Appendix C: Surface Water Study

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List of Acronyms and Abbreviations

AMEC	AMEC Environment & Infrastructure
bbl/d	barrels per day
Braya	Braya Renewable Fuels
CER	Canada Energy Regulator
cm	centimetre
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
FEED	Front-End Engineering Design
GPM	Global Precipitation Measurement
H_2O	water
Hatch	Hatch Ltd.
HGP	Hydrogen Generation Plant
HP	Hydrogenation Plant
IDF	Intensity-Duration-Frequency
km	kilometre
km^2	square kilometre
kV	kilovolt
$L/s/km^2$	Litres per second per square kilometre
LAA	Local Assessment Area
LOHC	Liquid Organic Hydrogen Carrier
m	metres
m/s	metres per second
m^3	cubic metres
m^3/s	cubic metres per second
MAR	mean annual runoff
MCH	methylcyclohexane
mm	millimetres
MW	megawatt
NARL	North Atlantic Refining Limited
NASA	National Aeronautics and Space Administration
NFPA	National Fire Protection Association
NL	Newfoundland and Labrador
NL DECC	Newfoundland and Labrador Department of Environment and Climate Change
North Atlantic	North Atlantic Refining Corp.

NRCan	Natural Resources Canada
PA	Project Area
PEM	Proton Exchange Membrane
PVC	polyvinyl chloride
R^2	coefficient of determination
RFFA	Regional Flood Frequency Analysis
RTK GPS	real-time kinetic positioning global positioning system
SEM	Sikumiut Environmental Management Ltd.
the Project	Wind to Hydrogen Project
UN FAO	United Nations Food and Agriculture Organization
USGS	United States Geological Survey
WSC	Water Survey of Canada
°C	degrees Celsius
7Q10	7-day 1:10-year low flow
7Q50	7-day 1:50-year low flow

1.0 Introduction

North Atlantic Refining Corp. (North Atlantic) is proposing to undertake the development of a Wind to Hydrogen project (the Project) on the Isthmus of Avalon Region in Newfoundland and Labrador (NL). This Project will entail the development, construction, operation and eventual decommissioning of a 324 megawatt (MW) Wind Farm consisting of 45 wind turbines on an undeveloped peninsula situated between Sunnyside and Deer Harbour. The Wind Farm will provide renewable electricity via a 138 kilovolt (kV) transmission line to a newly developed Hydrogen Generation Plant (HGP), from where generated hydrogen will be transported to a Hydrogenation Plant (HP) for transformation into a Liquid Organic Hydrogen Carrier (LOHC), which will then be shipped from North Atlantic's port facilities to international markets for use in various decarbonization technologies.

The HGP will employ Proton Exchange Membrane (PEM) electrolyzers to produce hydrogen and oxygen from a supply of fresh water from Inkster's Pond Industrial Water Supply Area. Oxygen will be vented to the atmosphere as a byproduct while hydrogen will be piped to the HP which will combine hydrogen with toluene to produce methylcyclohexane (MCH) - a type of LOHC. The conversion to LOHC enables safe and efficient storage, transport, and release of hydrogen, with the toluene available for re-use (Li *et al*., 2021). The LOHC will be stored in tanks to await shipment and North Atlantic plans to use its existing liquid fuel infrastructure at the Come By Chance Terminal for this purpose. The LOHC will be exported directly from the Come By Chance port, and once it reaches buyers in international markets it will be dehydrogenated (i.e., MCH will be transformed back into toluene) to release the hydrogen. The Project will produce an average of 85.6 tonnes of green hydrogen per day (30,000 tonnes per year).

In support of the Project, North Atlantic has initiated a series of environmental baseline studies in the Project Area (PA) and the Local Assessment Area (LAA). The Project location is illustrated in Figure C-1.0-1, and the LAA is shown in Figure C-1.0-2. This report presents the results of the Surface Water Study. Desktop analyses and field surveys were conducted to characterize hydrological conditions at local and regional scales. The study describes hydrological conditions near the Project and assesses the water balance of the proposed water supply watershed to support Project operations.

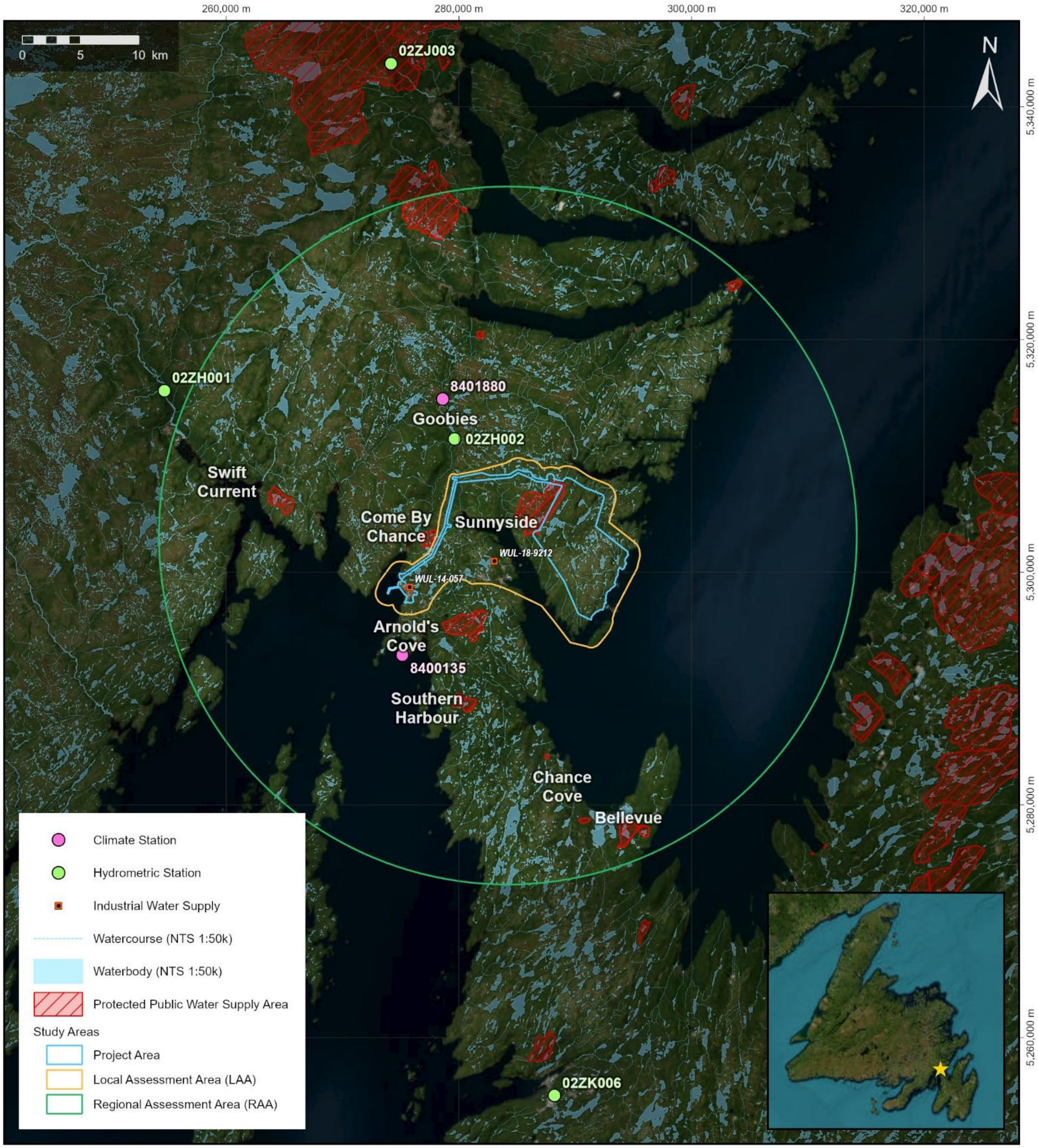

FIGURE TITLE:	NOTES:	PREPARED BY:	DATE:
Project Location	Hydrometric Stations, Industrial Water Supplies, and Protected Public Water Supply Areas sourced from NL Government's Water Resources Portal. Climate Stations sourced from Government of Canada website. Watercourse and Waterbody data sourced from Canadian National Topographic System (NTS) 1:50k series.	C. Burke	05/06/2025
PROJECT TITLE: North Atlantic Wind to Hydrogen Project		REVIEWED BY: J. Crocker 05/06/2025	
		APPROVED BY: C. Collins 05/06/2025	
		CRS: WGS 1984 UTM Zone 22N	

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Figure C-1.0-1 Project location.

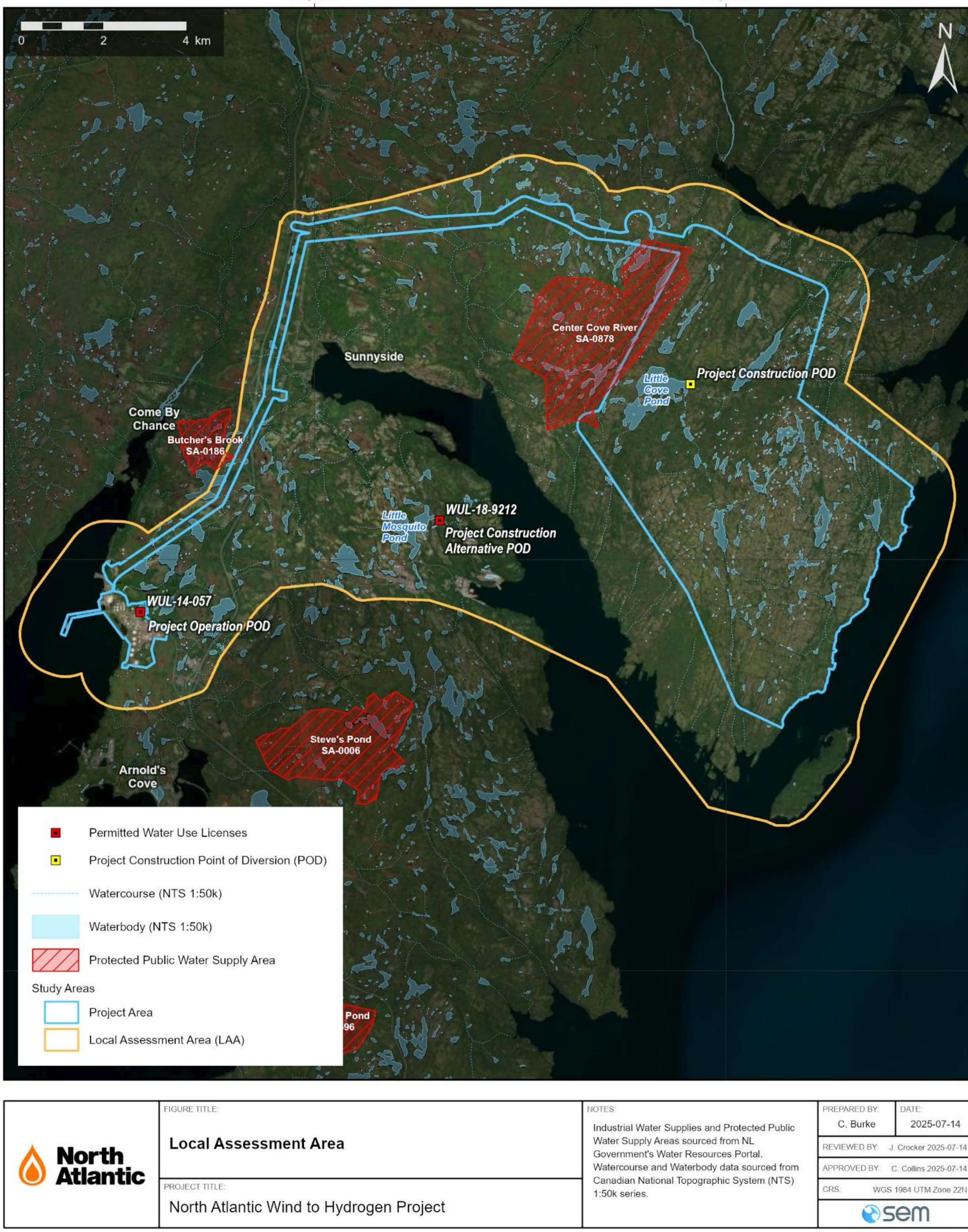


Figure C-1.0-2 Local Assessment Area.

1.1 Water Source and Usage

North Atlantic proposes to obtain water for construction purposes from Lady Cove Pond, with Little Mosquito Pond identified as a backup water supply (currently permitted under WUL-23-13359 for Bull Arm Fabrication Inc, formerly under WUL-18-9212 for Nalcor Energy). After construction, water will be sourced during operations from Inkster's Pond Industrial Water Supply Area for processing and fire-protection purposes. The locations of the points of diversion (PODs) are illustrated in Figure C-1.0-2.

1.1.1 Construction

The Project will require a total water use of 31,225 m³ during the Construction Phase (estimated breakdown provided in Table C-1.1.1), with 40% of water consumption expected in year 1 of construction and 60% expected in year 2. The proponent anticipated 80% of the annual water needs between May and October. A monthly estimate of water use is provided in Table C-1.1.2. Prior to Project start-up, North Atlantic will apply for a water use licence from the Newfoundland and Labrador Department of Environment and Climate Change (NL DECC) for water use during construction at Lady Cove Pond.

Table C-1.1-1 Estimated breakdown of construction water requirements.

Item	Water Requirements (m³)
Concrete - Foundation	6,468
Concrete - Electrolyser	2,331
Curing of Concrete	1,599
Filling - Compaction	12,169
Curing of Concrete Cube for Testing	540
Cleaning of Foundation Machineries / After Batching	110
Cleaning of Wind Turbine Generator Component	248
Dust Suppression	5,760
EHV, Collector, Substation, and O&M Building	2,000
Total	**31,225**

Table C-1.1-2 Monthly estimate of construction water requirements.

Water Requirement (m³)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Year 1	416	416	416	416	1,665	1,665	1,665	1,665	1,665	1,665	416	416	12,490
Year 2	624	624	624	624	2,498	2,498	2,498	2,498	2,498	2,498	624	624	18,735

1.1.2 Operations

Project operations will require a reliable supply of demineralized water for HGP and LOHC processes. All water during operations is proposed to be sourced from the Inkster's Pond Industrial Water Supply Area (hereafter referred to as the water supply watershed). This watershed includes a network of ponds and streams that flow into Placentia Bay and was designated by the Government of NL in 1994 for the benefit of North Atlantic. The main waterbodies in this watershed include Big Pond, Rushy Pond, Willie Jarge Pond, and Barrisway Pond. The locations and drainage areas of these water supply ponds are shown in Figure C-1.1-1.

Inkster's Pond functions as a holding reservoir, supplying water to the refinery via a dedicated pipeline. It is an isolated waterbody with no natural surface water inflow or outflow and is actively supplied with water pumped from Barrisway Pond (also referred to as Barasway Pond). Additional active storage is available in Barrisway Pond, which is regulated by a hydraulic control structure and a pumphouse, and in Willie Jarge Pond, which is regulated by a hydraulic control structure equipped with a concrete spillway, fishway, and a low-level outlet pipe with a valve. Water is released from Willie Jarge Pond to Barrisway Pond, ensuring a controlled supply to maintain adequate water levels for pump operations. Excess runoff is diverted through a spillway at Barrisway Pond.

1.1.2.1 Project Operation Water Use

Inkster's Pond Industrial Water Supply has a permitted annual withdrawal of up to 4,500,000 m³. North Atlantic proposed an annual operation water demand of 947,000 m³ (0.030 m³/s), representing approximately 21% of the currently licenced annual withdrawal volume. Prior to Project start-up, North Atlantic will apply for a water use licence from NL DECC for water use at Inkster's Pond.

The continuous feed water requirement of 0.021 m³/s was specified in a Pre-FEED (Front-End Engineering Design) for the HGP based on a production of 30,000 tonnes of hydrogen per year (Hatch, 2024). For water availability assessments, the maximum feed water requirement of 0.028 m³/s (883,000 m³ per year) was adopted.

The LOHC system will use a closed-loop cooling system that does not require continuous water intake under normal operating conditions. However, to account for losses, a water supply of up to 0.002 m³/s (64,000 m³ per year) will be withdrawn as needed from Inkster's Pond (Hatch, 2025).

Raw water will be stored on site in a 1,706 m³ raw water tank, sized to provide eight hours of water supply. A separate 2,544 m³ fire water storage tank will be installed to meet fire protection requirements, sized for two hours of continuous use in accordance with National Fire Protection Association (NFPA) standards (Hatch, 2024).

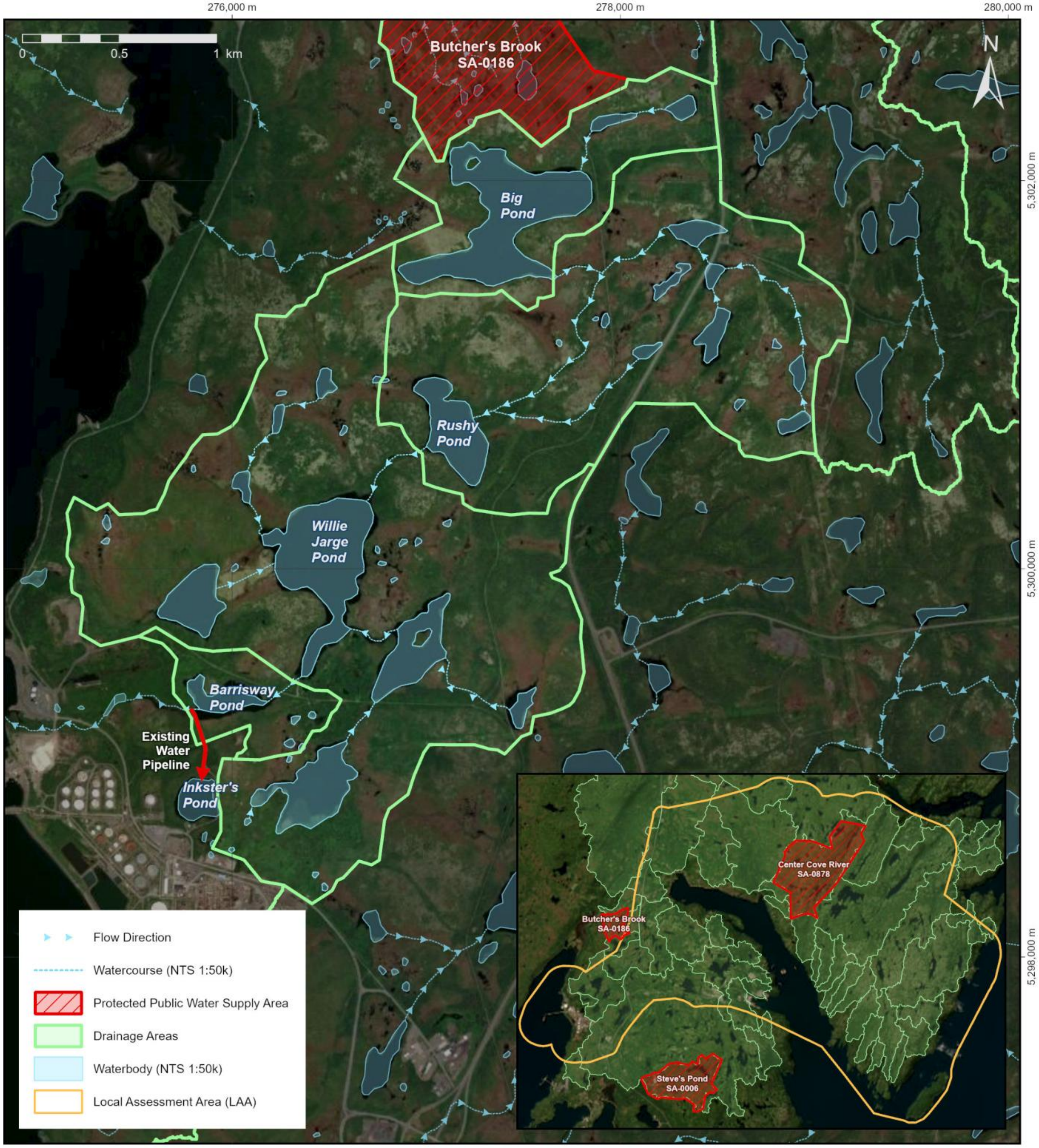
1.1.2.2 Existing Water Use

Inkster's Pond currently supplies industrial water to Braya Renewable Fuels (Braya) under water use licence WUL-14-057, which permits an annual withdrawal of 4,500,000 cubic metres (m^3). The licence was issued on November 13, 2014 to North Atlantic Refining Inc. as the General Partner of NARL Refining Limited Partnership, the former operator of the Come By Chance Terminal. The licence has been transferred to Braya and is valid until December 31, 2039.

The refinery at the Come By Chance Terminal was established in 1973 and had a capacity to process up to 130,000 barrels per day (bbl/d) of crude oil under North Atlantic Refining Corp. (CER, 2024). Prior to its closure in April 2020, the facility relied on water from the Inkster's Pond system to support operations. In 2019, the final year of operation before closure, a total water volume of 1,404,100 m^3 (equivalent to 0.045 cubic metres per second [m^3/s]) was withdrawn. This value is used in this assessment as a representative estimate of historical water use and is approximately 31% of the licenced withdrawal volume.

Between 2021 and 2023, the facility was converted to produce renewable diesel under Braya's ownership. Operations began in February 2024, with a capacity of 18,000 bbl/d (CER, 2024). While current production volumes are lower than historic oil refining levels, Braya continues to utilize existing water infrastructure for operation needs.

North Atlantic is proposing to connect to this industrial water supply for the operations. The use of an already industrialized water source with established infrastructure and licensed withdrawal volumes helps to minimize the environmental footprint of the Project's operation water needs.



North Atlantic	FIGURE TITLE: Watersheds in the Local Assessment Area	NOTES: Watersheds derived from NL 5m Digital Elevation Model and, in public drinking supply areas, supplemented with detailed watershed boundaries provided by Water Resources Management Division (NL Government). Watercourse and Waterbody data sourced from Canadian National Topographic System (NTS) 1:50k series.	PREPARED BY: C. Burke	DATE: 05/06/2025
			REVIEWED BY: J. Crocker 05/06/2025	
			APPROVED BY: C. Collins 05/06/2025	
	PROJECT TITLE: North Atlantic Wind to Hydrogen Project		CRS: WGS 1984 UTM Zone 22N	
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Figure C-1.1-1 Watersheds in the Local Assessment Area.

2.0 Objectives

The objectives of this study are to characterize baseline surface water hydrology and assess seasonal variability in water availability within the PA. Understanding baseline hydrological conditions is necessary to identify seasonal variations in water availability, evaluate potential effects of the Project construction and operation on the environment, and inform the design of water management infrastructure and operations.

Specific objectives of the study include:

- Characterize regional climate and hydrological conditions, as well as the local hydrology within the water supply watershed;
- Summarize results from the baseline surface water monitoring program;
- Evaluate source water availability for the proposed Project; and,
- Simulate long-term water availability using hydrologic models.

3.0 Methods

The study combined desktop analyses of regional climate and hydrometric data with site-specific field monitoring and hydrological modelling. Multiple data sources were used to characterize both regional and local hydrological conditions. Regional datasets provided historical context and long-term trends, and field data captured conditions at a local scale. The following subsections describe the key data sources and methodologies adopted in this study.

3.1 Climate and Water Balance

Climate patterns were analyzed to characterize inter-annual variability in source water inputs. The results helped establish baseline water inputs for water balance calculations and hydrological modelling. These results also provided context for interpreting the baseline monitoring records relative to long-term conditions.

3.1.1 Data Sources

Three precipitation data sources (Table C-3.1-1) were obtained and analyzed to provide estimates of water input into the hydrological cycle based on different methodologies:

- Environment and Climate Change Canada (ECCC) Climate Station records (ECCC, 2025);
- National Aeronautics and Space Administration (NASA) Global Precipitation Measurement (GPM) (NASA, 2025); and,
- Intensity-Duration-Frequency (IDF) data at Argentia Airport (ECCC, 2022).

Table C-3.1-1 Precipitation datasets.

<table>
<tr><th>Dataset</th><th>Components</th><th>Period of Record</th><th>Record Interval</th><th>Coordinates</th><th>Distance from the Water Supply Watershed</th></tr>
<tr><td rowspan="2">ECCC Climate Station</td><td>Arnold’s Cove (Station ID: 8400135)</td><td>1971 to 1994 (Climate Normals period: 1971 to 2000)</td><td rowspan="2">1 day</td><td>47.8°N, 54.0°W</td><td>6 km</td></tr>
<tr><td>Goobies (Station ID: 8401880)</td><td>1978 to 2011 (Climate Normals period: 1981 to 2010)</td><td>47.9°N, 54.0°W</td><td>17 km</td></tr>
<tr><td colspan="2">IDF Data at Argentia Airport</td><td>1980 to 2013 (Published in 2022)</td><td>-</td><td>47.3°N, 54.0°W</td><td>56 km</td></tr>
<tr><td colspan="2">NASA GPM</td><td>1998 to 2025 (Retrieved in 2025)</td><td>30 minutes</td><td>47.8°N, 54.0°W</td><td>0 km</td></tr>
</table>

Evapotranspiration data was obtained from two sources (Table C-3.1-2) to provide estimates of water losses due to evaporation and plant transpiration based on different methodologies:

- Natural Resources Canada (NRCan): Combined land surface actual evapotranspiration and water surface evaporation datasets between 2000 and 2023 (NRCan, 2024a, 2024b, 2024c); and,
- United Nations Food and Agriculture Organization (UN FAO): Global actual evapotranspiration and canopy interception records from 2018 to present (UN FAO, 2025).

Table C-3.1-2 Evapotranspiration datasets.

Dataset	Components	Period of Record
NRCan Composite Evapotranspiration	Land Surface Evapotranspiration for Canada's Landmass	2000 to 2023
	Water Surface Evaporation for Canada's Landmass	2000 to 2023
	Inland Water Bodies Map of Canada and Neighbouring Regions at 250-m Spatial Resolution	1984 to 2021
UN FAO Actual Evapotranspiration and Interception		2018 to present

3.1.2 Analysis Methods

Precipitation provides the source water input into a watershed. Precipitation data was analyzed using the following methods:

- Monthly and Annual Statistics: Monthly and annual precipitation totals were calculated for ECCC climate stations and the NASA GPM dataset. Monthly percentiles were derived to characterize typical conditions and extremes;
- Drought Period Identification: Continuous low precipitation periods were identified from the NASA GPM dataset; and,
- Extreme Events: Peak precipitation intensities were determined from the NASA GPM (1998 to 2024) and compared against Argentia Airport IDF values.

