.3	1.18
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK36	1	210	123.4	1.33
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK37	1	222	157.4	1.44
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB03	1	71	4.5	1.26
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB04	1	59	3.0	1.46
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB05	1	60	3.1	1.44
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB06	1	52	2.6	1.85
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB07	1	53	2.7	1.81
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB08	1	65	3.4	1.24
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB09	1	54	1.6	1.02
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB10	1	46	1.3	1.34
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB11	1	48	1.3	1.18
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB12	1	39	0.6	1.01
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB13	1	84	7.5	1.27
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB14	1	57	1.5	0.81
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB15	1	58	1.7	0.87
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB16	1	48	0.8	0.72
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB17	1	76	3.8	0.87
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB18	1	52	1.4	1.00
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB19	1	57	2.4	1.30
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB20	1	43	1.5	1.89
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB21	1	44	1.9	2.23
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB22	1	58	1.7	0.87
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB23	1	53	1.8	1.21
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB24	1	46	1.4	1.44
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB25	1	43	2.2	2.77
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB26	1	51	1.5	1.13
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB27	1	51	2.3	1.73

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T		SB28	1	60	2.7	1.25
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB29	1	62	3.1	1.30
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB30	1	46	1.3	1.34
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB31	1	53	1.4	0.94
11-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	SB32	1	56	2.1	1.20
12-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	107		221.6	
12-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	107		221.7	
12-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	93		191.8	
12-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	27		56.4	
12-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	1511		3120.0	
12-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK01	1	126	21.6	1.08
12-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK02	1	298	303.7	1.15
12-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	SB	Batch	3656		7550.0	
12-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK03	1	245	188.4	1.28
12-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK04	1	248	202.1	1.32
12-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK05	1	284	272.9	1.19
12-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	250		515.7	
12-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	260		536.7	
12-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	150		309.6	
12-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	136		280.7	
12-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	22		45.4	
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	Batch	156		321.7	
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	Batch	141		291.5	
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB01	1	59	1.5	0.73
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB02	1	46	1.0	1.03
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB03	1	76	3.9	0.89
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB04	1	63	3.2	1.28
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB05	1	24	0.1	0.72
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB06	1	29	0.3	1.23
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB07	1	38	1.1	2.00

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB08	1	52	1.6	1.14
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB09	1	54	1.6	1.02
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB10	1	55	2.4	1.44
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB11	1	63	1.8	0.72
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB12	1	55	1.6	0.96
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB13	1	56	1.4	0.80
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB14	1	53	1.7	1.14
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB15	1	22	0.1	0.94
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB16	1	53	2.1	1.41
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB17	1	53	1.9	1.28
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB18	1	44	1.4	1.64
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB19	1	49	1.1	0.93
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	SB20	1	61	2.1	0.93
12-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	BK	BK06	1	178	67.2	1.19
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	1070		2210.0	
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	SB	Batch	407		840.0	
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK01	1	252		0.00
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK02	1	185		0.00
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK03	1	136	29.7	1.18
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK04	1	237	188.3	1.41
13-Aug-21	Great Pond	Fyke Net	FN01	5280295	367353	22T	BK	BK05	1	285	236.4	1.02
13-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	SB	Batch	1893		3910.0	
13-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK06	1	249	213.4	1.38
13-Aug-21	Great Pond	Fyke Net	FN02	5280235	367108	22T	BK	BK07	1	262	250.2	1.39
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	SB	Batch	2823		5830.0	
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	SB	Batch	402		830.0	
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK08	1	202	108.6	1.32
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK09	1	219	143.8	1.37
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK10	1	186	79.4	1.23
13-Aug-21	Great Pond	Fyke Net	FN04	5280544	367283	22T	BK	BK11	1	143	32.2	1.10

Fyke Netting Data

Date	Sample Location	Gear Type	Net ID	Northing	Easting	Zone	Species	Fish ID	Total Catch	Length (mm)	Weight (g)	Condition
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	378		780.0	
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK12	1	235	176.3	1.36
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK13	1	223	119.7	1.08
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK14	1	179	72.3	1.26
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK15	1	282	276.7	1.23
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	BK	BK16	1	182	78.6	1.30
13-Aug-21	Great Pond	Fyke Net	FN05	5280836	367513	22T	SB	Batch	213		440.0	
13-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	Batch	1738		3590.0	
13-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	SB	Batch	155		320.0	
13-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	BK	BK17	1	228	155.4	1.31
13-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	BK	BK18	1	243	177.8	1.24
13-Aug-21	Great Pond	Fyke Net	FN03	5280514	367687	22T	BK	BK19	1	266	245.2	1.30

APPENDIX C: Great Pond Study

DRAFT

GREAT POND STUDY

Submitted to:

Town of Torbay
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Submitted by:

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25 February 2021
Wood Project #: TF1969415

IMPORTANT NOTICE

This report was prepared exclusively for Town of Torbay by Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Wood's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Town of Torbay only, subject to the terms and conditions of its contract with Wood. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

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1.0 INTRODUCTION

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood), was retained by the Town of Torbay to conduct a study on the Great Pond Watershed (Drawing 1; Appendix A).

1.1 Background

The Town of Torbay retained CH2M Hill Canada Ltd to complete a feasibility study and conceptual cost estimate for water treatment facilities for both North Pond and Great Pond in 2011. Bench-scale testing results of raw water samples from Great Pond, collected in 2009, were used as the basis for a proposed water treatment process that would result in a Great Pond water system that would be in compliance with the Guidelines for Canadian Drinking Water Quality (e.g. 3-log reduction of cryptosporidium). Given that these raw water samples are now ten years old, there is a need to review more recent water quality sample data to establish treatment requirements for the Great Pond system.

The capital cost estimate of the water treatment process for Great Pond established in the CH2M Hill Canada Ltd 2011 study was approximately $13.2 million, with annual Operations and Maintenance (O&M) costs of $329,000. When compared to North Pond, the CH2M Hill (2011) study indicates Great Pond would have a higher capital and O&M cost due to the larger rated capacity and additional treatment required for iron and manganese control.

The proposed Great Pond water treatment plant (WTP) was designed for a maximum instantaneous production rates of 3.9 ML/day – a production rate based on the estimated maximum yield from the supply established in 2008 as 3900 m^3/day. The average flow was assumed to be 50% of the maximum flow (50% x 3900 = 1950 m^3/day) and the minimum flow was assumed to be 25% of the maximum flow (25% x 3900 = 975 m^3/day).

The treatment system designs proposed in the CH2M Hill Canada Ltd. (2011) for both North Pond and Great Pond include a 6.5 million Litre contact tank and reservoir. The reservoir was sized assuming an average daily water demand of 4,260 m3/day in the year 2031.

There is currently not enough information available to establish the reasonableness of the assumed 3900 m^3/day design capacity and sustainable yield of Great Pond as a water supply. A capacity assessment of Great Pond is required to establish the maximum available yield from the watershed which in turn is used to establish estimated capital investment and operational costs. In addition, a planning and land use review is required to establish Future planning issues that may arise should Great Pond be used as the source for a public water supply.

2.0 SCOPE OF WORK

The original scope of work consisted of the following:

- Source water study, including:
  - Watershed delineation
  - Bathymetric profile
  - Flow monitoring of the outflow of Great Pond
- Water balance;
- Planning and land use review;
- Distribution system review; and
- A water treatment plant options analysis.

The scope was ultimately changed to further include a wetted perimeter study within the source water study, while the distribution system review and water treatment plant options analysis were postponed due to findings within the source water study and water balance portions of the study, as discussed in Section 5.0.

3.0 METHODOLOGY

3.1 Source Water Study

Wood conducted a source water study of Great Pond to establish the storage capacity and to provide background data to establish a safe rate of water removal, that included a watershed delineation, bathymetric profile, discharge monitoring, and wetted perimeter study, as described in the following sections.

3.1.1 Watershed Delineation

The Great Pond watershed area was delineated using recently collected LiDAR information to provide a more precise watershed area than previously delineated.

3.1.2 Bathymetric Profile

To better characterize the water storage capacity of Great Pond, a detailed bathymetric survey was completed on June 5, 2020. The bathymetric survey was conducted using a differential GPS sonar unit attached to a Zodiac style inflatable boat. The unit links GPS and sonar technology in a digital environment so that depths and location (differential GPS) are digitally mapped.

The Lowrance sonar/GPS unit was set up in the field to collect combined positional and depth data once every second. The boat was generally moving at a rate of less than 2 metres per second (m/s) for optimal coverage. The unit has been tested using known survey pin locations for positional accuracy and has been recorded at being less than one metre. The error associated with sonar depth detection has been given as 1 centimetre (cm); however, weather conditions such as wave height and variable water temperatures can also affect this slightly.

Quality assurance/quality control (QA/QC) was conducted on all data collected with respect to validity (e.g., positional data and/or depth data acquired) prior to contour generation. Water surface elevation was recorded before and after surveys to better tie generated contours to elevation datum. Final contours were completed and assessed using GIS to provide a bathymetric contour of the study area.

3.1.3 Flow Monitoring

Unlike North Pond, where an approximation of the impact of demand on the water levels can be established (e.g. based on some flow metering, sporadic observations of water level, and the general observations of the pond's performance since the water supply came online), there is no baseline for establishing a threshold for demand of Great Pond as a water supply. As such, there is a need to conduct some feasibility-level estimate of inflow into Great Pond, that can serve as a comparison to the 3900 m^3/day assumed in the CH2M Hill (2011) study.

The outflow survey consisted of an elevation survey that can be tied to existing LiDAR data. The elevation survey included a cross section of the base of the outlet river. Measurements were conducted using standard procedures as outlined in Sooley *et al.* (1998) and McCarthy *et al.* (2007). Standard measurements such as wetted width, water depth and mean water velocity were recorded across each transect. Depth was recorded using a metre stick while mean velocity will be recorded using a Global Flow Probe (Model 101a). Wood's standard flow equipment provides instantaneous calculation of mean water velocity at an accuracy of +0.01m/s. This data was also be used to calculate discharge rates for each survey transect.

A dataloggers was installed at the outlet of Great Pond to conduct flow monitoring. The elevation data collected from the datalogger was calibrated with flow data to create a flow curve.

3.1.4 Wetted Perimeter

The Wetted Perimeter Method (WPM) is a fixed flow hydraulic rating method based on the hydraulic relationship between flow (i.e. discharge) and wetted river perimeter at selected transect(s) (Stalnaker et al. 1994). Using the relationship, the flow corresponding to the wetted perimeter (wetted width of the stream transect), which is needed to minimally protect all habitats, can be estimated. Figure 3-1presents a schematic of a wetted perimeter/flow relationship and indicates the point of inflection for that relationship. The point of inflection is taken as the flow below which dewatering would take place rapidly for the represented habitat. Field surveys typically cover the range of natural flows. Where this is not achievable, Manning's equation can be applied to estimate extreme values. Manning's equation is given by:

Velocity (m/s) = $R^{2/3} * S^{1/2} / n$ where

R = Hydraulic radius (Area / wetted perimeter) – see Figure 3-1

S = slope at transect

n = Manning's n.

The cross-sections, or transects, selected to determine the minimum flow for habitat protection is very important in this technique. The selected transects for assessment must stand as an index habitat for the rest of the river or river section being assessed (Stalnaker et al. 1994). Riffles are typically selected because cross sections in these areas exhibit sensitivity of width, depth and velocity to changes in flow. They are usually the shallowest habitat type found and as such, would indicate adequate water levels needed to protect all habitats. Therefore, once a minimum level of flow is estimated for a riffle, it is assumed that other habitat areas, such as pools and runs, are also satisfactorily protected. Because the shape of the channel can influence the results of the analysis, transects are usually located in areas that are wide, shallow, and rectangular.

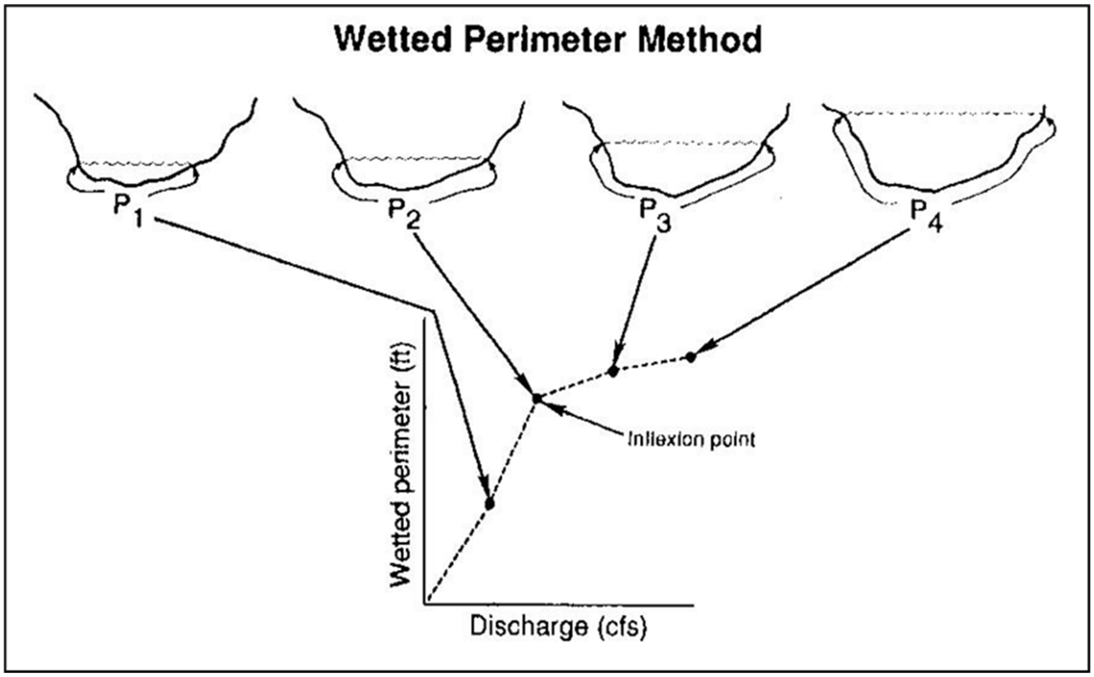

Figure 3-1: Example of wetted perimeter method to estimate instream flows (Nelson 1980).

The following assumptions apply to the WPM:

- the selected area is a suitable index of habitat for the rest of the river, i.e., if the minimum flow requirement is satisfied at the chosen sensitive location, it will be satisfied in other habitat types. The greater the number of transect locations, the higher the level of confidence in the minimum flow estimation;
- the point of inflection is a suitable surrogate for acceptable habitat, i.e., flow reductions below that point on the graph will result in loss of habitat quality; and
- all wetted area is equally important as habitat or to satisfy other biological criteria.

All information from each transect survey was used to create AutoCAD drawings of the transect. Using Manning's equation, the discharge at various water levels was then simulated using the profile and data provided by the AutoCAD drawing. The maximum water depth at each transect was used as the marker for an estimate of the water level associated with each simulated discharge. For each transect location, the water level was modeled from the measured levels by decreasing in 0.10m increments until the streambed was practically dry and increasing in 0.10 m increments until the water level reached the height of the streambed.

