FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

PRIMONT (THOROLD/WELLAND) INC.

436 QUAKER ROAD, WELLAND

Project No.: 2022-0091-10

July 22, 2024

WALTERFEDY

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APPENDICES

1.0 INTRODUCTION

WalterFedy Inc. has been retained by Primont (Thorold/Welland) Inc. to provide Civil Engineering Consulting services in support of a Draft Plan of Subdivision for the lands located at 436 Quaker Road in the City of Welland, hereafter referred to as the Subject Lands. The site is located within the Northwest Welland Secondary Plan (NWSP) Area.

The purpose of this report is to provide an overview of how the development can be serviced and identify connections to existing and future adjacent municipal infrastructure. The report will discuss the existing conditions, the capacity of the municipal systems, and will identify how the development can be accommodated with storm and sanitary sewer and watermain sizing presented to demonstrate compliance with the City of Welland guidelines and criteria. In addition, the report will summarize the Stormwater Management (SWM) strategy to address requirements of the City of Welland and the Niagara Peninsula Conservation Authority (NPCA).

The report will also discuss the potential for servicing additional lands owned by the proponent located within the City of Thorold via an extension of sanitary and water servicing through the Subject Lands.

1.1 Background

The 30.1 ha Subject Lands are located in the northwestern quadrant of the intersection of Quaker Road and First Avenue within the town of Welland. The lands are bound existing residential lands and future development lands to the west, Quaker Road to the south, First Avenue to the east, and Welland and Thorold's Municipal boundary to the north. As previously, noted, the Subject Lands are located in the NWSP Area. Refer to Figure 1.1 for the Site Location.

Figure 1.1: Site Location[1]

The current land use of the Subject Lands is a mix of agricultural and open space. The open space within the Blocks also encompasses environmentally-regulated areas which includes a Provincially Significant Wetlands (PSW).

As previously noted, an additional 30.3 ha of land is owned by the proponent, north of the Subject Lands and within the municipal boundary of the City of Thorold, herein after noted as the Thorold Lands. As with the Subject Site, these lands are currently used for agricultural purposes and open space.

1.2 Proposed Draft Plan

A Draft Plan of Subdivision was prepared by A.T McLaren Ltd. Refer to Figure 1.2 and Appendix A implements the Official Plan land uses comprised of a mix of residential densities (i.e., single-detached homes, townhouses, multi-unit blocks, etc.), SWM facilities, a block for the realigned Towpath Drain, public park spaces, and associated roads including a proposed collector traversing through the Subject Lands linking future intersections at First Avenue and Quaker Road to the east and the south, respectively.

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[1] Mapping taken from Region of Niagara GIS Website: https://maps.niagararegion.ca/Navigator/?viewer=npi, October 3, 2022

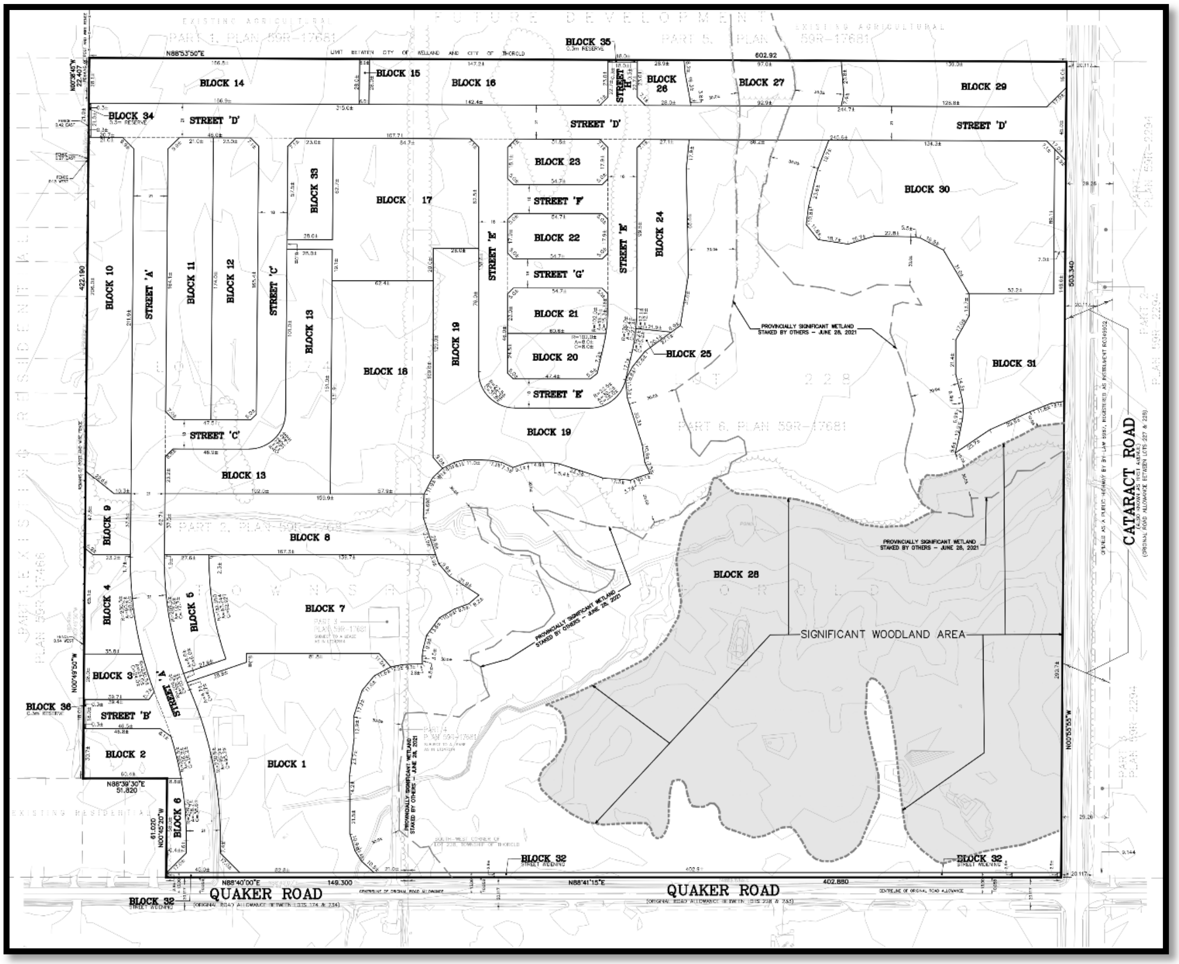

Figure 1.2: Draft Plan

1.3 Reference Reports and Drawings

The following were referenced in the preparation of this Functional Servicing and Stormwater Management Report:

1. *City of Welland Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*, by Associated Engineering, December 2023.
2. *City of Welland Municipal Standards,* February 2013
3. *Hydrogeologic Study and Wetland Water Balance,* by Terra-Dynamics Consulting Inc., June 2024
4. *Environmental Impact Study***,** by GEI, June 2024.
5. *Geotechnical Investigation and Hydrogeological Considerations – Proposed residential development Quaker Road and First Avenue Welland, Ontario,* by Soil-Mat Engineers & Consultants LTD. Revised June 2024.
6. *Technical Memorandum – Primont Welland and Thorold Road Network*, by CGH, November 2022.
7. *Welland Northwest Area Secondary Plan – Stormwater Management Plan*, prepared by Aquafor Beech Limited, dated February 30, 2020.
8. *Draft Northwest Welland Stormwater Management Implementation Plan***,** prepared by Upper Canada Consultants, dated August 22, 2022.

9. *Stormwater Management Planning and Design Manual*, prepared by the Ministry of the Environment, Conservation and Parks (MECP), March 2019.
10. *Niagara Watershed Plan (Equivalency) – Volume 1: Characterization*, prepared by Wood, May 16, 2022
11. *Niagara Region Water and Wastewater Master Servicing Plan Update, 2021*, prepared by GM Blue Plan Engineering, December 2023.
12. *Region of Niagara's 2022 Development Charges Background Study, 2022,* prepared by Watson and Associates Economists Ltd.
13. *City of Thorold City Wide Water Service Master Plan (Draft),* prepared by GM Blue Plan Engineering, November 2019
14. *Official Plan of the City of Thorold,* Aril 2016
15. *436 Quaker Road Review and Entry into the Ontario Public Register of Archaeological Reports*: prepared by Ministry of Citizenship and Multiculturalism (MCM) September 20, 2023
16. *Lot 228 Quaker Road Review and Entry into the Ontario Public Register of Archaeological Reports*: prepared by Ministry of Citizenship and Multiculturalism (MCM) September 20, 2023
17. *City of Welland Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report:* prepared by Associated Engineering December 2023
18. *Transportation Impact Study – Primont 436 Quaker Road, Welland* by CGH, June 2024.
19. Plan, Profile, Storm, Sanitary, and Watermain Information provided by the City of Welland and Region of Niagara.
20. Topographic Information provided by J.D. Barnes Limited and Upper Canada Consultants.

2.0 EXISTING INFORMATION

2.1 Topography and Land Use

The Subject Lands have historically been agricultural and open space land uses. Topographic information was obtained from surveys completed by J.D. Barnes (2022), and Upper Canada Consultants (2022). This topographic information was supplemented with OMARFA Lidar provided by the Ontario Ministry of Natural Resources and Forestry (MNRF).

As previously noted, the Subject Lands are bound by existing residential lands and future development lands to the west, Quaker Road to the south, First Avenue to the east, and additional lands of the owner north of the municipal boundary (Thorold Lands). The topography of the site varies from 185 m to 183 m across the agricultural field, with lower grades of 182 m to 181 m throughout the wetlands. The subject lands generally slope towards the wetlands and watercourse (Towpath Drain) which bisects the property and drains from west-to-east. Refer to the Existing Conditions Drawing in Appendix E.

2.2 Geotechnical and Hydrogeological Conditions

The geotechnical assessment was undertaken by Soil-Mat Engineers & Consultants Ltd. 16 boreholes were drilled in October 2021, and were advanced between 6.7 m and 6.3 m below grade, with three deep boreholes drilled in March 2022 to a depth of 35.6 m below grade, and an additional 13 boreholes advanced to depths of 6.7 m to 20.4 m below the existing ground surface in December 2022. The boreholes indicate a layer of topsoil generally ranging in thickness between 0.2 and 0.35 metres, with one borehole (BH21-16) recording a topsoil depth of 0.6m. Field and laboratory testing demonstrated the native soils consist of silty clay with traces of sand to silt to sandy silt with some clay at lower levels. The clay and silt soils would generally behave as a cohesive material with slight to medium plasticity, and low hydraulic conductivity, on the order of 10^{-7} to 10^{-8} cm/sec and would be of low permeability to effectively impermeable. Refer to Appendix F for the Geotechnical Investigation and Hydrogeological Considerations Report

The Hydrogeological Assessments was undertaken by Terra-Dynamics Consulting Inc. with 16 monitoring wells drilled starting in November 2021. Based on the results found with the monitoring wells, the static seasonal groundwater level tends to be relatively shallow across much of the site and flows east towards First Avenue; typically ranging between 0.2 m and 0.5 m below existing grades. Refer to Appendix G for the Hydrogeological Assessment and the Groundwater Monitoring results.