Quantification of evapotranspiration is necessary for surface water availability calculations as it represents a pathway of water losses. Evapotranspiration data were assessed using the following approaches:

- Source Data Aggregation: Weighted average evapotranspiration was obtained for the watershed area that provides source water. The UN FAO Actual Evapotranspiration and Interception data were obtained directly, whereas the NRCan composite evapotranspiration was determined from its components based on the following relationship, where ET = composite evapotranspiration, AET = land surface actual evapotranspiration, PE = water surface evaporation, and α = water surface fraction.

$$ET = (1 - \alpha)AET + \alpha PE$$

- Monthly and Annual Statistics: Monthly and annual evapotranspiration totals were derived from the NRCan and UN FAO datasets during their full record periods. Monthly percentiles were derived to characterize typical conditions and extremes.
- Dataset Comparison: A comparison was made between the two datasets to identify inter-annual variations.

A monthly water balance was assessed to determine water availability expressed as runoff depth, by subtracting evapotranspiration from precipitation for an average climate year. Runoff factors were calculated on a monthly basis to assess the percentage of precipitation that contributed to runoff.

3.2 Regional Hydrology

Regional hydrological conditions were assessed by evaluating the streamflow records at the regional hydrometric stations. Water yield, hydrological variability, and potential high and low flow conditions were quantified to represent the regional hydrology.

3.2.1 Data Sources

Hydrometric data provides streamflow records that represent surface water yield and can be used to derive runoff patterns. Flow records from four Water Survey of Canada (WSC) stations (WSC, 2025) within 50 kilometres (km) of the water supply watershed were obtained (Table C-3.2-1).

Table C-3.2-1 WSC stations within 50 km of the water supply watershed.

Hydrometric Station	Station ID	Period of Record	Distance from the Water Supply Watershed	Drainage Area
Pipers Hole River at Mothers Brook	02ZH001	1953 to present	43 km	764.0 km²
Come By Chance River near Goobies	02ZH002	1970 to present	15 km	43.3 km²
Shoal Harbour River near Clarenville	02ZJ003	1986 to present	46 km	106.0 km²
Rattling Brook below Bridge	02ZK006	2007 to present	50 km	32.7 km²

Precipitation was also obtained to derive runoff factors for each WSC station. NASA GPM records were retrieved at the center of each station's watershed to represent each watershed's precipitation.

Low flows (7-day, 1:50-year low flow [7Q50]) were estimated using the Newfoundland and Labrador Low Flows Estimation Calculator (NL DECC, 2017) to supplement the WSC station records in evaluating low flow periods. A 50-year return interval was chosen to match the average WSC station records (~46 years).

3.2.2 Analysis Methods

To facilitate comparison between watersheds of different sizes, flow data was normalized to derive unit flow rates (L/s/km² [Litres per second per square kilometre]) and runoff depths (mm [millimetres]). Monthly flow statistics were calculated for each hydrometric station to characterize seasonal patterns and variability. Monthly runoff was derived by converting flow rates to runoff depths over the watershed area, allowing for direct comparison with precipitation and the derivation of runoff factors.

A year was divided into two seasonal periods, Summer/Fall (June to November, when there is minimal snow influence) and Winter/Spring (December to May, when snow accumulates and eventually melts), to account for snow effects and achieve water balance. Precipitation and streamflow data between 1998 and 2024 were used to calculate runoff depths and runoff factors for both seasons to determine how regional watersheds responded.

Low flow conditions were assessed by analyzing the full continuous flow records at the WSC stations to identify minimum cumulative runoff depth for durations ranging between 7 and 365 days. The results were compared with the 7Q50 estimated for each station (NL DECC, 2017).

3.3 Local Hydrology

A baseline hydrology monitoring program was conducted within the water supply watershed between May 2024 and May 2025. Water level loggers were installed at six monitoring locations to monitor water levels continuously and estimate streamflow rates. The coordinates and instruments for the continuous monitoring stations are provided in Table C-3.3-1 and their locations are illustrated in Figure C-3.3-1.

Table C-3.3-1 Continuous monitoring stations.

Station ID	Location	UTM Zone	Easting	Northing	Instruments
RP-L	Rushy Pond	22	276997	5300617	Water level logger
WJP-L	Willie Jarge Pond	22	276341	5299437	Water level logger
BP-L	Barrisway Pond	22	275799	5299267	Water level logger
RP-O	Rushy Pond Outlet	22	276974	5300613	Water level logger, barometer

Station ID	Location	UTM Zone	Easting	Northing	Instruments
WJP-O	Willie Jarge Pond Outlet	22	276310	5299406	Water level logger
BP-O	Barrisway Pond Outlet	22	275766	5299263	Water level logger, barometer

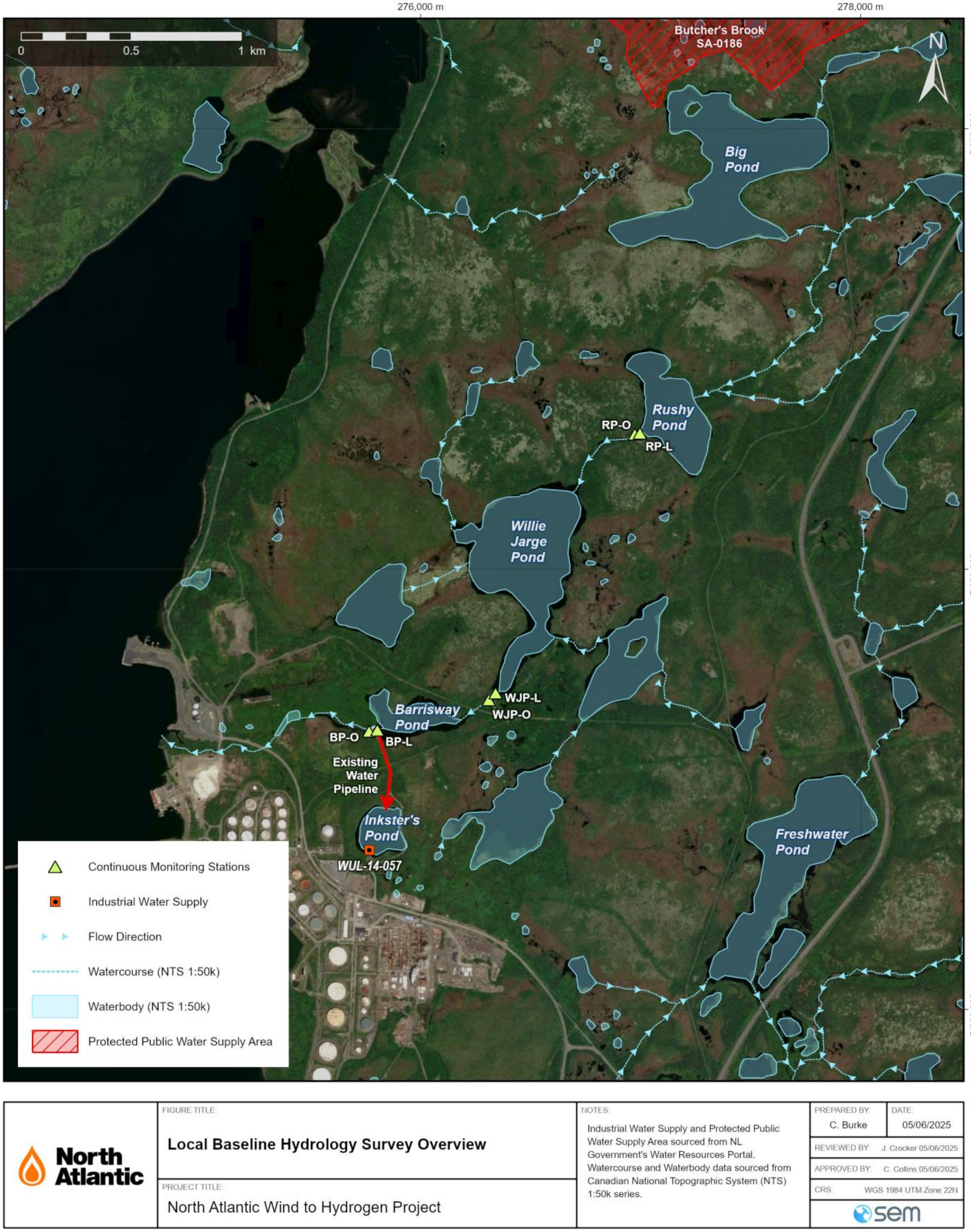


Figure C-3.3-1 Local baseline hydrology survey overview.

3.3.1 Water Level Monitoring

Water level monitoring was conducted continuously with Van Essen Mini Divers water level loggers and by obtaining spot staff gauge readings during 12 site visits. The selected water level loggers were utilized for their simplicity, long battery lifespan, and accuracy. The water level loggers measured the combined pressure of the column of water above them and the pressure of the atmosphere above the water column (i.e., atmospheric pressure). Data was recorded in centimetres (cm) of water (H_2O) (0.5 cm accuracy) every 15 minutes. Each water level logger also recorded water temperature in degrees Celsius (°C) (0.1°C accuracy).

Water level loggers are not vented to the atmosphere and therefore need to be corrected for atmospheric pressure changes to produce true water levels. Barometers were installed above the water surface to record atmospheric pressure. This data was used to adjust readings from the water level loggers within the same geographic region. Data was downloaded in *.csv format for ease of processing.

During each site visit water levels were manually measured at installed staff gauges to which the water level loggers were affixed. Staff gauges were constructed by fastening a graduated ruler to a polyvinyl chloride (PVC) pipe with self-tapping screws. Additional holes were drilled in the pipe prior to deployment to ensure constant water flow through the pipe and thus ensuring an accurate water level measurement from the water level loggers.

Metal T-posts were hammered into the stream bed to hold staff gauges in place. Water level loggers were attached to the metal T-post inside the base of the PVC pipe. A manual reading of the staff gauge was recorded for each staff gauge following installation. Staff gauge readings were recorded along with the date and time during each subsequent site visit to the monitoring locations. Staff gauge readings were used to calibrate the continuous water level records.

3.3.2 Streamflow Monitoring

Manual streamflow measurements were obtained during each site visit, and from the range of measurements, streamflow rating curves were developed. The field team followed protocols established by Water Survey of Canada (WSC, 1999) and the United States Geological Survey (USGS, 1982). Manual flow measurements (i.e., water depth and velocity measurements) were conducted three times along the established stream transect during each site visit using a Hach FH950 Acoustic Doppler velocity flowmeter with wading rod. Each transect was securely marked using a wooden survey stake and/or a metallic rebar. A measuring tape was stretched across the stream from the high-water mark on each side at each transect. Beginning at the water's edge and depending on the transect width, depth (cm) and velocity (metres per second [m/s]) measurements were recorded at each vertical section, with a spacing of 40 cm or less. Velocity was recorded at 60% water depth. These measurements were used to calculate streamflow (m^3/s) for each transect using formulas from the WSC (1999) and the USGS (1982).

WSC (2016) protocols were employed to develop preliminary rating curves (i.e., stage-discharge) for each stream monitoring location. Streamflow and staff gauge measurements were fitted to water levels and their associated flows with a power function. The quality of rating curves was assessed by calculating the coefficient of determination (R^2).

Continuous water level monitoring records were used to extrapolate streamflow using the rating curves; however, caution should be exercised when extrapolating flows beyond the highest and lowest measurements. Continuous flow records were then derived, and compared with the available meteorologic and hydrometric data, as well as hydrology model results.

3.3.3 Comparison with Meteorologic and Hydrometric Data

Unit flow rates and runoff depths were derived from baseline monitoring records and compared between different water supply ponds to assess hydrological variabilities on a local scale. The local runoff was compared with that derived from the water balance for the same period to validate the NASA GPM precipitation and UN FAO evapotranspiration data to be used for the hydrology model input.

The local flow database was also compared with regional WSC hydrometric records during the same period to assess spatial flow variations. Average, low, and high flow conditions were quantified during the baseline monitoring period and were compared with the long-term WSC station records. This helped evaluate hydrological conditions captured during the baseline monitoring period relative to historical trends.

Environmental instream flow requirements were determined by following the Low Flow Frequency Study for Newfoundland and Labrador (Zadeh, 2012). The 7-day 1:10-year low flow (7Q10) was adopted as the environmental threshold flow, which was calculated by the Low Flows Estimation Sheet (NL DECC, 2017) based on the drainage areas of water supply ponds.

High flow conditions were estimated at the water supply ponds, adopting Regional Flood Frequency Analysis (RFFA) for NL (AMEC, 2014). These results were compared against the peak flow captured during the baseline monitoring period, based on their return interval estimated with the NASA GPM records and the IDF data.

3.3.4 Water Availability Assessment

Project water availabilities were assessed during the Construction and O&M Phases. The evaluations were informed by the proposed water sources, baseline field data, publicly available hydrometric station records, and provincial guidelines.

During construction, Project water availabilities were assessed based on the records of four regional WSC stations (Table C-3.2-1). The expected mean annual flow at Lady Cove Pond and Little Mosquito Pond was derived based on a linear relationship between the regional WSC stations' mean annual flows and the drainage area at each location. Low flows (7-day, 1:2-year low flow [7Q2] and 7-day, 1:10-year low flow [7Q10]) were evaluated based on the Low Flows Estimation Sheet (NL DECC, 2017). The results were compared with the proposed Project construction withdrawal rates.

Water availability for operations was evaluated by comparing projected annual water requirements (Section 1.1) with estimated mean annual runoff (MAR) for the water supply watershed. MAR was calculated based on regional hydrometric data and data acquired during the baseline monitoring period at Rushy Pond Outlet. Live storage will be needed for Project operation during low flow periods, which was assessed according to the Guide to Storage Yield Analysis at Ungauged River Sites (NL DECC, 1997). The estimation was performed adopting records of nearby WSC stations (02ZH001, 02ZH002, and 02ZJ003) and the drainage area of the water supply watershed. Live storage was estimated based on three water withdrawal scenarios to determine live storage requirements: existing (Section 1.1.1), Project operations (Section 1.1.2), and future withdrawal (combining both existing and Project operations). The results were compared with the total live storage at Inkster's Pond, Barrisway Pond, and Willie Jarge Pond, based on their bathymetry, pump invert elevations, and hydraulic control structure elevations captured during bathymetric and topographic surveys (Appendix C-2).

3.4 Hydrology Model

Hydrological models were developed to simulate water balance dynamics in the water supply ponds and evaluate water availability under various withdrawal scenarios. Two models were developed, a monthly water balance model (January 2000 to December 2023) for long-term trend analysis and an event scale model (January 2018 to April 2025) for short-duration event simulation. Model performance was evaluated through comparison with baseline monitoring records.

3.4.1 Water Withdrawal

Two water withdrawal scenarios were incorporated into the monthly and event scale hydrological models to evaluate water availability under existing and future conditions. The existing conditions scenario considered only existing water use (Section 1.1.1), whereas the future conditions scenario included both existing and Project water uses (Section 1.1.2).

3.4.2 Model Assumptions

The water supply watershed was conceptualized as two interconnected components, land areas (land portions of watershed areas excluding waterbodies) and waterbodies. In the land areas component, precipitation enters soil moisture storage, which is depleted by evapotranspiration. When soil moisture exceeds a threshold capacity, the excess generates runoff to the waterbodies. The waterbodies component receives this runoff plus direct precipitation on its surface and loses water through evaporation and water withdrawals. When pond storage capacity is exceeded, overflow occurs. Both components carry forward their respective storage values between time steps.

The following assumptions were incorporated in the monthly and event scale models:

- No Groundwater Contribution: Runoff ceases when soil moisture falls below a threshold value. Groundwater in the RAA has limited quantity compared with surface water (Registration Section 3.1.2.2).
- Unlimited Evapotranspiration Capacity: The model allows evapotranspiration to reduce soil moisture infinitely below its threshold value.
- No Direct Runoff Process: All precipitation over land is routed through soil moisture storage before generating runoff to waterbodies.
- Uniform Soil Properties: Land areas were assumed to have uniform soil characteristics.
- No Snow Accumulation Effects: All precipitation was treated as immediately available for infiltration or runoff.

3.4.3 Monthly Model

A monthly water balance model was developed to assess long-term water availability in the water supply ponds based on monthly data between 2000 and 2023. This model operates on a monthly timestep, incorporating NASA GPM precipitation data and NRCan evapotranspiration estimates aggregated to monthly totals.

3.4.4 Event Scale Model

An event scale model was developed to simulate the response of the source water system to individual precipitation events and operational changes. This model operated at a 30-minute timestep using NASA GPM precipitation data and UN FAO evapotranspiration data between January 1, 2018, and April 30, 2025, simulating water level fluctuations and flow responses not captured by the monthly model.

The model incorporated physical characteristics of water control structures and their operational management. Outlet structures at Willie Jarge Pond and Barrisway Pond were modelled using broad-crested weir equations with dimensions obtained from topographic surveys. Water withdrawal from Barrisway Pond was simulated at constant rates for both existing and future scenarios. Pond water levels were calculated at each timestep using stage-storage relationships derived from bathymetric data. Soil water retention was calibrated to align modelled peak flow with that flow recorded at the Rushy Pond Outlet monitoring station. The calibrated model results for the natural Rushy Pond system were compared with the baseline monitoring records for performance validation.

4.0 Regional Climate and Water Balance

The PA is located within the Maritime Barrens Ecoregion of Newfoundland (Newfoundland and Labrador Heritage, 2018). This region is characterized by a maritime climate with relatively abundant and evenly distributed precipitation throughout the year. This coastal location results in climate patterns influenced by its proximity to the ocean, with the area being exposed to prevailing southwesterly winds.

The regional climate follows both diurnal and seasonal patterns. Daily land-sea temperature differences drive advective transport of moisture inland. Seasonally, the climate is governed by the subtropical high-pressure system and the subpolar low-pressure system. Summer typically sees reduced precipitation, while fall brings increased precipitation.

4.1 Climate Normals

Climate normals data from ECCC for Arnold's Cove and Goobies are presented in Tables C-4.1-1 and C-4.1-2, respectively. These are the only climate normals within 50 km of the water supply watershed and provide regional context for temperature and precipitation. These datasets span two different 30-year periods: 1971 to 2000 (Arnold's Cove) and 1981 to 2010 (Goobies).

Table C-4.1-1 Arnold's Cove Climate Normals (1971 to 2000).

Parameter		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)		120.7	107.2	100.6	86.0	92.7	126.2	95.2	103.2	109.2	138.0	128.6	111.5	1,319.0
Temperature (°C)	Daily Minimum	-8.1	-8.9	-5.5	-0.9	2.4	6.0	10.5	12.0	9.3	4.6	0.4	-4.7	1.4
	Daily Average	**-4.4**	**-5.1**	**-2.0**	**2.3**	**5.9**	**9.5**	**13.8**	**15.3**	**12.6**	**7.9**	**3.4**	**-1.5**	**4.8**
	Daily Maximum	-0.7	-1.3	1.5	5.4	9.3	13.0	17.1	18.6	15.9	11.0	6.3	1.7	8.2

Table C-4.1-2 Goobies Climate Normals (1981 to 2010).

Parameter		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)		148.3	118.1	113.2	114.1	105.4	100.0	100.0	98.1	141.0	139.2	149.6	136.9	1,463.9
Temperature (°C)	Daily Minimum	-10.7	-10.9	-7.4	-2.2	1.6	5.3	10.2	10.7	7.3	2.7	-1.7	-6.4	-0.1
	Daily Average	**-6.0**	**-6.2**	**-3.0**	**2.1**	**6.6**	**10.7**	**15.3**	**15.8**	**12.2**	**6.8**	**2.0**	**-2.5**	**4.5**
	Daily Maximum	-1.4	-1.4	1.4	6.3	11.6	16.0	20.4	21.0	17.1	10.9	5.8	1.5	9.1

The climate normals indicate that monthly precipitation data ranges between 85 to 150 mm, distributed throughout the year with seasonal variations. Higher precipitation generally occurs during fall and early winter months (October to January), while the spring and summer months typically receive less precipitation. Temperature trends reflect maritime climate influence, which results in mild temperatures with moderate daily and monthly variations.

4.2 Precipitation

Precipitation is the primary input to the hydrological cycle and the source of surface water for the Project. To establish an understanding of precipitation patterns, NASA GPM precipitation data was analyzed for the period of 1998 to 2024. This provides a more recent record than the climate normals and enables direct climate reference for the baseline monitoring program. Monthly percentiles derived from this dataset are summarized in Table C-4.2-1.

Table C-4.2-1 Monthly precipitation (1998 to 2024).

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
5th percentile	52.3	57.8	65.3	27.6	44.9	66.3	78.6	64.8	60.2	63.6	77.2	84.6	1,249.5
Average	**128.3**	**130.7**	**122.9**	**90.5**	**90.4**	**110.9**	**108.9**	**109.2**	**125.1**	**148.8**	**159.8**	**150.9**	**1,476.2**
95th percentile	209.8	176.0	182.6	169.3	131.4	169.4	162.8	149.6	207.3	238.4	237.5	239.9	1,640.0

The NASA GPM data aligns with the monthly precipitation patterns observed in the climate normal records. Average monthly precipitation ranges between 90 mm and 160 mm. The annual average precipitation of 1,476.2 mm closely aligns with the Goobies climate normal (1,463.9 mm), validating the satellite-derived measurements. Fall and early winter months (October to December) show the highest average precipitation and the greatest variability between 5th and 95th percentiles, consistent with the influence of the subpolar low-pressure system during these months. Even during dry years (5th percentile), annual precipitation exceeds 1,200 mm.

4.2.1 Peak Precipitation Events

Understanding the intensity and frequency of peak precipitation events is critical for assessing flood risks and designing hydraulic structures. Peak precipitation event intensities are provided through IDF data at Argentia Airport, which is summarized in Table C-4.2-2. Instantaneous peak precipitation intensities at the water supply watershed were also examined on a time scale of 30 minutes to 24 hours. The peak precipitation intensities recorded by NASA GPM over its 27-year period of record were summarized in Table C-4.2-3, which showed 39% lower to 8% higher intensities than the 1:25-year IDF data at Argentia Airport with durations between 30 minutes and 24 hours.

Table C-4.2-2 Intensity-Duration-Frequency data at Argentia Airport.

Peak Precipitation Intensity (mm/hr)						
Duration	**Return Interval (years)**					
	2	**5**	**10**	**25**	**50**	**100**
5 min	53.8	70.1	81.0	94.6	104.8	114.8
10 min	47.2	62.5	72.6	85.3	94.8	104.2
15 min	41.5	54.4	62.9	73.6	81.6	89.5
30 min	28.8	36.5	41.5	47.9	52.6	57.3
1 hr	19.3	24.7	28.3	32.9	36.3	39.6
2 hr	13.3	17.9	20.9	24.8	27.6	30.5
6 hr	7.3	11.6	14.5	18.1	20.8	23.5
12 hr	4.6	7.5	9.4	11.8	13.5	15.3
24 hr	2.8	4.3	5.4	6.6	7.6	8.5

Table C-4.2-3 Peak precipitation data and comparison with IDF.

Duration	Peak Precipitation Intensity (mm/hr)	Deviation from 1:25-Year IDF (%)
30 min	49.2	3%
1 hr	35.4	8%
2 hr	22.9	-8%
6 hr	12.6	-30%
12 hr	7.2	-39%
24 hr	5.5	-17%

4.2.2 Drought Conditions

Identifying potential drought conditions is essential for water resource management and understanding the resilience of the watershed to sustained periods of low precipitation. NASA GPM precipitation records at the water supply watershed were examined to identify continuous low precipitation periods with durations ranging between 7 and 365 days. The results are summarized in Table C-4.2-4 in comparison with the average precipitation expected to accumulate between 7 and 365 days.

Table C-4.2-4 Low precipitation period magnitudes and durations.

Duration (days)	7	14	30	60	120	180	365
Average Cumulative Precipitation (mm)	28.3	56.6	121.2	242.5	485.0	727.5	1,475.2
Minimum Cumulative Precipitation (mm)	0.0	0.0	5.4	51.6	200.4	394.2	1,058.5
5th Percentile Cumulative Precipitation (mm)	1.3	10.6	47.7	131.4	315.6	525.6	1,270.2

The record shows that periods with no precipitation have occurred for durations up to 14 days. For 60-day durations, the historical minimum precipitation was 51.6 mm, representing 21% of the average expected precipitation for that timeframe. As the duration increases, the precipitation totals show greater resilience to sustained drought. The 180-day minimum precipitation reaches 394.2 mm (54% of average), while the 365-day minimum rises to 1,058.5 mm (72% of average). This pattern indicates that while short-term drought conditions do occur in the region, they tend not to be sustained. The record indicates that even during the driest period, precipitation deficits tend to recover within 60 to 180 days.

4.3 Evapotranspiration

Evapotranspiration represents a component of the water cycle, accounting for water losses through combined soil evaporation, plant transpiration, canopy interception, and open water evaporation processes. Evapotranspiration in the water supply watershed was characterized using two datasets provided by NRCan (2000 to 2023) and UN FAO (2018 to 2024), summarized in Table C-4.3-1.

Table C-4.3-1 Monthly evapotranspiration.

Data Source	Evapotranspiration (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
NRCan	5th percentile	9.6	12.0	16.6	18.0	22.8	30.9	49.5	45.9	36.0	17.3	8.3	5.4	309.7
	Average	**14.1**	**15.8**	**20.8**	**21.5**	**28.9**	**40.2**	**58.1**	**59.2**	**39.1**	**20.4**	**9.9**	**9.9**	**337.8**
	95th percentile	17.7	20.5	23.5	25.3	35.7	46.7	69.8	64.8	42.9	24.3	12.2	14.8	361.6
UN FAO	5th percentile	0.4	1.3	2.4	4.0	10.0	26.9	60.1	63.7	40.7	16.8	3.7	0.8	249.0
	Average	**1.1**	**1.9**	**3.7**	**5.0**	**14.9**	**36.8**	**68.7**	**74.7**	**46.8**	**20.4**	**5.6**	**1.3**	**279.1**
	95th percentile	1.9	2.7	4.7	6.8	21.6	46.9	81.8	81.7	49.8	25.1	6.7	2.2	305.3

The two datasets show similar seasonal patterns with evapotranspiration peaking in summer months and reaching minimum values in winter. The NRCan dataset, despite higher annual evapotranspiration, recorded lower evapotranspiration between July and September. The UN FAO dataset was assessed in comparison with the baseline monitoring records (Section 6.2). Further evaluation was made in the hydrology model sensitivity analysis (Section 7.3.3) using overlapping data between 2018 and 2023.