The transect profiles at these various water depths were simulated to get parameters needed to estimate discharges using Manning's equation. The estimated velocity values derived from Manning's equation were used to calculate discharges at each simulated water level.

3.2 Water Balance

A water-balance was conducted to evaluate how water moves within the Great Pond drainage area. The water-balance calculations account for water being added to a drainage area (e.g. precipitation) and removed from a drainage area (e.g. a river that flows out). An illustration of the hydrologic (water) cycle is shown in Figure 3-2.

A water-balance can be represented by the following equation:

$$P + SW_{in} + GW_{in} - GW_{out} - SW_{out} - ET - \Delta S = 0$$

Where P represents precipitation, SW_{in} represents surface water flow into the drainage area, GW_{in} represents groundwater inflow, GW_{out} represents groundwater outflow, SW_{out} represents surface water flow out, and ET represents evapotranspiration (evaporation and transpiration). All of these terms have the same units of depth (mm).

The number of variables in the above equation can be reduced through an assumption that over the long term (e.g. 30-years), changes in surface and groundwater storage are negligible, therefore ΔS=0. Groundwater flow into and out of the drainage area is assumed to be equal, so that the terms GW_{in} and GWout cancel each other out (i.e. the amount of flow into the system equals the amount of the flow out of the system over the year). The drainage area for each drainage area extends to the headwaters, as a result, there is no surface water flow coming in at the upstream boundary and SW_{in} =0.

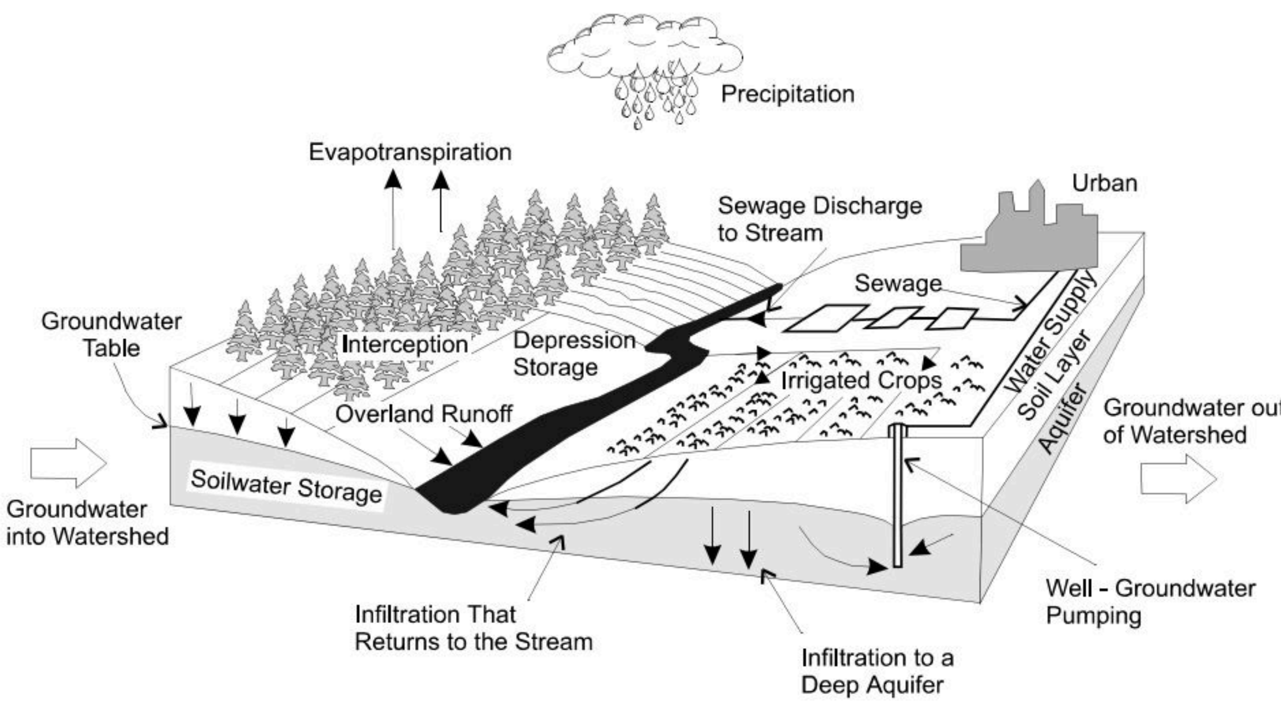

Figure 3-2: An illustration of the water cycle (Image Source: After et al. 1991)

The water-balance equation is therefore reduced to:

$$Precipitation - SW_{out} - ET = 0$$

A variety of methods exist for computing the terms in the above water-balance equation. The Thornthwaite and Mather (1955) methodology was the first to use air temperature and precipitation to compute a water balance that tabulates the additions, losses and changes in water storage at a location. The methods of computing the terms of the daily and monthly water balances have previously been discussed in Mather (1978) and Phillips (1976). A more recent version currently being used by Environment Canada to conduct water-balance assessments, uses daily temperature and precipitation data as the required inputs. The use of daily climatic data permits better modeling of snowmelt and improves the accounting of snow storage which is of particular importance in the Canadian climate.

3.3 Planning and Land Use Review

A planning review was conducted to develop a clear understanding of the potential issues related to existing land use practices within the Great Pond watershed area. The planning review consisted of a comprehensive review of the following, as described in Section 5.3:

- Provincial Regulations, Policies and Land Use Interests;
- Regional Policies, Agreements and Land Use Interests;
- Town of Torbay Regulations and Land Use Interests; and
- Town Portugal Cove- St. Philip’s Regulations and Land Use Interests.

4.0 RESULTS

4.1 Source Water Study

The source water study of Great Pond consisted of a watershed delineation, bathymetric profile, discharge monitoring, and wetted perimeter study, as described in the following sections.

4.1.1 Watershed Delineation

The Great Pond watershed area was delineated using recently collected LiDAR information to provide a more precise watershed area than previously delineated. The newly delineated watershed is shown on Drawing 2 (Appendix A), along with the NDAL (2008), the Town of Torbay and Town of Portugal Cove – St. Philip's protected watershed zones, for comparison.

Results indicate the watershed area delineation using LiDAR produced a significantly larger watershed area (~80 ha; Table 4-1) than the previous delineations that were likely completed using 1:50,000 scale NTS maps. It is recommended that land use mapping be updated to reflect the larger area.

Table 4-1: Area of Watershed Delineations

Watershed Delineation	Area (ha)
Wood (2020)	383.19
NDAL (2008	305.88

4.1.2 Bathymetric Survey

A bathymetric survey of Great Pond was completed by Wood staff on June 5, 2020 (Figure 4-1) to support the development of a geo-referenced bathymetric contour map of the water supply.

A bathymetric contour map of the water supply developed in ESRI ArcGIS is shown on Drawing 3 (Appendix A)

At the time of the bathymetric survey (June 5, 2020), the measured water surface elevation was 117.75 m. The lowest measured elevation at the bottom of the pond was 109.6 m, resulting in a maximum water depth at the time of survey of approximately 8.2 m.

A storage volume curve for Great Pond was established using the 3D analytical capabilities provided in ESRI ArcGIS (Table 4-2 and Figure 4-2). The calculated 2D surface area of the pond at the time of survey was 286,716 m^2 and the total storage volume was 884,192 m^3. At the time of the survey, there was approximately 271,271 m^3 contained within the top one (1) m of Great Pond.

As a point of comparison, the calculated 2D surface area of North Pond is 146,914 m2 and the total storage volume of North Pond is 792,691 m^3. There are approximately 150,400 m^3 (150.4 million litres) contained within the top one (1) m of North Pond and approximately 400,000 m^3 of water between the water surface (elevation 93.39 m) and the estimated elevation of the intake (elevation 90 m).

Figure 4-1: Great Pond Bathymetric Survey Equipment

In general, Great Pond has a significantly larger surface area than North Pond but only a marginally larger amount of storage volume (i.e. much of Great Pond is shallow, particularly the southwest portion). Approximately 58% of the total volume is contained within the top two (2) m of the pond.

The deepest portion of the pond is in the northwest corner, which will be beneficial if any future intake is to be sited near the outlet of the pond.

Table 4-2: Storage Volume Table for Great Pond Developed Using Bathymetric Data.

Reference Elevation	2D Surface Area (m^2)	Volume Below Reference Plane (m^3)	Volume difference between this elevation and the one below (m^3)
117.75	286,716	884,192	206,343
117	263,580	677,849	64,929
116.75	255,807	612,920	181,705
116	228,040	431,216	55,539
115.75	216,185	375,677	146,705
115	173,232	228,972	135,387
114	88,424	93,585	57,493
113	30,853	36,092	21,300
112	14,767	14,791	10,659
111	7,059	4,132	4,081
110	584	51	51
109.6	Bottom of Pond	0	0

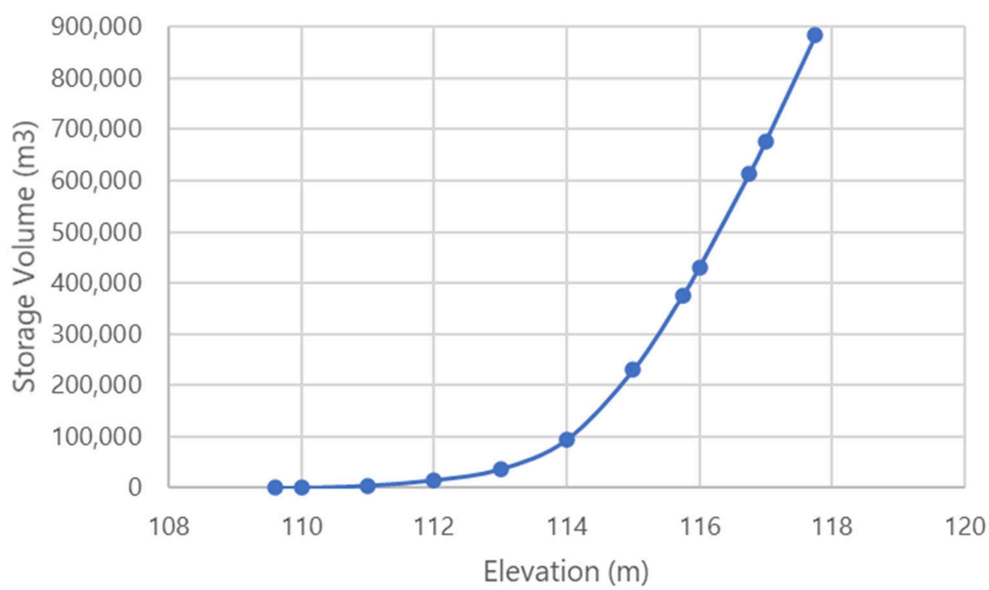

Figure 4-2: Great Pond Storage Volume Curve Developed Using Bathymetric Data.

4.1.3 Flow Monitoring

Pressure transducers were installed at the outflow of Great Pond, immediately downstream of Great Pond, and have been collecting data continuously since December 2019. One transducer is located in the stream, and measures water temperature and pressure, while a second sensor is located nearby to measure air pressure. This is used to calculate the depth of the transducer. During regular downloads, discharge transects (that measure flow rates in the stream) are also completed in order to develop a regression to estimate discharge based on water depth (Figure 4-4).

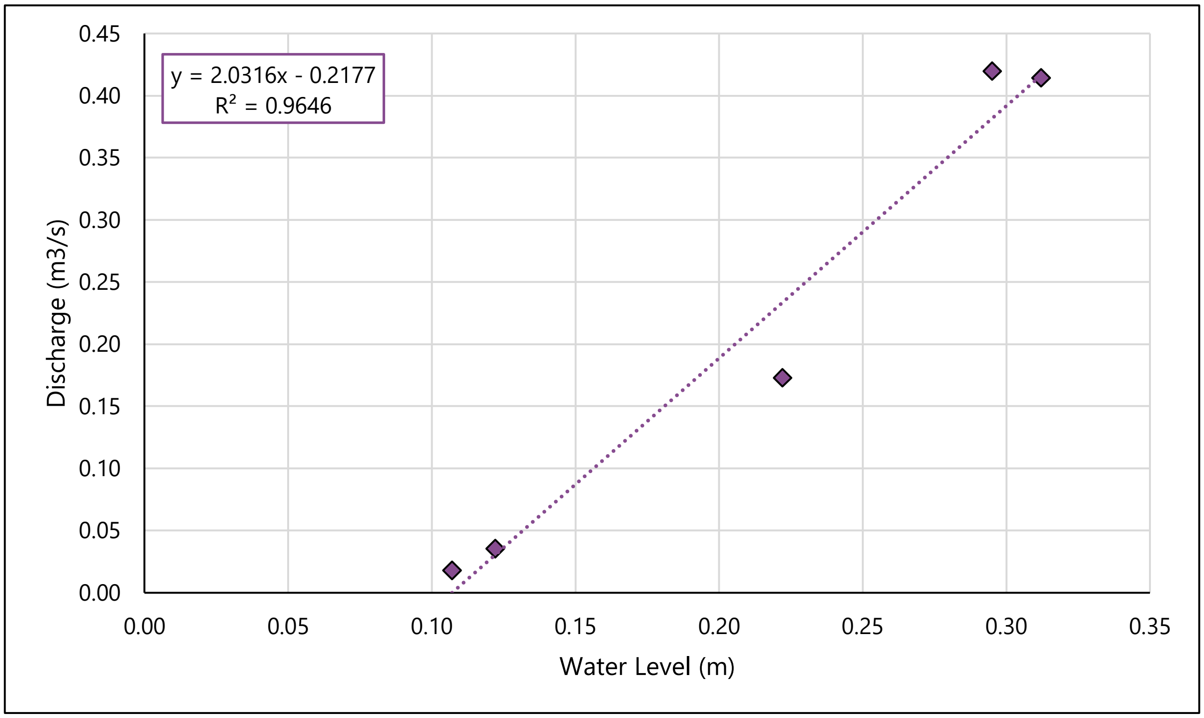

Figure 4-3: Discharge (m^3/s) vs. Stage (m).

Using the water level-discharge relationship presented above, discharge has been calculated throughout the period from December 2019 to early January 2021 (Table 4-2 and Figure 4-5). Figure 4-5 also presents the prorated discharge based on the gauging station in Northeast pond River (Station # 02ZM006). Both methods of discharge estimation produced similar mean annual discharges of approximately $0.16 m^3/s$.