An Environmental Impact Study (EIS) was initiated as part of the Draft Plan submission by GEI. Significant areas of interest were identified within Primont's Lands. There is a Provincially Significant Wetland (PSW) on the subject lands, referred to as the Niagara Street Cataract Road Woodlot PSW Complex, as mapped by the MNRF. This PSW has been ground-verified by GEI and NPCA. This PSW complex was determined not to include some smaller wetlands present on site and was evaluated under the revised Ontario Wetland Evaluation System (OWES; 2022). Through evaluation, GEI confirmed that all five of the smaller wetlands can be classified as "unevaluated" and will be treated as non-significant from a planning perspective.

In conjunction with the Hydrogeological Assessment, a water balance has been completed to confirm if the wetlands on the site are hydraulically connected. Terra-Dynamics Consulting Inc. has established, through the monitoring of the site and the soil composition, that the wetlands are not hydraulically connected and are only fed by precipitation. Based on these findings and the high elevations of groundwater, additional low-impact development (LID) will not function as designed and is therefore not incorporated into the SWM strategy. The site will be graded to allow proposed residential units backing onto the wetlands to sheet flow clean runoff to the wetlands.

2.3 Traffic Impact Review

A Road Network Technical Memorandum was completed by CGH Transportation, which summarizes transportation assessments, Municipal Class Environmental Assessment studies, and future road widenings in the NWSP. CGH Transportation has completed a Traffic Impact Study (TIS). The report states the impact of the proposed development on the surrounding study area road network is relatively minor compared to the other developments in the area and can be mitigated by network signal improvement and the proposed development application is recommended to proceed from a transportation perspective.

2.4 Archaeological Assessment

A combined Stage 1 and Stage 2 Archaeological Assessment was completed by ASI and added to the provincial registry on June 2 and September 20, 2023, respectively. These assessments confirmed further assessment and investigation were required; as such, in the Spring of 2023, Stantec commenced additional fieldwork on areas identified for further investigation in the previous assessments in support of Stage 3 and Stage 4 Archeological Assessment. Refer to Figure 2.1, which indicates areas requiring Stage 3 and 4 Assessments, utilizing the Land Titles Reference plan prepared by A.T. Mclaren Limited as the base.

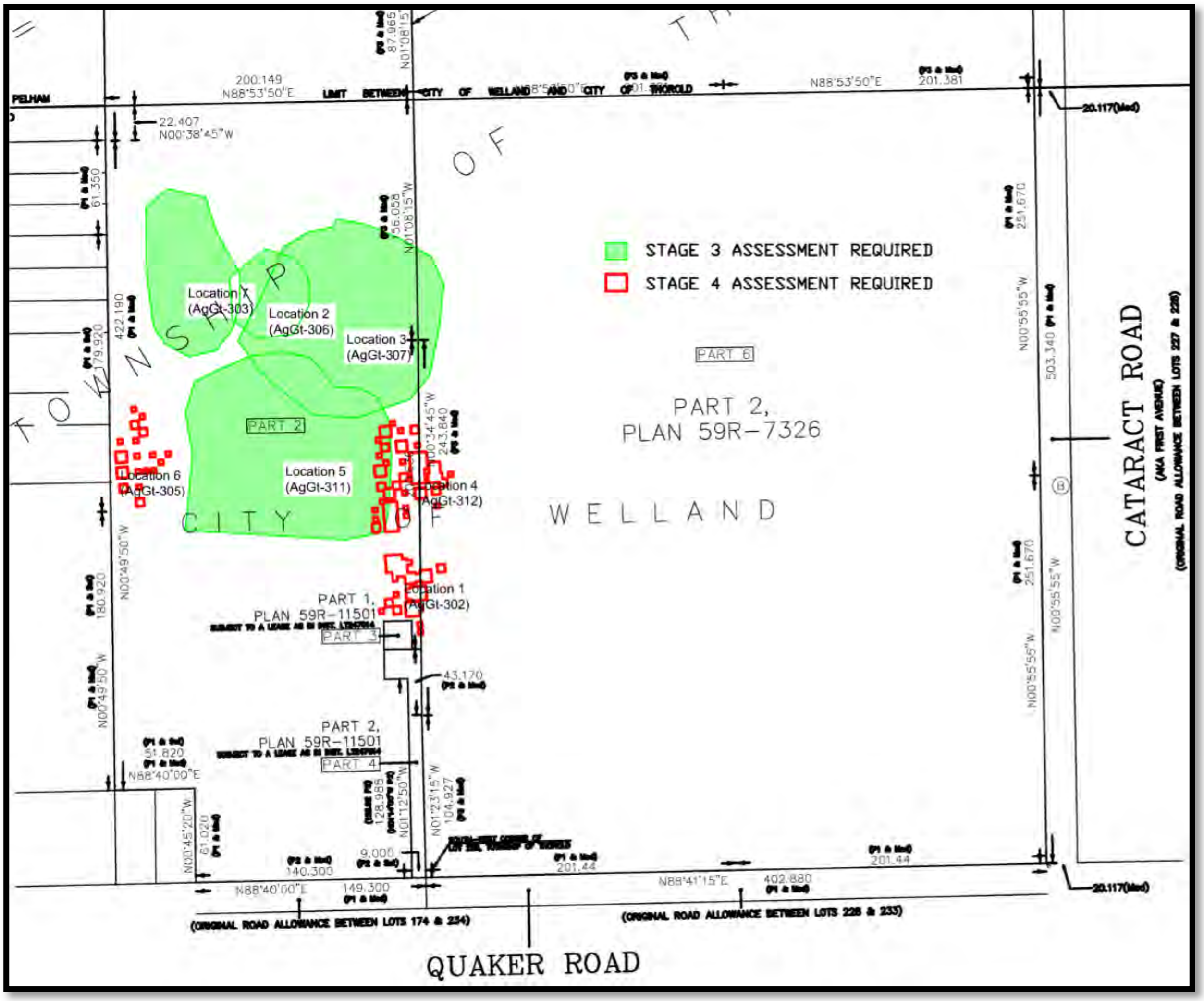

Figure 2.1: Archaeological Assessment Area

It should be noted that all field work for the Stage 3 and Stage 4 assessments have been carried out in coordination with the First Nations, with representatives from First Nations overseeing the excavation activities.

2.5 Existing Servicing

2.5.1 Sanitary Servicing

Wastewater servicing within the Region of Niagara operates under a two-tier system, with the Region being responsible for the operation and maintenance of the pumping stations (SPSs), force mains, trunk sewers, and wastewater treatment plants (WWTPs). The local municipality is responsible for the smaller gravity mains within the local roads and conveyance to the regional system. Refer to Figure 2.1 for the layout of the Regional Sanitary system servicing the NWSP Area.

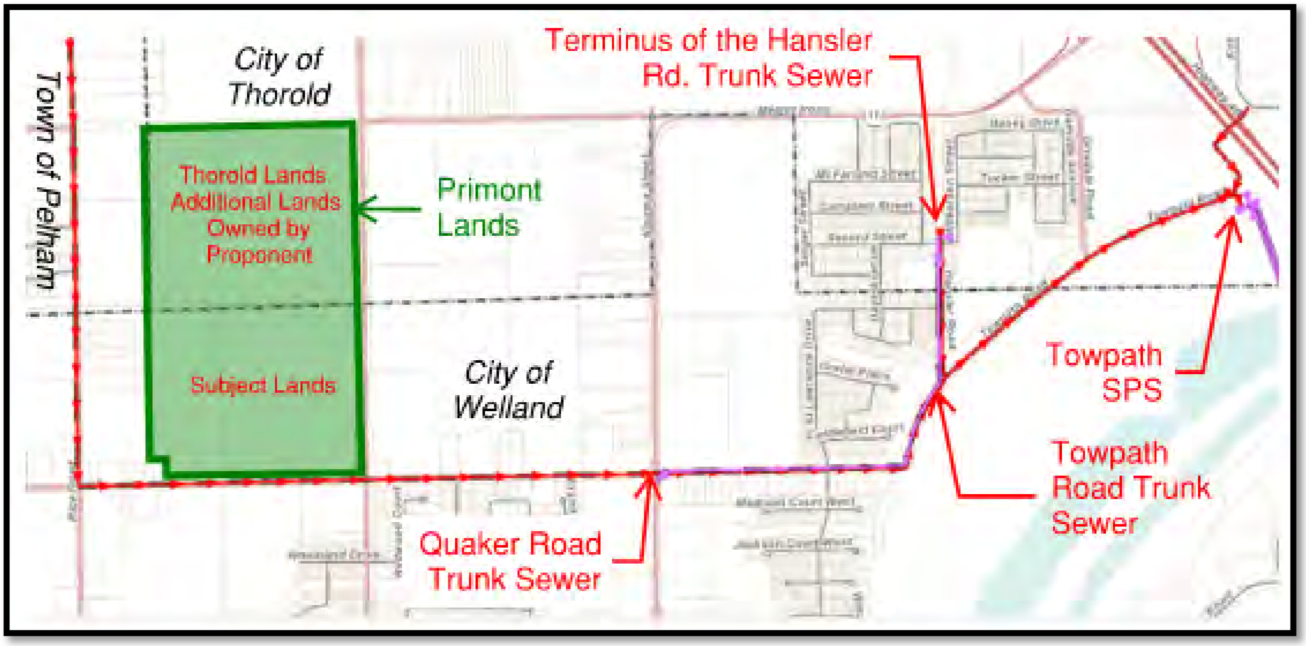

Figure 2.2: Existing Wastewater Main Connection Points[2]

A 750-mm diameter regional wastewater main is located adjacent to the Subject Lands frontage of the Quaker Road right-of-way, outletting to the Towpath Road Trunk Sewer before being conveyed to the Towpath SPS and then pumped via forcemain under the Recreational Canal and Welland River to the Woodlawn Road Trunk Sewer and ultimately to the Welland WWTP. There are no existing wastewater mains within the First Avenue right-of-way north of Quaker Road.