4.4 Water Balance

A water balance approach was used to assess surface water availability by subtracting precipitation inputs from evapotranspiration losses. Monthly runoff depths and runoff factors were calculated and are summarized in Table C-4.4-1.

Table C-4.4-1 Monthly water balance.

Parameter	Dataset	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)	GPM	128.3	130.7	122.9	90.5	90.4	110.9	108.9	109.2	125.1	148.8	159.8	150.9	1,476.2
Evapotranspiration (mm)	NRCan	14.1	15.8	20.8	21.5	28.9	40.2	58.1	59.2	39.1	20.4	9.9	9.9	337.8
	FAO	1.1	1.9	3.7	5.0	14.9	36.8	68.7	74.7	46.8	20.4	5.6	1.3	279.1
Runoff Depth (mm)	GPM-NRCan	114.2	114.9	102.1	69.0	61.5	70.7	50.8	50.0	86.0	128.4	149.9	141.0	1,138.4
	GPM-FAO	127.2	128.8	119.2	85.5	75.5	74.1	40.2	34.5	78.3	128.4	154.2	149.6	1,197.1
Runoff Factor (%)	GPM-NRCan	89%	88%	83%	76%	68%	64%	47%	46%	69%	86%	94%	93%	77%
	GPM-FAO	99%	99%	97%	94%	84%	67%	37%	32%	63%	86%	96%	99%	81%

Both evapotranspiration datasets were used to provide a range of estimates. This analysis shows that approximately 77 to 81% of annual precipitation contributes to runoff, yielding between 1,138.4 mm and 1,197.1 mm of annual runoff depth. This translates to a water yield of 36.1 to 37.9 L/s/km².

Monthly runoff depth shows seasonal variation, ranging from as low as 34.5 mm in August to as high as 154.2 mm in November. The lowest runoff factors occur in summer months when evapotranspiration rates are highest.

This monthly water balance analysis assumed direct conversion of precipitation to runoff within the same month, without accounting for snow accumulation and melting. A seasonal analysis was conducted by dividing the year into months without snow (June to November) and months with snow (December to May), as summarized in Table C-4.4-2.

Table C-4.4-2 Seasonal water balance.

Parameter	Dataset	Jun to Nov	Dec to May
Precipitation (mm)	GPM	762.7	713.7
Evapotranspiration (mm)	NRCan	226.9	110.9
	FAO	253.0	27.9
Runoff Depth (mm)	GPM-NRCan	535.8	602.8
	GPM-FAO	509.7	685.8
Runoff Factor (%)	GPM-NRCan	70%	84%
	GPM-FAO	67%	96%

The seasonal analysis indicated that months with snow produce more runoff than months without snow, due to more precipitation and less evapotranspiration in colder months. Runoff factors reach 84% to 96% during months with snow compared to 67% to 70% during snow-free months. Seasonality in water availability was predicted, with more water available from December to May.

5.0 Regional Hydrology

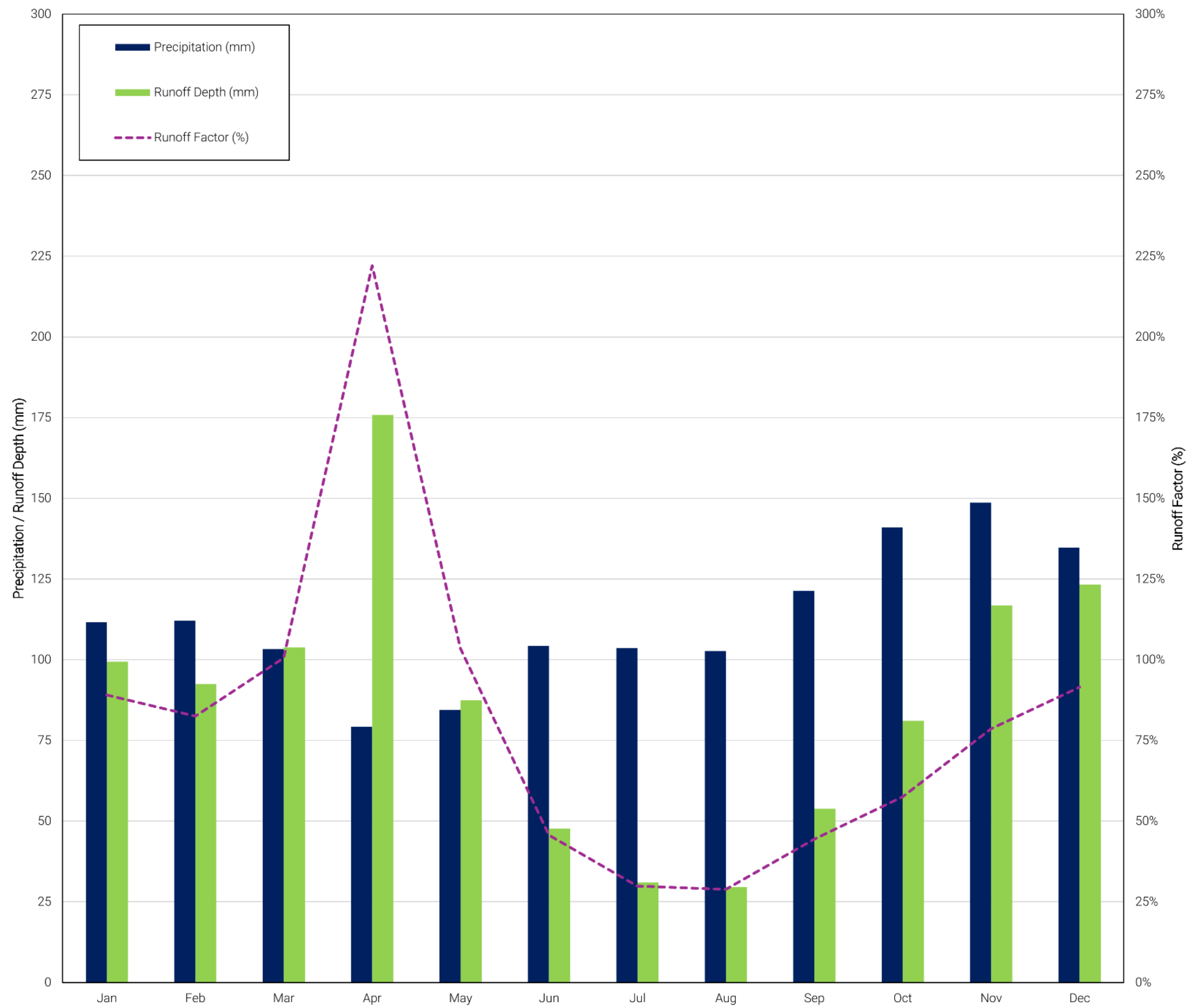
Regional hydrological analysis was conducted to establish baseline streamflow conditions and understand regional variability. Hydrometric station records were analyzed to characterize streamflow patterns, assess potential low flow conditions, and identify key hydrological processes.

5.1 Monthly and Seasonal Flow and Runoff Depth

Long-term flow records are available in hydrometric station datasets, which offer valuable insight into regional watershed response patterns that complement climate data. Records at four WSC stations within 50 km of the water supply watershed were examined to characterize streamflow patterns and their variability. Monthly flow rates were derived for each station (Table C-1-1, Appendix C-1), and unit flow rates were calculated based on drainage area (Table C-1-2). Monthly runoff depth was also calculated (Table C-1-3), allowing for comparison with precipitation records and to calculate runoff factors for each station (Figures C-5.1-1 to C-5.1-4).

Regional hydrometric data showed consistent seasonal patterns, with lower flow and runoff depth during the summer months and higher values during the remainder of the year. The highest flow and runoff typically occur in April, coinciding with spring snowmelt. Runoff factors followed similar seasonal patterns, ranging from as low as 25% in August to as high as 252% in April. Runoff factors exceeding 100% reflect snowpack contributing to surface water flows that exceed monthly precipitation inputs.

To resolve the monthly imbalance between precipitation and runoff due to snow accumulation and melting, a seasonal analysis was conducted where a year is separated into seasons with and without snow melting (Section 3.2.2). These results are summarized in Table C-1-4 (Appendix C-1) and plotted for each station in Figures C-5.1-5 to C-5.1-8.



Notes:

1. NASA GPM precipitation record was obtained at the Pipers Hole River (02ZH001) watershed center (48.05°N, 54.44°W).

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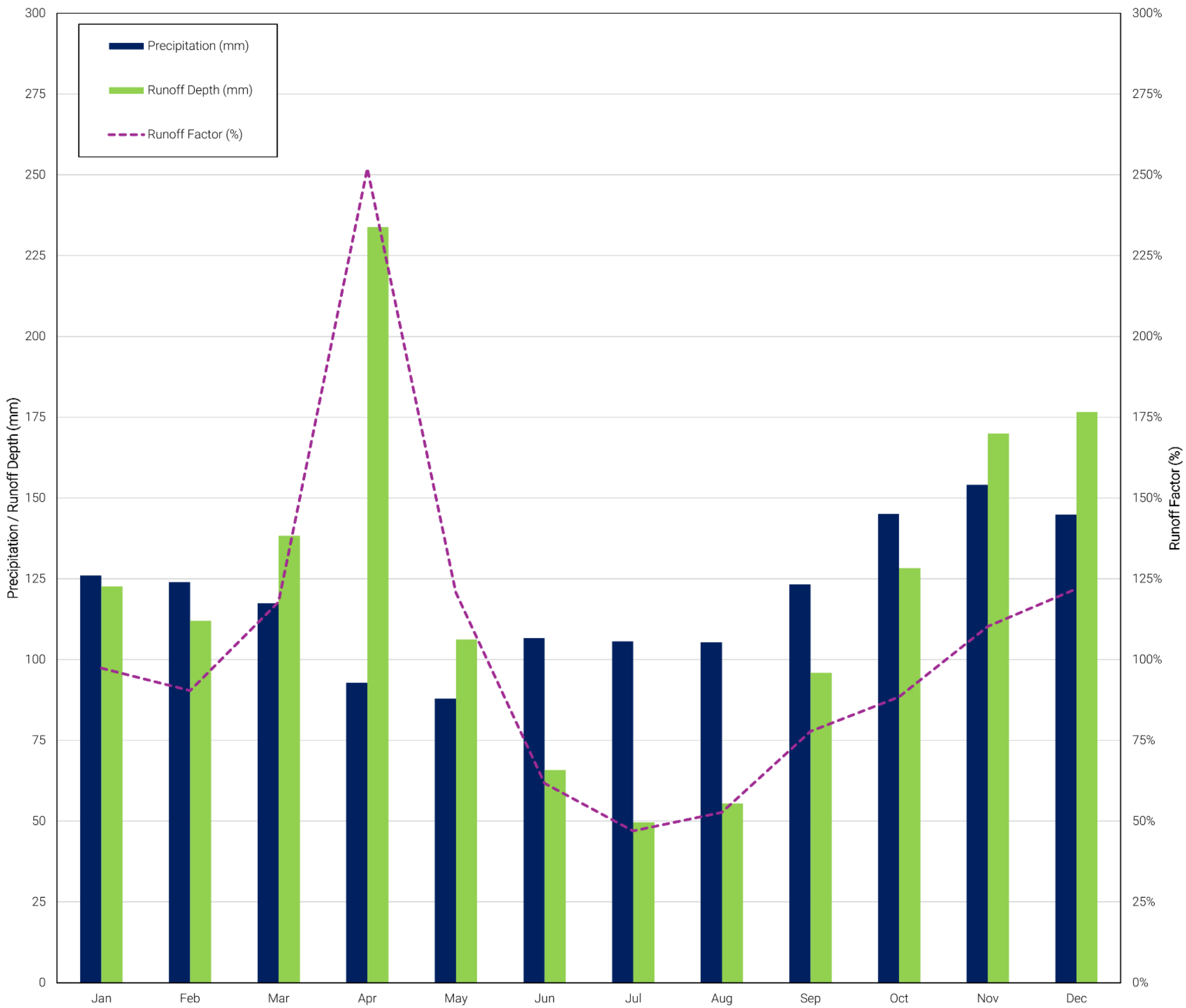
NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

MONTHLY PRECIPITATION AND RUNOFF
PIPERS HOLE RIVER (02ZH001)
1998 TO 2024

DATE: MAY 2025	PROJECT: 016-015	SUBMITTER: Z.ZHAO	REVIEWER: T.BRENTON

FIGURE: C-5.1-1



Notes:

1. NASA GPM precipitation record was obtained at the Come By Chance River (02ZH002) watershed center (47.95°N, 53.57°W).

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SURFACE WATER STUDY

MONTHLY PRECIPITATION AND RUNOFF
COME BY CHANCE RIVER (02ZH002)
1998 TO 2024

DATE: MAY 2025	PROJECT: 016-015	SUBMITTER: Z.ZHAO	REVIEWER: T.BRENTON
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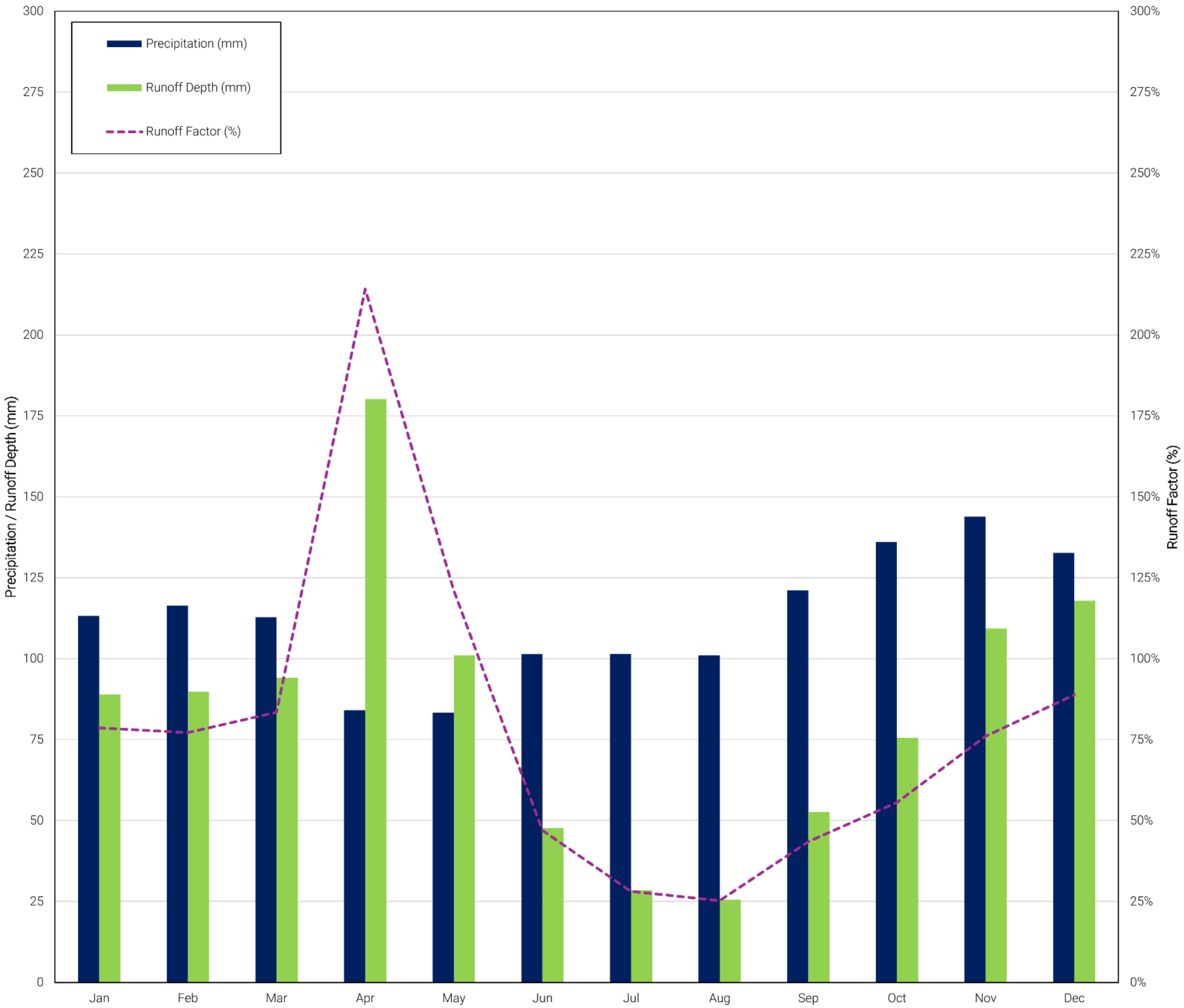

Notes:

1. NASA GPM precipitation record was obtained at the Shoal Harbour River (02ZJ003) watershed center (48.22°N, 54.13°W).

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SURFACE WATER STUDY

MONTHLY PRECIPITATION AND RUNOFF
SHOAL HARBOUR RIVER (02ZJ003)
1998 TO 2024

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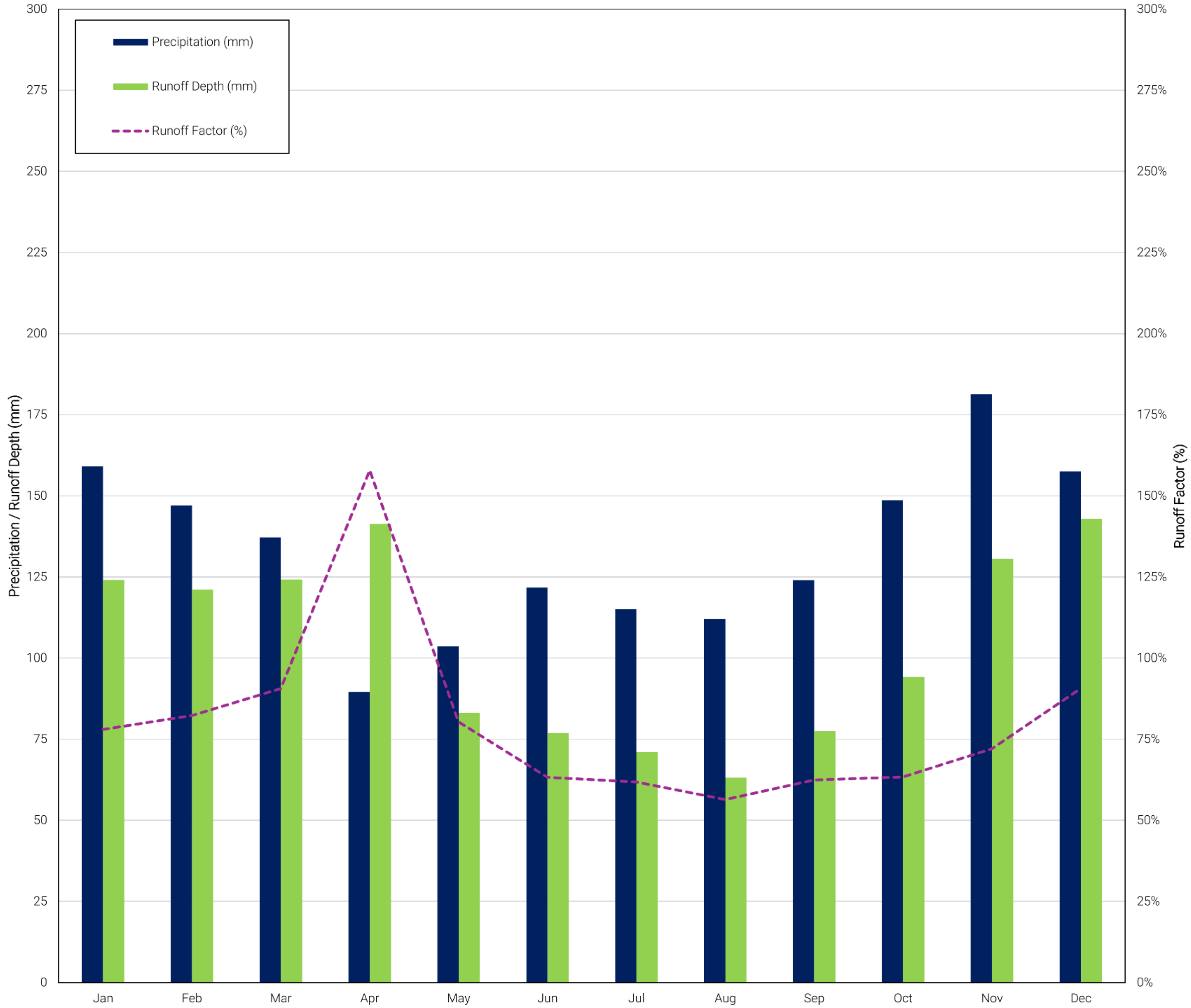
FIGURE: C-5.1-3



Notes:

1. NASA GPM precipitation record was obtained at the Rattling Brook (02ZK006) watershed center (47.40°N, 53.77°W).

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SURFACE WATER STUDY

MONTHLY PRECIPITATION AND RUNOFF
RATTLING BROOK (02ZK006)
2007 TO 2024

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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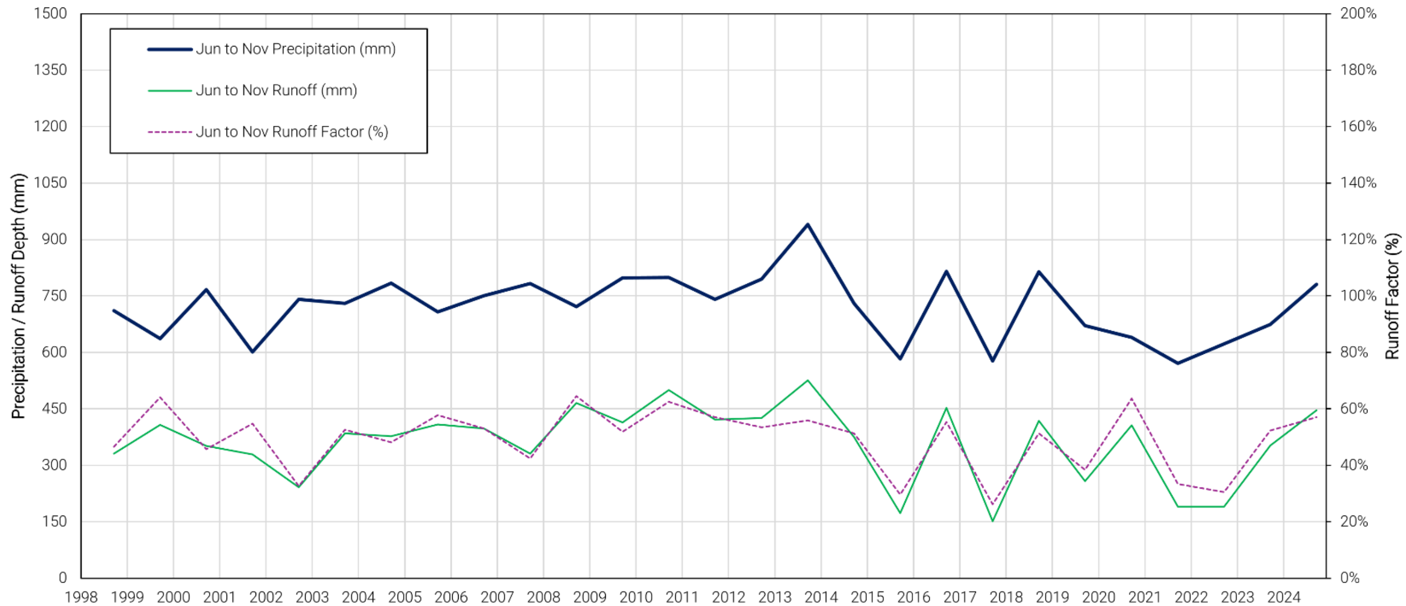
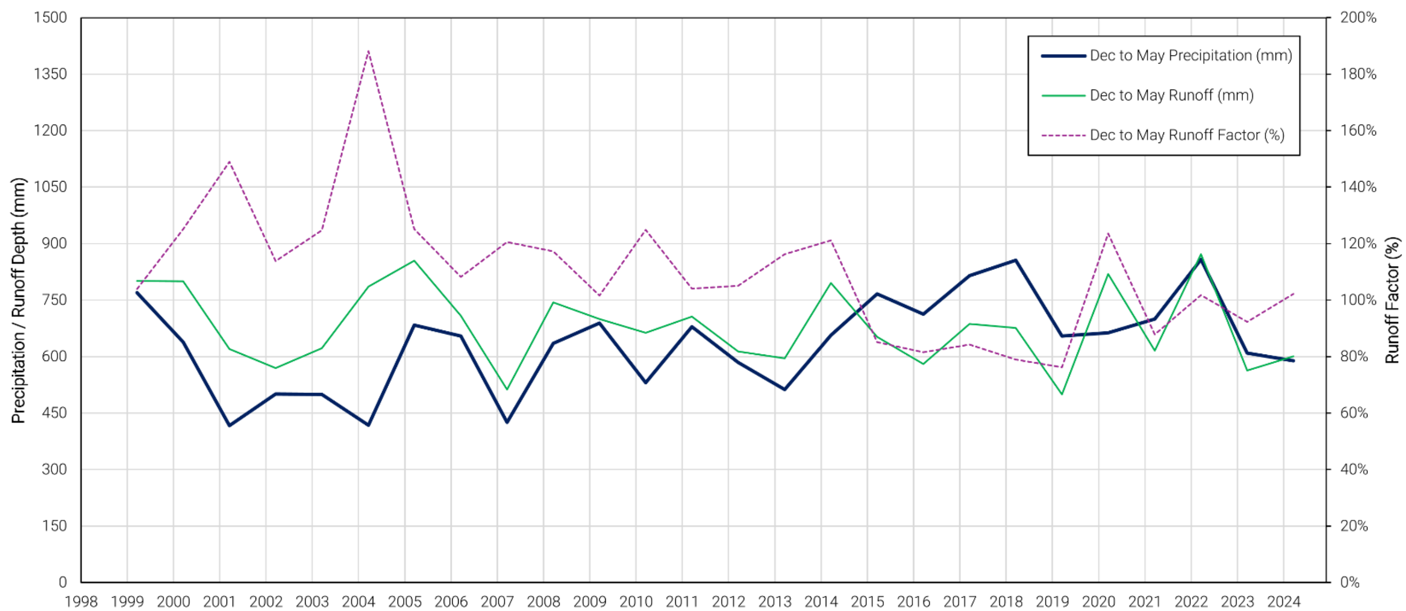
FIGURE: C-5.1-4