Table 4-3: Summary of estimated discharge from Great Pond

Discharge Measure	Mean Annual Discharge	50th Percentile Discharge	Maximum Discharge
Sensor Discharge	0.155	0.128	0.739
Prorated Discharge	0.166	0.081	5.676
Note Prorated discharge based on Station # 02ZM006 which has 69 years of data available			

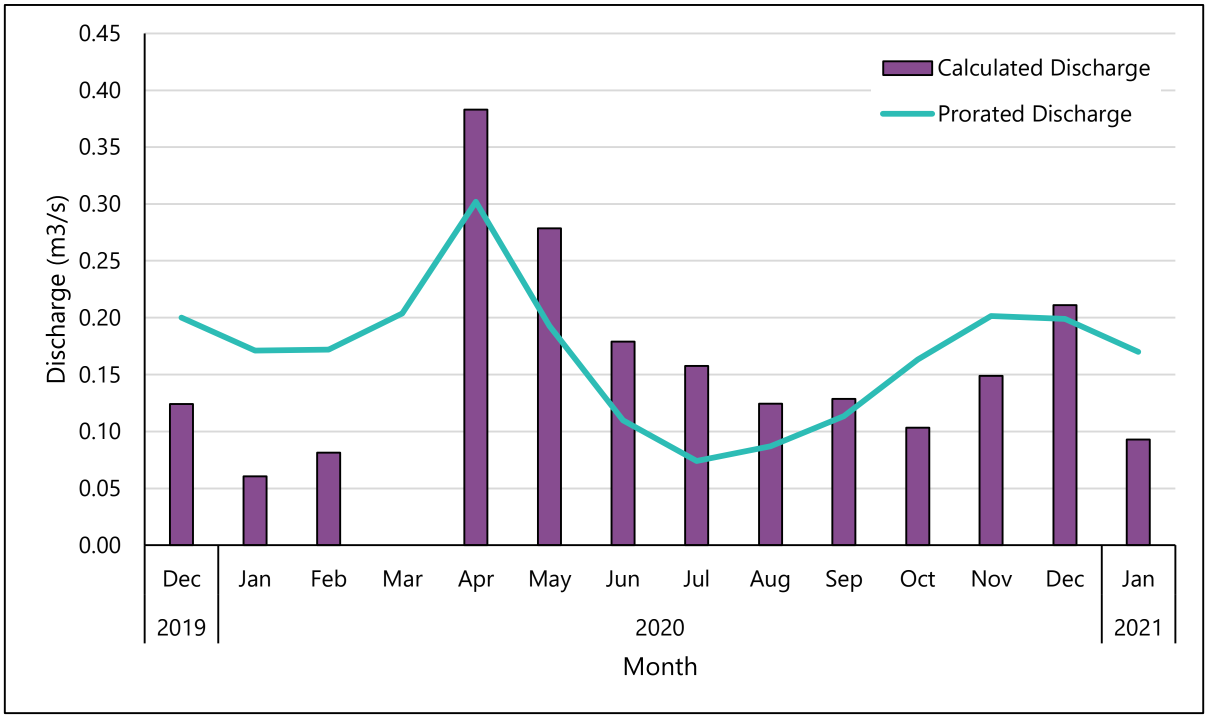

Figure 4-4: Calculated Discharge Leaving Great Pond, with Missing Data for March 2020.

4.1.4 Wetted Perimeter

Using cross sectional data collected on April 22, 2020, a wetted perimeter model was developed using Manning's N equation. This model shows an inflection point, which indicates the minimum discharge required to maintain wetted perimeter (i.e. available aquatic habitat). Figure 4-6 presents the modelled wetted perimeter and discharge, as well as measured wetted perimeter and discharge. As shown, the modelled inflection point is 0.08 m^3/s, while the measured inflection point is 0.04 m^3/s.

The wetted perimeter model has three key assumptions, as presented in Section 3.1.4. This transect location was chosen initially as a discharge monitoring transect. While the location is suitable for this purpose, it does not make it an ideal location for wetted perimeter assessments, specifically because it may not be considered a critical or sensitive habitat. In order to further define minimum flow release, further field surveys and discharge measurements are recommended.

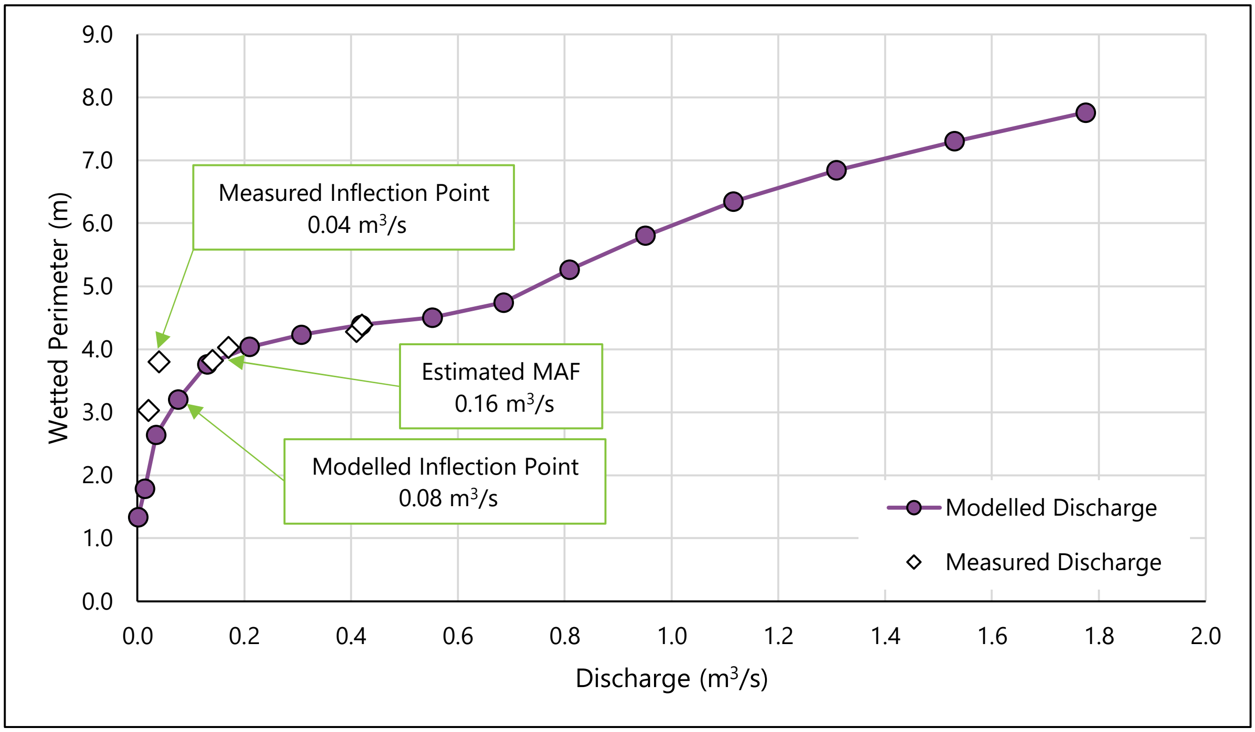

Figure 4-5: Wetted perimeter analysis for Great Pond Outflow.

4.2 Water Balance

A water-balance assessment was conducted to evaluate how water moves within the Great Pond drainage area. The results are presented in the following sections.

4.2.1 Precipitation and Temperature

All available climatic data was retrieved for the Environment Canada St. John's A climate station (Climate ID 8403506, 47°37'20.000" N, 52°44'34.000" W, elevation 140.5 m; Environment Canada, 2020). Climate normals for St. John's are presented in Table 4-4. The mean monthly temperature ranges from -4.9 °C in February to 16.1 °C in August.

The monthly precipitation data for St. John's is reported as Total Rainfall (the amount of all liquid precipitation in millimetres such as rain, drizzle, freezing rain and hail observed at the location during a specified time interval), Total Snow (the amount of frozen/solid precipitation in centimetres, such as snow and ice pellets observed at the location during a specified time interval), and Total Precipitation (the sum of the total rainfall and the water equivalent of the total snow in millimetres observed at the location during a specified time interval). Total precipitation does not always equal rainfall plus one tenth of the snowfall in the statistical summary (e.g. missing observations is one cause of such discrepancies).

The average monthly total precipitation range at the climate station is 91.6 mm in July to 164.8 mm in December. The average annual total precipitation is 1534 mm. The historical data contains a record of the snow on the ground on the last day of each month, with the most snow on the ground at the end of January. Historically, the wettest year during the period of record was 1955, where the total precipitation was 1636 mm. The driest year during the period of record was 1989, where the total precipitation was 590 mm.

Table 4-4: Monthly Temperature and Precipitation Normals (1981–2010) for St. John's International Airport (Environment Canada, 2020).

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average Temperature (°C)	-4.5	-4.9	-2.6	1.9	6.4	10.9	15.8	16.1	12.4	7.4	3	-1.5	5
Total Rain (mm)	66	61.6	84.8	96.1	97.9	97.5	91.6	100	129.6	153.7	124.8	102.9	1206.4
Total Snow (cm)	88.7	71	57.3	25.3	4.4	0	0	0	0	2.4	22.4	63.4	335
Precipitation (mm)	149.2	129.5	142.2	122.9	102.6	97.6	91.6	100	129.6	156.2	148.1	164.8	1534.2
Snow Depth at Month-end (cm)	31	30	15	1	0	0	0	0	0	0	2	12	8

4.2.2 Water Holding Capacity

The water holding capacity (WHC) of the soil in the area of interest is required to perform the water-balance calculations. WHC refers to the maximum amount of water that can be held in the capillaries of soil for the use of plants and it depends on the composition, structure and depth of the soil and the type of vegetation surface (Phillips 1976).

The surficial geology (Batterson, 2000) indicates the Great Pond watershed consists mainly of a thin till veneer (<1.5m) to a till blanket (>1.5m) Till typically consists of clay, silt, sand and boulders. For the purposes of this desktop assessment, the WHC used in the water-balance calculations was assumed to be 125 mm.

4.2.3 Estimating Monthly Runoff

Surplus water is the excess after the evaporation needs of the surface have been met (i.e. when actual evapotranspiration equals potential evapotranspiration) and soil storage has been returned to the water holding capacity (Johnstone and Louie 1983). The surplus within each drainage area was distributed into runoff and infiltration using Ontario MOE Guidelines (MOE 2003). The total infiltration in a month (of which some discharges back to the stream as base flow) was determined by considering topography, soils and cover as per MOE (2003) guidelines. For this desktop study, the soil in each drainage area is assumed to have an infiltration factor of 30% due to the hilly land, soil type, limited woodland cover and exposed bedrock). As a result, 70% of the monthly surplus ends up as runoff. The lake areas in each drainage area, which are assumed to contribute wholly to the volume of the lake with no infiltration losses, were assigned an infiltration factor of 0.

These are considered to be high-level estimates of surplus and infiltration, typically only applied on an annual basis. As such, in the following section, estimates of surplus, infiltration and runoff will be summarized for each drainage area on an annual-basis.

Thornthwaite water-balance calculations (St. John's Airport for the period of 1942-2019) were provided by the Climate Services division of Environment Canada are shown in Table 4-5. The average annual surplus for the period of analysis was 1016 mm. The total annual surplus is shown in Figure 4-6 for all years on record. The driest year with the least amount of surplus was 1989 (total precipitation = 1147 mm and total surplus = 590 mm). The wettest year with the greatest amount of surplus was 1955 (total precipitation 2068 mm and total surplus = 1636 mm).

The Newfoundland and Labrador Guidelines for the Design, Construction and Operation of Water and Sewerage Systems (ECCM, 2005) indicate a surface water quantity assessment should, demonstrate that, where possible, a minimum drought return period of one in fifty years should be used for calculating the safe yield. Assuming, the total annual precipitation data collected at the St. John's Airport location follows an extreme value distribution, the driest year 1989.

Table 4-5: Water Balance Averages for the Period of 1942-2019.

Month	TEMP (°C)	PCPN (mm)	RAIN (mm)	MELT (mm)	PE (mm)	AE (mm)	DEF (mm)	SURPLUS (mm)	SNOW (mm)	SOIL (mm)	ACCUM PCPN (mm)
January	-4.1	151	65	36	2	2	0	98	85	125	615
February	-4.7	135	53	34	2	2	0	85	133	125	749
March	-2.5	134	69	56	4	4	0	121	142	125	883
April	1.5	115	96	119	16	16	0	199	42	125	999
May	5.9	100	99	43	47	47	0	96	0	124	1098
June	10.7	94	94	0	80	80	0	23	0	115	1192
July	15.7	88	88	0	113	112	-1	8	0	82	1280
August	15.8	110	110	0	105	101	-4	10	0	81	1391
September	12.1	125	125	0	71	70	-1	32	0	103	1517
October	7.3	150	150	0	41	41	0	90	0	122	149
November	3.2	154	148	5	18	18	0	132	2	125	303
December	-1.5	160	104	23	5	5	0	122	35	125	463
Annual	4.9	1515	1201	316	504	498	-6	1016			

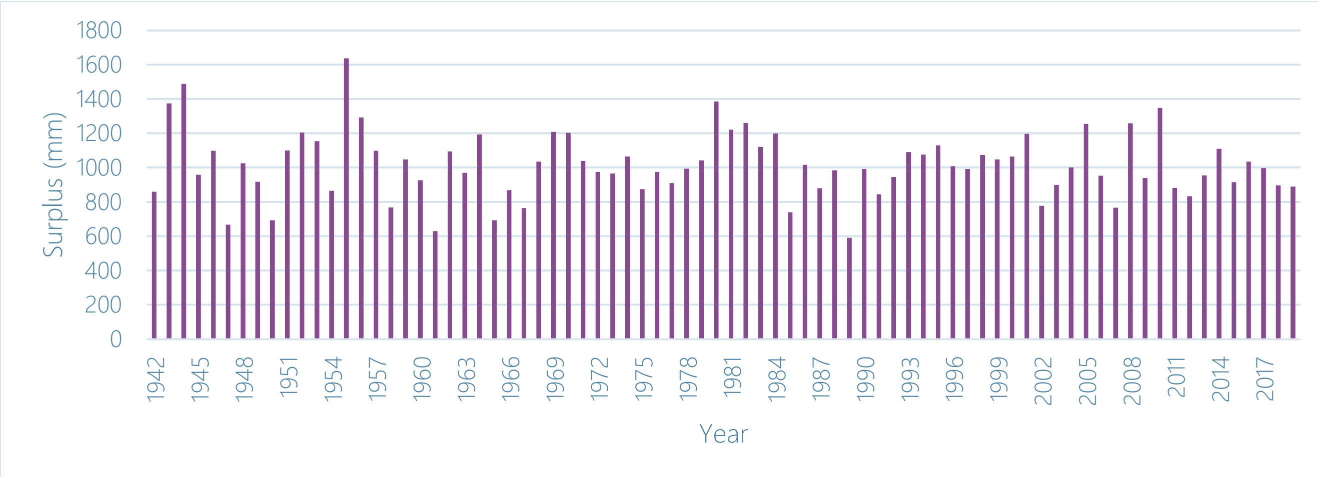

Figure 4-6: Total Surplus (mm) by Year as Determined by the Thornthwaite Water Balance.