2.5.2 Storm Servicing

Currently there are no storm sewers adjacent to the site on either Quaker Road or First Avenue, which both utilize roadside ditches outletting to the Towpath drain. Under pre-development conditions, the undeveloped site sheet flows to wetlands and ultimately outlets to a 1800 mm culvert crossing under First Avenue, discharging to the Towpath Drain. It should be noted that phase one of the design and approval of the channelization of the Towpath Drain has been completed. Additional wetland and channel monitoring is currently underway and will wrap up in May 2024. At that time phase 2 of the Channel design can be completed which includes the sizing of the future culvert under First Avenue.

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[2] Mapping taken from Region of Niagara GIS Website: https://maps.niagararegion.ca/Navigator/?viewer=npi, September 29, 2022

2.5.3 Water Servicing

Available water servicing for the site includes the 300-mm-diameter watermain owned and operated by the City of Welland, located adjacent to the site frontage on Quaker Road. There is no watermain within the First Avenue right-of-way north of Quaker Road. Drinking water is supplied by the Welland Water Treatment Plant (WTP) and pumped to the Shoalt's Drive Reservoir. When the WTP pumps are offline, the area is mainly supplied by gravity by the reservoir, with the Bemis Elevated Storage Tank (located in the southern portion of the City of Welland) system providing supplementary flows. Refer to Figure 2.3 for the existing watermain network.

Associated Engineering's hydraulic modeling of the municipal system, based on increased future demands and without the demands of the NWSP Area, found that under the current operating configuration, the existing municipal water system was unable to maintain adequate pressure due to a mid-morning shutdown at the WTP. The *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report* found that by adjusting the operation of the pumps (i.e. eliminating the mid-morning shutdown) adequate pressure could be maintained throughout the existing system.

When the modeling using the adjusted pump operations schedule included the NWSP Area, it was found that the system would function within the City's operating criteria in all areas below an elevation of 190.0 m. In areas higher than 190.0 m, it was found the hydraulic grade line was too low and an operating pressure of 275 kPa could not be achieved. Further modeling by Associated Engineering found that no modifications to the system could be made to address the low pressure. The Subject Site generally has finished grades in the range of 185m – 187m which enables the system to provide appropriate operation pressures. Refer to Appendix C for the report by Associated Engineering.

2.5.4 Other Utilities

The development will require review by other utility providers for the supply and installation of services including, but not limited to, hydro, gas, and telecommunications (cable and fiber). A desktop review noted that the various utility services (Welland Hydro, Bell Canada, and Cogeco) are currently available on roadside utility poles along Quaker Road. There is a 150-mm-diameter gas main on the northern side of Quaker Road and the eastern side of First Avenue. It is anticipated that each of these utilities will identify their specific requirements through the standard application circulation, review, and design process as required. The utility design process is to be initiated at the same time as the second submission of detailed engineering drawings.

Figure 2.3: Existing Watermain in the City of Welland[3]

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[3] Mapping taken from *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report, page 4.*

2.5.5 Servicing – The Thorold Lands

As previously noted, the upper west half of the Thorold Lands are currently outside Thorold's Urban Boundary, with the lands adjacent to the municipal boundary along the southern portion of the property included in the Urban Boundary and subject to the Port Robinson West Secondary Plan with a residential lands use. Refer to Figure 2.4. Under the current condition, there is no municipal servicing to the property. The City of Thorold's Official Plan notes the Secondary Plan will require the extension of sewer facilities to the area in accordance with the Region's servicing strategy to ensure all new development occurs on the basis of full urban water and sanitary sewer facilities. GM BluePlan has been awarded the task of assessing the City of Thorold water and wastewater systems, rectifying current shortcomings, forecasting impending necessities, and introducing critical enhancements. A draft copy of the *City of Thorold City Wide Water Service Master Plan*, November 2019, has been prepared which outlines the need to extend water service to the Port Robison West Secondary Plan under the Ultimate Buildout design and provides project ID's for the work required to extend the servicing. A report for wastewater is not currently available.

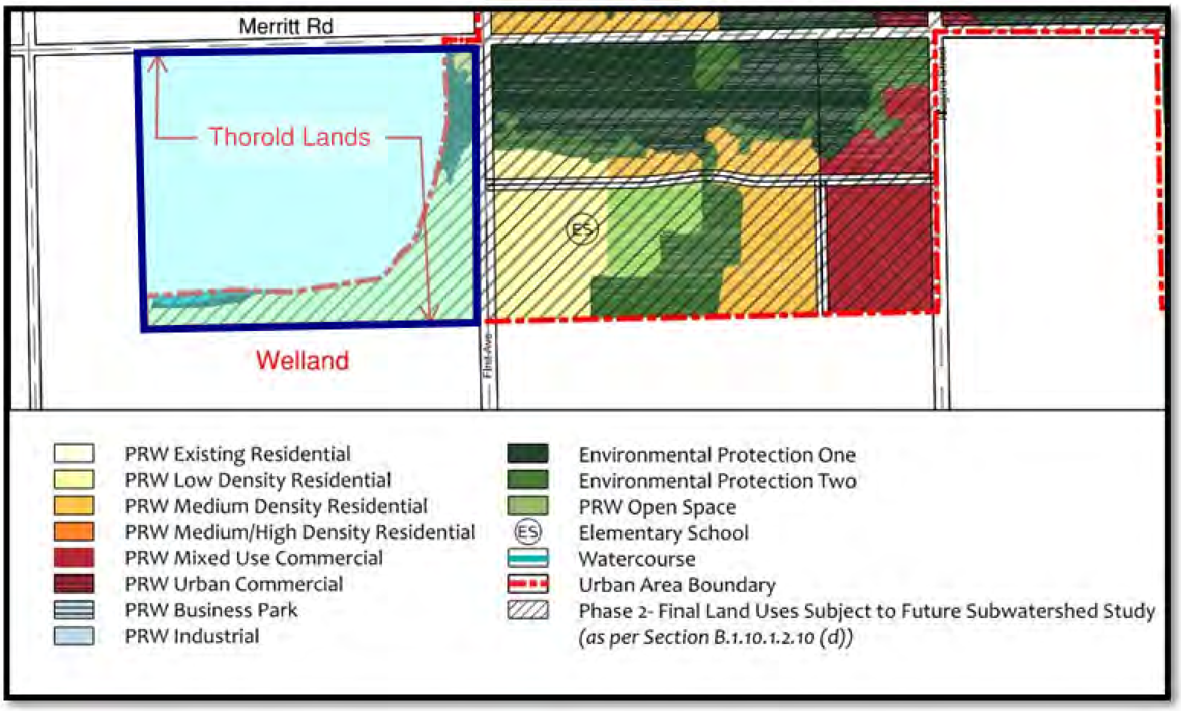

Figure 2.4: City of Thorold Urban Boundary and Land Use [4]

3.0 REVIEW AGENCIES

3.1 City of Welland

The City of Welland will be responsible for the review and approval of the Draft Plan of Subdivision, as well as detailed servicing, grading, and SWM designs for the overall development, including the issuance of the necessary CIL-ECA approvals.

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[4] Base Map taken from Schedule A6- PRW Land Use Plan.

3.2 City of Thorold

As the report discusses the potential servicing of lands located within the City of Thorold's municipal boundary, the City of Thorold will be responsible for reviewing the report and providing comment and approval for the servicing scheme set forth to service the Thorold Lands.

3.3 Niagara Region

Niagara Region will be responsible for the review and approval of the Draft Plan of Subdivision, as well as detailed servicing, grading, and SWM designs for the overall development.

3.4 Niagara Peninsula Conservation Authority

The NPCA will be responsible for the review and approval of the Draft Plan of Subdivision, as well as detailed grading, drainage, and SWM designs for the overall development.

3.5 Ministry of the Environment, Conservation and Parks

The MECP is no longer involved in the Environmental Compliance Approval (ECA) process. The MECP will continue to be responsible for the direct review and approval of Records of Site Condition as may be required.

4.0 PROPOSED DEVELOPMENT

Utilizing the Draft Plan prepared by A.T. Mclaren Limited, and in reference to the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*, WalterFedy has prepared preliminary grading and servicing plans for the Subject Lands. The proponent intends to develop the property into a residential subdivision, including single-detached dwellings (136 units), street townhouses (112 units), a condominium townhouse block (44 units), a condominium mid-rise block (422 units), a channel block for the realignment and channelization of the Towpath Drain, and three stormwater management facilities.

Based on the proposed Draft Plan, the design population was calculated using the population densities outlined in Region of Niagara's 2022 Development Charge By-Law Report. Table 4.1 summarizes the population densities based on the residential unit type.

Table 4.1: Populations Densities

Unit Type	Persons per Unit (ppu)
Single-Family	2.929
Medium/Density	2.093
High Density	1.690
Apartments	
• 2 or more bedrooms	1.991
• 1 bedroom or less	1.214

Utilizing the Region's population densities and the unit counts from the proposed Draft Plan, the design population is summarized in Table 4.2. (Note: a 50/50 split of 1 bedroom and 2+ bedrooms were assumed for the midrise block). Table 4.3 summarizes the population calculations from the NWSP Municipal Servicing Conceptual Design Report (Associated Engineering, December 2023 – See Appendix C), utilizing a density of 110 persons/ha for comparison.

Table 4.2: Populations Densities for Primont Lands

Unit Type	Unit Count	Persons per Unit (ppu)	Total Persons
Outlet to Future First Avenue Sewer from Primont Lands			
Single-Family	0	2.929	0
Medium/Density	19	2.093	40
High Density	0	1.690	0.0
Apartments			
• 2 or more bedrooms	211	1.991	420
• 1 bedroom or less	211	1.214	256
		Sub -Total:	716
Outlet to Quaker Road Trunk Sewer at Street 'A' from Primont Lands			
Single-Family	78	2.929	229
Medium/Density	222	2.093	465
High Density	0	1.690	0.0
Apartments			
• 2 or more bedrooms	0	1.991	0
• 1 bedroom or less	0	1.214	0
		Sub -Total:	694
		Total Design Population:	1410

Table 4.3: Population Calculations from the NWSP Municipal Servicing Conceptual Design Report

Parameter	Northwest Welland Secondary Plan
Developable Area	14.6 ha
Population Density	110 persons/ha
Design Population	1606 persons

5.0 SANITARY SERVICING

5.1 Design Criteria

The City of Welland Municipal Standards state that sanitary flows shall be calculated as per the latest revision of the Region of Niagara Master Servicing Plan. Based on the 2023 Master Servicing Plan update, design flows for the new development were based on a per capita daily flow of 255 l/person/day, and an infiltration rate of 0.286 L/ha; the Harmon formula was used to calculate the peaking factor.

5.2 Sanitary Demands

Refer to Table 5.1 for the sanitary design flow; the design flows from the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report* (Associated Engineering, December 2023 – See Appendix C) are also summarized for reference.