Notes:

1. NASA GPM precipitation record was obtained at the Pipers Hole River (02ZH001) watershed center (48.05°N, 54.44°W).

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SURFACE WATER STUDY

SEASONAL PRECIPITATION AND RUNOFF
PIPERS HOLE RIVER (02ZH001)
1998 TO 2024

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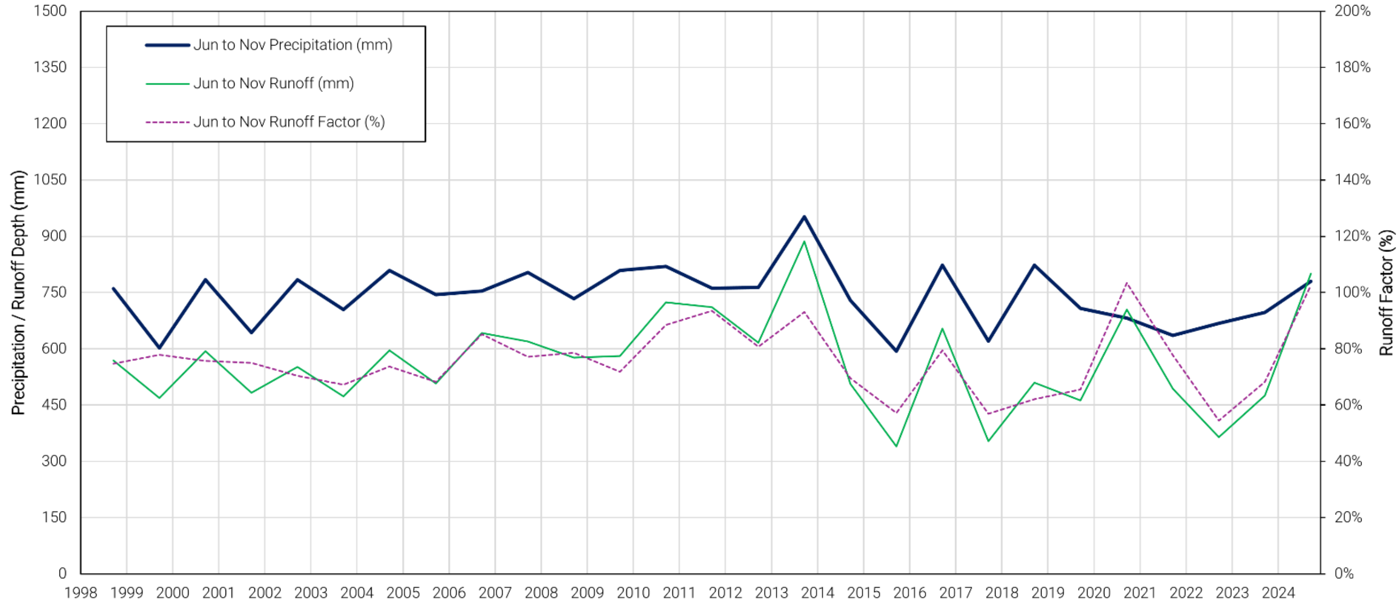
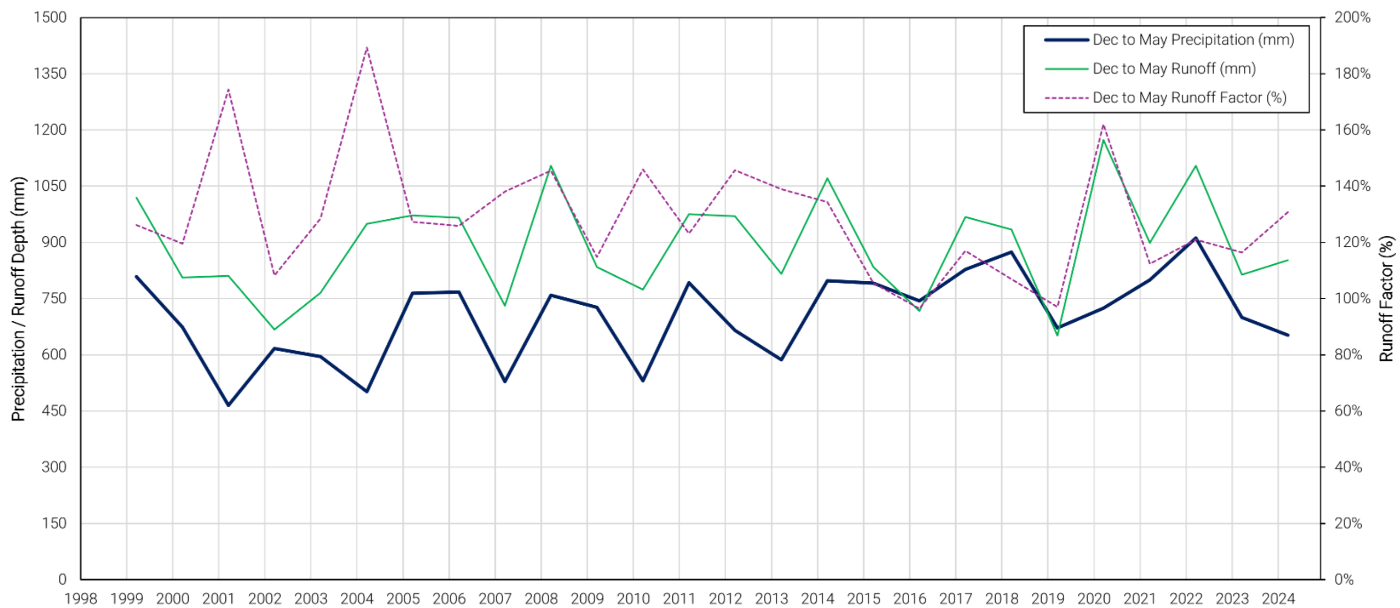
FIGURE: C-5.1-5





Notes:

1. NASA GPM precipitation record was obtained at the Come By Chance River (02ZH002) watershed center (47.95°N, 53.57°W).

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NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

SEASONAL PRECIPITATION AND RUNOFF
COME BY CHANCE RIVER (02ZH002)
1998 TO 2024

DATE: MAY 2025	PROJECT: 016-015	SUBMITTER: Z.ZHAO	REVIEWER: T.BRENTON

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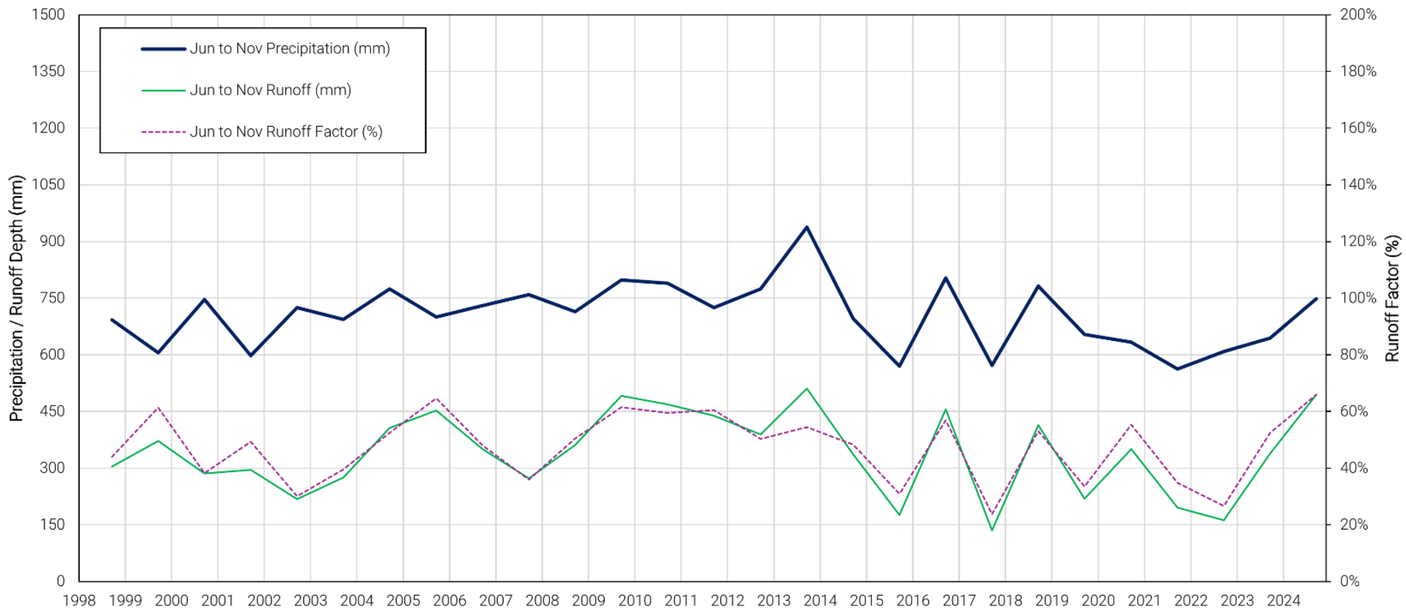
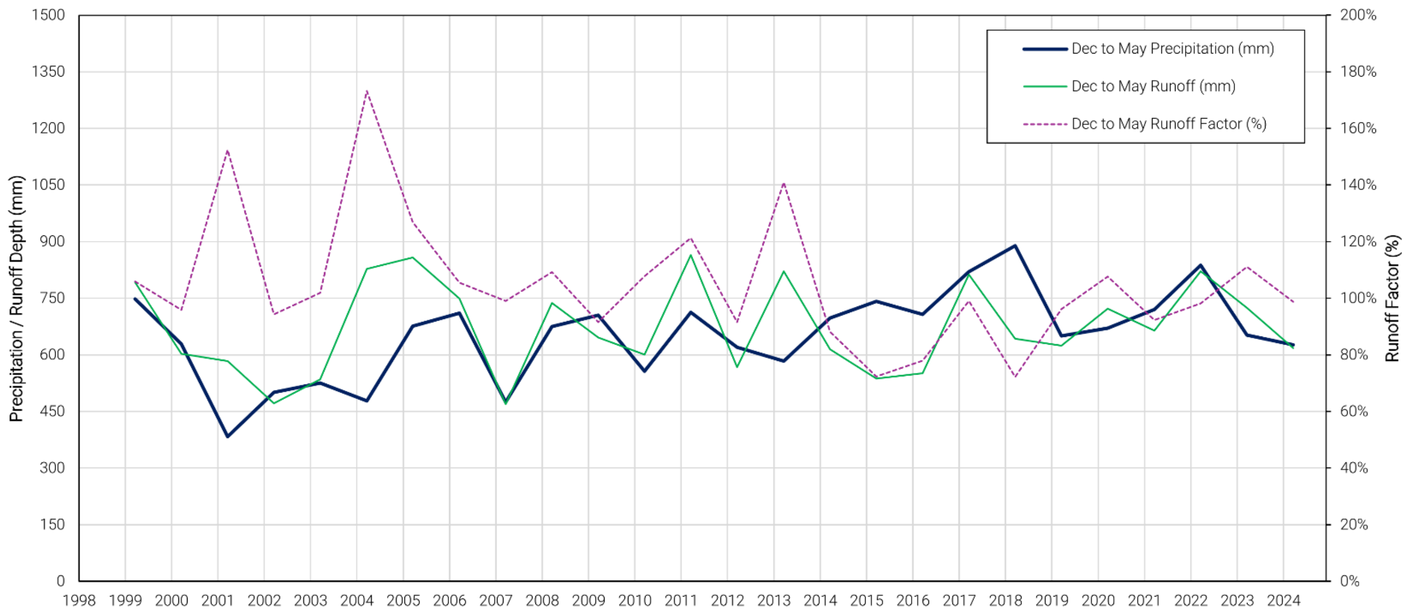
FIGURE: C-5.1-6





Notes:

1. NASA GPM precipitation record was obtained at the Shoal Harbour River (02ZJ003) watershed center (48.22°N, 54.13°W).

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SURFACE WATER STUDY

SEASONAL PRECIPITATION AND RUNOFF
SHOAL HARBOUR RIVER (02ZJ003)
1998 TO 2024

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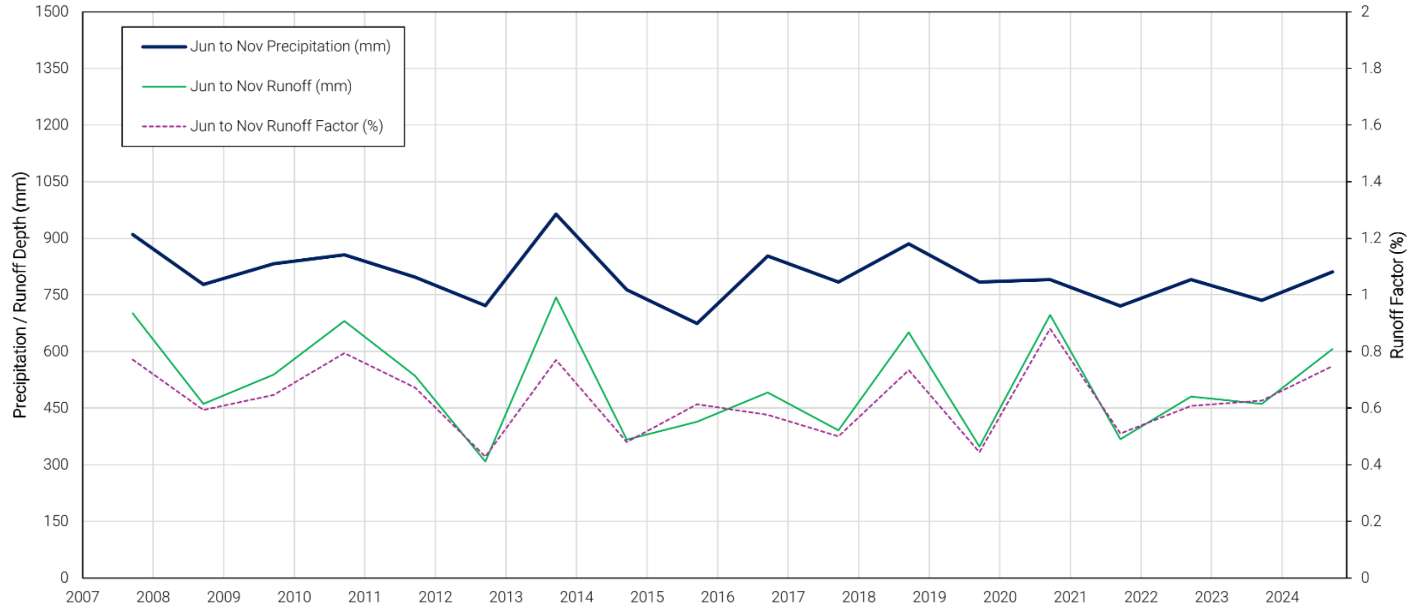
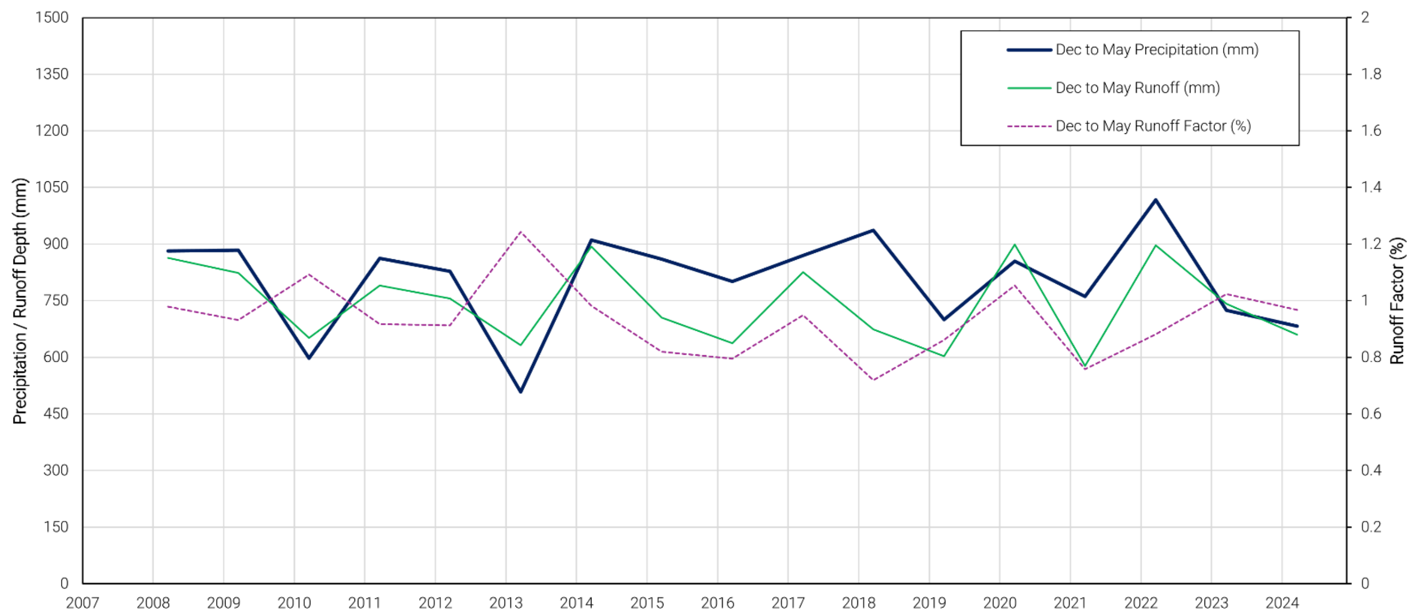
FIGURE: C-5.1-7





Notes:

1. NASA GPM precipitation record was obtained at the Rattling Brook (02ZK006) watershed center (47.40°N, 53.77°W).

NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

SEASONAL PRECIPITATION AND RUNOFF
RATTLING BROOK (02ZK006)
2007 TO 2024

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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FIGURE: C-5.1-8

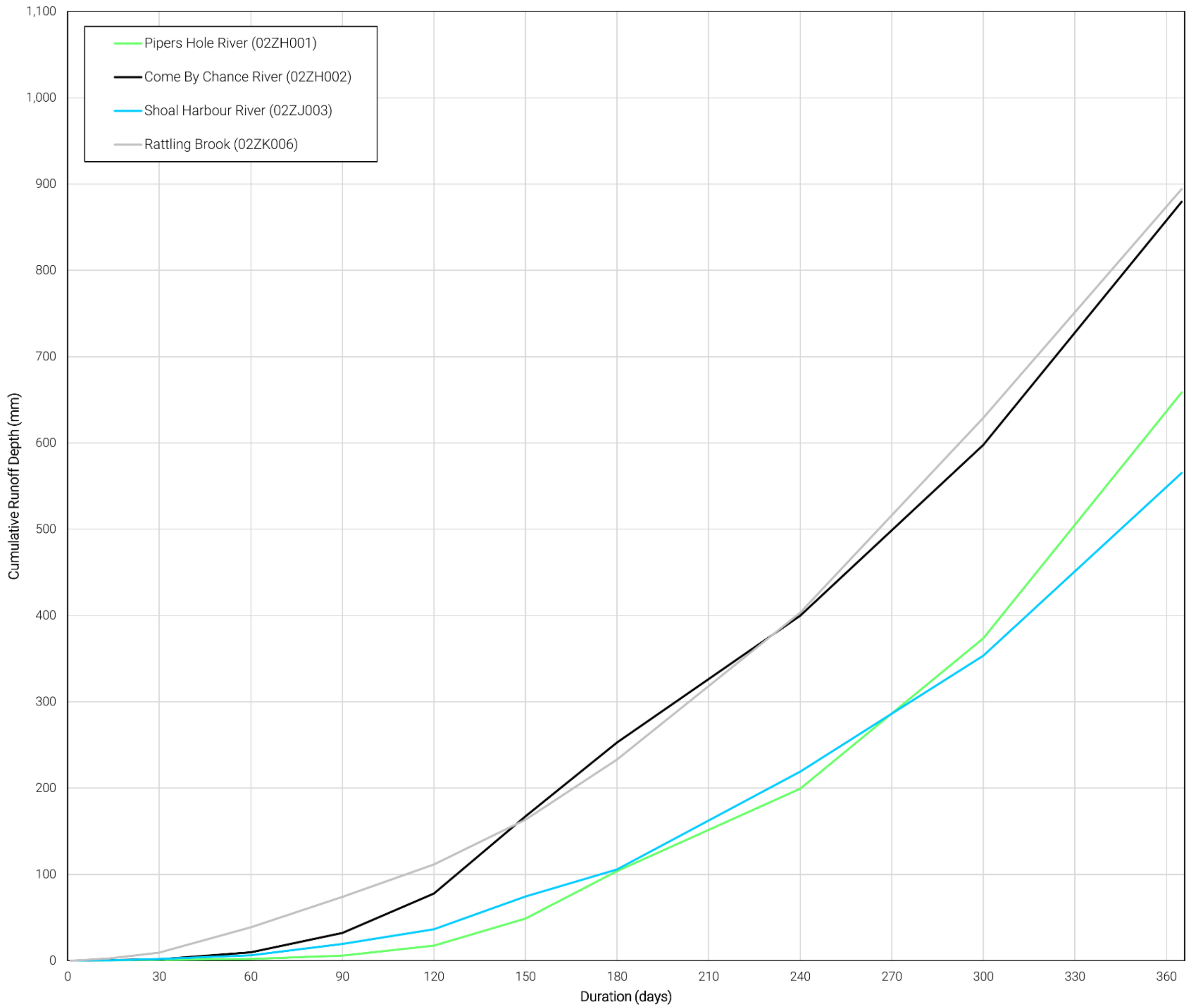
Lower runoff depths (165.9 to 777.1 mm) were recorded during snow-free seasons, compared to higher values (487.5 to 1,104.1 mm) during snow seasons. Inter-annual variations were observed during snow-free seasons, with lower runoff and runoff factors occurring in drier years such as 2015 and 2017 (Figures C-5.1-5 to C-5.1-8). Spatial variations were also present across the WSC stations, with lower runoff and runoff factors observed at Pipers Hole River (02ZH001) and Shoal Harbour River (02ZJ003), where watersheds received less precipitation (NASA, 2025) and experienced greater losses due to evapotranspiration (NRCan, 2024b).

5.2 Low Flow Conditions

Low flow conditions were assessed by examining continuous flow records at each WSC station. Minimum and 5th percentile cumulative runoff depths were calculated for durations ranging from 7 and 365 days (Table C-1-5; Figures C-5.2-1 and C-5.2-2). 1:50-year low flows were calculated with the Newfoundland and Labrador Low Flows Estimation Calculator (NL DECC, 2017). These values were converted to runoff depths for comparison and included in Table C-1-5.

Among the WSC stations, the lowest cumulative runoff was recorded at Pipers Hole River (02ZH001) and Shoal Harbour River (02ZJ003). A dry spell at Pipers Hole River (02ZH001) in 1961 lasted up to 120 days, during which cumulative runoff was as low as 17.3 mm (June to September).

As duration increases, cumulative runoff demonstrates greater resilience to sustained drought, with 365-day period runoff depths reaching 565.4 mm or more (i.e., 63% or more of the historical average) even during the lowest-flow 365-day period on record. Higher runoff and early recovery from dry periods were observed at Come By Chance River (02ZH002) and Rattling Brook (02ZK006), suggesting less severe drought conditions in smaller, windward watersheds.