4.2.4 Great Pond Drainage Area Water-Balance Results

The water balance calculations for the Great Pond drainage area (3.83km^2) are outlined in Table 4-5. Detailed calculations are included in Appendix B.

- **Average year:** total surplus is 3,890,133 m^3 and total infiltration is 1,079,993 m^3 resulting in a total surface runoff is 2,810,140 m^3. The average flow rate as determined in the water-balance calculations is 0.09 m^3/s (89 L/s).
- **Wet year:** total surface runoff is 4,521,893 m^3 (average flow rate of 0.14 m^3/s or 143 L/s).
- **Dry year:** total surface runoff is 1,640,032 m^3 (average flow rate of 0.05 m^3/s or 52 L/s).

4.3 Planning and Land Use Review

Various watershed areas have been identified for Great Pond. These include a boundary delineated by the Department of Municipal Affairs and Environment as a potential watershed area in 2008 (ECCM, 2019). The Torbay Municipal Plan identifies a larger watershed boundary including an extended area to the northwest (Town of Torbay, 2015). The Town of Portugal Cove-St. Philips has defined an area for the portion of Great Pond watershed within its boundaries (Town of Portugal Cove-St. Philips 2016). In 2020, Wood delineated a more detailed watershed boundary within both municipalities, which is referred to as the watershed in this review.

4.3.1 Provincial Regulations, Policies and Land Use Interests

Water Resources Act, SNL 2002

The Great Pond watershed delineated by the Department of Environment, Climate Change, and Municipalities is identified by the Government of Newfoundland and Labrador as a potential water supply (ECCM, 2019). While a potential future water supply may receive protection through Section 39 of the *Water Resources Act*, Great Pond does not presently have protection through provincial legislation (GNL, 2016).

Protecting a watershed area under the *Water Resources Act* requires submission of a "Protection of a Public Water Supply Area" application to the regional office of the Water Resources Management Division (WRMD). The application, which requires information about the watershed including major water supply name, location, consultant information, water quality and land use, is found at: https://www.gov.nl.ca/mae/files/waterres-regulations-appforms-dev-protected-area-fees.pdf. Once submitted, the application is reviewed by WRMD for completeness and accuracy. Additional information on existing or potential development activities may be requested and a site visit arranged. The watershed boundary is delineated, and the application is reviewed by the Interdepartmental Land Use Committee (ILUC) to identify development activities, potential land use conflicts with other resource use and interests of other departments and agencies (DMAE 2013; Government of NL No Date a).

Upon approval, a notice of designation is published in the Newfoundland and Labrador Gazette and the municipality receives confirmation. The municipality is required to give public notice of the designation through ads in local newspapers and/or posters in public spaces in the community (e.g., council office, community centre). The municipality is advised to post signage at suitable locations (e.g., access points) along the boundaries of the designated area. Digital maps of protected public water supply area boundaries are maintained in WRMD's Geographical Information System (GIS) on the Water Resources Portal website to identify the location of protected public water supply areas and to provide digital data (ECCM 2013; GNL No Date a). Provincial development proposals within a protected water supply area are forwarded to the municipality for comment.

Potential Water Supply Areas

A potential public water supply area may be protected under the same process as a public water supply area if one of the following conditions apply:

- it is demonstrated that the yield of the present source is inadequate to meet the present and future water demands of its users;
- the quality of the present source is not in compliance with existing drinking water quality guidelines and may pose a risk to the health of consumers;
- due to other factors as determined by the department.

Once protected, the provisions of Section 39 apply to the potential public water supply area from the date of the publication of the notice of the designation in the Newfoundland and Labrador Gazette. In the same manner as with protected public water supply areas, signs should be posted at suitable locations along the boundaries of the designated area for public information (ECCM, 2013). Provincial development proposals within a protected potential water supply area are also forwarded to the municipality for comment.

Expropriation Act

In Newfoundland and Labrador, the *Expropriation Act* provides the Provincial government, or a designate, with the power to expropriate land for public purposes. Section 3 of the *Act* outlines situations where expropriation may be permitted. Expropriation would only occur where the minister considers it necessary for purposes described in Section 3. Potential scenarios include: the owner refuses to sell, an agreement cannot be reached on compensation or terms, the owner is unknown or cannot be found after reasonable inquiry, the owner is incapable of conveying the land or their interest in it or for other reasons (GNL, 2019).

Urban and Rural Planning Act, 2000

Where a Newfoundland and Labrador municipality requires lands surrounding a water supply waterbody for protection, it may purchase the land from legal owners. Where this is not possible, the *Urban and Rural Planning Act, 2000*, Part 9 gives municipalities the right to expropriate property, land or an interest in land for the purpose of powers granted under the *Municipalities Act, 1999* (GNL, 2017a).

Municipalities Act, 1999

Under the *Municipalities Act, 1999* Part 7, a municipality may expropriate land, property or an interest in property for a variety of purposes including a public water supply system. A municipality may acquire waters for the purpose of providing a water supply for the municipality and may acquire, by purchase or expropriation, adjacent lands to prevent pollution of those waters (GNL, 2017b).

Forestry

In Newfoundland and Labrador, a permit is required for domestic cutting, which occurs mainly in fall and winter using ATVs or snowmobiles. Each permit allows harvesting of 7-9 m^3. Torbay is within the Provincial Zone 1 Forestry Management District, which has a current operations plan for the period of 2017-2021. Domestic cutting blocks are located throughout the District including in Torbay (Drawing 4; Appendix A). Operating Unit Area No. CC01603 Patrick's Path (369.7 ha) overlaps with the Great Pond Watershed (2020). The estimated annual domestic harvest in CC01603 is approximately 16,742 m^3 and recent cutting is evident off Great Pond Road / Whiteway Pond Road (Forest Service 2016). Forest access roads are located within the watershed connecting to Great Pond Road / Whiteway Pond Road and Woodfine's Lane (GNL, 2020a).

Domestic harvesting increased in Zone 1 in the last planning period. Demand for fuel wood is particularly high and anticipated to grow given the rising cost of other heating methods and decreased availability of fuel wood sources. No commercial cutting, silviculture blocks or planned forestry road construction are identified for Torbay (Forest Service, 2016).

Twenty (20) m No-Cut Buffers are located around most of the edge of Great Pond and streams leading into the Pond. Wider buffers are established where a waterbody is a protected water supply areas; the guidelines are attached to any cutting permits issued in the area and compliance is monitored. The Forest Service must receive annual approval under the *Water Resources Act* for harvesting within a protected watershed. Great Pond watershed is not identified as a protected water supply in the forestry plan. District Ecosystem Managers and planning teams may widen buffer widths to protect sensitive areas such as salmon spawning habitat, cabin areas or for aesthetic purposes (Forest Service, 2016).

Agriculture

Based on satellite imagery and field investigation, it appears that agricultural activity occurs in the Great Pond watershed (2020). It is likely that one or more sod farms with residences and outbuildings, are located on Great Pond Road / Whiteway Pond Road (Drawing 5; Appendix A).

Mining

Mining data is available through the Newfoundland and Labrador Geoscience Atlas. No exploration licences or mining leases are in the Great Pond watershed (2020). A quarry is located near Great Pond partially within the watershed (Drawing 6; Appendix A). It appears that this quarry is inactive as the permit expired in 2014 (GNL, 2020a).

Hunting and Trapping

Torbay is within various hunting zones. Permitted activities include moose hunting, which occurs usually from September to December and small game (willow and rock ptarmigan, ruffed and spruce grouse and snowshoe hare) hunting generally from September to March each year. Caribou and black bear management areas surrounding Torbay are closed to hunting. Torbay is in trapping Zone B, where various species may be harvested (Government of NL 2020b). Trapping generally occurs in winter when fur quality is optimal. While this information is not detailed enough to confirm the level of activities in Torbay, hunting and trapping may occur within the Great Pond watershed.

Stewardship Association of Municipalities

In 1997, the Town of Torbay signed a Municipal Wetland Stewardship Agreement with the Stewardship Association of Municipalities (SAM). A Stewardship Zone, which covers more than half of the Municipal Boundary area, encompasses most of the major wetlands and waterfowl habitat within the Town (Drawing 7; Appendix A). Within the Stewardship Zone, conservation areas (significant waterfowl habitats) have been identified at Western Island Pond, Gosse's Pond (also known as Goose Pond), Upper Three Corner Pond, Jones Pond Riparian Zone, The Gully and the Shoreline Conservation Area. The Habitat Conservation Plan for Torbay allows canoeing, hiking, photography, bird watching and opportunities to learn about wetlands and waterfowl conservation. Applications for development located within the Stewardship Zone and conservation areas are reviewed by Council, which also refers these development proposals to Wildlife Division, Department of Municipal Affairs and Environment for review and comment. Council may use mitigating measures to reduce habitat degradation that may result from development within the Stewardship Zone (Town of Torbay, 2015). The Stewardship Zone encompasses Great Pond, but all Management Units are outside the Great Pond watershed (2020).

4.3.2 Regional Policies, Agreements and Land Use Interests

Development of land in Torbay is subject to regional policies. These were examined to determine if they may affect the potential for Great Pond as a water supply.

St. John's Urban Region Regional Plan

The St. John's Urban Region Regional Plan (SJURRP) seeks to enhance development to accommodate population growth within the City of St. John's and adjacent areas to maximize use of existing roads, water and sewerage and other services. The SJURRP identifies Torbay as a local centre, which is to be developed within the limits of the following identified constraints: existing and future municipal services; financing for capital works; infilling within developed areas; capital expenditures on the regional road network; capacity of existing local roads; capacity of school facilities; and protection of regional resources (e.g., agricultural and forest lands, watersheds and scenic resources). Residential development in local centres would generally be low density, consisting mainly of single-family dwellings (Town of Torbay, 2015). Municipal plans are to be aligned with the SJURRP, but this plan should not pose challenges for protection of Great Pond and its watershed. Protection of this watershed would support population growth by allowing more dense housing development.

Trail Systems

The Eastern Avalon has extensive trail systems including the East Coast Trail and Grand Concourse, which are both partly located in Torbay. The Father Troy, a 5 km section of the East Coast Trail, connects Torbay to Flatrock. The Silver Mine Head Path connects to Middle Cove also along the coast (Town of Torbay 2020). None of these trails are within the Great Pond watershed (2020).

4.3.3 Municipal Regulations, Policies and Land Use Interests

Town of Torbay

The portion of Great Pond watershed (2020) that is within the Town of Torbay is governed by the Town's Municipal Plan and Development Regulations. The following sections describe the policies and development regulations relevant to the Great Pond watershed along with existing and potential future land use in Torbay.

Municipal Planning and Development Regulations

The Town of Torbay has a current Municipal Plan and Development Regulations for the period of 2015 to 2025. The Great Pond watershed is mostly contained within the Watershed (WAT) Zone. Rural (RUR) and Residential Large Lot (RLL) land use zones overlap in small areas of the watershed south of the intersection of Torbay Bypass Road and Bauline Line (Town of Torbay 2015). See Drawing 8 (Appendix A).

Based on policy statements in the Municipal Plan, Torbay's Watershed (WAT) Zone is intended to preserve the water quality of North Pond, South Pond and Great Pond as municipal water supplies or potential future sources of drinking water. The boundaries of the WAT Zone are intended to encompass all lands that drain into these waterbodies (Town of Torbay 2015). However, this is currently not the case for Great Pond.

The current Municipal Plan includes policies that are, or could potentially be, applicable to Great Pond watershed:

- Uses permitted in Watershed areas may include passive recreation (e.g., hiking, picnicking). Structures required for erosion control or other environmental conservation purposes may be permitted. No form of urban development shall be permitted. All proposals for development are subject to approval by the Department of Environment, Climate Change, and Municipalities, Water Resources Management Division.
- No development or activities that would adversely affect water quality shall be carried out in a Watershed area.
- To comply with Department of Municipal Affairs and Environment standards, existing residential

development in the Great Pond Watershed may be required to be removed if Great Pond is developed as a municipal water supply.

- Council shall cooperate with the Town of Portugal Cove-St. Philip's to ensure that no development that could adversely affect water quality occurs within the Great Pond Watershed.
- Selective wood harvesting may be permitted within Watershed areas, subject to approval of the Department of Environment, Climate Change and Municipalities. Maintaining water quality is the overriding priority (Town of Torbay, 2015).

The Torbay Development Regulations indicate that the only permitted use within the WAT zone is Conservation. Forestry, agriculture or antennae may be permitted at the discretion of Council provided they are complementary to permitted uses (i.e., Conservation) and will not adversely affect the quality or quantity of water in the waterbody identified as a water supply source. Selective forestry activities, agriculture and maintenance, and limited extension of existing uses, may be permitted provided they will not have detrimental effects on water quality (Town of Torbay, 2015). All existing development in Great Pond watershed appears to be within the WAT Zone.

The Residential Large Lot (RLL) Zone permits development of single dwellings and recreational open space. Discretionary uses include double dwellings, row dwellings, apartment buildings, places of worship, educational facilities, convenience stores, childcare facilities, offices, medical and professional services, personal services, light industry, traditional agriculture (i.e., hobby farming), boarding house residential and antennae (Town of Torbay 2015). As there appears to be no current development within the portions of the RLL Zone that overlap with the 2020 watershed area, these areas could be rezoned as WAT.

The Rural (RUR) Zone permits agriculture, forestry, recreational open space and conservation. Discretionary uses include single dwellings, general industry, mineral workings, antennae, places of worship and cemeteries (Town of Torbay 2015). As there appears to be no current development within the portions of the RUR Zone that overlap with the 2020 watershed area, these areas could be rezoned as WAT.

Various Crown Lands grants have been issued in Torbay. Thirteen (13) are located within the Great Pond watershed (Crown Lands 2019). These are zoned as WAT, RLL and RUR as per the Municipal Plan.

Environmentally Sensitive Areas

Along with the SAM Conservation Areas, the Torbay Municipal Plan identifies environmentally sensitive areas as steep slopes, wetlands, areas prone to landslides and rockfalls, and a 30 m buffer along the sea wall. These areas are identified in the Future Land Use Map as Conservation Areas (Town of Torbay 2015). No Conservation Areas are identified within the Great Pond watershed.

The Torbay Municipal Plan identifies a floodway (1:20 year flood zone) as an area subject to the most frequent flooding and the floodway fringe (1:100 year flood zone) as an area that may be flooded but less frequently and receives less damage. These areas are identified to reduce the risk of future damage (Town of Torbay 2015). No floodways and floodway fringes are within the Great Pond watershed.

Stormwater Detention

The Town of Torbay has established engineering design guidelines for subdivisions. These include net zero stormwater runoff from proposed developments. Stormwater detention systems must be designed to temporarily store the difference in volume between the 100-year 24-hr post-development peak discharge runoff for the planned development and the 100-year 24-hr pre-development runoff (Town of Torbay 2016).