Table 5.1: Subject Lands Sanitary Catchment Parameters

Parameter	**Subject Lands (Total)**	**Outlet to Quaker Road Trunk Sewer at Street 'A'**	**Outlet to Future First Avenue Sanitary**	**Northwest Welland Secondary Plan**
Developable Area	15.5 ha	*12.9ha*	*2.6 ha*	14.6 ha
Population Density	n/a	n/a	n/a	110 persons/Ha
Design Population	1410 persons	*694*	*716*	1606 persons
Peaking Factor (Harmon Formula)	3.70	*3.90*	*3.89*	3.66
Per Capita Design Flow	255 L/c/d	*255 L/c/d*	*255 L/c/d*	275 L/c/d
Dry Weather Design Flow	4.2 L/s	*2.0 L/s*	*2.1 L/s*	5.1 L/s
Peak Dry Weather Flow	15.4 L/s	*8.0 L/s*	*8.2 L/s*	18.7 L/s
Infiltration Rate	0.286 L/s/ha	*0.286 L/s/ha*	*0.286 L/s/ha*	0.286 L/s/ha
Infiltration Flow	4.4 L/s	*3.7 L/s*	*0.7 L/s*	4.2 L/s
Total Design Flow (Q)	**19.8 L/s**	*11.7 L/s*	*8.9 L/s*	**22.9 L/s**

Note: Total Design Flow (Q) for the Street "A" outlet and First Ave outlet can not be added together to calculate the Subject Lands Total Design Flow (Q) based on the Peaking Factor.

5.3 Service Design and System Layout

Under the proposed design concept, servicing for the Subject Lands will be via two new connections to the Quaker Road sanitary trunk sewer. In addition to the Subject Lands, the Region Master Servicing Plan Update (MSPU) identified a new 600-mm-diameter sanitary (WW-SS-002) connection along Quaker Road at the intersection with Rice Road, extending north to Line Avenue. This new connection will redirect approximately 100 L/s of flow from the Town of Pelham (northwest of Line Avenue) to the Quaker Road trunk sewer, ultimately discharging to the Towpath SPS. An analysis was completed as part of the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report* to determine the available capacity within the trunk sewer to service the NWSP Area as well as the additional flows from The Town of Pelham via the Rice Road connection. This analysis found a significant available capacity of a minimum of 130 L/s, which is sufficient to service the subject lands. This included the new Line Avenue connection.

The sanitary servicing concept for the Subject Lands is in general conformance with the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*, including extending a 300-mm-diameter sanitary sewer from the connection to the Quaker Road trunk sewer at the intersection with Street 'A', north along Street 'A' to the intersection of Streets 'A' and 'D', continuing east on Street 'D' to the intersection of Streets 'D' and 'H'. This sanitary system will service 12.4 ha of developable area. Due to cover constraints, a second 300-mm-diameter is proposed from the connection to the Quaker Road trunk sewer, extending north on First Avenue to the intersection of First Avenue and Street 'D', with the sewer continuing west on Street 'D' to the eastern limits of Block 29. The drainage area of this outlet to the Quaker Road trunk sewer would be approximately 2.2 ha. A network of smaller 200-mm-diameter sewers will service the local roads.

It is noted that a review of the as-recorded plan and profile drawings provided by the Region and the sanitary sewer design sheets included in the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report* indicated some inconsistencies in the pipe slopes. As such, the most current information found in the Report was used for the capacity analysis.

5.4 Sanitary System Constraints

The Region's 2023 MSP update included a review of the operational status of the Region's sanitary infrastructure in the sewershed, and noted the following deficiencies and concerns with potential impacts to the development of the Subject Lands:

- The Towpath SPS does not have capacity for wet weather flows under the existing conditions.
- The Foss Road SPS has sufficient capacity to service existing demands, but additional capacity will be required to service the proposed growth in the catchment area.
- The existing 600-mm-diameter Towpath forcemain will need to be commissioned to address growth-related capacity at the Towpath SPS.
- Replacement of the existing 200-mm-diameter Foss Road forcemain with a 250-mm-diameter forcemain will increase capacity and provide operational security.
- The existing Welland WWTP is projected to reach 80% of the operational capacity, triggering the review process, but projected flows are not expected to exceed the 2051 horizon.

Based on the details provided in the Region's MSP update, upgrades to the Towpath SPS (Master Plan ID: WW-SPS-037) to increase capacity from 118 L/s to 600 L/s (Master Plan ID: WW-FM-022) has a "Year in Service" estimate of 2022-2026, with the commissioning of the 600-mm-diameter Towpath forcemain undertaken between 2023-2036. The "Year in Service" estimate for the Foss Road forcemain replacement(Master Plan ID: WW-FM-003), increasing the forcemain from the existing 200 mm diameter to 250 mm diameter, is anticipated between 2027 and 2031. The current MSP also identifies the "Year in Service" for the Foss Road SPS upgrades (Master Plan ID: WW-SPS-011), increasing the station capacity from 25 L/s to 52 L/s, is also between 2027 and 2031.

As previously noted, the Welland WWTP will reach the 80% capacity threshold within the 2036-2041 time horizon, triggering the need for a study of the plant operations in preparation for the design and construction of the required upgrades to increase capacity once the WWTP operating level reaches 90% of its total capacity, which is anticipated after the 2051 horizon.

5.4.1 Thorold Lands

As previously noted, the proponent owns land located north of the Subject Lands in the Port Robinson West Secondary Area in the City of Thorold. These lands are not currently serviced and, based on the City of Thorold's Official Plan, the Secondary Plan will require the extension of sewer facilities to the area in accordance with the Region's servicing strategy to ensure all new development occurs on the basis of full urban water and sanitary sewer facilities. GM BluePlan has been awarded the task of assessing the City of Thorold sanitary systems, rectifying current shortcomings, forecasting impending necessities, and introducing critical enhancements. Based on a desktop review, the nearest regional trunk sewer is located approximately 1.7 km east of the site.

For the basis of discussion, the Thorold Lands are further subdivided based on status as follows:

- East Development Drainage Area TL1, representing the lands within the current City of Thorold Urban Boundary, located immediately north of the Subject lands, east of Block 29, abutting the Thorold and Welland municipal boundary, having an area of 4.2 ha.
- West Development Drainage Area TL2, representing the developable land located in the western portion of the Block and west of the existing wetland which are located outside the urban boundary, having an area of 5.0 ha.

Drainage areas LT1 and LT2 cannot be connected internally with services due to environmental constraints. A connection outlet will need to be provided at both Cataract Road and Merritt Road.

For this analysis, a population density of 60 persons/ha is based on a ratio of 25% townhouse and multi-unit development and 75% single-family residential. This exceeds the minimum gross density population of 50 persons and jobs combined per hectare outlined in the Port Robison West Secondary Plan.

Estimated design flows for the Thorold Lands are summarized in Table 5.3. based on the outlet to the Quaker Road trunk sewer. Given the layout of the available developable lands, it is anticipated that the flows from Drainage Area LT1 will be conveyed to the new connection to the Quaker Road Trunk Sewer at First Avenue via the new sewer on First Avenue, with the flows from Drainage Area LT2 conveyed to the Quaker Road trunk sewer via Street 'A'.

Table 5.3: Thorold Lands Sanitary Catchment Parameters

Parameter	Drainage Area TL1	Drainage Area TL2
Developable Area	4.2 Ha	5.0 Ha
Population Density	50 persons/Ha	70 persons/Ha
Design Population	219 persons	342 persons
Peaking Factor (Harmon Formula)	4.13	4.05
Per Capita Design Flow	255 L/c/d	255 L/c/d
Dry Weather Design Flow	0.6 L/s	1.0 L/s
Peak Dry Weather Flow	2.7 L/s	4.1 L/s
Infiltration Rate	0.286 L/s/Ha	0.286 L/s/Ha
Infiltration Flow	1.2 L/s	1.4 L/s
Total Design Flow (Q)	**3.9 L/s**	**5.5 L/s**

Below is a summary of the work required to provide a sanitary outlet.

Option 1 - Extend Existing Servicing within the City of Thorold

- Extend the existing regional 675-mm-diameter trunk sewer from the terminus on Hansler Road, north through the unopened Hansler Road right-of-way to Merritt Road (360 m),
- Construct a sanitary sewer from the intersection of Merritt Road and Hansler Road, west to the intersection of Merritt Road and Cataract Road (1675 m),
- Construct a sanitary sewer, south from the intersection of Merrit Road and Cataract Road to the limits of the East Development Area (LT1) (525 m), and
- Extend the sanitary sewer west from the intersection of Merritt Road and Cataract Road to the limits of the West Development Area (LT2) (650 m).
- The total length of the required external sanitary sewer = 3,210 m.

If a Sanitary sewer is extended from the terminus on Hansler, it would ultimately drain through the Towpath SPS. A preliminary investigation has been performed to confirm there is appropriate cover to extend the sanitary stub of Hansler Road. The design was completed at a minimum slope of 0.1% to maximize cover. This extension would be achievable. It is noted that all the frontage of Merritt Road is either NPCA-regulated land or existing single-family residences. There will be little-to-no additional sanitary connections along the 1.7 km length.

Option 2 – Extend Sanitary Servicing from the Subject Site to the City of Thorold Boundary

- Extend a sanitary sewer 50 m north from the sanitary sewer on Street 'D' in the proposed development, north through an easement to the southern limits of the Thorold Lands to service the West Thorold Lands and a portion of the South Thorold Lands.
- Extend a sanitary sewer north of the municipal boundary on First Avenue to Cataract Road (100 m) to service the eastern portion of the South Thorold Lands in the City of Thorold.
- The total length of required sanitary sewer to extend service from Welland = 150 m.
- Increased flow to the Quaker Road trunk sewer = 9.4 L/s.

With Option 2, the developable areas will be serviced via the Quaker Road trunk sewer and, as such, a review of the available capacity was completed and confirmed. Capacity within the trunk sewers including the additional catchment areas will all operate within the Regional criteria (sewers flowing at less than 85% of capacity under wet-weather conditions). Flows from the Drainage Area TL2 were included in the collector road drainage area out to the Quaker Road trunk sewer. Flows from Drainage Area TL1 were added to the flows from the east block of Welland which are conveyed down First Avenue to the Quaker Road trunk sewer via the 300-mm-diameter sanitary sewer. Flows have been totaled and shown in Table 5.4 below.

Based on the anticipated development schedule for the Primont Lands and the capacity within the Quaker Road trunk sewer, Option 2 is recommended to service the Thorold Lands. Option 2 eliminates the need for extensive external sanitary sewers and offers more efficient use of existing services over a faster time horizon. It is noted that the flows from both properties were to be conveyed to the Towpath SPS, the increased flows resulting from Option 2 will not increase the capacity deficit at the Towpath SPS.