Notes:

1. The historical data was obtained for each station's continuous record period:
   Pipers Hole River (02ZH001): 1953 to 2024
   Come By Chance River (02ZH002): 1970 to 2024
   Shoal Harbour River (02ZJ003): 1986 to 2024
   Rattling Brook (02ZK006): 2007 to 2024

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NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

REGIONAL CUMULATIVE RUNOFF
LOW FLOW CONDITIONS AND DURATIONS
HISTORICAL RECORD MINIMUM

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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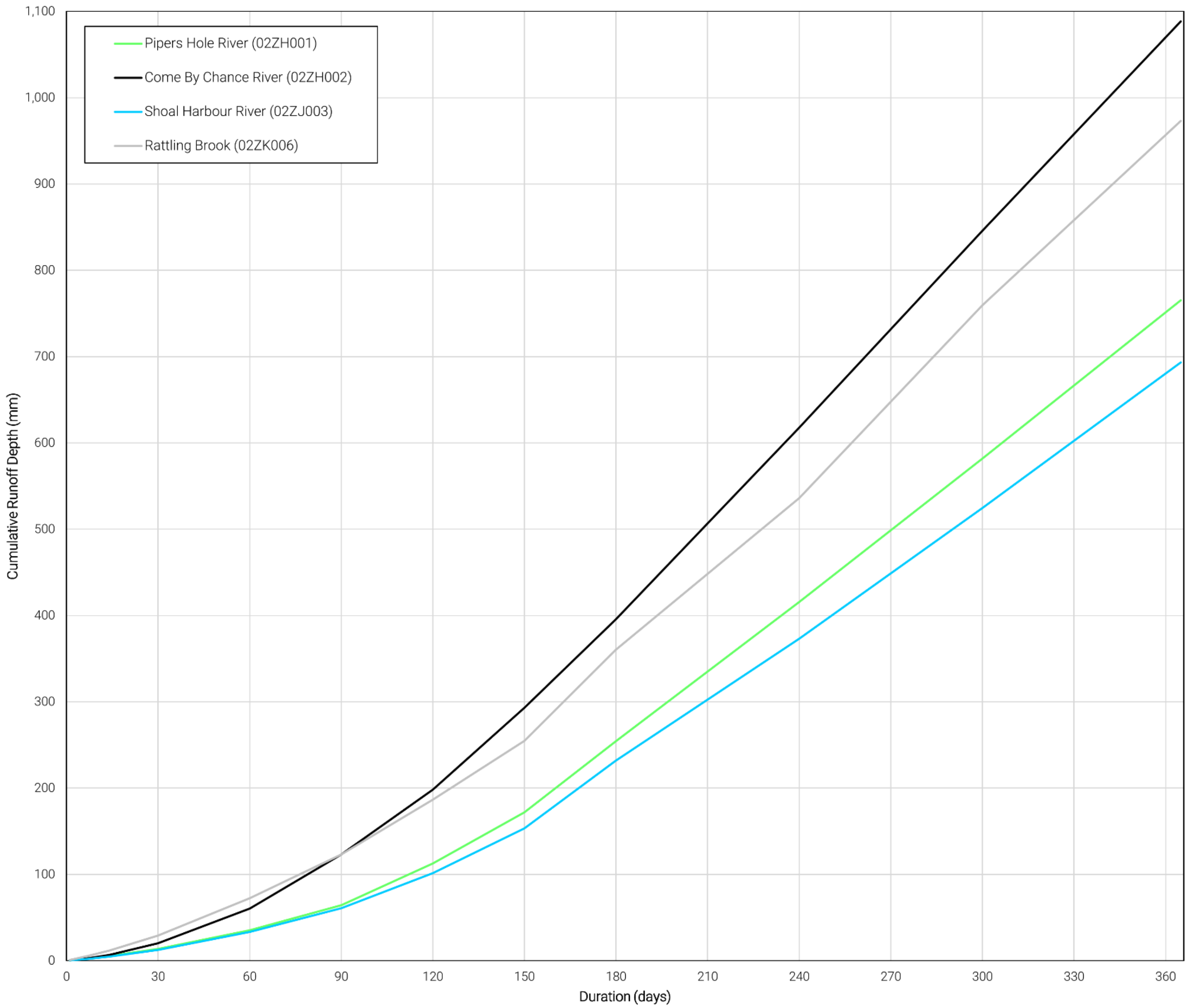
FIGURE: C-5.2-1



Notes:
1. The historical data was obtained for each station's continuous record period:
Pipers Hole River (02ZH001): 1953 to 2024
Come By Chance River (02ZH002): 1970 to 2024
Shoal Harbour River (02ZJ003): 1986 to 2024
Rattling Brook (02ZK006): 2007 to 2024

NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

REGIONAL CUMULATIVE RUNOFF
LOW FLOW CONDITIONS AND DURATIONS
HISTORICAL RECORD 5TH PERCENTILE

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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FIGURE: C-5.2-2

6.0 Local Baseline Hydrology

Water for the Project operations will be sourced from the water supply watershed, with surface water flowing through five interconnected ponds – Big Pond, Rushy Pond, Willie Jarge Pond, Barrisway Pond, and Inkster's Pond. The drainage areas of the water supply ponds are presented in Table C-6.0-1, and illustrated in Figure C-1.1-1 with flow directions. The baseline monitoring program began in May 2024 and continued until May 2025. Bathymetry surveys were completed at all ponds except for Rushy Pond (where site access challenges were encountered), with results summarized in Appendix C-2.

Table C-6.0-1 Drainage areas of water supply ponds.

Location	Sub-Basin Area (km^2)	Gross Drainage Area (km^2)
Big Pond	1.03	1.03
Rushy Pond	2.59	3.62
Willie Jarge Pond	4.13	7.75
Barrisway Pond	0.33	8.08
Inkster's Pond	N/A, receives pumped inflow from Barrisway Pond	

Water levels and outflow at Rushy Pond represent natural hydrologic conditions of the water supply watershed. In contrast, water levels and outflow at Willie Jarge and Barrisway Pond are regulated by hydraulic control structures and do not reflect natural conditions.

6.1 Field Survey Results

Pond water level, stream water level, and streamflow were measured during each site visit throughout the ice-free period, when sites were accessible and data collection could be safely completed. The earliest water level and streamflow measurements were completed on May 28, 2024, and continuous monitoring stations were established on June 26, 2024. The latest field measurement and monitoring station data retrieval were completed on May 1, 2025.

6.1.1 Precipitation

Monthly precipitation recorded during the baseline monitoring period was compared against the historical average between 1998 and 2024 (Table C-6.1-1). Precipitation totaled 1,174.3 mm between June 26, 2024, and May 1, 2025. Daily precipitation averaged 3.79 mm/day, which is comparable to the historical average of 4.04 mm/day at the water supply watershed. Slightly lower than average precipitation was recorded between June 26 and October 24, 2024 (average 2.74 mm/day). This was followed by a 63.7 mm precipitation event on October 25, 2024, and a wetter period afterward (average 4.46 mm/day).

Table C-6.1-1 Monthly precipitation during the baseline monitoring period.

Precipitation (mm)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Baseline Monitoring Period	2024	-	-	-	-	111.6	180.5	88.2	102.9	60.1	114.7	240.5	108.2	1,424.5
	2025	78.6	71.8	86.1	181.3	-	-	-	-	-	-	-	-	
Historical Average		128.3	130.7	122.9	90.5	90.4	110.9	108.9	109.2	125.1	148.8	159.8	150.9	1,476.2

6.1.2 Big Pond

Big Pond is a natural waterbody without a hydraulic control structure or engineered water withdrawals. The outlet stream is approximately 2 metres (m) wide, with a substrate consisting of cobbles, pebbles, and sand, becoming finer towards the banks where aquatic and riparian vegetation is established.

6.1.3 Rushy Pond

Rushy Pond is a natural waterbody and the outlet stream is approximately 7 m wide. The substrate is a mixture of boulders, cobbles, and pebbles, becoming finer towards the banks with aquatic vegetation. Site photos are shown in Figure C-6.1-1, illustrating general site conditions, flow directions, and continuous monitoring station locations.

Staff gauge readings and flow measurements at Rushy Pond and its outlet were obtained throughout the monitoring period and are summarized in Table C-1-6 (Appendix C-1). Water level data was collected continuously using water level loggers installed at both the pond and outlet. A rating curve was developed for the outlet using 12 manual measurements, yielding an R^2 of 0.98 (Figure C-6.1-1). This rating curve was applied to the continuous water level record to derive a continuous flow time-series (summarized in Figure C-6.1-2 along with precipitation records). Water level and discharge statistics are summarized in Table C-6.1-2.

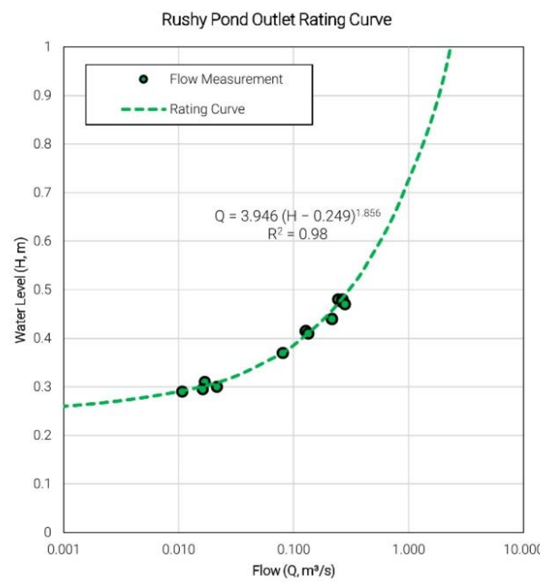
Table C-6.1-2 Rushy Pond and Outlet baseline monitoring program summary.

Parameter	Rushy Pond	Rushy Pond Outlet	
	Water Level (cm)	Water Level (cm)	Flow (m^3/s)
Average	45.5	38.7	0.130
Minimum	34.3	26.5	0.002
Median	44.6	37.2	0.082
Maximum	87.4	82.9	1.436

Photo 1. Rushy Pond looking from the outlet at the lake staff gauge.

Photo 2. Rushy Pond Outlet looking upstream from the outlet staff gauge.

Photo 3. Rushy Pond Outlet looking downstream from the outlet staff gauge.



Notes:

1. Site photos were captured on March 10, 2025.
2. Rating curve was based on 12 flow measurements.

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SURFACE WATER STUDY

RUSHY POND AND OUTLET
SITE PHOTOS AND RATING CURVE

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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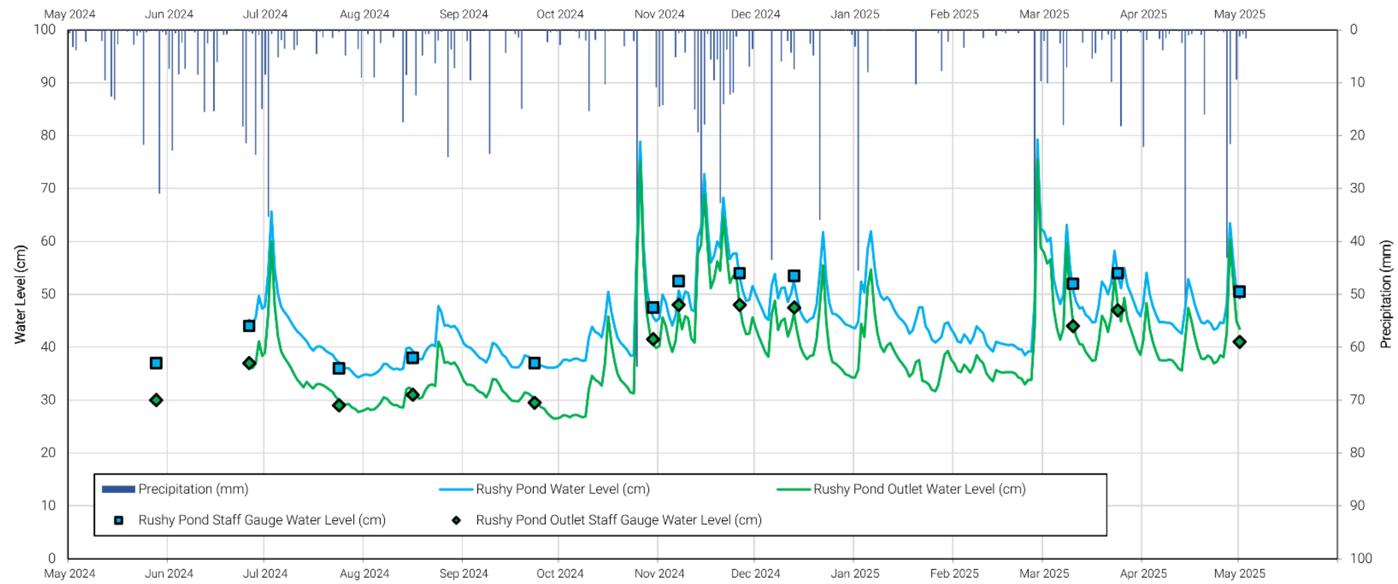
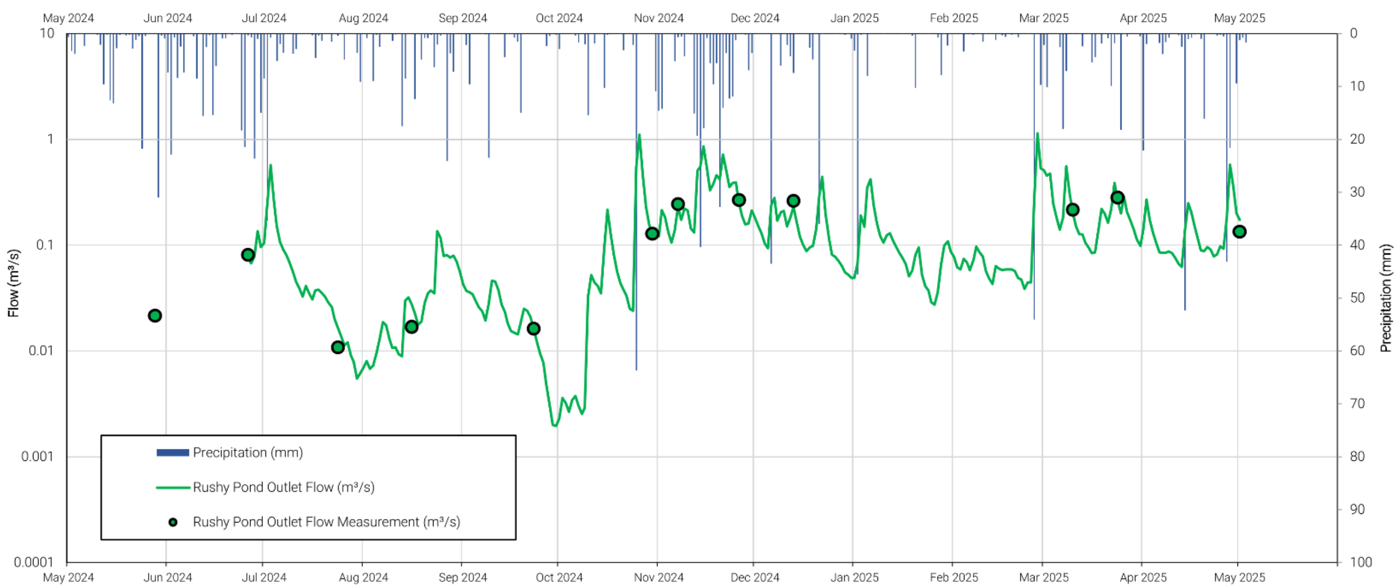
FIGURE: C-6.1-1





Notes:
1. Real-time water level loggers were installed on June 26, 2024.
2. Water levels were calibrated with staff gauge water level readings during site visits.
3. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.

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NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

RUSHY POND AND OUTLET WATER LEVEL AND FLOW

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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FIGURE: C-6.1-2

6.1.4 Willie Jarge Pond

Willie Jarge Pond is located approximately 1.3 km downstream from Rushy Pond. The outlet features a manual control structure that can be operated with stoplogs and a valve-operated outflow pipe. The outlet monitoring station is located approximately 40 m downstream. The outlet stream is approximately 4 m wide, with sparse in-stream vegetation, and a substrate consisting predominantly of cobbles and pebbles. Site photos are shown in Figure C-6.1-3, illustrating general site conditions, flow directions, and continuous monitoring station locations.

Staff gauge readings and flow measurements at Willie Jarge Pond and its outlet were obtained throughout the monitoring period and are summarized in Table C-1-7 (Appendix C-1). The monitoring equipment was temporarily displaced by a high flow event on October 26 and was reinstalled on October 30.

A rating curve was developed for the outlet based on 12 manual measurements, yielding an R^2 of 0.92 (Figure C-6.1-3). This rating curve was applied to the continuous water level record to derive a continuous flow time-series (summarized in Figure C-6.1-4 along with precipitation records). Water level and discharge statistics are summarized in Table C-6.1-3.

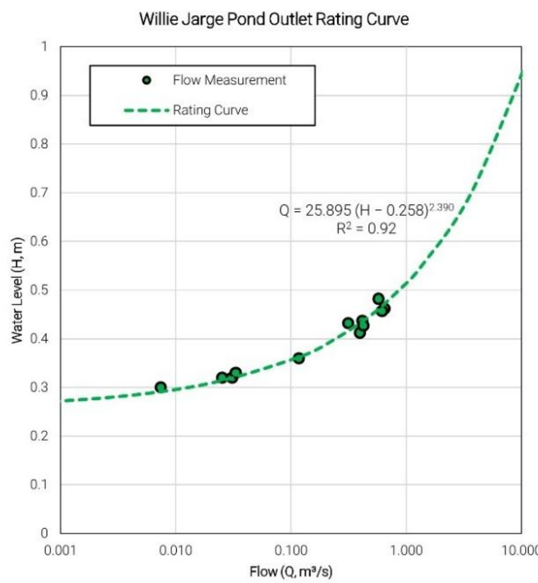
Table C-6.1-3 Willie Jarge Pond and Outlet baseline monitoring program summary.

Parameter	Willie Jarge Pond	Willie Jarge Pond Outlet	
	Water Level (cm)	Water Level (cm)	Flow (m^3/s)
Average	32.0	39.1	0.280
Minimum	2.9	28.4	0.004
Median	31.0	38.6	0.193
Maximum	76.8	63.1	2.451

Photo 1. Willie Jarge Pond looking upstream from the hydraulic outlet control structure.

Photo 2. Willie Jarge Pond Outlet looking upstream from the outlet staff gauge.

Photo 3. Willie Jarge Pond Outlet looking downstream from the outlet staff gauge.



Notes:

1. Site photos were captured on March 10, 2025.
2. Rating curve was based on 12 flow measurements.

NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

WILLIE JARGE POND AND OUTLET SITE PHOTOS AND RATING CURVE

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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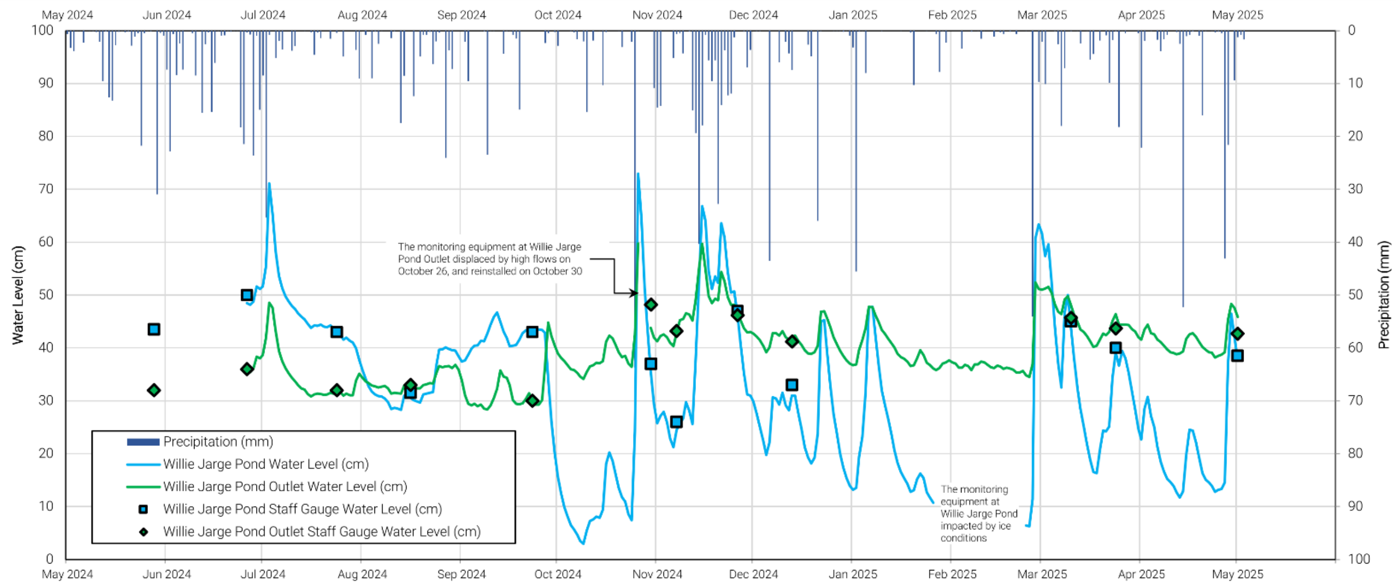
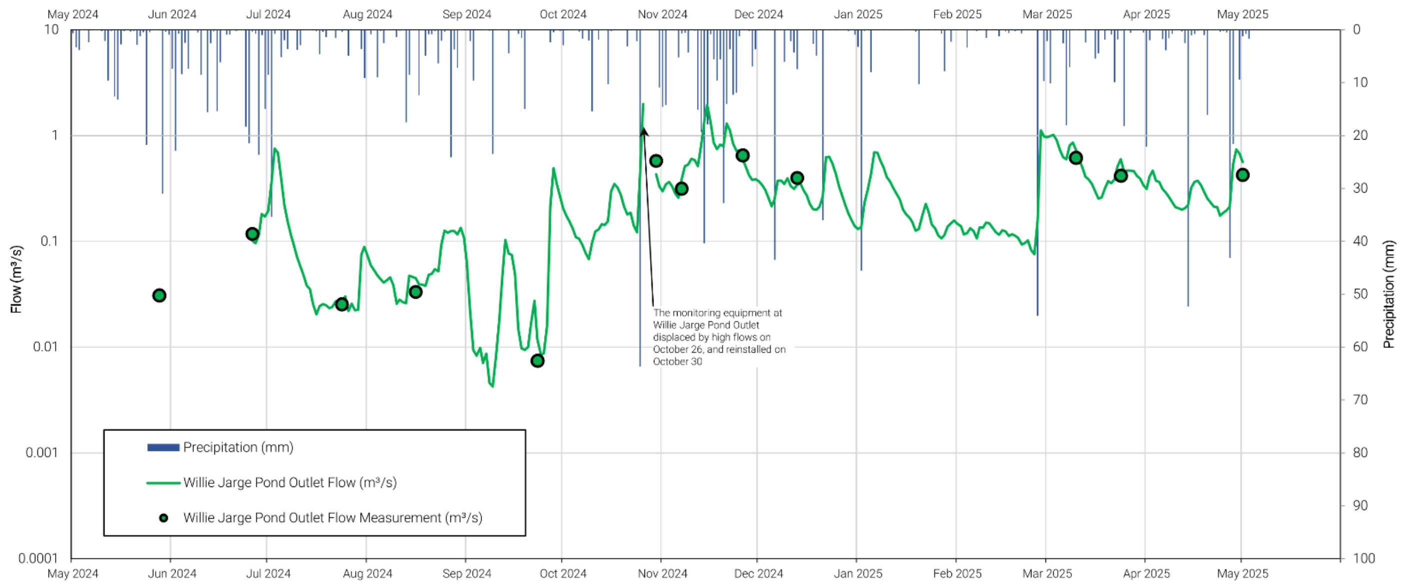
FIGURE: C-6.1-3





Notes:

1. Real-time water level loggers were installed on June 26, 2024.
2. Water levels were calibrated with staff gauge water level readings during site visits.
3. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.

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SURFACE WATER STUDY

WILLIE JARGE POND AND OUTLET WATER LEVEL AND FLOW

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FIGURE: C-6.1-4

6.1.5 Barrisway Pond

Barrisway Pond is located approximately 0.5 km downstream of Willie Jarge Pond. This pond outlet features a spillway, and a pumphouse to partially divert the outflow into Inkster's Pond via a pipeline to support industrial operations. The outlet stream is approximately 5 m wide, with sparse vegetation, and a substrate of cobbles and pebbles. Site photos are shown in Figure C-6.1-5, illustrating general site conditions, flow directions, pump location, and continuous monitoring station locations.

Staff gauge readings and flow measurements at Barrisway Pond and its outlet were obtained throughout the monitoring period and are summarized in Table C-1-8 (Appendix C-1). A rating curve was developed for the outlet based on 12 manual measurements, yielding an R^2 of 0.99 (Figure C-6.1-5). This rating curve was applied to the continuous water level record to derive a continuous flow time-series (summarized in Figure C-6.1-6 along with precipitation records). Water level and flow statistics are summarized in Table C-6.1-4. Flow at the outlet only represents a portion of the total water yield from the contributing watershed, because water is diverted via the pumphouse to Inkster's Pond.

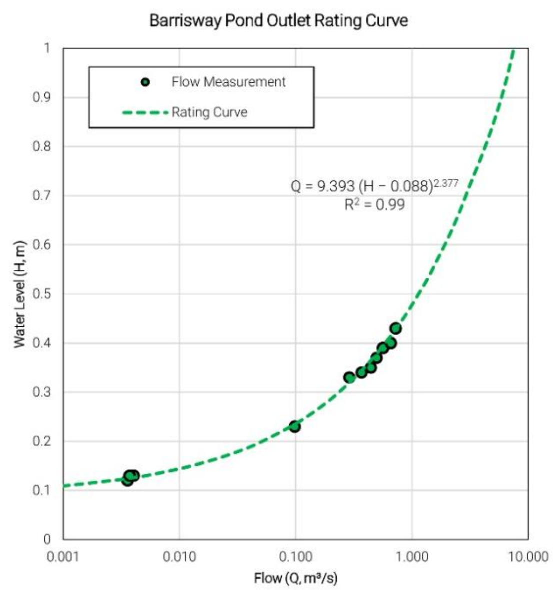
Table C-6.1-4 Barrisway Pond and Outlet baseline monitoring program summary.

Parameter	Barrisway Pond	Barrisway Pond Outlet	
	Water Level (cm)	Water Level (cm)	Flow (m^3/s)
Average	45.8	26.7	0.283
Minimum	2.9	10.2	0.000
Median	47.6	26.1	0.148
Maximum	84.5	85.5	5.006

Photo 1. Barrisway Pond looking from the lake staff gauge at the pump and outlet.

Photo 2. Barrisway Pond Outlet looking upstream from the outlet staff gauge.

Photo 3. Barrisway Pond Outlet looking downstream from the outlet staff gauge.



Notes:

1. Site photos were captured on March 10, 2025.
2. Rating curve was based on 12 flow measurements.

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SURFACE WATER STUDY

BARRISWAY POND AND OUTLET
SITE PHOTOS AND RATING CURVE

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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FIGURE: C-6.1-5

Notes:

1. Real-time water level loggers were installed on June 26, 2024.
2. Water levels were calibrated with staff gauge water level readings during site visits.
3. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.

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SURFACE WATER STUDY

BARRISWAY POND AND OUTLET WATER LEVEL AND FLOW

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FIGURE: C-6.1-6

6.1.6 Inkster's Pond

Inkster's Pond is located within 0.5 km of the North Atlantic process plants and approximately 0.4 km south of Barrisway Pond. It is an isolated waterbody with no natural inlet or outlet. Water is partially diverted from Barrisway Pond at its outlet and is pumped via a pipeline into Inkster's Pond to support industrial operations.

Site photos are shown in Figure C-6.1-7, illustrating general site conditions, pump locations, and flow directions.

Photo 1. Inkster's Pond looking at the Refinery.

Photo 2. Inkster's Pond water intake.

Photo 3. Inkster's Pond pumped inflow.

Notes:

1. Site photos were captured on October 30, 2025.

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NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

INKSTER'S POND
SITE PHOTOS

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
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FIGURE: C-6.1-7

6.2 Flow and Runoff Analysis

Continuous flow records obtained during the baseline monitoring program were converted into unit flow rates (L/s/km²) and cumulative runoff depths (mm) to allow for cross-comparison of hydrometric records between stations and with precipitation/evapotranspiration records.