Trail Development in Torbay

Municipal trails have been established in Upper Three Corner Pond Park, along Western Island Pond, at Woodbridge Park and along Island Pond Brook (Drawing 9; Appendix A). None of these trails are within the Great Pond watershed (Town of Torbay 2020). The Torbay Open Space Management Strategy proposes a larger scale multi-use trail system referred to as the Inner Loop and Outer Loop (Town of Torbay, 2010). A portion of the Outer Loop would be in the Great Pond watershed (2020).

Existing Land Use in the Great Pond Watershed

While much of the land within the Great Pond watershed (2020) in Torbay is undeveloped, various land uses currently exist within the watershed. The following list describes these areas based on a desktop study using the Town of Torbay's EagleView system. Field reconnaissance was used to clarify some of the observations.

- A portion of Bauline Line passes through the Great Pond watershed (2020).
- Residential and / or seasonal properties are located within the Great Pond Watershed (2020). One property is located on an extension of Pondside Lane and another on Great Pond Road / Whiteway Pond Road. Whole, or portions of, 10 to 15 properties on either side of Bauline Line are within the watershed (Drawing 9; Appendix A). Properties within the watershed appear to include houses or cabins and outbuildings, cleared areas (e.g., lawns and potentially hobby farms), hard surfaces such as roads and driveways, boat launches and stored automobiles and / or recreational vehicles.
- Agricultural development(s), possibly one or more sod farms with residences and outbuildings, are located on Great Pond Road / Whiteway Pond Road within the Great Pond watershed (2020).
- Several roads (paved and unpaved), dirt tracks and ATV trails begin at the terminus of Great Pond Road / Whiteway Pond Road extending to cleared areas (e.g., domestic cutting, agriculture areas) and an inactive gravel pit (accessed from Indian Meal Line). ATV trails extend to a pond that is within the Torbay WAT Zone but outside of the Great Pond watershed (2020). This trail crosses a stream that runs into Great Pond. This stream appears to have been forded.
- An easement runs from a power substation at the Torbay Bypass Road and Whiteway Pond Road through the Great Pond watershed (2020) on its way to Flatrock.
- Several areas north of Great Pond Road / Whiteway Pond Road have trails and domestic cutting.
- A stream that runs beneath Bauline Line via a culvert empties into Great Pond. The stream connects to Big River, which runs adjacent to an agricultural area off Three Island Pond Road.

Future Development in Torbay

Torbay's 2015-2025 Municipal Plan and Development Regulations anticipate future residential development. Approximately 50 units per year were developed in each of the 10 years leading up to the new plan. Relevant policies include providing an adequate amount of serviced land to accommodate residential development within the municipality and encouraging residential infilling in existing neighbourhoods. The Municipal Plan indicates that Torbay has ample land designated for future residential growth. Development of large residential lots has proceeded along Indian Meal Line, Marine Drive and Bauline Line. Higher density development has been constrained by the cost of extending municipal services to undeveloped areas (Town of Torbay, 2015). However, the Town of Torbay has not undertaken studies to estimate the number of potential lots based on servicing scenarios and / or land suitability or capability.

Torbay's General Land Use Policies for subdivisions identifies land bordering developed residential areas as suitable for future large-scale residential development. Council will subject proposed subdivision developments to a comprehensive evaluation. The content of this evaluation will include:

- an investigation of physical features of the site and the opportunities and constraints to development. Where possible, the layout of proposed lots and roads shall conform to the topography;
- an outline of how the proposed subdivision will integrate with existing development and roads and services on adjacent lands and provide for future access to undeveloped lands in the area;
- ensure compatibility between the subdivision and surrounding land uses, both existing and future; and
- review of municipal servicing proposals by the developer and the public costs of providing and maintaining these services (Town of Torbay 2015).

Residential Subdivision Areas (RSAs) are identified in the Municipal Plan as tracts of undeveloped land that border developed residential areas and may be suitable for future large-scale residential development. No development shall take place in these areas until the land has been appropriately zoned in the Torbay Development Regulations (Town of Torbay, 2015). Eight such areas are identified on the Land Use Zoning Map.

In RSA zones that require municipal water and sewerage, the developer shall submit a subdivision plan, showing how the proposed development will connect to the remainder of the RSA zone and adjacent development. In RSA zones that permit development without municipal water and sewerage, the developer shall submit a design scheme for the entire RSA zone, showing how the proposed development will connect to adjacent development. Lot sizes shall conform to standards of the Residential Large Lot zone (Town of Torbay, 2015).

In areas near municipal services, Council shall require the installation of municipal water and sewerage for new development. In areas that are sufficiently remote from existing municipal services, Council may consider development without municipal water and sewerage (Town of Torbay, 2015).

The Future Land Use map indicates proposed or suggested future access points and future road links into Residential areas. The access points and road links shall be reserved until a subdivision design is approved by Council. In areas that require full municipal services, the developer shall submit a subdivision design for the proposed area, showing road layout, proposed lots, open space and servicing plan. The developer shall identify how the proposed development will connect to adjacent development (Town of Torbay, 2015).

Town of Portugal Cove-St. Philips

The portion of Great Pond watershed that falls within the Municipal Boundary of the Town of Portugal Cove-St. Philips is governed by the Town's Municipal Plan and Development Regulations. Much of the land in the watershed within Portugal Cove-St. Philips is also undeveloped. The following sections describe the policies and development regulations relevant to the Great Pond watershed along with existing land use in Portugal Cove St. Philips.

Municipal Planning and Development Regulations

The Town of Portugal Cove-St. Philips's Municipal Plan and Development Regulations cover the period of 2014 to 2024. Most of the Great Pond watershed area that extends within the Portugal Cove-St. Philips Municipal Boundary is zoned as Protected Watershed (PW) by the Municipality and the rest is zoned as Rural (RUR) (Town of Portugal Cove-St. Philips, 2014). This section discusses policies and development regulations relevant to Great Pond watershed.

Portugal Cove-St. Philips has several policy statements that apply to the portion of Great Pond watershed that falls within its Municipal Boundary:

- The Town ensures that the location of any potential new conservation or approved discretionary land uses development do not conflict with the regional water supply agreement.
- Owners / operators of land within designated watershed areas are responsible for protecting the water supply.
- All discretionary land uses (e.g., antennae, forestry, passive recreational uses such as hiking trails) and any other development activities, proposed to be within the designated watershed areas are referred to the Department of Environment and Conservation for prior approval.
- The Portugal Cove-St. Philips Municipal Plan is referred to the Town of Torbay for comments related to the potential Great Pond Water Supply.
- Any development proposals are referred to the Town of Torbay for comments related to the potential Great Pond Water Supply.
- Conservation uses related to managing and protecting designated watershed areas may be considered by Council as a permitted use (Town of Portugal Cove-St. Philips, 2014).
- Council shall not consider, support or permit any form of urban land development within Watershed Protection Areas (Town of Portugal Cove-St. Philips, 2014).

The Portugal Cove-St. Philips Development Regulations indicate that Conservation is the only permitted land use within the Protected Watershed (PW) Zone. Discretionary uses include antennae, forestry and recreational open space (Town of Portugal Cove-St. Philips, 2014).

Permitted uses within the Rural (RUR) Zone include agriculture, conservation, forestry and recreational open space. Discretionary uses include animal, antennae, cemetery, commercial residential (tourist cottage only), general industry (resource-based only), light industry (resource-based only), mineral working, outdoor assembly, single dwelling, veterinary, private and commercial wind turbines (Town of Portugal Cove-St. Philips 2014).

Existing Land Use in the Great Pond Watershed

Development is limited in the Great Pond watershed (2020) within the Town of Portugal Cove-St. Philips. Windy Heights Farm is located on Bauline Line Extension extends to the northeast in the headwaters of Great Pond watershed (2020). This farm produces hay and nursery sod. In 2019, Windy Heights began to produce gourmet mushrooms in an indoor, chemical free facility year-round (Windy Heights, 2020; GNL, No Date b).

5.0 DISCUSSION AND RECOMMENDATIONS

Discussion and recommendations are provided below for the source water study and water balance and the planning review.

5.1 Source Water Study and Water Balance

The watershed area that was delineated for this study using LiDAR is approximately 80 ha larger than the previously delineated watershed area (NDAL, 2008), as well as the watershed areas used in municipal zoning.

The calculated 2D surface area of Great Pond at the time of survey was 286,716 m^2 and the total storage volume was 884,192 m^3. At the time of the survey, there was approximately 271,271 m^3 contained within the top one (1) m of Great Pond. In general, Great Pond has a significantly larger surface area than North Pond but only a marginally larger storage volume, since much of Great Pond is shallow, particularly the southwest portion. Approximately 58% of the total volume is contained within the top two (2) m of the pond.

Results of the bathymetric survey indicate that the deepest portion of the pond is in the northwest corner, which is the ideal location for a water intake is to be sited near the outlet of the pond.

The results of the water balance indicate that flow rate in an average year is 0.09 m3/s (89 L/s), rate of 0.14 m^3/s (143 L/s) in a wet year, and 0.05 m^3/s (52 L/s) in a dry year. Given the provincial guidance to use a minimum drought return, the available recharge that could potentially be used for drinking water is 0.05 m^3/s, with an approximate average available demand of 2000 m^3/day (Table 5-1).

Table 5-1: Anticipated Demand for Great Pond and Current Demand at North Pond.

m3/day	North Pond	Great Pond
Average demand	1300	2000
Peak demand	2600	4000
Instantaneous	2600	4000

The results of the flow monitoring indicate a mean annual discharge of approximately 0.16m^3/s, which corresponds well with the calculated flow rate for a wet year.

The results of the wetted perimeter study indicate a measured inflection point is 0.04 m^3/s, which is a preliminary minimum flow release value to the Big River. Given the current available flow for a drinking water treatment plant is 0.05 m^3/s and the preliminary nature of the wetted perimeter study, additional aquatic surveys are recommended in the full Big River watershed (see Drawing 11; Appendix A) to further determine the actual available flow for a drinking water supply at Great Pond.

Recommended fish and fish habitat surveys include:

- Fish species presence and relative abundance in Great Pond;
- Fish species presence and abundance in Great Pond outflow;
- Fish species presence and abundance in Big River;
- Detailed habitat surveys in Great Pond;

- Detailed habitat surveys in Great Pond outflow; and,
- Selected habitat surveys in Big River downstream of Great Pond outflow.

Additional pressure transducers installed near the end of Big River, in Flatrock, NL are also recommended to determine the contribution of Great Pond to the overall Big River discharge.

5.2 Planning Review

The following recommendations were identified through the planning review:

- Should Torbay decide to use Great Pond as a future drinking water source, the Town should apply to have Great Pond watershed (2020) designated as provincially protected.
- It is recommended that the town amend the WAT zone to include all the land in the watershed boundaries delineated within this project.
    - As there appears to be no current development within the portions of the RLL Zone that overlap with the 2020 watershed area, these areas could be rezoned as WAT in the Municipal Plan and Development Regulations.
    - As there appears to be no current development within the portions of the RUR Zone that overlap with the 2020 watershed area, these areas could be rezoned as WAT in the Municipal Plan and Development Regulations.
- To comply with Department of Environment, Climate Change, and Municipalities regulations, existing residential development in the Great Pond Watershed will require review, as removal may be required if Great Pond is designated as a municipal water supply.
- The Town could request, through the District 1 Ecosystem Managers and planning teams that wider forestry buffers be implemented around Great Pond.
- The Town should pursue and agreement with the Town of Portugal Cove-St. Philips regarding future land use in the Great Pond watershed (2020).
- To better understand future development opportunities and constraints, the Town of Torbay could undertake studies to estimate the number of potential lots based on servicing scenarios and / or land suitability or capability.

6.0 CLOSURE

This report has been prepared for the exclusive use of the Town of Torbay. The water and wastewater sampling and analyses were conducted using standard practices and in accordance with written requests from the client. No further warranty, expressed or implied, is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Wood accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. The limitations of this report are attached in Appendix C.

Yours sincerely,

Wood Environment & Infrastructure Solutions,
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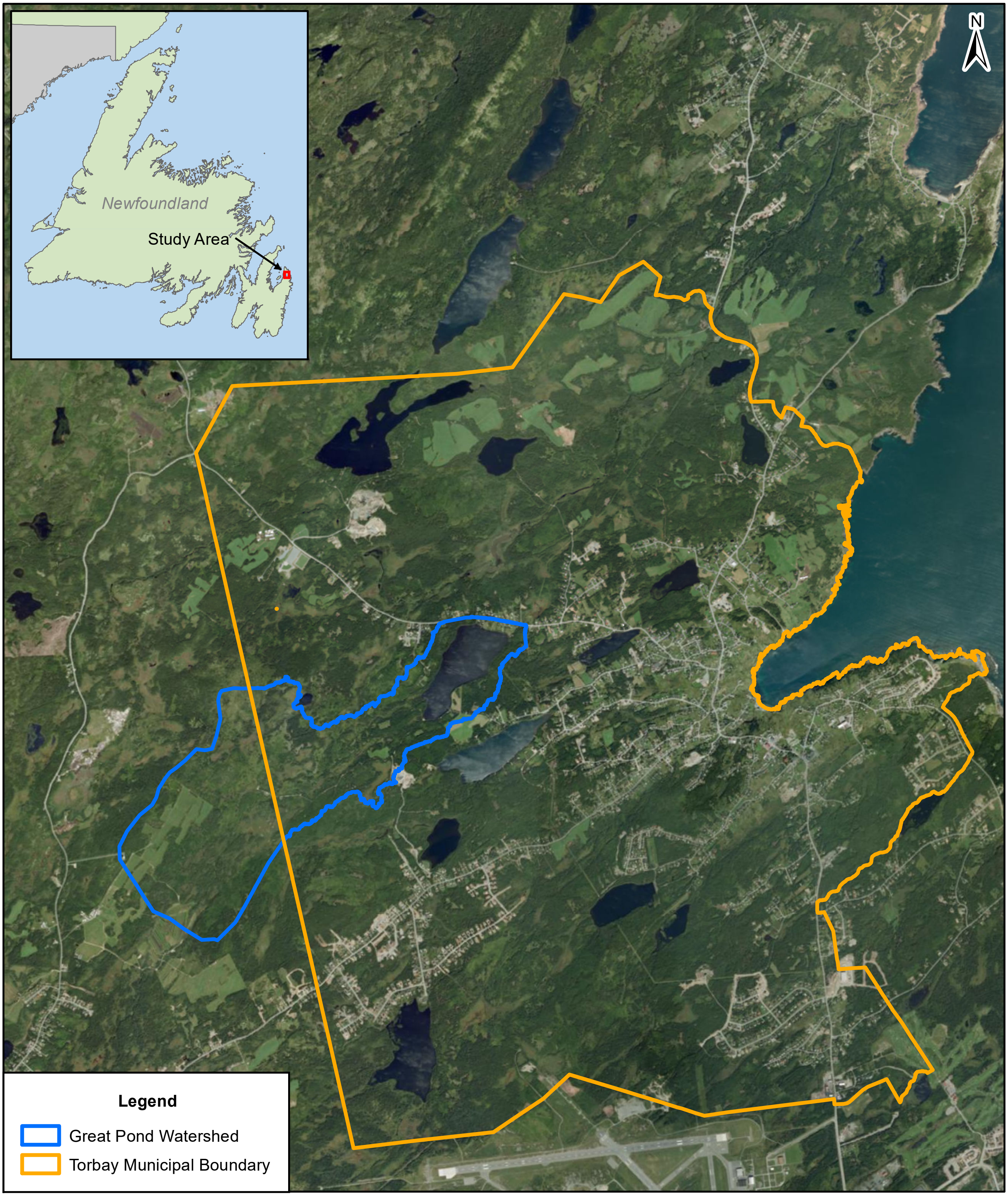
APPENDIX A: MAPS