Table 5.4: Draft Plan (South) Block Sanitary Catchment Parameters with External Catchments from Thorold Lands

Parameter	Outlet at Quaker Road and Street 'A'	Outlet at Quaker Road and First Avenue
Drainage Area	17.9 ha	6.8 ha
Design Population	1036 persons	935 persons
Peaking Factor	3.79	3.82
Per Capita Design Flow	255 L/s	255 L/s
Dry Weather Design Flow	3.1 L/s	2.8 L/s
Peak Dry Weather Flow	11.6 L/s	10.5 L/s
Infiltration Rate	0.286 L/s/ha	0.286 L/s/ha
Infiltration Flow	5.1 L/s	1.9L/s
Total Design Flow (Q)	**16.7 L/s**	**12.4 L/s**

6.0 WATER SERVICING

6.1 Design Criteria

The City of Welland requires that watermain distribution systems be able to convey the larger of the maximum daily demand and fire flow or the peak hourly demand. Additionally, the preferred system operating pressure is between 350 kPa to 550 kPA (50 to 80 psi). The infrastructure standards recommend that the maximum working pressure shall not exceed 690 kPa (100 psi). Pressure-reducing valves are required where localized areas exceed 690 kPa. The minimum working pressure shall not fall below 275 kPa (40 psi) under normal operation conditions nor fall below 140 kPa (20 psi) under fire flow conditions. Fire flows should be considered in accordance with the Fire Underwriter Survey (FUS) 2020.

6.2 Domestic Demand

Calculations of the water demand for the proposed development have been performed using the City of Welland Municipal Standards for watermains. In accordance with the City standards, the average residential demand for the proposed development was estimated using a demand of 320 L/c/day. A peaking factor of 1.5 was used to convert the average daily demand into a maximum day demand. Similarly, a peaking factor of 2.81 was used to convert the average daily demand into the peak hourly demand.

Table 6.1 below summarizes the domestic water demand for the proposed development.

Table 6.1: Domestic Water Demands

Design Population ^{A}	1410 persons
Average Daily Demand	320 L/c/d
Total Average Daily Flow	5.2 L/s
Peaking Factors	
Maximum Day Factor (MDF)	1.5
Peak Hour Factor (PHF)	2.81
Peak Water Demand	
Maximum Day Domestic Demand	**7.8 L/s**
Peak Hourly Domestic Demand	**14.7 L/s**

^{A} Population (P) within Welland as indicated on the Draft Plan concept.

6.3 Fire Flow Demand

In addition to the daily domestic demand for the proposed development, fire flow demands were calculated to assess the adequacy of the proposed watermain system. The City of Welland specifies that all fire flow requirements shall be determined in accordance with the current issue of *Water Supply for Public Fire Protection* published by the Fire Underwriters Survey (FUS) and the Ontario Building Code.

The fire flow demands for the development were assessed based on parameters established as per FUS. Based on current modeling from the Northwest Secondary Plan Municipal Servicing report there is approximately 125 L/s (Figure A-3 of Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report found in Appendix C) of Available fire flow during maximum daily demand. Changes in the pumping procedure at the water treatment plant will increase the available fire flow during maximum daily demand to approximately 140-145 L/s (Figure A-6 of Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report). With the use of non-combustible exterior finishes and 2-hour-rated firewalls every three units the site would require fire flow demands of 110 L/s to 117 L/s. See Appendix F for preliminary FUS calculations. This will be the anticipated construction method for the first phase of the site at Quaker Road until new infrastructure can be installed.

6.4 Service Design and Modelling

It is the intent to service the Subject Lands as per the scheme outlined in the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*; extending a 300 mm diameter watermain along the proposed collector road from a connection on Quaker Road, north and east through the site to First Avenue. A future watermain will be required on First Avenue to complete the looped system on streets A and D and provide adequate flow.

A network of smaller watermains will service the local roads. As per the Watermain Infrastructure Standards, the internal water distribution networks shall be sized to convey the combination of the Maximum Day

Demand (MDD) and the Fire Demand, within the operating pressure and velocity ranges as specified by the City of Welland.

Watermain modeling using the City-wide model will need to be completed on a phase-by-phase basis depending on which municipal upgrades have been completed or are required to be completed to support development. Upgrades to the municipal system will have a large effect on the future available fire flow during MDD based on modeling from the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*. It is anticipated to increase the flow rate 100 L/s in the area of subject lands, this increase will reduce the requirements for non-combustible exterior finishes and 2-hour-rated firewalls on townhouses.

6.5 Water Distribution System Constraints

The subject lands are located within the Welland Northwest Secondary Plan. Upgrades to the City's water distribution system have been discussed in the *Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report*. They included changes in the pumping procedure at the water treatment plant and upgrades to the existing watermains along with additional new looping watermains. These upgrades are summarized below;

- Upgrade the existing 150-mm-diameter main on Rice Road to a minimum of 250 mm diameter.
- A new 300-mm-diameter interconnection (Loop-A) is required to connect the existing 750 mm regional trunk main on Clare Avenue to the existing 300 mm main on Quaker Road.
- A 300-mm-diameter main (Loop-B) branching off Quaker Road, running up the future collector road and then south down First Avenue to Quaker Road. This is required to supply the northern area of the development.
- A north and south connection line to complete loops off Quaker Road.

See Figure 6.1 highlighting areas where upgrades and new watermain are required.

Figure 6.1: (NWSP) Watermain Upgrades[5]

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[5] Figure taken from Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report, March 6, 2024

6.5.1 Thorold Lands

As previously noted, the proponent owns land located north of the Subject Lands in the Port Robinson West Secondary Area in the City of Thorold. These lands are not currently serviced and, based on the City of Thorold Official Plan, the Secondary Plan will require the extension of public water to the area in accordance with the Region's servicing strategy to ensure all new development occurs on the basis of full urban water and sanitary sewer facilities. GM BluePlan has been awarded the task of assessing the City of Thorold water systems as noted previously. The City of Thorold city-wide water service Draft Master Plan identifies the need to extend the Regional watermain at Hansler Road as an ultimate buildout requirement.

Estimated design flows for the Thorold Lands are summarized in Table 6.2. Given the layout of the available developable lands, the Thorold Lands have been subdivided to correspond with the sanitary drainage area plans as follows:

- East Development Area TL1, representing the lands within the current City of Thorold Urban Boundary, located immediately north of the Subject lands, east of Block 29, abutting the Thorold and Welland municipal boundary, having an area of 4.2 ha.
- West Development Area TL2, representing the developable land located west of Block and west of the existing wetland which are located outside the urban boundary, having an area of 5.0 ha.

Table 6.2: North Block Water Demands

Parameter	**Area TL1**	**Area TL2**
Design Population	219 persons	342 persons
Average Day Per Capita Design Flow	320 L/c/d	320 L/c/d
Maximum Day per Capita Design Flow	480 L/c/d	480 L/c/d
Peak Hour per Capita Design Flow	899.2 L/c/d	899.2 L/c/d
Minimum Fire Flow (Multi-Unit Blocks)	133 L/s	133 L/s
Average Day Demand	0.81 L/s	1.27 L/s
Maximum Daily Demand (Q_{MDD})	1.2 L/s	1.9 L/s
Q_{MDD} + Fire Flow	134.2 L/s	134.9 L/s
Peak Hour Demand ($Q_{PEAK.}$)	2.3 L/s	3.6 L/s

As previously noted, the Thorold Lands are currently unserviced by a watermain, with the nearest regional watermain located approximately 1.7 km east of the site. Based on a review of the existing conditions and available servicing, two servicing scenarios are proposed as follows:

- **Option 1 – Extend the Existing Watermain within the City of Thorold**
    - Extend the existing watermain from the terminus on Hanlser Road, north through the unopened Hanlser Road right-of-way to Merritt Road (360 m), (Master Plan ID: W-M-037)
    - Continue the watermain from the intersection of Merritt Road and Hansler Road, west to the intersection of Merritt Road and Cataract Road (1675 m), (Master Plan ID: W-M-038)
    - Construct a watermain, south from the intersection of Merrit Road and Cataract Road to the limits of the East Development Area (525 m), and (Master Plan ID: W-M-040)
    - Extend the watermain west from the intersection of Merritt Road and Cataract Road to the limits of the West Development Area (650 m).
    - The total length of the required external watermain = 3,210 m.

- **Option 2 – Extend Watermain from the Subject Lands Collector Road to the City of Thorold Boundary**
    - Extend a watermain 50 m north from the watermain on the proposed collector road in the Subject Lands, north through an easement to the south limits of the West Development Area.
    - Extend a watermain north on First Avenue to Cataract Road in the City of Thorold (100 m).
    - The total length of the required watermain to extend service from Welland = 150 m

Based on the anticipated development schedule for the Subject Lands, Option 2 is recommended to service the Thorold Lands. Option 2 eliminates the need for extensive external watermain installation and presents potential opportunities to loop the proposed watermain to improve the operating characteristics of the system and offer more efficient use of existing services.

7.0 STORM SERVICING AND STORMWATER MANAGEMENT

The subject lands will be developed into a residential development consisting of single-detached homes, townhouses, and multi-unit blocks, along with related parks and rights-of-way. Based on the current grading and servicing design that was undertaken, it was determined that five stormwater management facilities would be required to service the entire Primont development (North and South Blocks). This report will focus specifically on the SWM requirements and design for the three proposed SWM facilities within the Subject Lands located in the City of Welland. A proposed storm sewer system will collect and convey the 5-year storm from the subject lands and external areas and the proposed road network will convey major system flows to the proposed SWM facilities. The SWM facilities will outlet to the Towpath Drain.

7.1 Stormwater Management Criteria

The proposed SWM features incorporated into the development will be subject to the following criteria:

- Quantity Control – Control post-development peak flow discharge to less than or equal to pre-development discharge.

- Quality Control – In the Aquafor Beech Welland NWSP Stormwater Management Plan (February 2020) an Enhanced (80% total suspended solids (TSS) removal) level of water quality was implemented. Subsequent watershed characterization reporting (Wood, 2022) indicates that the Welland Canal North Watershed is predominantly warmwater fish habitat, which would be more indicative of a Normal (70% TSS removal) level of protection. For the purposes of this report, an Enhanced level of protection was maintained.

- Erosion Control – Provide extended detention drawdown over a 24- to 48-hour period for the 28 mm (4-hour duration) Chicago Storm event. The required 28 mm volume was determined by modeling the typical 25 mm event and then increasing the volume by 12% (28mm / 25mm = 1.12).