Unit flow rates were determined by normalizing flows against the contributing drainage area for each location. Runoff factors were calculated to evaluate the proportion of precipitation converted into surface flow. Key hydrological parameters, including average flow rates, runoff factors, and estimated water balance components are summarized in Table C-6.2-1.

Table C-6.2-1 Baseline monitoring program summary.

Parameter	Rushy Pond	Willie Jarge Pond	Barrisway Pond
Average Flow (m³/s)	0.130	0.280	0.283
Average Unit Flow Rate (L/s/km²)	36.0	36.1	35.0
Runoff Depth (mm)	965	966	938
Precipitation (mm)	1,174		
Runoff Factor (%)	82%	82%	80%
Evapotranspiration (mm)	259		
Water Balance Runoff (mm)	915		

Average flows, unit flow rates, and runoff depths were comparable at the water supply pond outlets. Slighter lower flows and runoff depths were recorded at Barrisway Pond Outlet due to pumped outflows. For comparative purposes, runoff depth was calculated based on local water balance parameters (i.e., precipitation and evapotranspiration) and this predicted a slightly lower runoff depth at Rushy Pond (-5%). This suggests a fit between baseline monitoring records at a natural watercourse and local meteorological records.

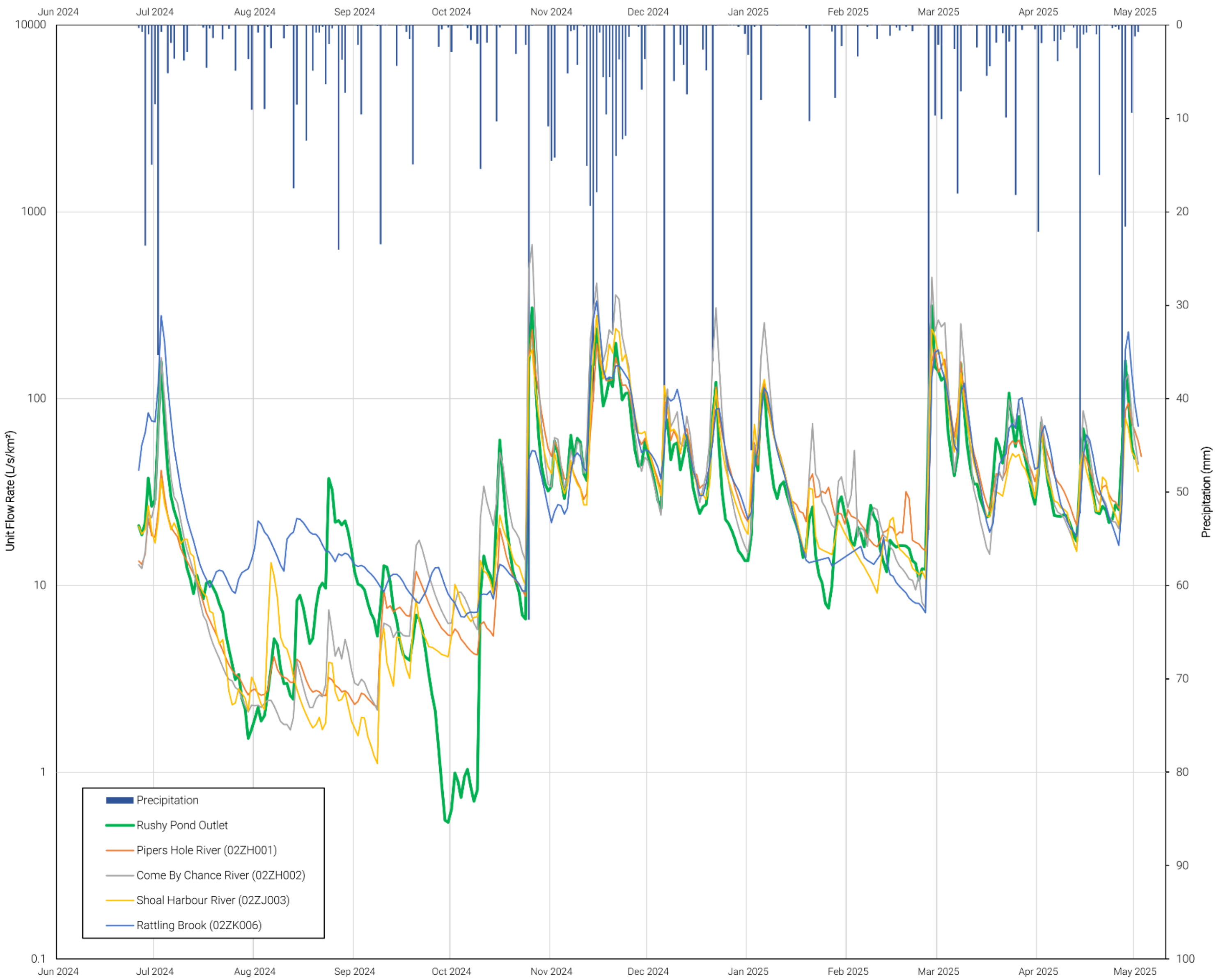
6.3 Comparison with Regional WSC Stations

Flow data captured at Rushy Pond Outlet during the baseline monitoring period was compared with records from regional WSC stations during the same period to evaluate whether unit flow rates, runoff depth, and seasonal hydrologic response observed in the water supply watershed are consistent with regional characteristics. Average unit flow rates were derived and compared with the full historical record at the WSC stations. The result is plotted in Figure C-6.3-1 and summarized in Table C-6.3-1.

Table C-6.3-1 Regional unit flow rate comparison.

Average Unit Flow Rate (L/s/km²)	Pipers Hole River (02ZH001)	Come By Chance River (02ZH002)	Shoal Harbour River (02ZJ003)	Rattling Brook (02ZK006)
Baseline Monitoring Period	36.8	51.3	36.7	43.8
Historical WSC Hydrometric Record	33.0	45.0	31.4	39.7

Regional unit flow rates averaged between 36.7 and 51.3 L/s/km² during the baseline monitoring period, which was comparable with each station's full record averages (31.4 to 45.0 L/s/km²). During the baseline monitoring period, unit flow rates at WSC stations were 102% to 142% of that at Rushy Pond (36.0 L/s/km²). Distinct low and high flow regimes were observed at Rushy Pond Outlet and the WSC stations before and after the October 25 precipitation event. Unit flow rates before this event generally remained below 20 L/s/km² and stayed above this threshold afterward.



Notes:

1. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.
2. Drainage areas at each monitoring station:
   Rushy Pond Outlet: 3.6 km²
   Pipers Hole River (02ZH001): 764.0 km²
   Come By Chance River (02ZH002): 43.3 km²
   Shoal Harbour River (02ZJ003): 106.0 km²
   Rattling Brook (02ZK006): 32.7 km²

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NORTH ATLANTIC REFINING CORP.
SURFACE WATER STUDY

UNIT FLOW RATES
RUSHY POND OUTLET AND WSC STATIONS

DATE:	PROJECT:	SUBMITTER:	REVIEWER:
MAY 2025	016-015	Z.ZHAO	T.BRENTON

FIGURE: C-6.3-1

6.3.1 Low Flow Conditions

While average flow rates were comparable with regional historical averages, the baseline monitoring period included a low flow period between June 26 and October 24, 2024. Low flow conditions were further assessed by analyzing the minimum continuous runoff depth for a period of 7 to 180 days. The results were compared with the historical minimum and 5th percentiles and summarized in Table C-6.3-2.

Table C-6.3-2 Minimum runoff depth and duration comparison.

Duration (days)		7	14	30	60	120	180	365
Baseline Period Minimum Runoff Depth (mm)	Rushy Pond Outlet	0.5	1.2	10.1	42.8	135.9	487.8	-
	Pipers Hole River (02ZH001)	1.5	3.1	7.3	19.1	78.0	476.5	-
	Come By Chance River (02ZH002)	1.4	2.9	7.2	19.9	141.0	754.9	-
	Shoal Harbour River (02ZJ003)	0.9	2.3	6.2	17.4	80.8	518.8	-
	Rattling Brook (02ZK006)	4.3	9.6	23.4	54.1	156.4	565.1	-
Historical Period Minimum Runoff Depth (mm)	Pipers Hole River (02ZH001)	0.1	0.2	0.6	1.9	17.3	103.8	658.4
	Come By Chance River (02ZH002)	0.2	0.6	1.7	9.8	77.7	252.8	879.7
	Shoal Harbour River (02ZJ003)	0.2	0.5	1.8	6.2	36.3	105.7	565.4
	Rattling Brook (02ZK006)	1.2	2.5	9.1	38.6	111.3	232.9	894.0
Historical Period 5th Percentile Runoff Depth (mm)	Pipers Hole River (02ZH001)	2.5	5.4	13.6	35.1	112.6	254.3	765.5
	Come By Chance River (02ZH002)	2.7	6.4	20.1	60.2	198.2	395.4	1088.4
	Shoal Harbour River (02ZJ003)	2.0	4.5	12.2	33.1	101.5	231.7	693.4
	Rattling Brook (02ZK006)	5.3	11.7	29.0	72.3	186.4	360.4	973.3

A 120-day low flow period was identified during the baseline monitoring period when all WSC stations recorded flow below their historical 5th percentile. This period ended on October 25, 2024, when 63.7 mm of precipitation fell.

Rushy Pond responded to precipitation sharply when compared to regional WSC stations, resulting in lower 7- and 14-day runoff depths when precipitation was sparse. This response likely occurred because Rushy Pond has a small drainage area and negligible groundwater contributions. The water supply ponds' proximity to the coast results in strong daily diurnal advection and frequent rainfall throughout the year, which helps reduce short-term dry periods. A high flow period followed the dissipation of the subtropical high on October 25, when the subpolar low brought sustained precipitation.

6.3.1.1 Environmental Threshold Flow

Environmental threshold flows were determined for each water supply pond outlet (summarized in Table C-6.3-3). These flows were compared with monthly field measurements. All measured flows at Rushy

Pond Outlet exceeded its environmental threshold flow. At Willie Jarge Pond Outlet and Barrisway Pond Outlet, most measured flows were above their environmental threshold flows, with occasional below environmental threshold flows during the low flow period in 2024.

Table C-6.3-3 Environmental Threshold Flows and Lowest Measured Flows in Site Visits.

Location	Environmental Threshold Flow (m^3/s)	Lowest Measured Flow (m^3/s)
Rushy Pond Outlet	0.005	0.011
Willie Jarge Pond Outlet	0.012	0.007
Barrisway Pond Outlet	0.012	0.001

6.3.2 High Flow Conditions

High flow conditions were assessed based on the RFFA for Newfoundland and Labrador (AMEC, 2014) using the drainage area only model. The RFFA results are summarized in Table C-6.3-4 for the water supply ponds, with return periods ranging between 2 and 200 years.

Table C-6.3-4 Estimated peak flows at the water supply ponds.

Return Interval (Years)	Rushy Pond Peak Outflow (m^3/s)	Willie Jarge Pond Peak Outflow (m^3/s)	Barrisway Pond Peak Outflow (m^3/s)
2	3.9	7.0	7.2
5	5.3	9.5	9.8
10	6.2	11.1	11.5
20	7.1	12.7	13.1
50	8.2	14.8	15.3
100	9.0	16.3	16.9
200	9.9	17.9	18.5

Precipitation intensities during the October 25, 2024 rainfall event exceeded the 1:2-year precipitation intensities for durations between 30 minutes and 12 hours. The highest recorded flows at the outlets of Rushy Pond (1.4 m^3/s) and Barrisway Pond (5.0 m^3/s) remained below the 1:2-year flow values predicted by the RFFA, suggesting that peak flow estimates were conservative.

6.4 Water Availability Assessment

Water availability at Lady Cove Pond, Little Mosquito Pond, and the water supply watershed were assessed based on the anticipated Project water needs during the Construction and Operation Phases.

6.4.1 Construction

Pond characteristics and estimated water yields for Lady Cove Pond and Little Mosquito Pond were evaluated (summarized in Table C-6.4-1). During construction, the estimated maximum monthly water requirement from Lady Cove Pond represents 0.5% of the mean annual flow and 10.5% of flow during low flow conditions (7Q10). These estimates indicate that Lady Cove Pond can reliably meet construction related water demands under both average and low-flow scenarios. Little Mosquito Pond has been identified as an alternative water source for construction, if required.

Table C-6.4-1 Water sources and availability.

Waterbody	Drainage Area (km^2)	Pond Surface Area (km^2)	Mean Annual Flow (m^3/s)	7Q2 (m^3/s)	7Q10 (m^3/s)
Lady Cove Pond	6.29	0.57	0.207	0.019	0.009
Little Mosquito Pond	3.73	0.54	0.123	0.011	0.005

6.4.2 Operations

Operational water availability was assessed using WSC station data and site-specific baseline monitoring. The estimated MAR from each dataset was compared to the proposed Project operations water demands, as well as total future water demand (Project water demand with existing Braya operations). A comparison of regional and baseline MAR estimates against Project water demands is summarized in Table C-6.4-2. Both regional and baseline MAR values suggest that the watershed is capable of supporting Project-related withdrawals under average flow conditions.

Table C-6.4-2 Estimated mean annual runoff and proportion of water demand.

Dataset	MAR (m^3/year)	Project Water Demand (% of MAR)	Total Future Water Demand (% of MAR)
Regional WSC	9,480,000	10%	25%
Baseline	9,178,000	10%	26%

During low flow periods, surface water inflow alone may be insufficient, necessitating live pond storage. Required live storage was estimated following the Guide to Storage Yield Analysis at Ungauged River Sites (NL DECC, 1997) for existing withdrawal and future withdrawal scenarios (Sections 1.1). The required live storage was determined for different withdrawal scenarios (Table C-6.4.3). The results were compared with available live storage at Inkster's Pond, Barrisway Pond, and Willie Jarge Pond totals 646,000 m^3, suggesting sufficient live storage for all scenarios.

Table C-6.4-3 Live storage requirements and comparison with available live storage.

Withdrawal Scenario	Live Storage Requirement (m^3)	% of Requirement to Available Live Storage
Existing Withdrawal	190,000	29%
Project Withdrawal	110,000	17%
Total Withdrawal	400,000	62%

7.0 Hydrologic Modelling

Long-term hydrologic dynamics in the water supply watershed were simulated in hydrologic models. Pond inflows, outflows, water levels, and water storage were modelled based on meteorological data, watershed parameters, pond bathymetries, and anticipated water withdrawal rates. The models predicted a range of water availability outcomes between January 2000 and April 2025 to quantify the water impact of Project operations and inform future water management.

7.1 Monthly Model

The monthly model predicted water levels at Barrisway Pond and Willie Jarge, based on anticipated water storage changes due to water withdrawal. Full storage at Inkster's Pond was kept in reserve, which can supply the future withdrawal for 14.5 continuous days or provide 37 refills of the fire emergency water tank. Modelled water levels for Willie Jarge Pond and Barrisway Pond were plotted for existing and future withdrawal conditions in Figure C-7.1-1. Monthly water levels at both ponds are summarized in Tables C-7.1-1 and C-7.1-2 for existing and future withdrawal scenarios, respectively. Combined live water storage at both ponds was calculated monthly and summarized in Table C-7.1-3.

Table C-7.1-1 Monthly Water Level – Existing Withdrawal.

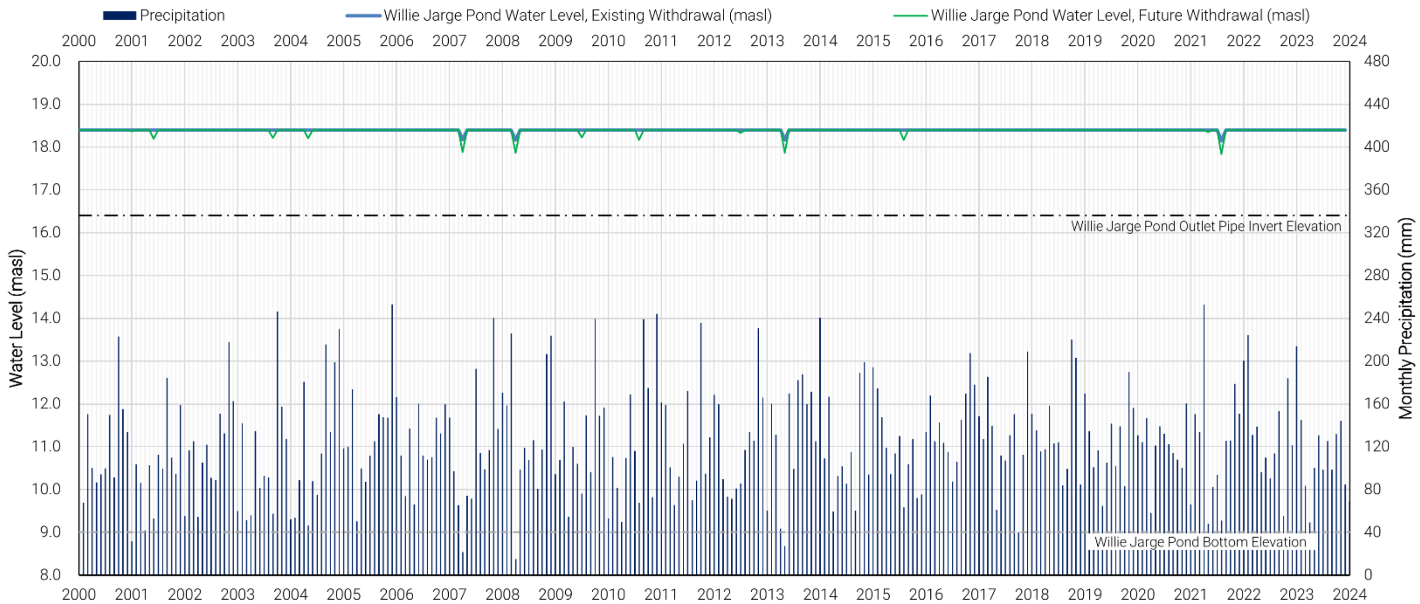
Water Level (masl)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	16.20	16.20	16.20	15.00	15.00	15.54	15.78	15.00	15.64	16.20	16.20	16.20
	Average	16.20	16.20	16.20	16.10	16.13	16.17	16.18	16.08	16.18	16.20	16.20	16.20
Willie Jarge Pond	Minimum	18.40	18.40	18.40	18.16	18.17	18.40	18.40	18.14	18.40	18.40	18.40	18.40
	Average	18.40	18.40	18.40	18.38	18.39	18.40	18.40	18.39	18.40	18.40	18.40	18.40

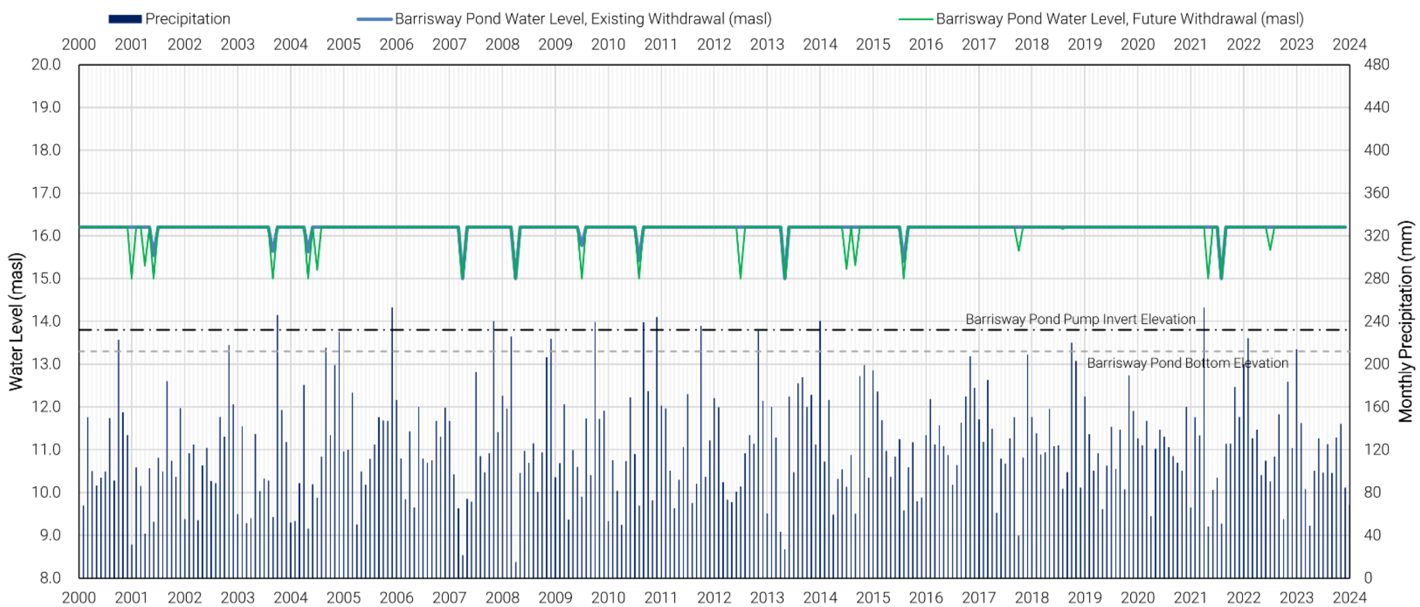
Table C-7.1-2 Monthly Water Level – Future Withdrawal.

Water Level (masl)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	15.00	16.20	16.20	15.00	15.00	15.00	15.00	15.00	15.00	15.65	16.20	16.20
	Average	16.15	16.20	16.20	16.06	16.05	16.15	16.00	16.05	16.11	16.18	16.20	16.20
Willie Jarge Pond	Minimum	18.36	18.40	18.40	17.87	17.87	18.20	18.23	17.84	18.21	18.40	18.40	18.40
	Average	18.40	18.40	18.40	18.36	18.37	18.39	18.39	18.36	18.39	18.40	18.40	18.40

Table C-7.1-3 Monthly Live Storage.

Live Storage (m^3)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing Withdrawal	Minimum	553,000	553,000	553,000	433,000	434,000	519,000	531,000	427,000	524,000	553,000	553,000	553,000
	Average	553,000	553,000	553,000	543,000	546,000	551,000	552,000	544,000	551,000	553,000	553,000	553,000
Future Withdrawal	Minimum	488,000	553,000	553,000	355,000	354,000	442,000	450,000	347,000	446,000	525,000	553,000	553,000
	Average	550,000	553,000	553,000	535,000	537,000	548,000	540,000	534,000	546,000	551,000	553,000	553,000





Notes:
1. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.
2. Evapotranspiration data adopted NRCan records at the water supply watershed.

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SURFACE WATER STUDY

MONTHLY MODEL RESULT
EXISTING AND FUTURE WITHDRAWAL
2000 TO 2023

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MAY 2025	016-015	Z.ZHAO	T.BRENTON

FIGURE: C-7.1-1

For the existing withdrawal scenario, monthly water levels averaged between 0 and 0.12 m below the spill point at Barrisway Pond, and within 0.02 m below the spill point at Willie Jarge Pond (Table C-7.1-1). Including Project operations water withdrawals would cause increased average drawdowns to up to 0.20 m at Barrisway Pond and 0.04 m at Willie Jarge Pond (Table C-7.1-2).

Combining the existing and Project withdrawals will lead to maximum drawdowns of 1.20 m at Barrisway Pond and 0.56 m at Willie Jarge Pond, which occurred in August 2021. Despite these drawdowns, 347,000 m³ of live storage was still available at Barrisway Pond and Willie Jarge Pond. Further drawdown may happen on a timescale finer than monthly, which will be resolved by the event scale model.

7.2 Event Scale Model

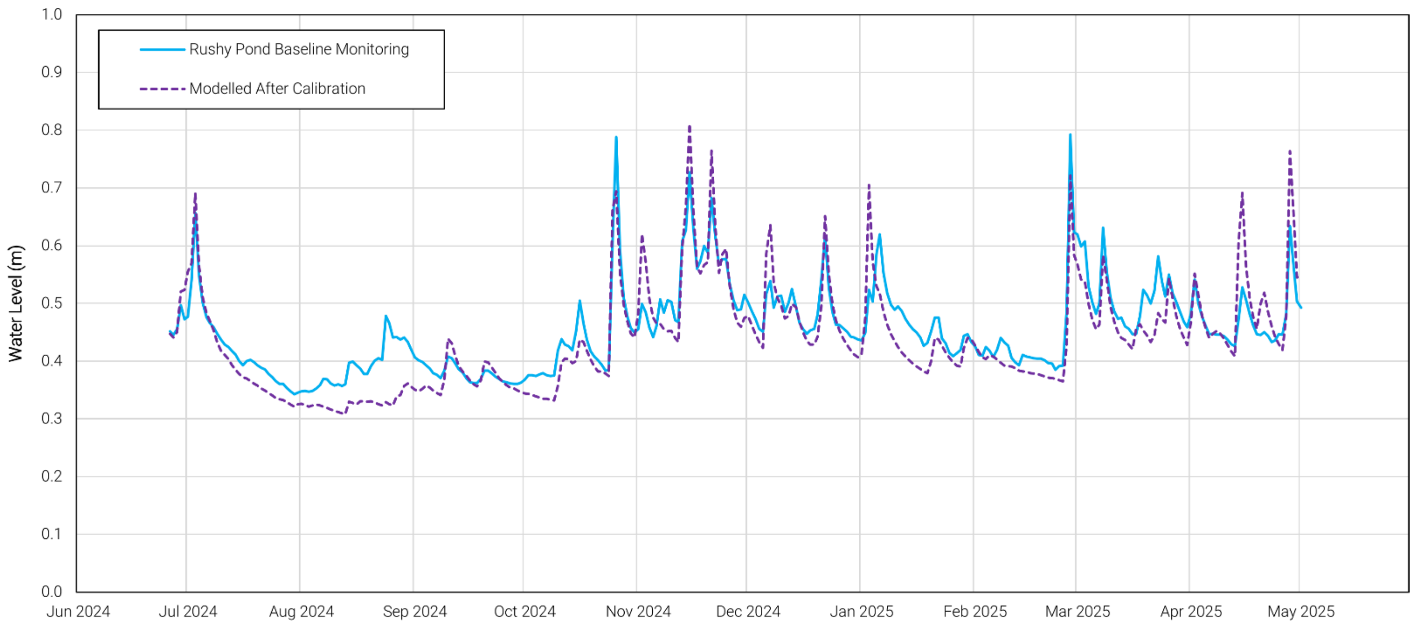
The event scale model assessed water levels at a temporal resolution of 30 minutes between January 2018 and April 2025. It predicted pond water storage responses to outflow and water withdrawal dynamics that are not captured in the monthly model. The model results will indicate the maximum drawdowns to occur under the existing and future withdrawal scenarios.