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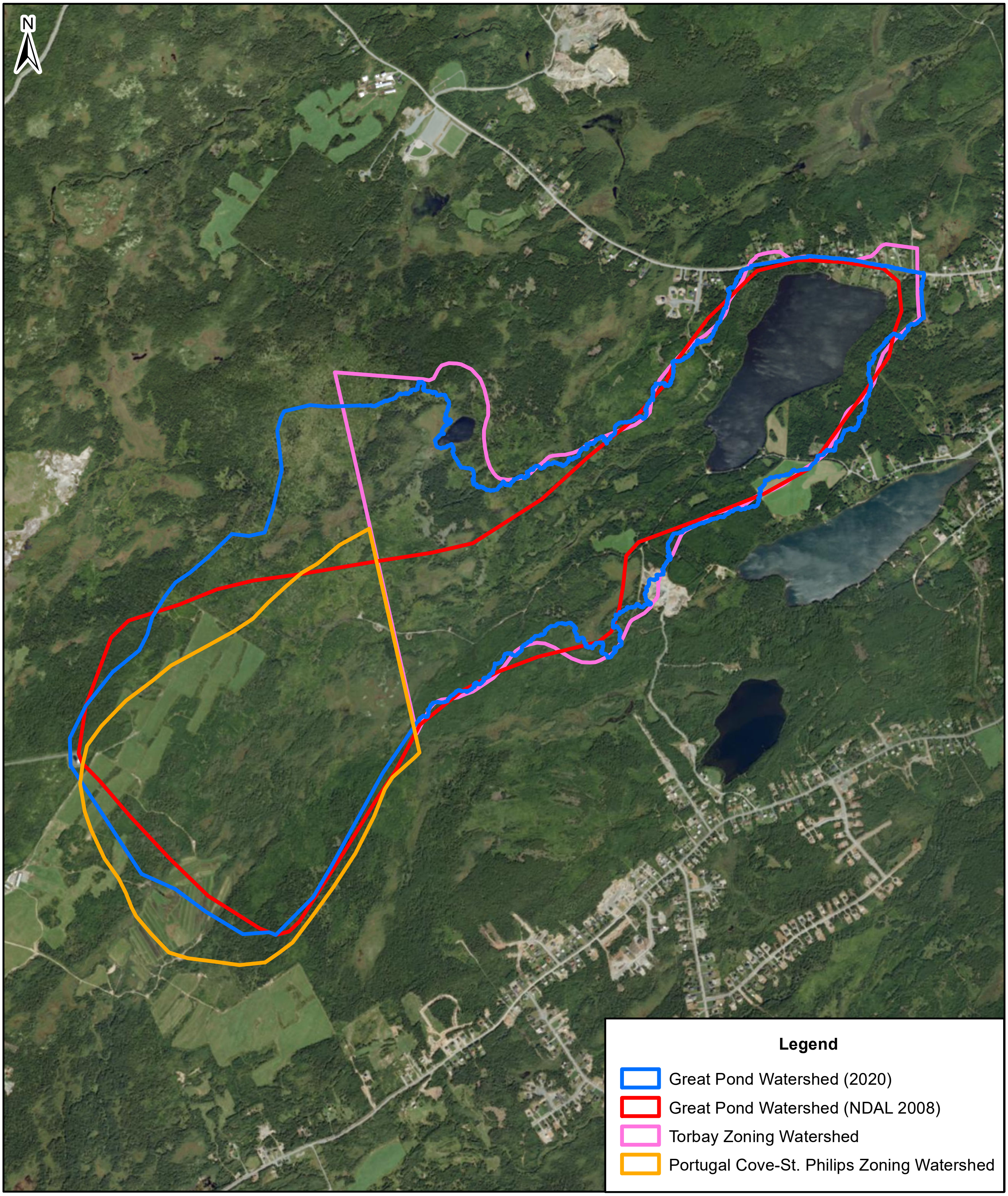

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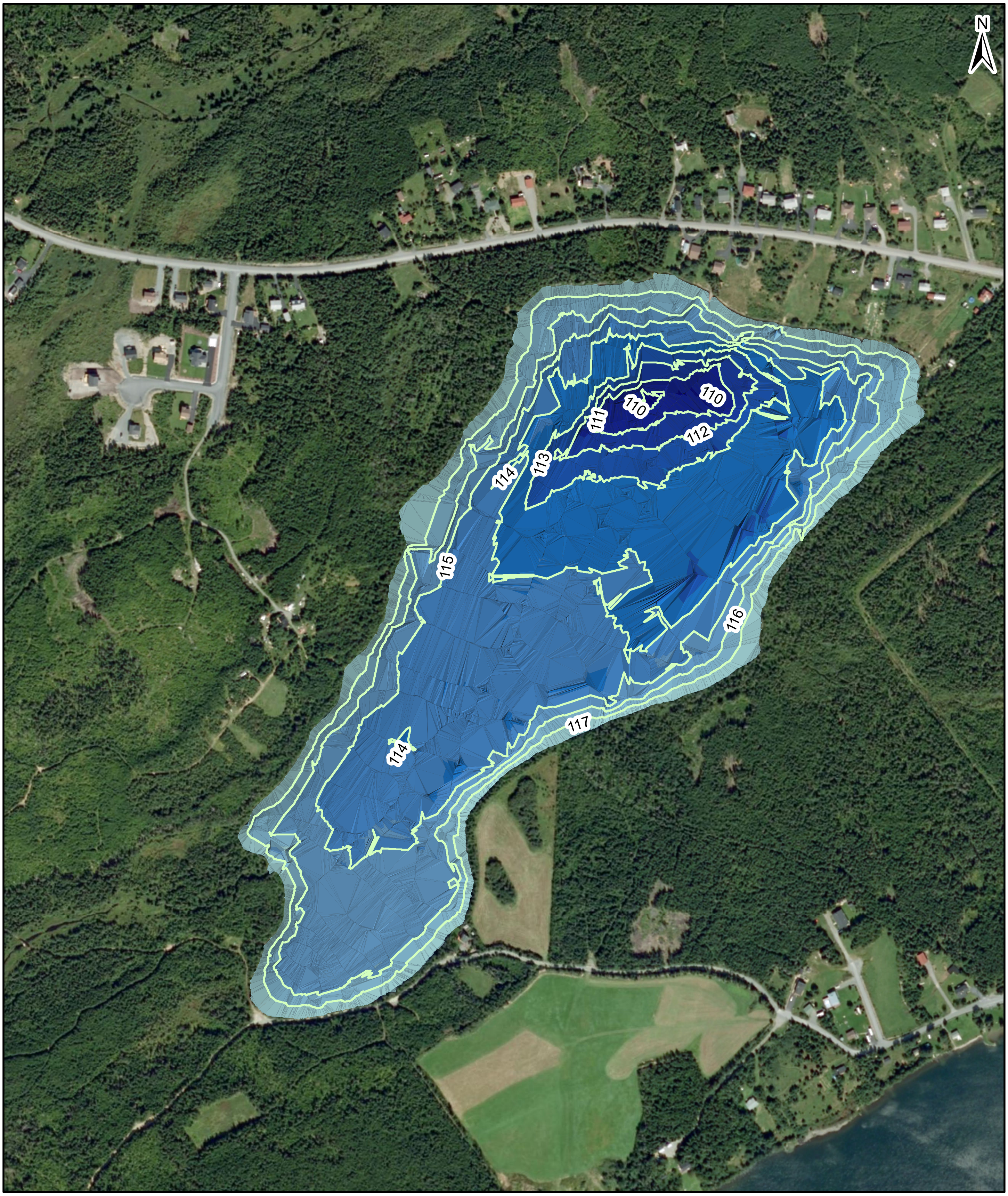

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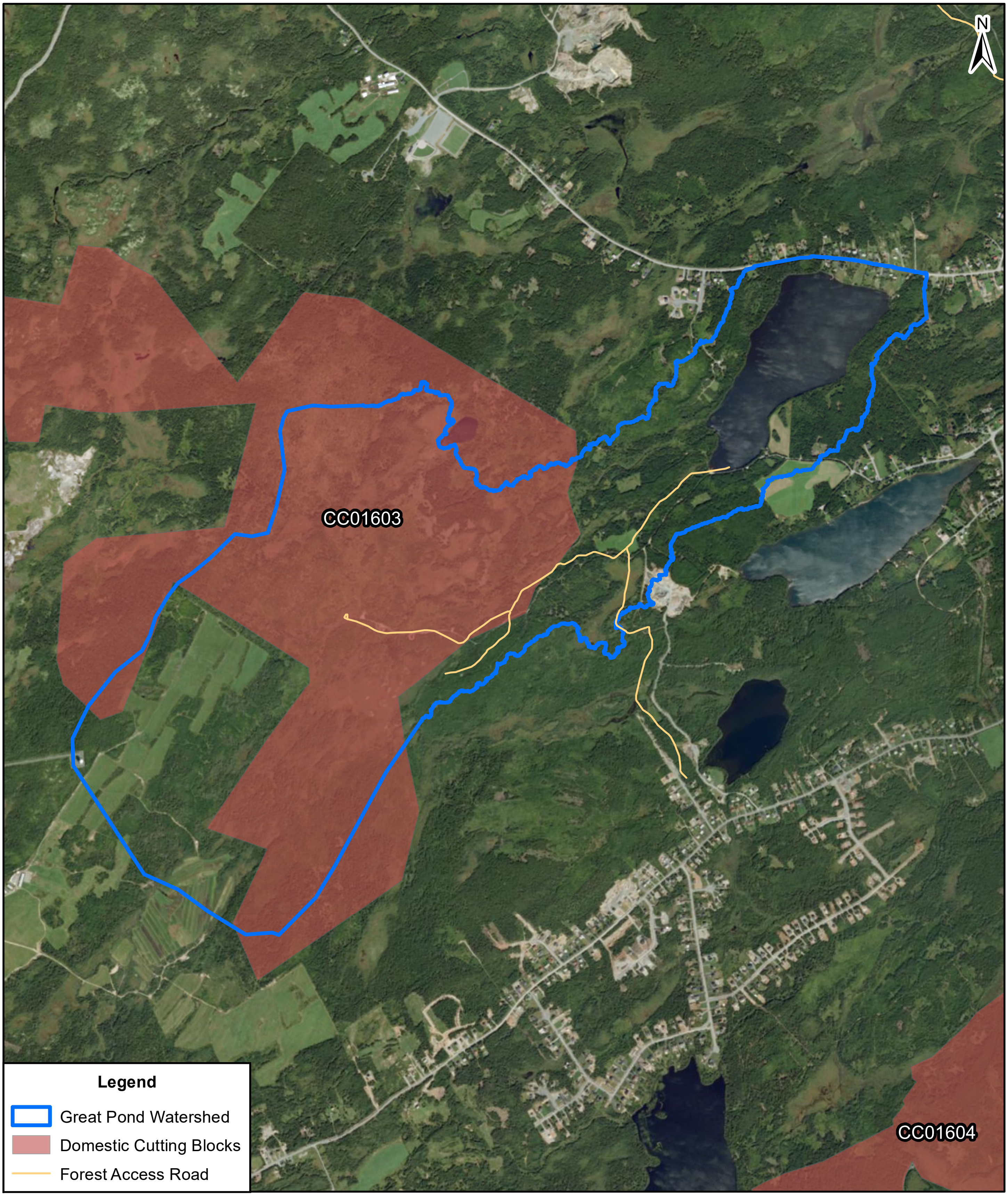

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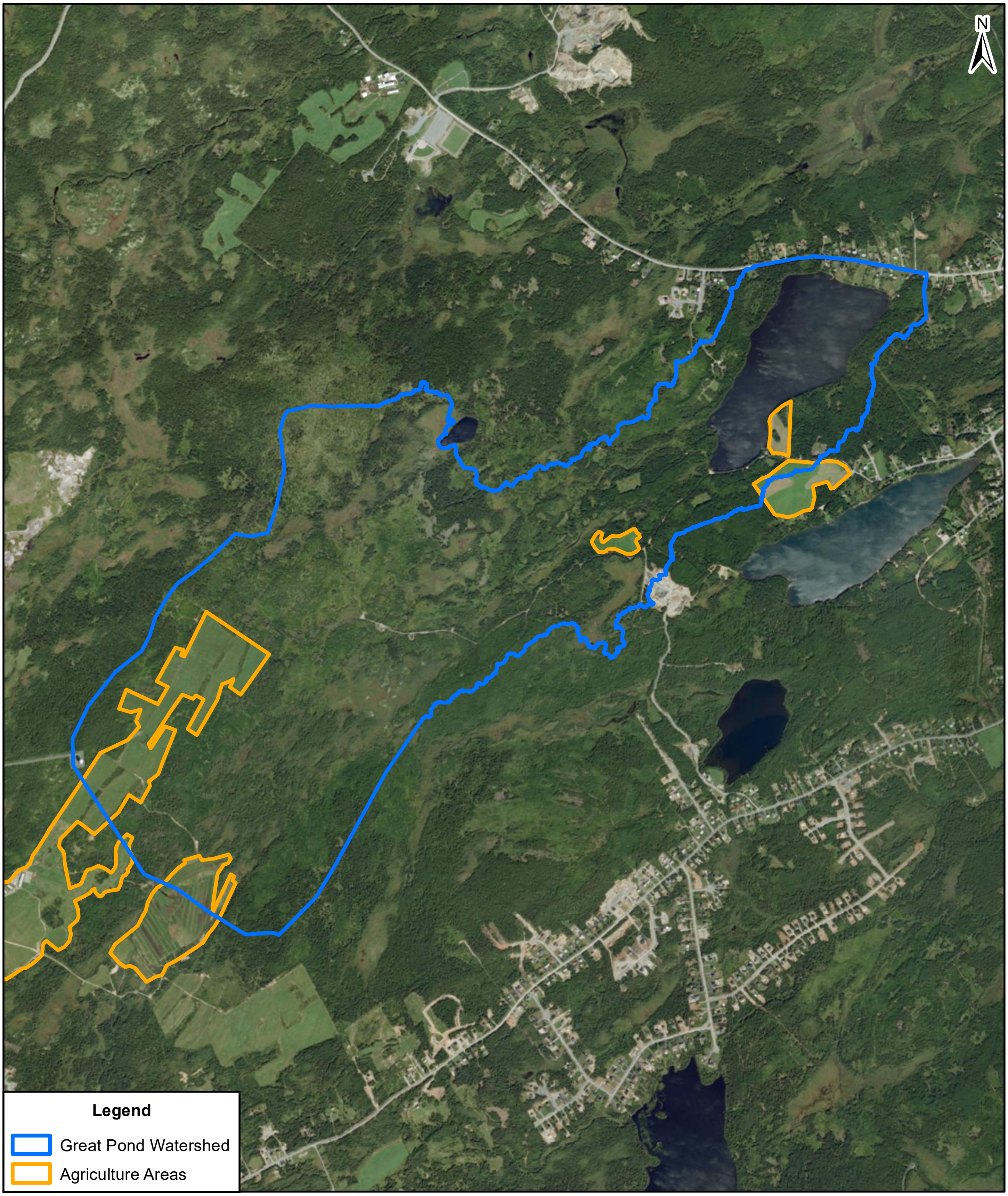