7.2 Pre-Development Conditions

The subject lands are located within the Welland Canal North Watershed which drains east via a number of local tributaries to the Welland Canal. The entirety of the Primont lands is bisected by a drainage divide that roughly coincides with the Welland/Thorold municipal boundary (See Figure 7.1 for pre-development drainage plan). The South Block drains to the Towpath Drain, while the North Block drains to Singers Drain. Under pre-development conditions, the agricultural and open space lands drain via sheet flow to the Towpath Drain. A small portion of the future Primont development at the northwestern corner will be located within Singers Drain subcatchment. The pre-development conditions were discretized into seven catchment areas as indicated in Table 7.1 and depicted in Figure 7.1. The drainage boundaries are based on natural drainage divides or are consistent with future internal drainage boundaries. The pre-development conditions were analyzed with the SWMHYMO hydrologic modeling program using a City of Welland 4-hour Chicago Storm distribution. A Curve Number of 74 was used with an initial abstraction of 8.924 mm, consistent with the modeling prepared by Upper Canada Consultants as part of the *Northwest Welland Stormwater Management Implementation Plan* (August 2022). Hydrologic modeling schematics, parameters, and SWMHYMO input/output files are included in Appendix D.

Table 7.1: Pre-Development Catchment Areas

Catchment ID	Description	Area (ha)	Precent Impervious
901	Primont lands south of Towpath Drain	3.06	0
902	Mountainview lands, west of Primont, south of Towpath Drain	3.50	0
602	Rear-yards of existing lots fronting Quaker Road	1.00	30
903	Primont lands north of Towpath Drain	9.49	0
904	External lands, west of Primont, north of Towpath Drain	3.47	0
905	Primont lands on east side adjacent First Ave.	2.55	0
906	Primont lands draining to Singers Drain	0.36	0
Total		**23.43**	**1.3**

The pre-development peak flows for each of the outlet locations as well as the total for the subject site are shown in Table 7.2. These flows will be used to compare with the post-development results.

Table 7.2: Pre-Development Peak Flows (m^3/s)

Storm Event	Lands South of Towpath Drain (901+902+602)	Primont Lands North of Towpath Drain (903 only)	Primont Lands at Northeast (905)	Total to Towpath Drain (All Catchments)	Primont Lands to Singers Drain (906)
25 mm	0.047	0.030	0.011	0.081	0.002
2-year	0.088	0.096	0.036	0.258	0.007
5-year	0.125	0.139	0.052	0.371	0.011
10-year	0.158	0.176	0.067	0.471	0.014
25-year	0.210	0.237	0.090	0.631	0.019
50-year	0.260	0.294	0.112	0.783	0.024
100-year	0.306	0.347	0.133	0.925	0.028

7.3 Post-Development Conditions

The Primont lands will be developed into a residential development consisting of single-detached homes, townhouses, and multi-unit blocks, along with related parks and rights-of-way. The Subject Lands will be serviced by 3 stormwater management facilities. In addition to the Primont lands, external areas west of the development that include the future Mountainview subdivision, existing residential areas, and other open space lands will also be serviced via the Primont development. The post-development conditions were discretized into 13 catchment areas as indicated in Table 7.3 and depicted in Figure 7.2. Hydrologic modeling schematics, parameters, and SWMHYMO input/output files for the post-development condition are included in Appendix D.

Under future, post-development conditions, it is anticipated that external Catchments 701 and 702 will provide their own stormwater management controls when they develop that will outlet directly to Towpath Drain. Under post-development conditions, significant filling would be required to drain and service the property through the Primont lands. As such, the post-development flows from Stormwater Management Facility (SWMF) #2 and the uncontrolled Primont flows for this area of the development were compared to existing conditions of Catchment 903 which only encompasses the Primont lands.

Table 7.3: Post-Development Catchment Areas

Catchment ID	Description	Outlet	Area (ha)	Precent Impervious
101	Primont development	SWMF #1	2.67	70
102	Primont lands draining uncontrolled	Towpath via Quaker	0.39	65
601	Future Mountainview development	SWMF #1	3.13	70
602	Rear-yards of existing lots fronting Quaker Road	SWMF #1	1.00	30
603	Future Mountainview development	Towpath Drain	0.37	40
201	Primont development	SWMF #2	8.16	65
202	Primont development	SWMF #2	3.47	40
203	Primont development	Towpath Drain	0.19	40
204	Primont development	Towpath Drain	0.66	40
701	External lands west of Primont	SWMF #2	2.43	0
702	External lands west of Primont	Towpath Drain	1.93	0
301	Primont development	SWMF #3	2.55	75
205	Primont lands draining to Singers Drain	Singers Drain	0.44	40
Total			**24.04**	**52**

7.4 Water Quantity Control

Development of the existing agricultural and open space lands will increase impervious coverage and produce an increase in stormwater discharge. To mitigate the impacts of increase peak flows, quantity control measures will be implemented within the three SWMFs.

The basic operating levels and control devices for the SWMFs are provided in Tables 7.4, 7.5 and 7.6. Detailed stage-storage-discharge worksheets are provided in Appendix D. The current designs include additional storage capacity to account for volume lost for berms and access roads that will be incorporated into the detailed design. SWMF's #1 and #2 are proposed to be MECP wet pond facilities complete with 1.0-m-deep permanent pools and 1.75 m of active storage depth (1.45 m to the overflow weir). The outlet pipes and overflow weirs for both of these facilities will discharge to the reconstructed portion of the Towpath Drain adjacent to the ponds.

SWMF #3 is proposed to be an MECP continuous flow dry pond with an active storage depth of 2.75 m (2.45 m to the overflow weir). The outlet pipe from the SWM facility will discharge to a proposed storm sewer system on First Avenue that will convey flows south to an outlet at the Towpath Drain. The overflow weir will discharge to the naturalized area south of the pond.

All SWM facilities will have maximum 5:1 interior side slopes and will include maintenance accesses and forebays (if applicable) as part of the final design.

Table 7.4: SWMF #1 Operating Levels (Wet Pond)

Stage	Elevation (m)	Active Volume (m^3)	Cumulative Volume (m^3)
Bottom of Pond	181.65	0	0
Permanent Pool	182.65	0	2008
Extended Detention (28mm)	183.05	1073	3081
Weir Sill	184.10	4746	6754
Top of Pond	184.40	6045	8053
Outlet Controls:	One – 100-mm-diameter low-flow orifice (quality) at elev. 182.65 m One - 375-mm-diameter orifice (quantity) at elev. 183.05 m 8-m-long weir at elev. 184.10 m		

Table 7.5: SWMF #2 Operating Levels (Wet Pond)

Stage	Elevation (m)	Active Volume (m^3)	Cumulative Volume (m^3)
Bottom of Pond	181.65	0	0
Permanent Pool	182.65	0	3127
Extended Detention (28mm)	183.05	1616	4743
Weir Sill	184.10	6990	10117
Top of Pond	184.40	8852	11979
Outlet Controls:	One – 125-mm-diameter low-flow orifice (quality) at elev. 182.65 m One - 300-mm-diameter orifice (quantity) at elev. 183.05 m 8-m-long weir at elev. 184.10 m		

Table 7.6: SWMF #3 Operating Levels (Dry Pond)

Stage	Elevation (m)	Cumulative Volume (m^3)
Bottom of Pond	180.70	0
Extended Detention (MECP)	181.50	747
Weir Sill	183.20	4158
Top of Pond	183.50	5237
Outlet Controls:	One – 75-mm-diameter low-flow orifice (quality) at elev. 180.70 m One - 200-mm-diameter orifice (quantity) at elev. 181.50 m 8-m-long weir at elev. 183.20 m	

Tables 7.7, 7.8 and 7.9 summarize the performance of SWMF's #1, #2 and #3 and show that there is sufficient volume to contain the 100-year storm event, and the 2-year to 100-year, post-development flows from the SWMF's are less than pre-development.

Table 7.7: SWMF #1 Discharge (m^3/s) and Volume (m^3) Summary

Storm Event	Inflow to SWMF	Discharge from SWMF	Storage Required	Ponding Elev. (m)	Total Post-Development Discharge Towpath Drain (Controlled + Uncontrolled)	Pre-Development Lands South of Towpath Drain (901+902+602) [A]
25 mm	0.570	0.011	901	182.98	0.057	0.047
2-year	0.869	0.029	1501	183.19	0.087	0.088
5-year	1.065	0.046	1746	183.27	0.107	0.125
10-year	1.232	0.062	1936	183.33	0.126	0.158
25-year	1.508	0.103	1272	183.11	0.158	0.210
50-year	1.715	0.137	2376	183.46	0.187	0.260
100-year	1.942	0.159	2589	183.53	0.222	0.306

[A] See Table 7.2

Table 7.8: SWMF #2 Discharge (m^3/s) and Volume (m^3) Summary

Storm Event	Inflow to SWMF	Discharge from SWMF	Storage Required	Ponding Elev. (m)	Total Post-Development Discharge Towpath Drain (Controlled + Uncontrolled)	Primont Lands North of Towpath Drain (903 only) [A]
25 mm	0.656	0.014	1104	182.93	0.043	0.030
2-year	1.020	0.026	2000	183.13	0.084	0.096
5-year	1.270	0.042	2436	183.23	0.112	0.139
10-year	1.490	0.058	2779	183.30	0.134	0.176
25-year	1.824	0.092	3244	183.40	0.176	0.237
50-year	2.074	0.119	3629	183.48	0.207	0.294
100-year	2.374	0.134	4017	183.56	0.242	0.347

[A] See Table 7.2

Table 7.9: SWMF #3 Discharge (m^3/s) and Volume (m^3) Summary

Storm Event	Inflow to SWMF	Discharge from SWMF	Storage Required	Ponding Elev. (m)	Pre-Development (905) [A]
25 mm	0.275	0.007	388	181.15	0.011
2-year	0.399	0.010	661	181.40	0.036
5-year	0.477	0.013	796	181.52	0.052
10-year	0.545	0.019	882	181.59	0.067
25-year	0.655	0.027	1003	181.69	0.090
50-year	0.732	0.037	1099	181.77	0.112
100-year	0.814	0.046	1182	181.83	0.133

[A] See Table 7.2

Table 7.10 compares the post- and pre-development flows to Towpath Drain from the overall areas under consideration (Primont and external lands). The results show a reduction in peak flow for the 2-year to 100-year storms under post-development conditions. The 25 mm storm event shows a marginal increase. This is due to the uncontrolled backyard areas around the perimeter of the proposed development that will drain by sheet flow into the adjacent Towpath Drain or wetland (i.e., Catchments 204, 603, and 702) as well as Catchment 102 that drains uncontrolled. These flows alone exceed the 25 mm, pre-development peak flow and are not reduced with additional controls on the SWM facility. Since these flows are sheet drainage distributed around the development, the exceedance will not exacerbate instream erosion.