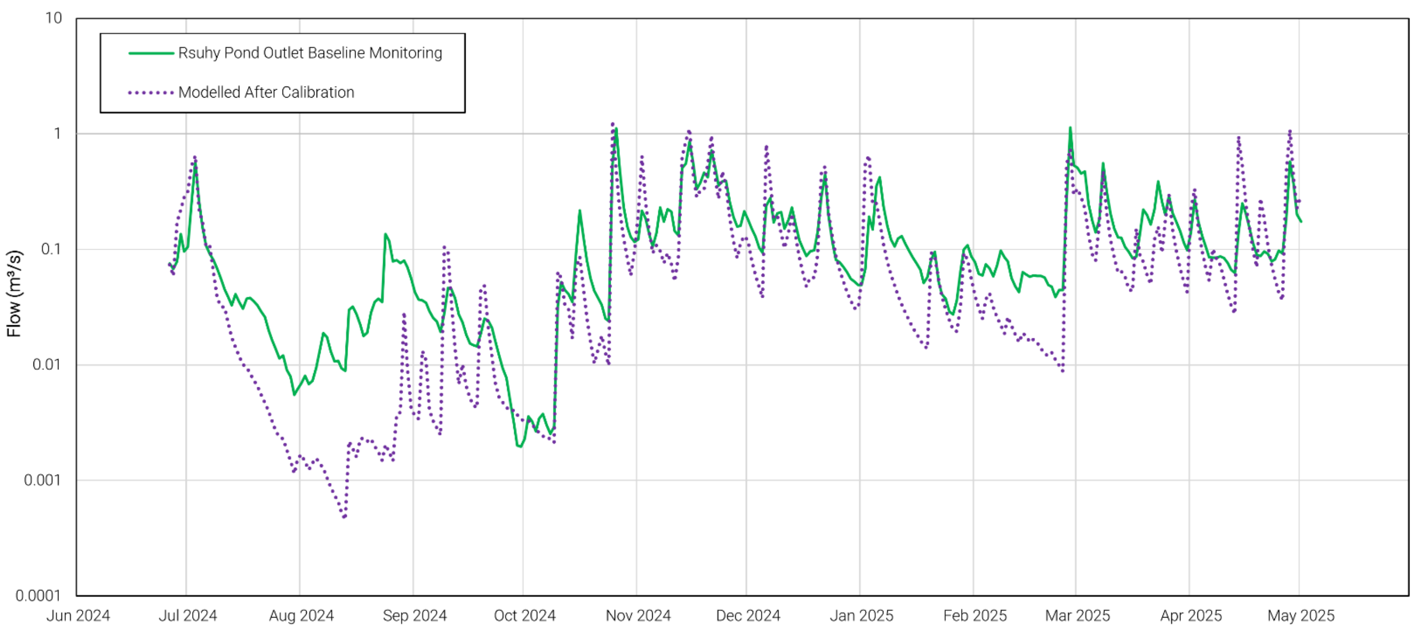
7.2.1 Model Calibration

The model was calibrated using data recorded during the baseline monitoring program. The calibrated model results for Rushy Pond were compared with baseline monitoring records (Table C-7.2-1 and Figure C-7.2-1).

Table C-7.2-1 Rushy Pond Water Level and Outflow Comparison.

Parameter		Monitored	Modelled
Water Level (m)	Average	0.455	0.437
	Minimum	0.343	0.308
	Median	0.446	0.427
	Maximum	0.874	0.875
Outflow (m³/s)	Average	0.130	0.119
	Minimum	0.002	0.000
	Median	0.082	0.047
	Maximum	1.436	1.436





Notes:

1. Precipitation data adopted NASA GPM records at 47.81°N, 53.99°W.
2. Evapotranspiration data adopted UN FAO records at the water supply watershed.

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SURFACE WATER STUDY

EVENT SCALE MODEL CALIBRATION AND COMPARISON WITH BASELINE MONITORING

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FIGURE: C-7.2-1

As shown in Figure C-7.2-1, modelled water levels and outflow generally matched with baseline monitoring records under high flow conditions (i.e., when flows were above 0.1 m^3/s). In low flow conditions, however, the model underpredicted water levels and outflow. Average water level predicted by the model was 0.02 m below average monitored water levels. Calibration ensured that the model matched observed maximum outflows produced, though average outflows were underpredicted by 9%.

The model predicted soil water loss rates comparable to observed trends following the October 25, 2024 precipitation event, but indicated faster loss of soil moisture during all other periods. The model produced conservative predictions of water availability because residual inflow from soil moisture was not simulated. Additionally, the Barrisway Pond's proximity to the coast may enhance precipitation contributions. These factors were not considered in the model, leading to a conservative prediction of water availability at the water supply ponds.

7.2.2 Existing Conditions

Event scale modelling under existing water withdrawal conditions was completed using data between January 2018 and April 2025. Monthly minimum and average water levels at Barrisway Pond and Willie Jarge Pond are summarized in Table C-7.2-2. Live water storage at Barrisway Pond and Willie Jarge Pond was calculated based on their respective pump chamber invert or outlet pipe invert elevations (Table C-7.2-3).

Table C-7.2-2 Monthly Water Levels – Existing Withdrawal.

Water Level (masl)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	16.16	15.96	16.18	16.20	15.93	15.94	15.78	15.48	15.39	15.32	16.23	16.24
	Average	16.34	16.35	16.34	16.35	16.29	16.31	16.16	16.05	16.03	16.21	16.38	16.36
Willie Jarge Pond	Minimum	18.46	18.45	18.47	18.47	18.42	18.44	18.31	17.99	17.92	17.83	18.47	18.47
	Average	18.54	18.54	18.54	18.54	18.52	18.53	18.48	18.40	18.37	18.46	18.55	18.54

Table C-7.2-3 Monthly Live Storage – Existing Withdrawal.

Live Storage (m^3)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	82,000	71,000	83,000	84,000	70,000	70,000	62,000	48,000	44,000	41,000	86,000	86,000
	Average	92,000	93,000	92,000	92,000	89,000	90,000	82,000	76,000	75,000	85,000	94,000	93,000
Willie Jarge Pond	Minimum	487,000	484,000	488,000	487,000	474,000	481,000	443,000	357,000	338,000	316,000	489,000	489,000
	Average	508,000	509,000	508,000	509,000	504,000	506,000	491,000	471,000	462,000	487,000	513,000	510,000
Combined	Minimum	569,000	556,000	571,000	571,000	544,000	551,000	505,000	405,000	383,000	357,000	575,000	576,000
	Average	600,000	602,000	601,000	601,000	593,000	596,000	573,000	547,000	538,000	573,000	607,000	603,000

Monthly average water levels at Barrisway Pond exceeded its spill point from January to June and October to December and dropped 0.17 m below in September. Willie Jarge Pond water levels stayed at or above the spill point for all months except September (drawdown of 0.03 m).

The model predicted maximum drawdown occurring in October 2024, when Barrisway Pond water level fell 0.88 m below the spill point. Despite this, 344,000 m³ of live storage remained available at Barrisway Pond and Willie Jarge Pond.

7.2.3 Future Conditions

Future conditions, including existing water withdrawal and proposed Project operations water withdrawal rates, were simulated using data between January 2018 and April 2025. Water level dynamics at Barrisway Pond and Willie Jarge Pond are plotted in Figure C-7.2-2. Monthly minimum and average water levels at Barrisway Pond and Willie Jarge are summarized in Table C-7.2-4. Live storage at Barrisway Pond and Willie Jarge Ponds was also estimated and is summarized in Table C-7.2-5.

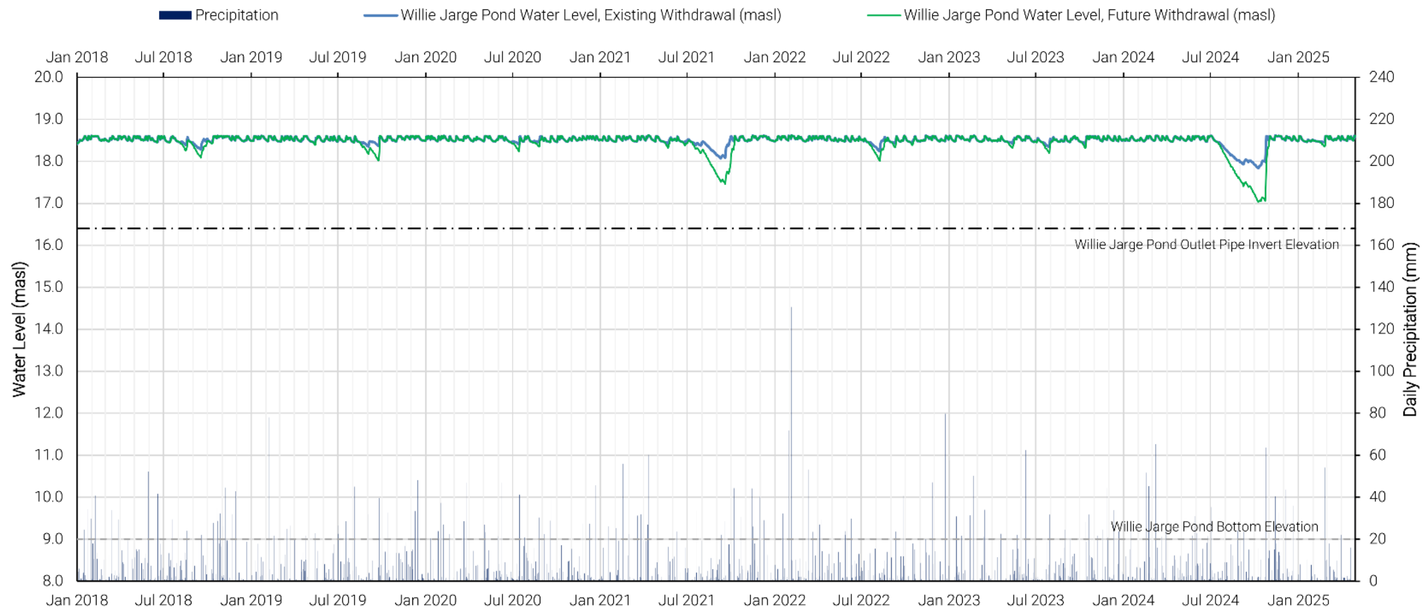
Table C-7.2-4 Monthly Water Levels – Future Withdrawal.

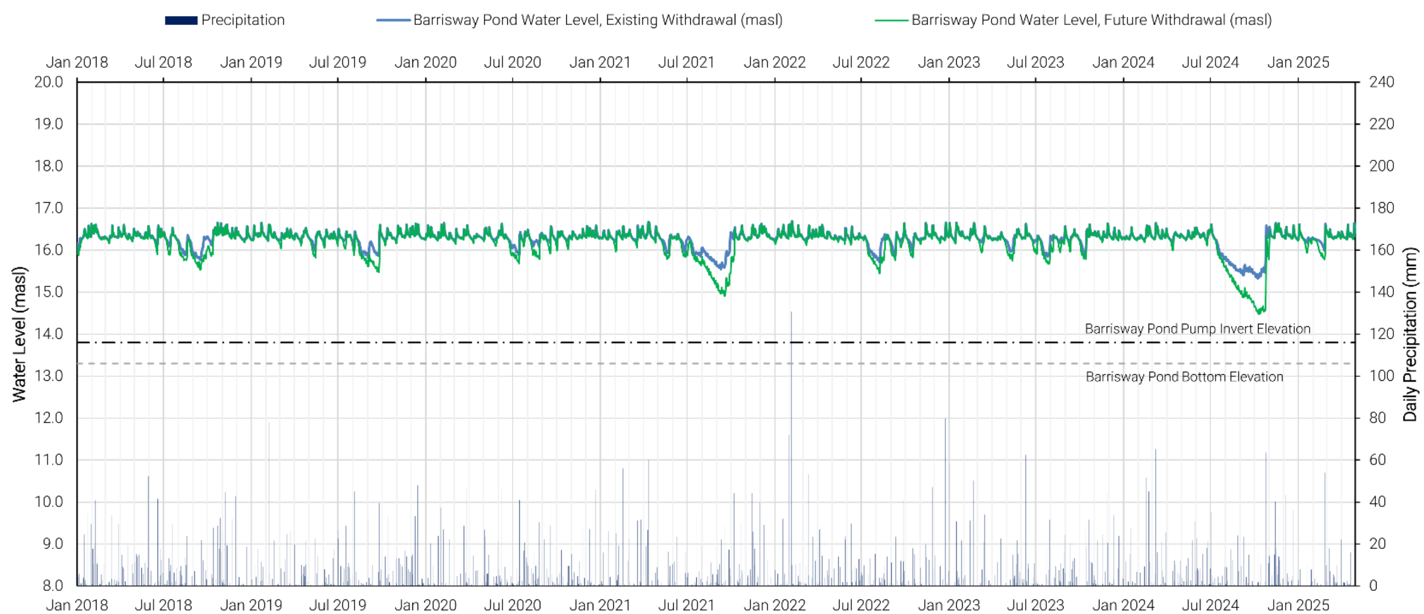
Water Level (masl)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	15.92	15.76	15.93	15.97	15.73	15.81	15.59	15.01	14.69	14.45	15.79	16.15
	Average	16.32	16.32	16.32	16.33	16.24	16.27	16.06	15.84	15.74	16.03	16.36	16.35
Willie Jarge Pond	Minimum	18.45	18.32	18.45	18.47	18.30	18.37	18.16	17.57	17.23	17.03	18.40	18.47
	Average	18.54	18.54	18.54	18.54	18.51	18.52	18.44	18.28	18.15	18.34	18.55	18.54

Table C-7.2-5 Monthly Live Storage – Future Withdrawal.

Live Storage (m³)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barrisway Pond	Minimum	69,000	61,000	70,000	72,000	60,000	64,000	53,000	27,000	13,000	2,000	63,000	81,000
	Average	91,000	91,000	91,000	91,000	86,000	88,000	77,000	66,000	62,000	77,000	93,000	92,000
Willie Jarge Pond	Minimum	484,000	447,000	484,000	487,000	442,000	461,000	402,000	249,000	168,000	122,000	468,000	489,000
	Average	508,000	508,000	508,000	509,000	501,000	505,000	480,000	437,000	405,000	457,000	513,000	510,000
Combined	Minimum	553,000	508,000	554,000	559,000	501,000	525,000	456,000	276,000	180,000	124,000	530,000	571,000
	Average	599,000	599,000	599,000	600,000	587,000	593,000	556,000	503,000	467,000	533,000	606,000	602,000

Live storage at Barrisway Pond and Willie Jarge Pond was shown to sustain the proposed Project operation needs. Average water levels remained above the spill point of both ponds from January to June and from November to December. The lowest monthly average pond levels occurred in September, with drawdown of 0.46 m at Barrisway Pond and 0.25 m at Willie Jarge Pond. The maximum drawdown occurred in October 2024, when Barrisway Pond water level dropped 1.75 m and Willie Jarge Pond dropped by 1.37 m. Despite this, a combined live storage of 124,000 m³ was available.





Notes:

1. Precipitation data adopted NASA GPM records at 47.81 °N, 53.99 °W.
2. Evapotranspiration data adopted UN FAO records at the water supply watershed.

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FIGURE: C-7.2-2

7.3 Model Uncertainty, Reliability, and Sensitivity

The hydrologic models were developed to evaluate water availability under existing and future withdrawal scenarios, using meteorological data from January 2000 to April 2025. The models incorporated conservative assumptions to ensure that potential Project operation water availability constraints were fully accounted for. Model results were validated with baseline monitoring records.

7.3.1 Monthly Model

The monthly model simulates water balance on a monthly basis, which limited its ability to capture short-term deficits. This can lead to underestimation of drawdown within a month. Despite this limitation, it remains useful for identifying broader seasonal and long-term trends. Under the future withdrawal scenario, the largest drawdown predicted by the monthly model occurred in August 2021. It did not capture additional drawdown likely to continue into September. This limitation in temporal resolution was overcome with the event scale model, which also covered the 2021 low flow period.

7.3.2 Event Scale Model

Uncertainty in the event scale model stems from meteorological inputs, calibration, and model assumptions. The baseline monitoring program captured a range of flow regimes, which supported validation of meteorological data (Section 6.2) and model calibration (Section 7.2.1). The model was calibrated to avoid overestimating soil and pond water retention, ensuring conservative water availability estimates. Snow storage was not considered, potentially causing underestimation of available water from March to May.

7.3.3 Sensitivity and Comparison with Baseline

Monthly and event scale models were compared for the overlapping 2018 to 2023 period to assess sensitivity to model resolution and evapotranspiration inputs. A maximum combined pond water deficit of 237,000 m^3 was predicted in August 2021 by the event scale model, comparable to the 206,000 m^3 deficit predicted by the monthly model. The event scale model also predicted a peak deficit of 311,000 m^3 in September 2021, which was reduced to 135,000 m^3 by the end of the month. The monthly model, however, predicted no water deficit in September 2021. This difference occurred due to adopting different evapotranspiration datasets, as shown in Table C-7.3-1.

Table C-7.3-1 Model Sensitivity Due to Evapotranspiration Dataset.

Date	Monthly Model	Event Scale Model	Difference	
	NRCan Evapotranspiration (mm)	UN FAO Evapotranspiration (mm)	Evapotranspiration (mm)	Equivalent Water Deficit (m^3)
August 2021	63.7	79.1	15.4	124,000
September 2021	40.7	51.2	10.5	84,000

The event scale model was also validated against baseline monitoring data. Under existing withdrawals, it predicted maximum drawdowns of 0.88 m at Barrisway Pond and 0.57 m at Willie Jarge Pond, compared to maximum drawdowns of 0.45 m at Barrisway Pond and 0.28 m at Willie Jarge Pond during the baseline monitoring period. Drawdown was also overestimated by the model at Rushy Pond compared to baseline monitoring records (Section 7.2.1). This confirms a conservative water availability prediction of the event scale model. Including Project operation water withdrawals increased the predicted pond drawdowns to up to 1.75 m at Barrisway Pond and 1.37 m at Willie Jarge Pond, with a combined water deficit of up to 428,000 m^3. This represents a 38% increase over the highest deficit between 2018 and 2023, identifying July to October 2024 as the lowest water availability months in the period of record.

8.0 Water Management Opportunities

Water availability for Project operations was assessed using baseline monitoring data (May 2024 to May 2025) and hydrologic model predictions. The analysis indicates that existing pond configurations provide sufficient live storage to meet operation demands. However, baseline monitoring observations indicate that the stoplogs at the Willie Jarge Pond outlet were not operated to maximize available storage.

Based on field observations and modelled water availability, considering seasonal flow regimes and Project operation water requirements, several opportunities have been identified to enhance water management. These opportunities are summarized in Table C-8.0-1.

Table C-8.0-1 Project water usage optimization opportunities.

Item	Timing	Detail	Rationale
Raise Willie Jarge Pond Water Level	High Flow Period (November to June)	Raise and maintain stoplogs at the outlet to their maximum elevation during this period.	Maximizes storage during peak inflow period to ensure water availability for low flow months.
Lower Willie Jarge Water Level	Low Flow Period (July to October)	Gradually lower the stoplogs to manage outflow.	Reduces risk of over-release and sustains downstream water supply.
Implement Low Water Level Alerts	All Periods	Install a real-time water level monitoring system and establish alert thresholds based on modelled low flow scenarios.	Enables proactive response to potential water shortages through early warning.
Raise Outlet Control Elevations	All Periods	Modify outlet control structures to increase the spill point elevations.	Increases active storage capacity and enhances system resilience to low flow conditions.

9.0 Conclusion

Hydrologic assessments combined baseline monitoring with regional climate and flow records and confirmed that Inkster's Pond Industrial Water Supply can meet the Project's operational water demand. Bathymetric surveys delineated 646,000 m³ of live storage, sufficient to sustain 99 days of future water needs with no inflow. Desktop evaluation of regional climate and hydrometric records characterized water availability and seasonality in an average year, as well as low and high flow conditions. The baseline field program captured a full hydrologic range, from a prolonged low flow period (flows below the historical 5th percentile for up to 120 days) to a precipitation event exceeding the 1:2-year recurrence interval. Unit flow rates recorded during the baseline field program averaged between 35.0 and 36.1 L/s/km², which is consistent with long-term regional WSC data (37.2 L/s/km²). Maximum operation water demands represent 10% of the estimated water yield in the water supply watershed, based on regional and baseline averages.

Hydrologic modelling was conducted to simulate long-term water availability under existing and future withdrawal scenarios. The modelling results suggest that average conditions between 2000 and 2023 can sustain existing and future proposed Project operation water needs, with drawdowns of up to 0.23 m and 0.04 m, respectively at Barrisway Pond and Willie Jarge Pond. In the event scale model that simulated water availability between January 2018 and April 2025, average monthly drawdown was up to 0.48 m at Barrisway Pond and 0.24 m at Willie Jarge Pond. The highest drawdown occurred between July and October 2024, which corresponded with the prolonged low flow period captured by the baseline program. A maximum drawdown of 1.60 m was predicted at the end of the low flow period; despite this, a live storage of 137,000 m³ remained available.

The study confirmed that sufficient live storage will be available to meet operation water needs across all climate conditions recorded between January 2000 and April 2025. Additionally, opportunities for improved water management were identified to optimize access to available pond storage and enhance resilience to hydrologic variability.

10.0 References

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Appendix C-1: Data Summary

Table C-1-1 Monthly flow rates at WSC stations.

Station	Flow (m^3/s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pipers Hole River (02ZH001)	5th percentile	8.24	7.04	12.71	22.81	11.80	5.57	2.35	1.62	3.02	6.19	14.06	14.46	18.42
	Average	**26.92**	**28.28**	**31.31**	**51.06**	**29.11**	**14.42**	**9.86**	**8.87**	**14.17**	**23.21**	**33.21**	**31.89**	**25.14**
	95th percentile	61.03	64.30	61.40	83.41	52.07	30.92	23.94	26.01	34.95	48.75	52.63	52.38	31.52
Come By Chance River (02ZH002)	5th percentile	0.41	0.44	0.86	1.73	0.78	0.47	0.17	0.14	0.45	0.69	1.20	1.15	1.56
	Average	**1.90**	**1.95**	**2.29**	**3.71**	**1.94**	**1.19**	**0.91**	**0.89**	**1.42**	**2.08**	**2.61**	**2.45**	**1.94**
	95th percentile	3.96	4.69	4.67	5.67	3.48	2.49	2.09	2.26	3.51	3.89	4.12	4.60	2.41
Shoal Harbour River (02ZJ003)	5th percentile	1.08	1.23	1.80	3.46	1.66	0.79	0.37	0.23	0.38	0.76	1.86	1.65	2.25
	Average	**3.21**	**3.68**	**3.86**	**7.45**	**4.25**	**2.05**	**1.32**	**0.93**	**1.89**	**3.02**	**4.26**	**4.14**	**3.33**
	95th percentile	5.87	7.42	6.46	10.44	7.02	3.55	2.21	1.87	3.48	5.76	6.05	6.19	4.00
Rattling Brook (02ZK006)	5th percentile	0.60	0.75	0.79	1.09	0.44	0.37	0.30	0.25	0.32	0.52	0.71	1.03	1.03
	Average	**1.52**	**1.62**	**1.52**	**1.79**	**1.02**	**0.97**	**0.87**	**0.77**	**0.98**	**1.15**	**1.65**	**1.75**	**1.30**
	95th percentile	2.64	3.14	2.67	2.93	1.75	1.83	1.52	1.51	2.38	2.10	3.04	2.63	1.56

Table C-1-2 Monthly unit flow rate at WSC stations.

Station	Unit Flow ($L/s/km^2$)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pipers Hole River (02ZH001)	5th percentile	10.8	9.2	16.6	29.9	15.4	7.3	3.1	2.1	4.0	8.1	18.4	18.9	24.1
	Average	**35.2**	**37.0**	**41.0**	**66.8**	**38.1**	**18.9**	**12.9**	**11.6**	**18.5**	**30.4**	**43.5**	**41.7**	**32.9**
	95th percentile	79.9	84.2	80.4	109.2	68.2	40.5	31.3	34.0	45.7	63.8	68.9	68.6	41.3
Come By Chance River (02ZH002)	5th percentile	9.5	10.1	19.9	40.0	18.1	10.9	4.0	3.3	10.3	15.9	27.7	26.6	35.9
	Average	**43.9**	**45.1**	**53.0**	**85.7**	**44.8**	**27.5**	**20.9**	**20.6**	**32.9**	**48.0**	**60.2**	**56.5**	**44.9**
	95th percentile	91.5	108.3	107.8	130.9	80.3	57.5	48.4	52.1	81.1	89.8	95.1	106.3	55.7
Shoal Harbour River (02ZJ003)	5th percentile	10.2	11.6	17.0	32.6	15.7	7.5	3.5	2.1	3.6	7.2	17.6	15.5	21.2
	Average	**30.3**	**34.7**	**36.4**	**70.3**	**40.1**	**19.3**	**12.4**	**8.8**	**17.8**	**28.5**	**40.2**	**39.0**	**31.4**
	95th percentile	55.4	70.0	60.9	98.5	66.3	33.5	20.9	17.7	32.8	54.3	57.1	58.4	37.8
Rattling Brook (02ZK006)	5th percentile	18.5	23.0	24.1	33.3	13.6	11.5	9.2	7.7	9.7	15.8	21.6	31.4	31.6
	Average	**46.3**	**49.4**	**46.4**	**54.8**	**31.1**	**29.7**	**26.5**	**23.6**	**29.9**	**35.2**	**50.4**	**53.4**	**39.6**
	95th percentile	80.6	95.9	81.6	89.5	53.4	56.0	46.5	46.0	72.9	64.3	93.0	80.3	47.7

Table C-1-3 Monthly runoff depth at WSC stations.