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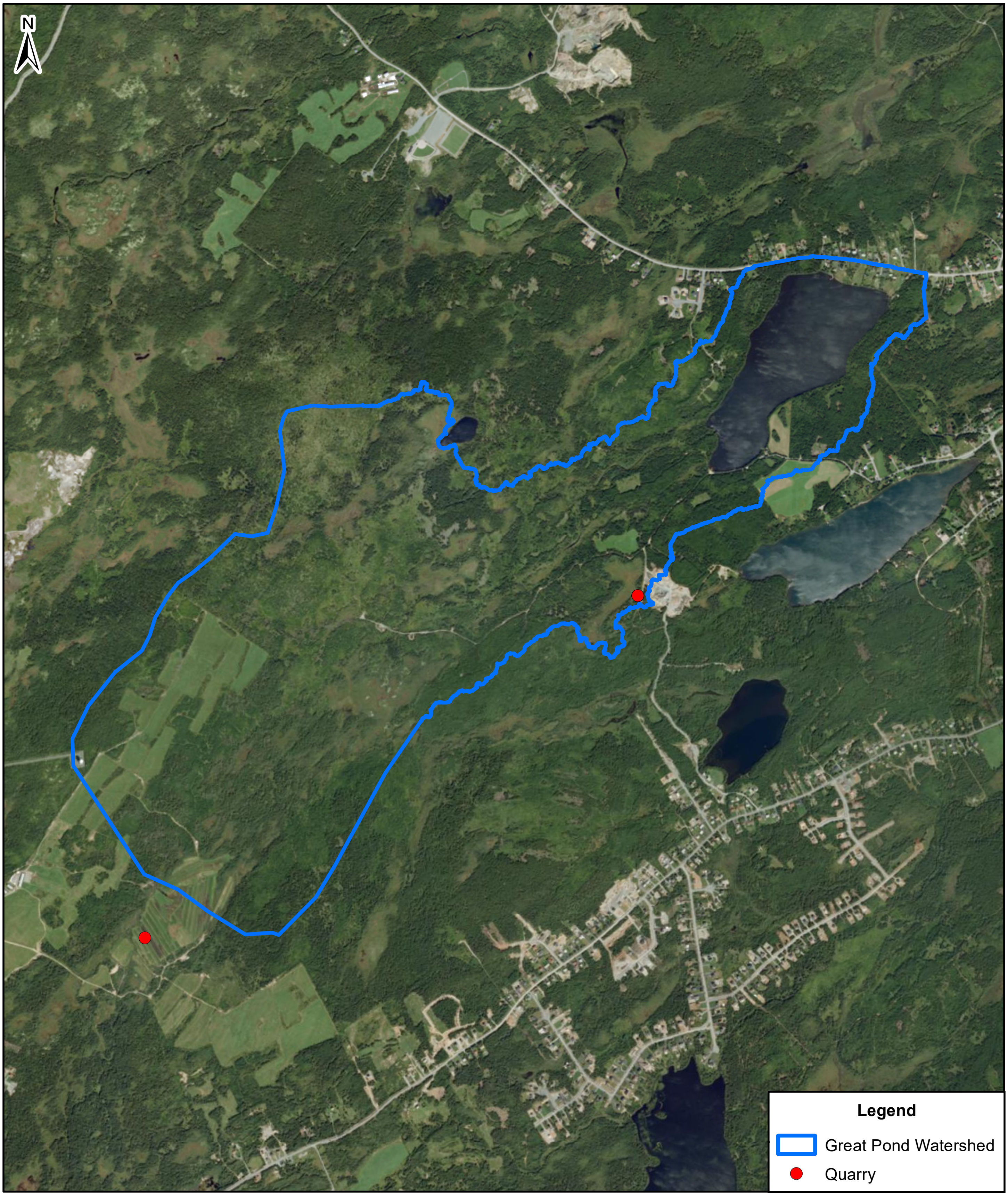

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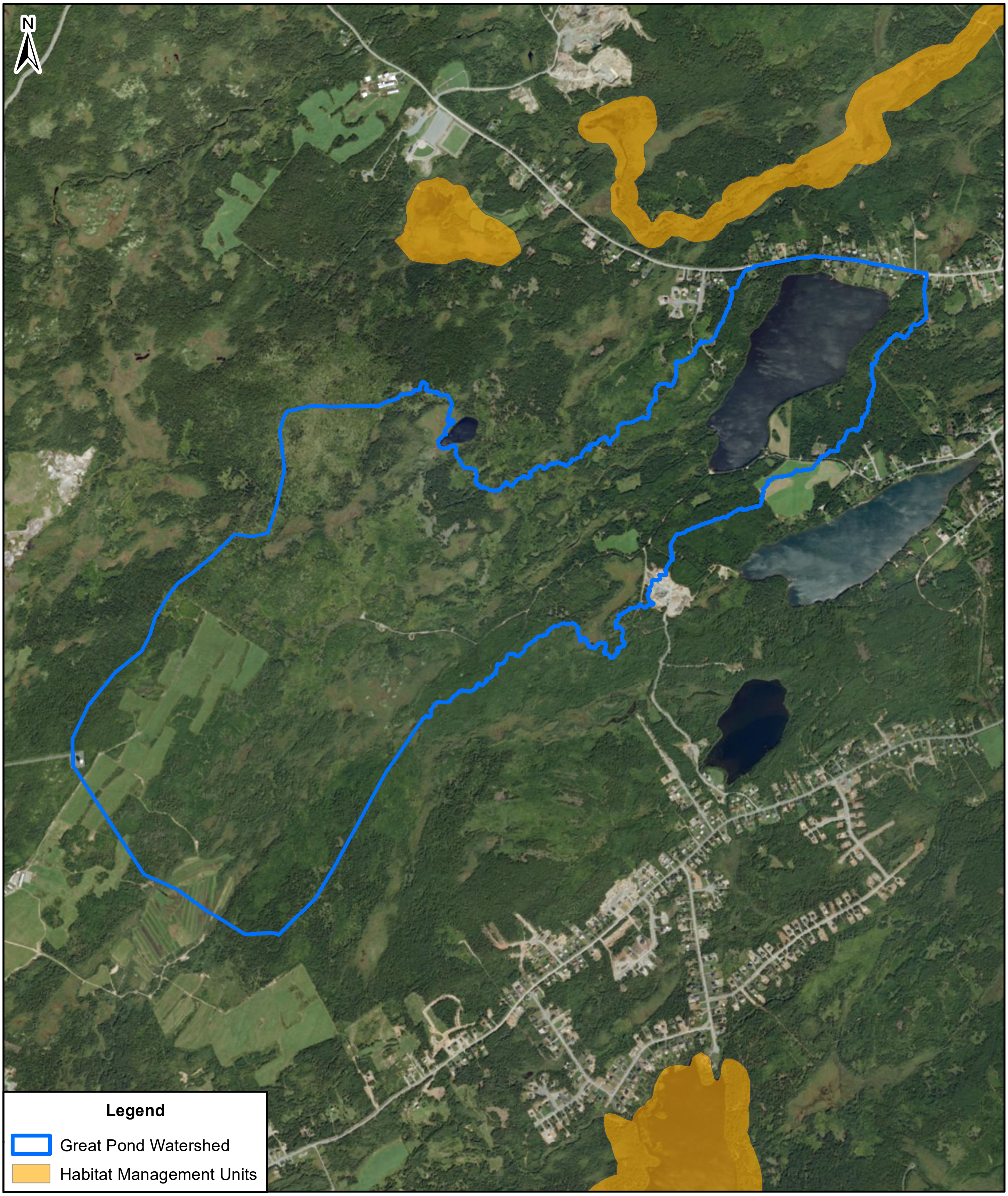

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	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
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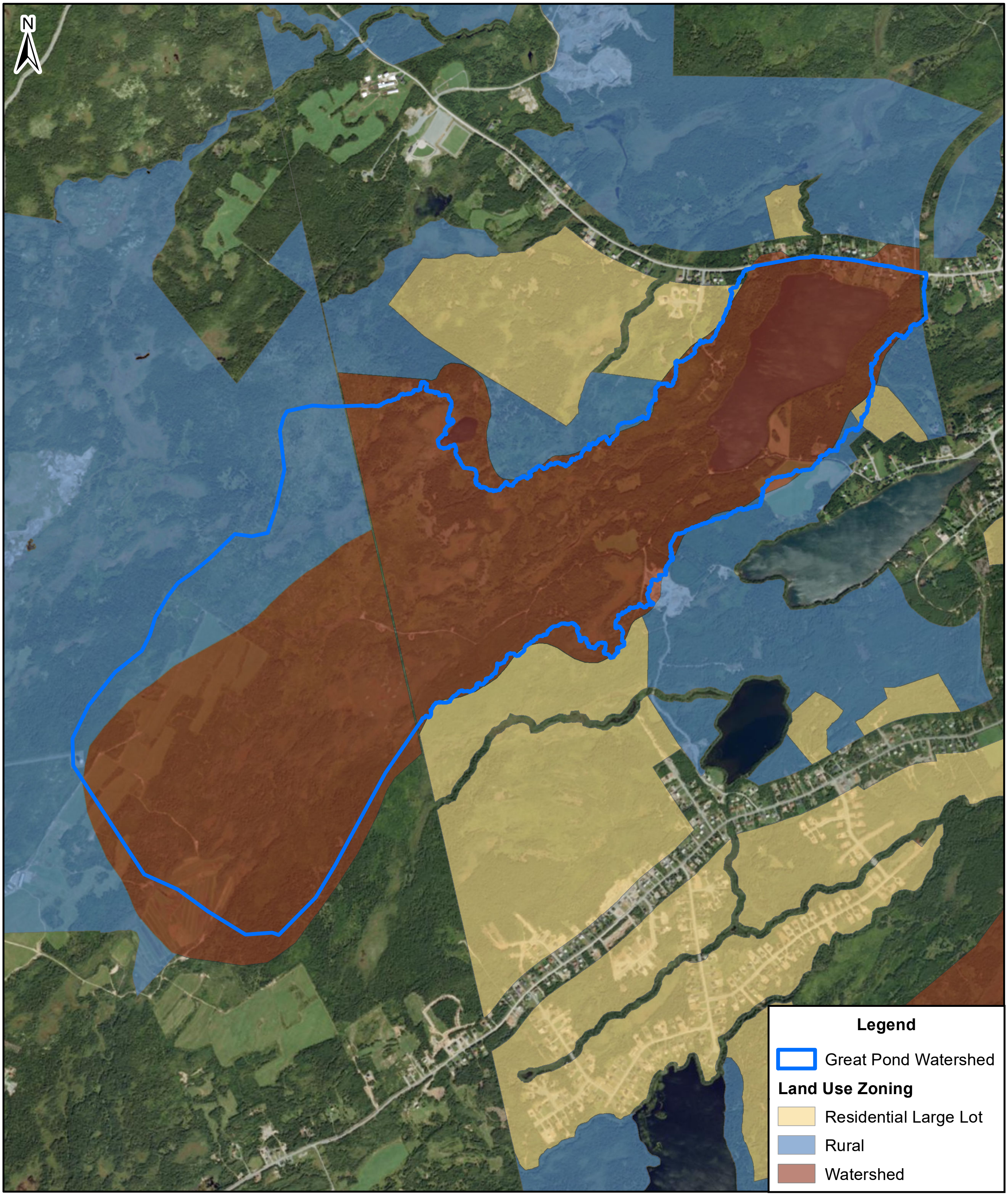