Table 7.10: Comparison of Post and Pre-Development Flows to Towpath Drain (m^3/s)

Storm Event	Post-Development (controlled + uncontrolled)	Pre-Development [A]	Change in Peak Flow
25 mm	0.105	0.081	+0.024
2-year	0.178	0.258	-0.080
5-year	0.227	0.371	-0.144
10-year	0.268	0.471	-0.203
25-year	0.342	0.631	-0.289
50-year	0.404	0.783	-0.379
100-year	0.475	0.925	-0.450

[A] See Table 7.2

Table 7.11 compares the post and pre-development flows for runoff to Singers Drain from the Primont development area (Catchments 205 and 906, respectively). The results show an increase in post-development flow, but it is not considered significant. Under post-development conditions, the area represents backyards that will sheet flow clean runoff from the lots into a large, naturalized area. The increase in flow is negligible relative to the size of the drainage area serviced by Singers Drain.

Table 7.11: Comparison of Post and Pre-Development Flows to Singers Drain (m^3/s)

Storm Event	Post-Development (205)	Pre-Development [A] (906)	Change in Peak Flow
25 mm	0.019	0.002	+0.017
2-year	0.036	0.007	+0.029
5-year	0.049	0.011	+0.011
10-year	0.058	0.014	+0.044
25-year	0.077	0.019	+0.058
50-year	0.090	0.024	+0.066
100-year	0.103	0.028	+0.075

[A] See Table 7.2

7.5 Water Quality and Erosion Control

Stormwater quality control will be provided by the proposed SWMFs servicing each of the catchment areas. The wet pond facilities (SWMF #1 and #2) will have a permanent pool sized based on MECP "Enhanced" (80% TSS removal) water quality protection. The extended detention component will be based on providing a low flow orifice that will achieve 24 to 48 hours of drawdown time for the MECP extended detention volume (40 m^3/ha) or the 28 mm storm event, whichever is greater. For the proposed wet pond facilities, the 28 mm storm event governs.

Due to small drainage area, Catchment 301 at the northeastern corner of the Primont lands will be serviced by a dry pond facility (SWMF #3) in conjunction with an oil/grit separator (OGS) unit to provide a treatment train. An MECP dry pond (continuous flow) can provide a Basic (60% TSS removal) level of water quality protection. The extended detention component will be based on providing a low flow orifice that will achieve 24 to 48 hours of drawdown time for the entire MECP unit volume or the 28 mm storm event, which ever is greater. For the proposed dry pond, the entire MECP unit volume governs. In order to achieve the minimum Enhanced (80% TSS removal) water quality protection, additional measures will be required to supplement the dry pond. A HydroStorm HS-6 OGS unit, sized based on an ETV particle size distribution, provides 57% TSS removal. The net TSS removal for the OGS unit and dry pond operating in series is 82%. Treatment train calculations for Catchment 301 are provided in Appendix D.

Catchment 102 will drain uncontrolled to the Quaker Road ditch and then to the Towpath Drain. Approximately 830 m^2 of proposed asphalt within Catchment 102 will not have specific quality control other than what is provided within the ditches.

Table 7.12 summarizes the water quality control characteristics for each of the SWM facilities. In addition, SWMF's #2 and #3 will include sediment forebays at the inlets. Additional detailed information and calculations are provided in Appendix D.

Table 7.12: Water Quality Control Summary

Parameter	Stormwater Management Facility			
	SWMF #1	SWMF #2	SWMF #3	
Drainage Area to SWM Facility (ha) and % Impervious	6.80 @ 64.1%	10.71 @ 50.1%	2.55 @ 75%	
Type of SWM Facility	Wet Pond	Wet Pond	Dry Pond and Oil/Grit Unit	Oil/Grit Unit HydroStorm HS-6
Level of Water Quality Protection	Enhanced (80% TSS)	Enhanced (80% TSS)	Enhanced (treatment train) Dry Pond – 60% Oil/Grit Unit – 57% ***Net 82%***	
Total MECP Water Quality Unit Volume (m^3/ha)	211	179	217	
MECP Required Permanent Pool Unit Volume (m^3/ha)	171	139	n/a	
MECP Required Extended Detention Unit Volume (m^3/ha)	40	40	217	
Req'd MECP Permanent Pool Storage Volume (m^3)	1165	1484	n/a	
Provided Permanent Pool Storage Volume (m^3)	2008	3127	n/a	

Parameter	Stormwater Management Facility			
	SWMF #1	SWMF #2	SWMF #3	
Req'd MECP Extended Detention Volume (m^3) [A]	272	428	***553*** [B]	
Req'd 28mm Storm Event Storage Volume (m^3) [C]	***1009***	***1138***	431	
Provided Extended Detention Volume (m^3)	1073	1616	673	
Water Quality Orifice #1 Diameter (mm)	100	125	75	
Water Quality Drawdown (hrs)	45	43	35	

[A] Required MECP based on 40 m^3/ha

[B] For SWMF #3 (dry pond), the entire MECP volume was used as extended detention, which governs over the 28mm event volume

[C] 28mm event volume based on 25mm SWMHYMO results multiplied by 1.12. 28mm event governs for extended detention for SWMF #1 and #2 compared to MECP extended detention volume.

8.0 GRADING

The proposed development will have two vehicular access points, from both Quaker Road and First Avenue, with two future connections at the west end of Street B and Street D. The internal roadway will consist of a 21.0 collector right-of-way which will be designed as a two-lane roadway with two integrated bike lanes. The remainder of the roads will be standard 18.0 m rights-of-way, which will be designed as a two-lane, standard local roadway. Copies of the 21.0 m and 18.0m right-of-way cross-sections are attached in Appendix G.

The grading strategy for the proposed development will ensure a minimum cover over the proposed municipal infrastructure of 0.8 m and a minimum separation of 0.5 m from the seasonal high groundwater to the underside of building footings. The grading will respect the existing grades along the property lines. External drainage for minor events will be collected in the storm sewers. Where a suitable overland flow route cannot be achieved for major storms, the structures and underground storm system will be designed to convey the additional flows. The proposed lot grading will direct runoff onto the municipal rights-of-way, rear lot swales, and ultimately into the proposed storm sewers. Dwellings backing onto environmental areas will convey clean runoff from a portion of the roof and rear yard to the wetland and the channel.

Efforts have been made to minimize the height of the site and ultimately limit the amount of fill required for the development. These efforts include split drainage lots for internal units and walk-out grading for external units. Utilizing additional internal risers will keep the undersides of footings above any groundwater without the use of fill. Adding a second overland flow route and storm connection to SWM Pond 2, along with incorporating a sawtooth road design will all help reduce the amount of fill required. The strategies above help limit the required import of structural fill to 250,000 cubic meters of soil.

Due to the lack of grade change, the proposed channel and wetland which bisects the site, three catchment areas will need to be created to effectively manage the stormwater runoff. The southwestern block will direct stormwater northeast toward a future SWM Facility 1 and channel outlet. The large central block will drain southwest to SWM Facility 2 with outlets to the channel. The remainder of the site in the northeastern corner will be directed southeast to the SWM Facility 3. SWM facility 3 will outlet to a future storm sewer in the First Avenue right-of-way and be conveyed south outleting into the channel on the east side of First Avenue which then flows to the east.

9.0 EROSION AND SEDIMENT CONTROL

A detailed Erosion and Sediment Control Plan will be provided with the submission of the final design drawings for development applications and will be based on the preliminary erosion and sediment control measures recommended herein.

- Erect heavy-duty silt fences before grading or construction adjacent to the woodlot and wetland areas, existing watercourse outlets, and existing road rights-of-way that are down-gradient along the perimeter of the property to protect adjacent and downstream areas from the migration of sediment in any overland flow (in consultation with the environmental Consultant).
- Erect additional (tiered) silt fence along major down-gradient slope areas.
- Provide sediment control basins sized to accommodate 250 m^3/ha of sediment storage at key locations during grading or construction operations in addition to the proposed SWM facility location. These facilities shall be relocated as operations proceed to always mitigate sediment transfer.
- Provide erosion control berms/swales in appropriate/critical areas to divert flows to temporary storage locations (sedimentation basins).
- Provide a stabilized construction entrance feature (‘mud mat’) to minimize the offsite transport of sediment from construction vehicles.
- Install temporary rock check dams in swales, where appropriate, to help attenuate flows and encourage sediment deposition.
- Install erosion control matting on all steep (greater than 3:1) slopes.
- Stabilize all disturbed areas according to OPSS 572.
- During construction, all catchbasins are to be sealed until roads are paved to prevent sediment deposition in the catchbasin sumps and conveyance of silt to the SWM facilities.
- An Erosion Control Implementation Schedule will be included with the Detailed Erosion and Sedimentation Control Plan prepared in conjunction with the pre-grading application and/or final engineering design.

To ensure the effectiveness of the various erosion and sediment control measures, an appropriate inspection and maintenance program is necessary. The inspection activities during construction may include:

- Inspections of the erosion and sediment controls bi-weekly and after each significant rainfall event (greater than 25 mm).
- Inspections should include all silt fence installations, sediment traps, basins, outlets, and vegetation.
- Submission of bi-weekly monitoring reports to the City of Welland and the NPCA during active construction periods.

All erosion and sediment control measures will be removed at the end of construction.

10.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis presented in this report it is concluded that:

- The proposed Draft Plan concept provides linkages for all forms of active transportation within the greater community.
- The proposed Draft Plan concept was developed to respect the natural heritage features located within the subject lands.
- Municipal servicing and roadworks can be designed and constructed in accordance with the City of Welland and MECP standards.
- The subject lands can be serviced with a sanitary sewer network outletting to the existing Quaker Road trunk sewer meeting the design criteria set forth by the City of Welland and the Region of Niagara. Upgrades to the Region's sanitary infrastructure are required to ensure capacity for the demands generated by the development of the Subject Lands.
- Construction of a storm sewer and headwall to outlet SWM pond 3 south in the First Avenue right-of-way to the eastern side of the channel.
- Sanitary Servicing of Thorold Lands can be provided by extending the proposed network from the Subject Lands via future easement from Street 'D' and extending the sanitary sewer on First Avenue from the intersection of Street 'D' and First Avenue, north to Cataract Road in the City of Thorold.
- The construction of two wet ponds and one dry pond SWMFs will provide attenuation of post-development flows to pre-development levels. The wet ponds will provide an Enhanced level of water quality protection while the water quality protection provided by the dry pond will be supplemented by an oil-grit unit. All the proposed SWM facilities will incorporate extended detention/erosion control.

The project will include the extension of the local municipal watermain network with connections at Quaker Road and the future intersection of First Avenue and the proposed collector road to service land within the Subject Lands. Additional water modeling will be required to confirm adequate capacity within the existing and proposed distribution network and ensure the network will operate within the City of Welland's operating criteria. Water modeling will be completed by the City of Welland at the detailed design stage.