Station	Runoff Depth (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pipers Hole River (02ZH001)	5th percentile	28.9	22.5	44.5	77.3	41.4	18.9	8.2	5.7	10.3	21.7	47.7	50.7	760.6
	Average	**94.4**	**90.3**	**109.8**	**173.0**	**102.0**	**48.9**	**34.6**	**31.1**	**48.1**	**81.4**	**112.7**	**111.8**	**1038.2**
	95th percentile	214.0	205.4	215.2	282.6	182.6	104.9	83.9	91.2	118.6	170.9	178.6	183.6	1301.7
Come By Chance River (02ZH002)	5th percentile	25.3	24.8	53.3	103.4	48.5	28.1	10.6	8.8	26.7	42.6	71.8	71.3	1133.2
	Average	**117.5**	**110.1**	**141.9**	**221.8**	**119.9**	**71.3**	**56.0**	**55.2**	**85.2**	**128.6**	**156.0**	**151.4**	**1415.3**
	95th percentile	245.1	264.3	288.7	338.5	215.2	149.0	129.5	139.6	210.3	240.5	246.6	284.7	1756.3
Shoal Harbour River (02ZJ003)	5th percentile	27.2	28.4	45.6	84.4	42.0	19.4	9.3	5.8	9.4	19.2	45.5	41.6	668.7
	Average	**81.1**	**84.7**	**97.6**	**181.8**	**107.4**	**50.1**	**33.3**	**23.4**	**46.1**	**76.4**	**104.2**	**104.6**	**991.2**
	95th percentile	172.2	190.5	199.9	285.6	207.6	105.2	77.4	52.6	124.2	148.0	164.1	174.7	1257.1
Rattling Brook (02ZK006)	5th percentile	49.5	56.2	64.5	85.9	36.4	29.7	24.6	20.7	25.1	42.4	55.9	84.1	996.1
	Average	**124.1**	**120.8**	**124.2**	**141.4**	**83.2**	**76.9**	**71.1**	**63.1**	**77.5**	**94.2**	**130.6**	**142.9**	**1250.5**
	95th percentile	215.9	234.4	218.5	230.7	143.0	145.1	124.7	123.3	188.9	172.3	241.1	215.2	1504.6

Table C-1-4 Seasonal runoff summary.

Parameter		Pipers Hole River (02ZH001)	Come By Chance River (02ZH002)	Shoal Harbour River (02ZJ003)	Rattling Brook (02ZK006)
Drainage Area (km²)		764.0	43.3	106.0	32.7
Snow-free Seasons Runoff Depth (mm)	5th Percentile	177.7	356.4	165.9	342.5
	Average	**360.0**	**565.2**	**339.3**	**513.4**
	95th Percentile	489.3	777.1	493.1	706.9
Snow-free Seasons Runoff Factor (%)	5th Percentile	30%	57%	28%	44%
	Average	**50%**	**76%**	**48%**	**64%**
	95th Percentile	64%	100%	64%	81%
Snow Seasons Runoff Depth (mm)	5th Percentile	524.6	680.1	487.5	597.3
	Average	**679.0**	**891.3**	**671.4**	**742.7**
	95th Percentile	845.6	1,104.1	850.0	896.8
Snow Seasons Runoff Factor (%)	5th Percentile	80%	99%	74%	75%
	Average	**107%**	**127%**	**103%**	**94%**
	95th Percentile	143%	171%	150%	112%

Table C-1-5 Low flow period runoff depth and durations at WSC stations.

Duration (days)		7	14	30	60	120	180	365
1:50-Year Low Runoff Depth (mm)	Pipers Hole River (02ZH001)	0.6	-	-	-	-	-	-
	Come By Chance River (02ZH002)	0.5	-	-	-	-	-	-
	Shoal Harbour River (02ZJ003)	0.5	-	-	-	-	-	-
	Rattling Brook (02ZK006)	0.5	-	-	-	-	-	-
Historical Low Runoff Depth (mm)	Pipers Hole River (02ZH001)	0.1	0.2	0.6	1.9	17.3	103.8	658.4
	Come By Chance River (02ZH002)	0.2	0.6	1.7	9.8	77.7	252.8	879.7
	Shoal Harbour River (02ZJ003)	0.2	0.5	1.8	6.2	36.3	105.7	565.4
	Rattling Brook (02ZK006)	1.2	2.5	9.1	38.6	111.3	232.9	894.0
5th Percentile Runoff Depth (mm)	Pipers Hole River (02ZH001)	2.5	5.4	13.6	35.1	112.6	254.3	765.5
	Come By Chance River (02ZH002)	2.7	6.4	20.1	60.2	198.2	395.4	1088.4
	Shoal Harbour River (02ZJ003)	2.0	4.5	12.2	33.1	101.5	231.7	693.4
	Rattling Brook (02ZK006)	5.3	11.7	29.0	72.3	186.4	360.4	973.3

Table C-1-6 Rushy Pond and Outlet Baseline Field Measurement Summary.

Date	Rushy Pond	Rushy Pond Outlet	
	Staff Gauge Depth (cm)	Staff Gauge Depth (cm)	Flow Measurement (m^3/s)
May 28, 2024	37.0	30.0	0.022
Jun 26, 2024	44.0	37.0	0.081
Jul 24, 2024	36.0	29.0	0.011
Aug 16, 2024	38.0	31.0	0.017
Sep 23, 2024	37.0	29.5	0.016
Oct 30, 2024	47.5	41.5	0.128
Nov 07, 2024	52.5	48.0	0.245
Nov 26, 2024	54.0	48.0	0.267
Dec 13, 2024	53.5	47.5	0.263
Mar 10, 2025	52.0	44.0	0.216
Mar 24, 2025	54.0	47.0	0.281
May 01, 2025	50.5	41.0	0.134

Table C-1-7 Willie Jarge Pond and Outlet Baseline Field Measurement Summary.

Date	Willie Jarge Pond	Willie Jarge Pond Outlet	
	Staff Gauge Depth (cm)	Staff Gauge Depth (cm)	Flow Measurement (m^3/s)
May 28, 2024	43.5	32.0	0.031
Jun 26, 2024	50.0	36.0	0.118
Jul 24, 2024	43.0	32.0	0.025
Aug 16, 2024	31.5	33.0	0.033
Sep 23, 2024	43.0	30.0	0.007
Oct 30, 2024	37.0	48.2	0.577
Nov 07, 2024	26.0	43.2	0.315
Nov 26, 2024	47.0	46.2	0.649
Dec 13, 2024	33.0	41.2	0.398
Mar 10, 2025	45.0	45.7	0.617
Mar 24, 2025	40.0	43.7	0.417
May 01, 2025	38.5	42.7	0.426

Table C-1-8 Barrisway Pond and Outlet Baseline Field Measurement Summary.

Date	Barrisway Pond	Barrisway Pond Outlet	
	Staff Gauge Depth (cm)	Staff Gauge Depth (cm)	Flow Measurement (m^3/s)
May 28, 2024	33.0	12.0	0.004
Jun 26, 2024	41.0	23.0	0.098
Jul 24, 2024	27.0	13.0	0.004
Aug 16, 2024	28.5	13.0	0.004
Sep 23, 2024	5.5	11.0	0.001
Oct 30, 2024	53.5	39.0	0.565
Nov 07, 2024	50.5	33.0	0.290
Nov 26, 2024	61.0	43.0	0.725
Dec 13, 2024	52.0	34.0	0.370
Mar 10, 2025	54.5	40.0	0.662
Mar 24, 2025	53.5	37.0	0.499
May 01, 2025	55.0	35.0	0.445

Appendix C-2: Bathymetric and Topographic Surveys

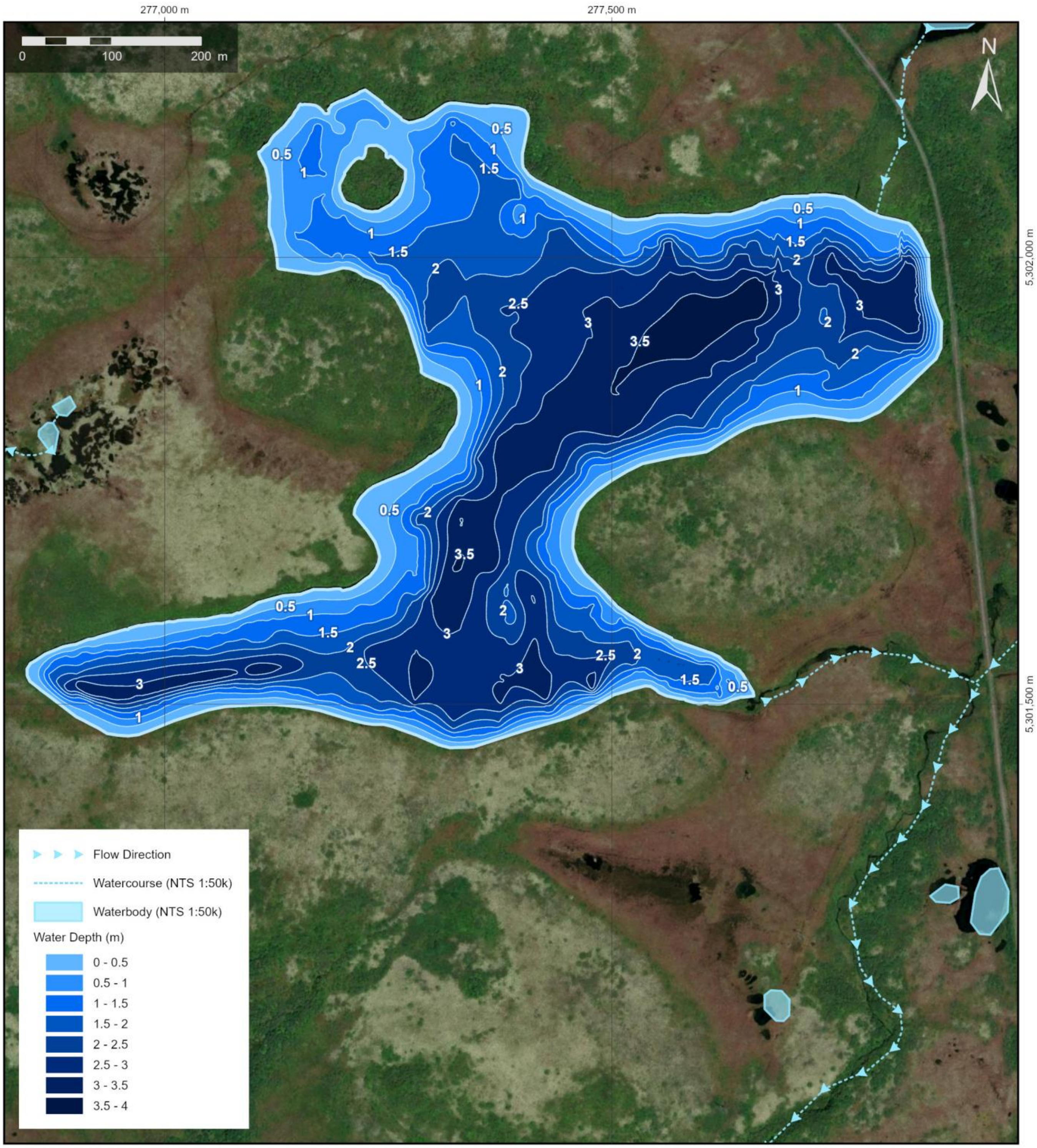
Bathymetry surveys were completed in December 2024 at four ponds in the water supply watershed using a real-time kinetic positioning global positioning system (RTK GPS) and an echosounder. The echosounder survey data was interpolated and plotted using ArcGIS. The bathymetric data allowed for elevation-volume curves (i.e., stage-storage curves) to be developed for each pond. These results provide a foundational dataset for ongoing and future hydrological assessments and infrastructure planning. Water levels and hydraulic outlet elevations were also surveyed with RTK GPS to identify spillway lengths, spill point elevations, and hydraulic control structure elevations.

Bathymetry surveys were completed at all the ponds within the water supply watershed, except at Rushy Pond where site access challenges were encountered. The results are summarized in Table C-2-1 and illustrated in Figures C-2-1 to C-2-4.

Table C-2-1 Bathymetric and topographic survey results.

Pond	Survey Date	Spill Point Elevation (masl)	Maximum Water Depth (m) *	Total Volume (m^3) **	Total Live Storage (m^3)	Surface Area (m^2) ***
Big Pond	Dec 19, 2024	49.6	4.5	696,776	-	335,100
Willie Jarge Pond	Dec 11 and 13, 2024	18.4	9.4	736,101	468,660	282,800
Barrisway Pond	Dec 09, 2024	16.2	2.9	88,294	83,968	54,200
Inkster's Pond	Dec 13, 2024	24.2	6.6	94,000	94,000	43,830

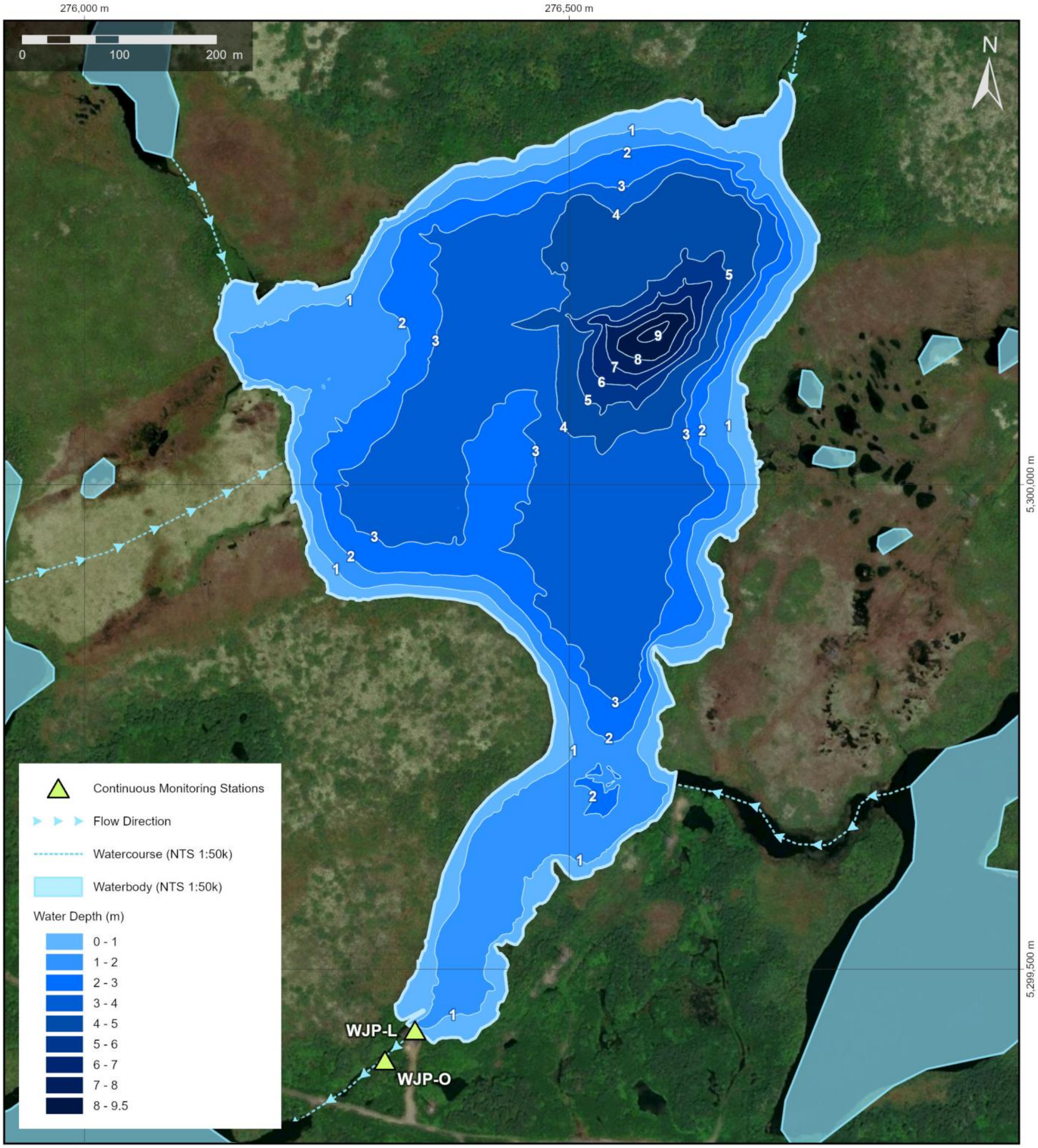
<u>Notes</u>
*: Maximum Water Depth was calculated below the spill point elevation.
**: Total Volume calculated based on water below the spill point elevation.
***: Surface Area was calculated based on contour at the spill point elevation.



North Atlantic	FIGURE TITLE: **Big Pond Bathymetry**	NOTES: Bathymetric data collected with single-beam transducer on December 19, 2024. Watercourse and Waterbody data sourced from Canadian National Topographic System (NTS) 1:50k series.	PREPARED BY: C. Burke	DATE: 05/06/2025
			REVIEWED BY: J.Crocker 05/06/2025	
			APPROVED BY: C. Collins 05/06/2025	
	PROJECT TITLE: North Atlantic Wind to Hydrogen Project		CRS: WGS 1984 UTM Zone 22N	
			sem	

SEM MAP ID: 016-015-GIS-303-Rev0

Figure C-2-1 Big Pond bathymetry.



North Atlantic	FIGURE TITLE: **Willie Jarge Pond Bathymetry**	NOTES: Bathymetric data collected with single-beam transducer on December 11, 2024. Watercourse and Waterbody data sourced from Canadian National Topographic System (NTS) 1:50k series.	PREPARED BY: C. Burke; DATE: 05/06/2025
	PROJECT TITLE: North Atlantic Wind to Hydrogen Project		REVIEWED BY: J.Crocker 05/06/2025
			APPROVED BY: C. Collins 05/06/2025
			CRS: WGS 1984 UTM Zone 22N
			sem

SEM MAP ID: 016-015-GIS-304-Rev0

Figure C-2-2 Willie Jarge Pond bathymetry.

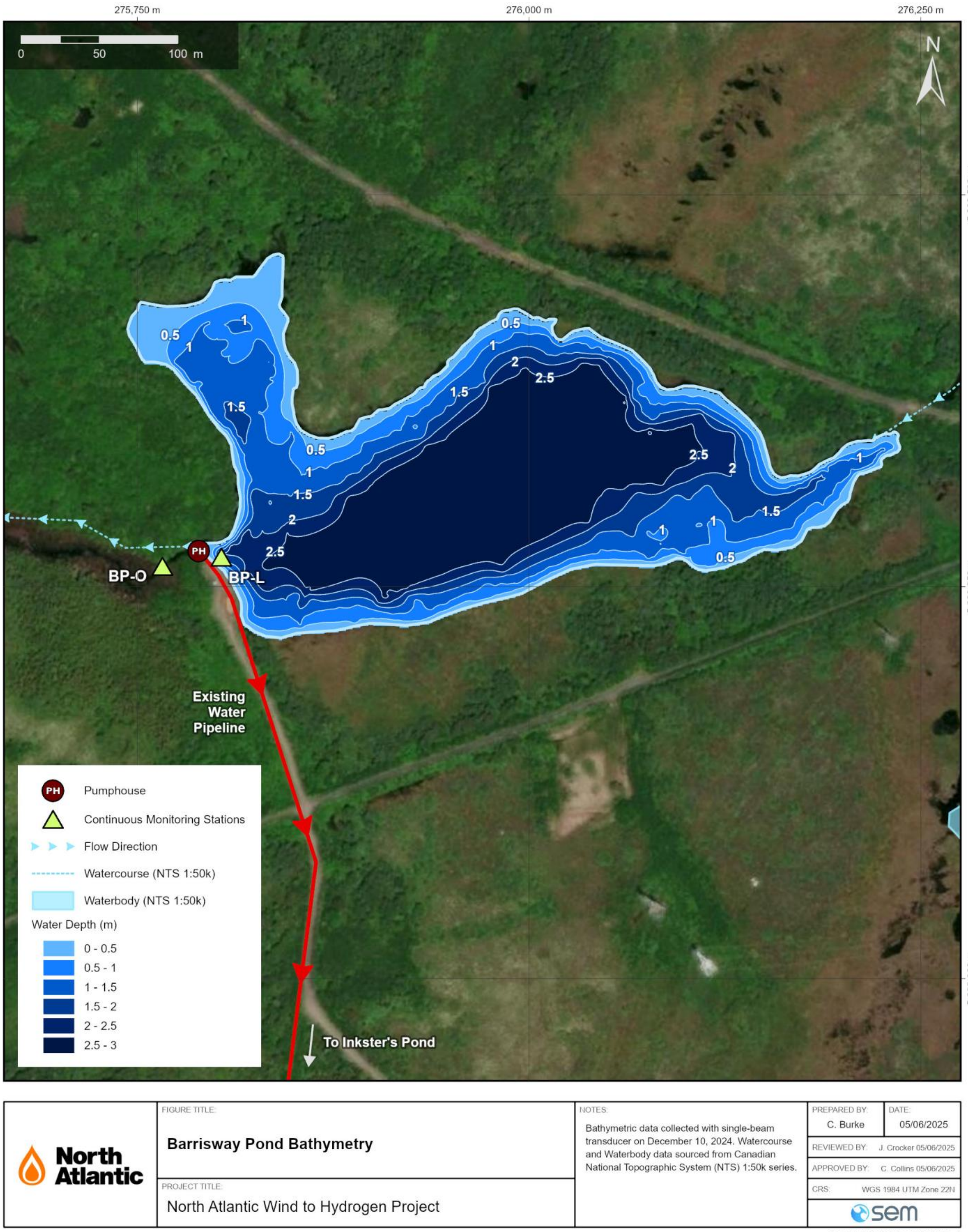
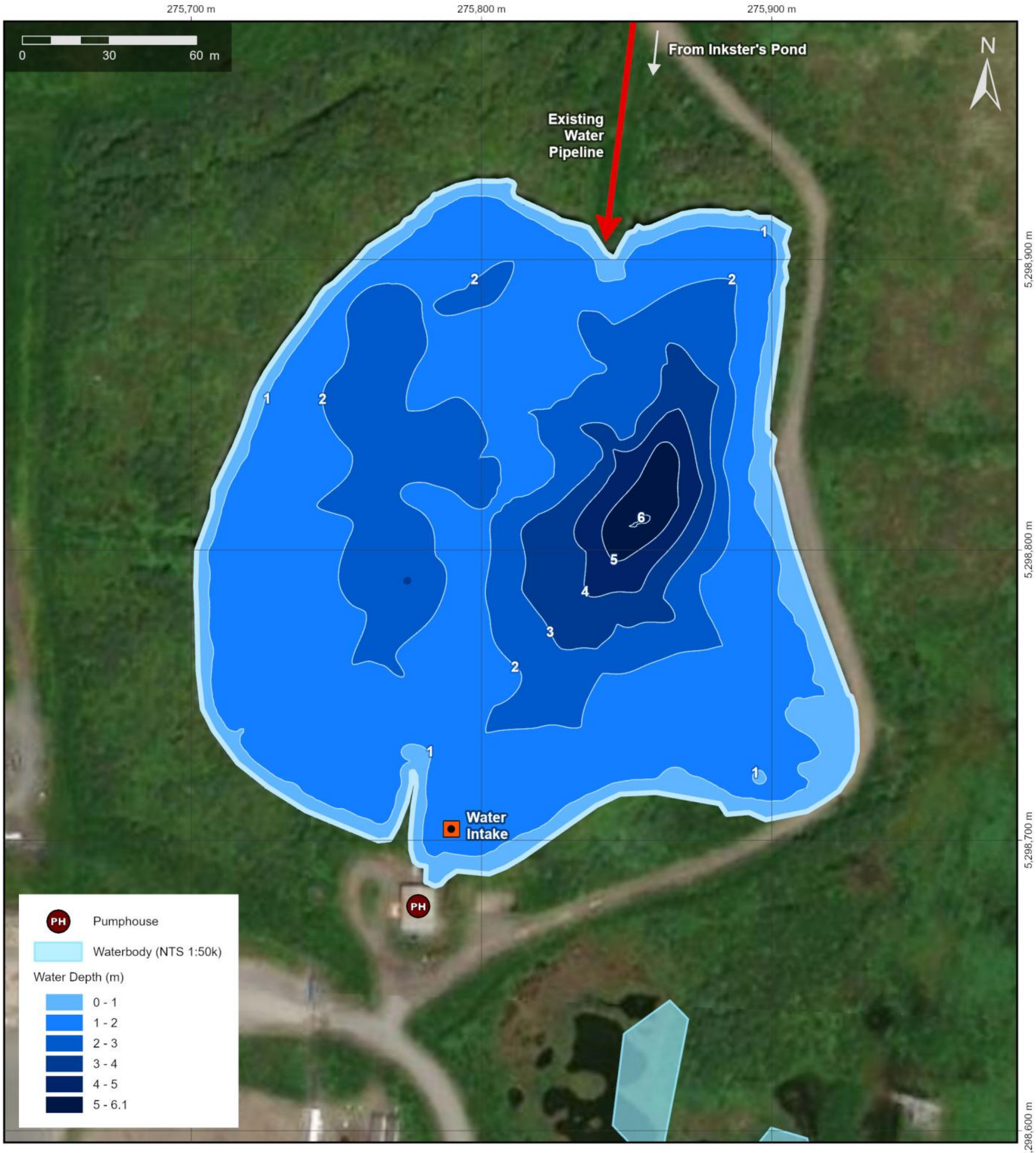


Figure C-2-3 Barrisway Pond bathymetry.



North Atlantic	FIGURE TITLE: Inkster's Pond Bathymetry	NOTES: Bathymetric data collected with single-beam transducer on December 9, 2024. Watercourse and Waterbody data sourced from Canadian National Topographic System (NTS) 1:50k series.	PREPARED BY: C. Burke	DATE: 05/06/2025
			REVIEWED BY: J. Crocker 05/06/2025	
			APPROVED BY: C. Collins 05/06/2025	
	PROJECT TITLE: North Atlantic Wind to Hydrogen Project		CRS: WGS 1984 UTM Zone 22N	
			sem	

SEM MAP ID: 016-015-GIS-306-Rev0

Figure C-2-4 Inkster's Pond bathymetry.

Study Limitations

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The content and opinions contained in the present report are based on the survey data and published information available to SEM at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by SEM and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial, and physical constraints applicable to this project.

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This limitations statement is considered an integral part of this report.