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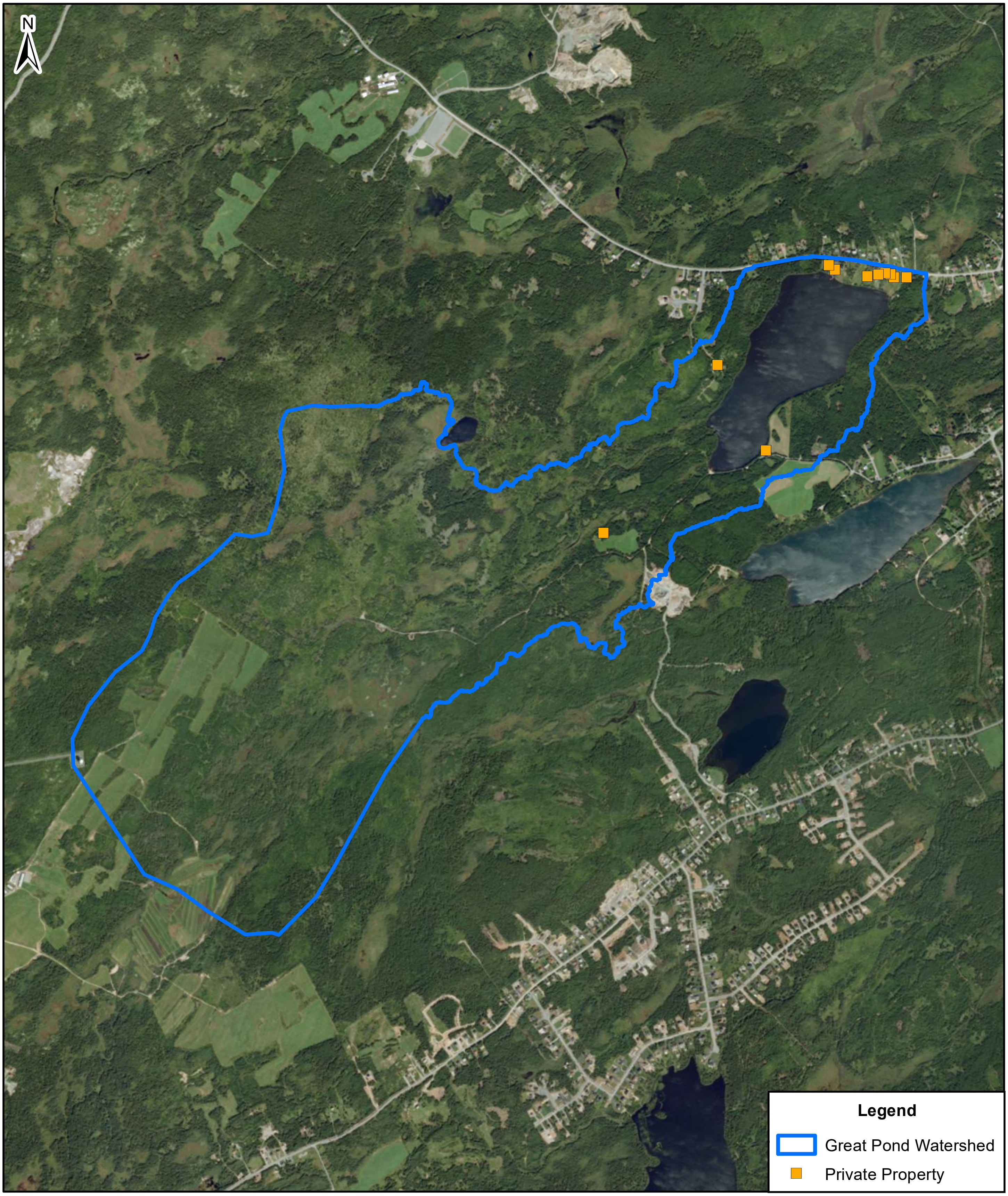
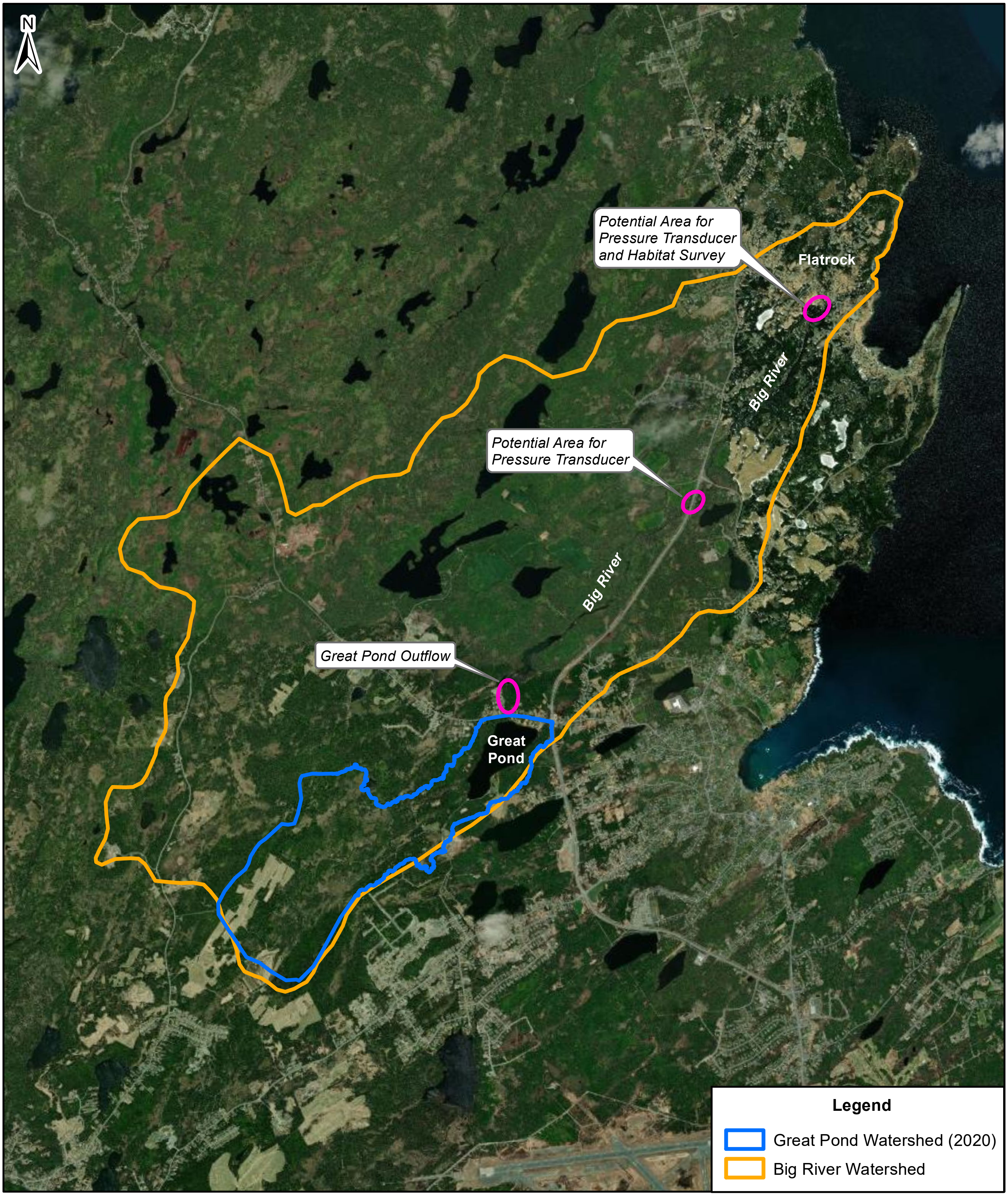
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 250 500 Meters	PROJECT TITLE: MUNICIPAL ZONING	DRAWING No. 8

Wood 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: FEBRUARY 2021
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 250 500 Meters	PROJECT TITLE: ROADS, TRAILS AND POWERLINES	DRAWING No. 9



Wood 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: FEBRUARY 2021
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 250 500 Meters	PROJECT TITLE: PRIVATE PROPERTIES	DRAWING No. 10



Wood 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: TORBAY GREAT POND STUDY AREA	DATE: FEBRUARY 2021
	CHKD BY: T. PRAAMSMA		PROJ No. TF1969415
CLIENT: TOWN OF TORBAY	SCALE: 0 630 1,260 Meters	PROJECT TITLE: BIG RIVER WATERSHED	DRAWING No. 11

APPENDIX B: WATER BALANCE CALCULATIONS

Water Balance -Average Year

Great Pond Watershed	km2	m2
Watershed Area	3.83	3.83E+06
Lake Area	0.29	2.87E+05
125 mm SMC Area	3.54	3.54E+06

	Thornthwaite Averages (For the period 1942-2019)											Total Surplus			Infiltration			Runoff		
												Total	Average		Total	Average			Average	
	TEMP	PRECIP	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P	Surplus	Surplus		Infiltration	Infiltration		Total Runoff	Runoff	
	deg C	mm	cm	mm	mm	mm	mm	mm	mm	mm	mm	m3	L/s	L/min	m3	L/s	L/min	m3	L/s	L/min
JAN	-4.1	151	65	36	2	2	0	98	85	125	615	389,963	146	8,736	104,173	39	2,334	285,790	107	6,402
FEB	-4.7	135	53	34	2	2	0	85	133	125	749	339,312	140	8,415	90,354	37	2,241	248,959	103	6,175
MAR	-2.5	134	69	56	4	4	0	121	142	125	883	466,010	174	10,439	128,621	48	2,881	337,389	126	7,558
APR	1.5	115	96	119	16	16	0	199	42	125	999	733,498	283	16,979	211,534	82	4,897	521,964	201	12,083
MAY	5.9	100	99	43	47	47	0	96	0	124	1098	355,351	133	7,960	102,047	38	2,286	253,305	95	5,674
JUN	10.7	94	94	0	80	80	0	23	0	115	1192	85,510	33	1,979	24,449	9	566	61,061	24	1,413
JUL	15.7	88	88	0	113	112	-1	8	0	82	1280	21,178	8	474	8,504	3	190	12,674	5	284
AUG	15.8	110	110	0	105	101	-4	10	0	81	1391	36,866	14	826	10,630	4	238	26,237	10	588
SEP	12.1	125	125	0	71	70	-1	32	0	103	1517	128,868	50	2,983	34,016	13	787	94,852	37	2,196
OCT	7.3	150	150	0	41	41	0	90	0	122	149	350,148	131	7,844	95,669	36	2,143	254,479	95	5,701
NOV	3.2	154	148	5	18	18	0	132	2	125	303	506,707	195	11,729	140,314	54	3,248	366,393	141	8,481
DEC	-1.5	160	104	23	5	5	0	122	35	125	463	476,722	178	10,679	129,684	48	2,905	347,037	130	7,774
Annual	4.9	1515	1201	316	504	498	-6	1016				3,890,133			1,079,993			2,810,140		

Water Balance - Wet Year

Great Pond Watershed	km2	m2
Watershed Area	3.83	3.83E+06
Lake Area	0.29	2.87E+05
125 mm SMC Area	3.54	3.54E+06

	Thornthwaite Averages (For the period 1942-2019)											Total Surplus			Infiltration			Runoff		
	TEMP	PRECIP	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P	Total Surplus	Average Surplus		Total Infiltration	Average Infiltration		Total Runoff	Average Runoff	
	deg C	mm	cm	mm	mm	mm	mm	mm	mm	mm	mm	m3	L/s	L/min	m3	L/s	L/min	m3	L/s	L/min
JAN	-1.4	264.6	187.9	68.9	3.8	3.8	0	253	76.4	125	648.5	971,226	363	21,757	268,935	100	6,025	702,291	262	15,732
FEB	-3.4	152.2	106.2	73.9	3.6	3.6	0	176.5	48.5	125	800.7	667,996	276	16,567	187,617	78	4,653	480,379	199	11,914
MAR	-2.5	162.4	50.5	37.1	2.1	2.1	0	85.5	123.3	125	963.1	348,911	130	7,816	90,885	34	2,036	258,026	96	5,780
APR	-1	191.8	79.4	76.6	5	5	0	150.9	159.2	125	1154.9	588,240	227	13,617	160,404	62	3,713	427,836	165	9,904
MAY	3.7	168.3	168.3	159.2	31.4	31.4	0	296.1	0	125	1323.2	1,088,418	406	24,382	314,750	118	7,051	773,668	289	17,331
JUN	10.4	188.5	188.5	0	77.9	77.9	0	110.6	0	125	1511.7	423,598	163	9,806	117,566	45	2,721	306,032	118	7,084
JUL	14.7	88.8	88.8	0	107	107	0	0	0	106.6	1600.5	-5,276	-2	-118	0	0	0	-5,276	-2	-118
AUG	15.2	97.6	97.6	0	101	101	0	0	0	103	1698.1	-1,032	0	-23	0	0	0	-1,032	0	-23
SEP	11.4	66.4	66.4	0	67.8	67.8	0	0	0	101.6	1764.5	-401	0	-9	0	0	0	-401	0	-9
OCT	6.4	209	209	0	36.4	36.4	0	149.2	0	125	209	578,145	216	12,951	158,597	59	3,553	419,548	157	9,398
NOV	2.8	319.8	319.8	0	14.9	14.9	0	304.9	0	125	528.8	1,167,767	451	27,032	324,104	125	7,502	843,663	325	19,529
DEC	-2.6	158.3	107.5	3.3	1.1	1.1	0	109.7	47.5	125	687.1	433,770	162	9,717	116,609	44	2,612	317,161	118	7,105
Annual	4.5	2067.7	1669.9	419	452	452	0	1636.4				6,261,362			1,739,469			4,521,893		

Water Balance - Dry Year

	km2	m2
Great Pond Watershed	km2	m2
Watershed Area	3.83	3.83E+06
Lake Area	0.29	2.87E+05
125 mm SMC Area	3.54	3.54E+06

	Thornthwaite Averages (For the period 1942-2019)											Total Surplus			Infiltration			Runoff		
	TEMP	PRECIP	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P	Total Surplus	Average Surplus		Total Infiltration	Average Infiltration		Total Runoff	Average Runoff	
	deg C	mm	cm	mm	mm	mm	mm	mm	mm	mm	mm	m3	L/s	L/min	m3	L/s	L/min	m3	L/s	L/min
JAN	-6	141.8	33.4	24.3	1	1	0	56.6	131.9	125	525.7	240,919	90	5,397	60,165	22	1,348	180,755	67	4,049
FEB	-7.1	119	48.4	36.1	1.7	1.7	0	82.8	166.4	125	644.7	327,016	135	8,111	88,015	36	2,183	239,001	99	5,928
MAR	-5	102.5	9.8	30.6	1.7	1.7	0	38.8	228.4	125	747.2	166,380	62	3,727	41,244	15	924	125,137	47	2,803
APR	2.6	45.8	43.8	230.4	20.2	20.2	0	254	0	125	793	907,334	350	21,003	269,998	104	6,250	637,336	246	14,753
MAY	7.9	21.3	19.9	1.4	60.4	60.4	0	0	0	85.9	814.3	-11,211	-4	-251	0	0	0	-11,211	-4	-251
JUN	11.8	109.4	109.4	0	87.4	87.4	0	0	0	107.9	923.7	6,308	2	146	0	0	0	6,308	2	146
JUL	15.3	97.8	97.8	0	110.7	110.7	0	0	0	95	1021.5	-3,699	-1	-83	0	0	0	-3,699	-1	-83
AUG	17.3	70.7	70.7	0	113.9	113.9	0	0	0	51.8	1092.2	-12,386	-5	-277	0	0	0	-12,386	-5	-277
SEP	13.1	83.4	83.4	0	76.6	76.6	0	0	0	58.7	1175.6	1,950	1	45	0	0	0	1,950	1	45
OCT	6.3	91.7	91.7	0	36.2	36.2	0	0	0	114.1	91.7	15,913	6	356	0	0	0	15,913	6	356
NOV	3.2	130.4	116	8.7	20	20	0	93.8	5.7	125	222.1	364,013	140	8,426	99,708	38	2,308	264,305	102	6,118
DEC	-4.9	133.4	55	9.3	0.4	0.4	0	63.9	74.8	125	355.5	264,549	99	5,926	67,925	25	1,522	196,624	73	4,405
Annual	4.5	1147.2	779.3	340.8	530.2	530.2	0	589.9				2,267,087			627,055			1,640,032		

APPENDIX C: LIMITATIONS

Limitations

1. The work performed in this report was carried out in accordance with the Standard Terms of Conditions made part of our contract. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.
2. The report was prepared in accordance with generally accepted science and/or engineering practices for the exclusive use of the Town of Torbay. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.
3. Third party information reviewed and used to develop the opinions and conclusions contained in this report is assumed to be complete and correct. This information was used in good faith and Wood does not accept any responsibility for deficiencies, misinterpretation or incompleteness of the information contained in documents prepared by third parties.
4. The objective of this report was to assess water and wastewater quality properties at the site, within the context of our contract and existing regulations within the applicable jurisdiction. Evaluating compliance of past or future owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.
5. Our observations relating to the condition of environmental media at the site are described in this report. It should be noted that compounds or materials other than those described could be present in the site environment.
6. The findings and conclusions presented in this report are based exclusively on the field parameters measured and the chemical parameters tested at specific locations. It should be recognized that subsurface conditions between and beyond the sample locations may vary. Wood cannot expressly guarantee that subsurface conditions between and beyond the sample locations do not vary from the results determined at the sample locations. Notwithstanding these limitations, this report is believed to provide a reasonable representation of site conditions at the date of issue.