- The Thorold Lands can be serviced with watermain via connections to the water distribution system proposed for the Subject Lands. Additional water modeling will be required to confirm adequate capacity within the existing and proposed distribution network.
- Roads are designed and can be constructed as per the City of Welland Engineering Guidelines.
- Existing utilities are present in the area (hydro, telecommunications, and natural gas) and can adequately service the Subject Lands.
- The grading of the lands will ensure cover over the proposed municipal infrastructure, the appropriate separation between the seasonal high groundwater and the underside of footings, and the elevation established along the proposed drainage channel in the southwestern quadrant of the site while respecting the existing boundary grades, and the setbacks or property lines while minimizing the importation of fill.

- Erosion control measures will be required and will be reviewed and designed during the detailed design stage.

10.1 Recommendations

- Therefore, it is recommended, that the preliminary servicing concept presented here be used to support the Draft Plan submissions and that this design be used as the starting point to refine the detailed design for the proposed development.

- This report be circulated to the various approval agencies in support of the Draft Plan of the subject lands.

All of which are respectfully submitted,

WALTERFEDY

LICENSED PROFESSIONAL ENGINEER
22-July-2024
J. G. ORESKOVIC
PROVINCE OF ONTARIO

Eric Salembier
Senior Civil Designer, Civil

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John Oreskovic, P.Eng.
Water Resources Engineer, Civil

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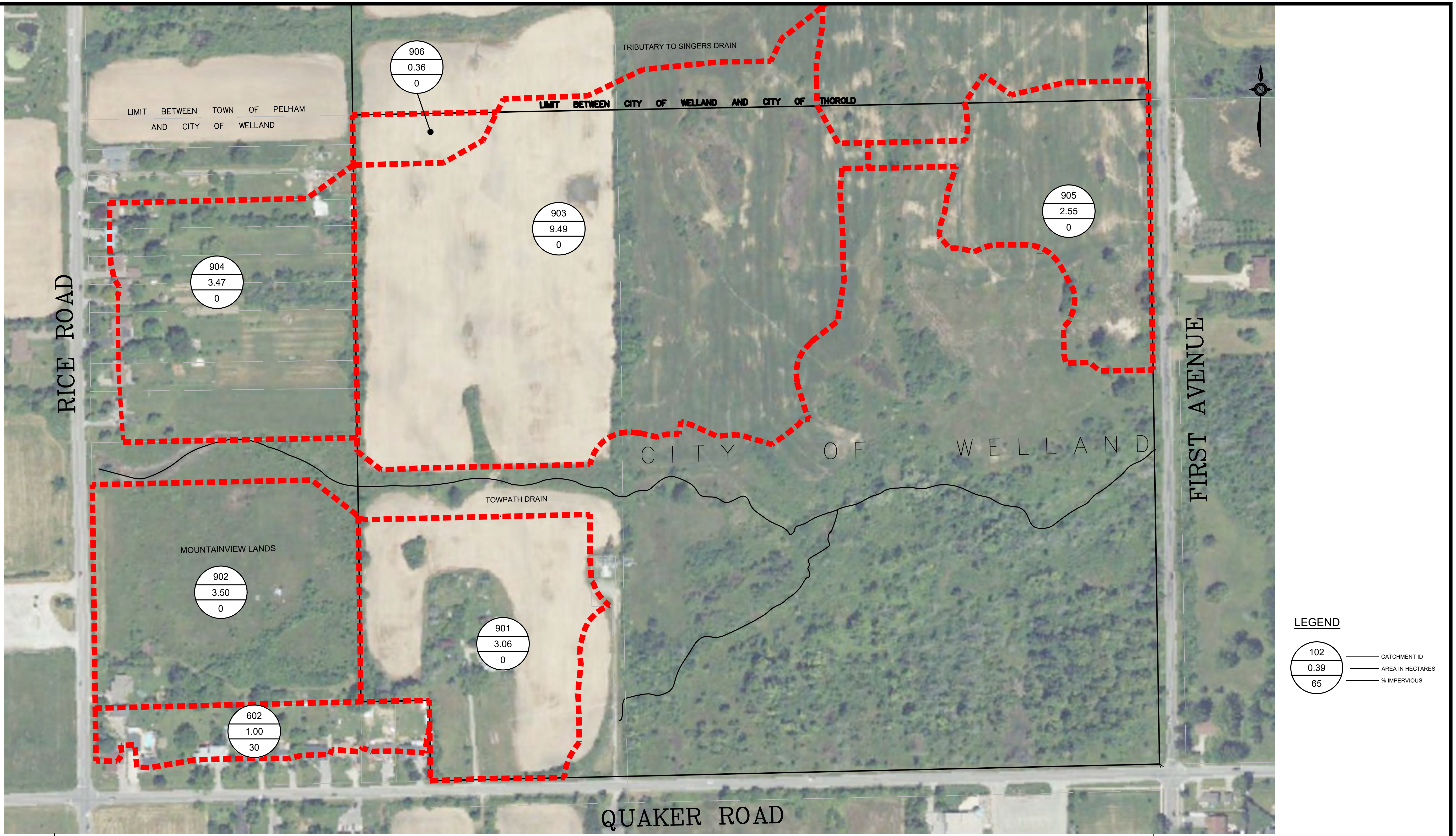

PROJECT:

436 QUAKER ROAD
WELLAND

TITLE:

PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN
WELLAND

REPRODUCTION OR DISTRIBUTION FOR PURPOSES OTHER THAN AUTHORIZED BY WALTERFEDY IS FORBIDDEN. CONTRACTORS SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS AND CONDITIONS ON THE JOB AND REPORT ANY VARIATIONS FROM THE DIMENSIONS AND CONDITIONS SHOWN ON DRAWINGS TO WALTERFEDY. DO NOT SCALE THIS DRAWING.

WALTERFEDY
HAMILTON OFFICE
20 Hughson Street South, Suite 1000, Hamilton, Ontario, L8N 2A1
T: 289.799.3547 **Toll Free**: 800.685.1378 **walterfedy.com**

SCALE:	N.T.S	DATE:	2024-04-05
DRAWN BY:	ES	PROJECT NO.:	2022-0091-10
CHECKED BY:	JO	FILE:	2022-0091-10 SDAP (Pre)
SHEET NO.:			

FIG 7.1

P:\2022\0091\10\03-RPRT\06 2024.02.20 FSR & SWM Report\Appendix\Drawings\2022-0091-10 SDAP (Pre); SDAP (Pre); None; Eric Salembier;
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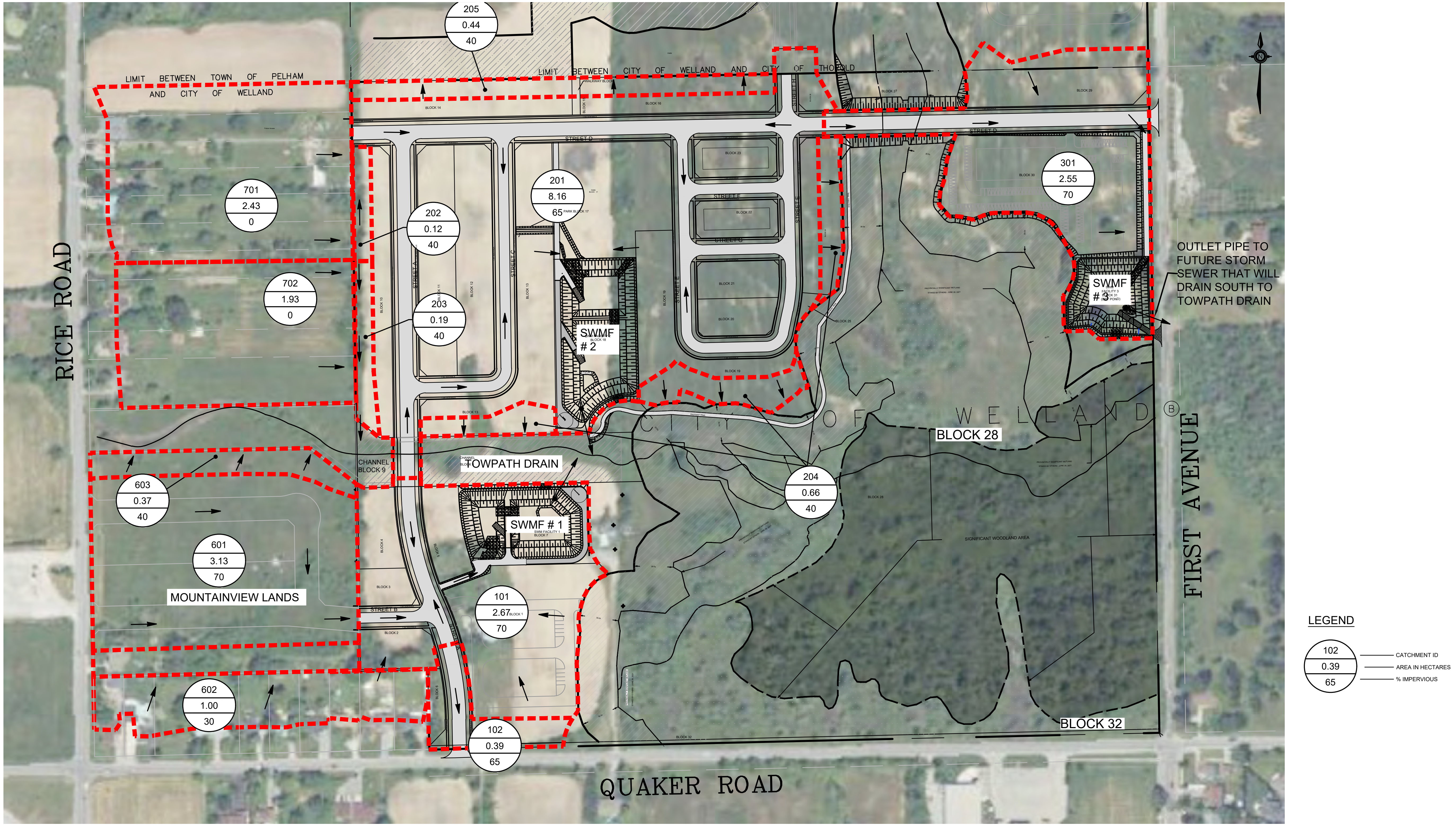

P:\2022\0091\10\05-DSGN\CIVL\Storm\SDAP\2022-0091-10 SDAP; Layout1; None; Eric Salembier; 2024-07-18 10:46:21 AM

PROJECT:

436 QUAKER ROAD
WELLAND

TITLE:

POST-DEVELOPMENT STORM DRAINAGE AREA PLAN
WELLAND

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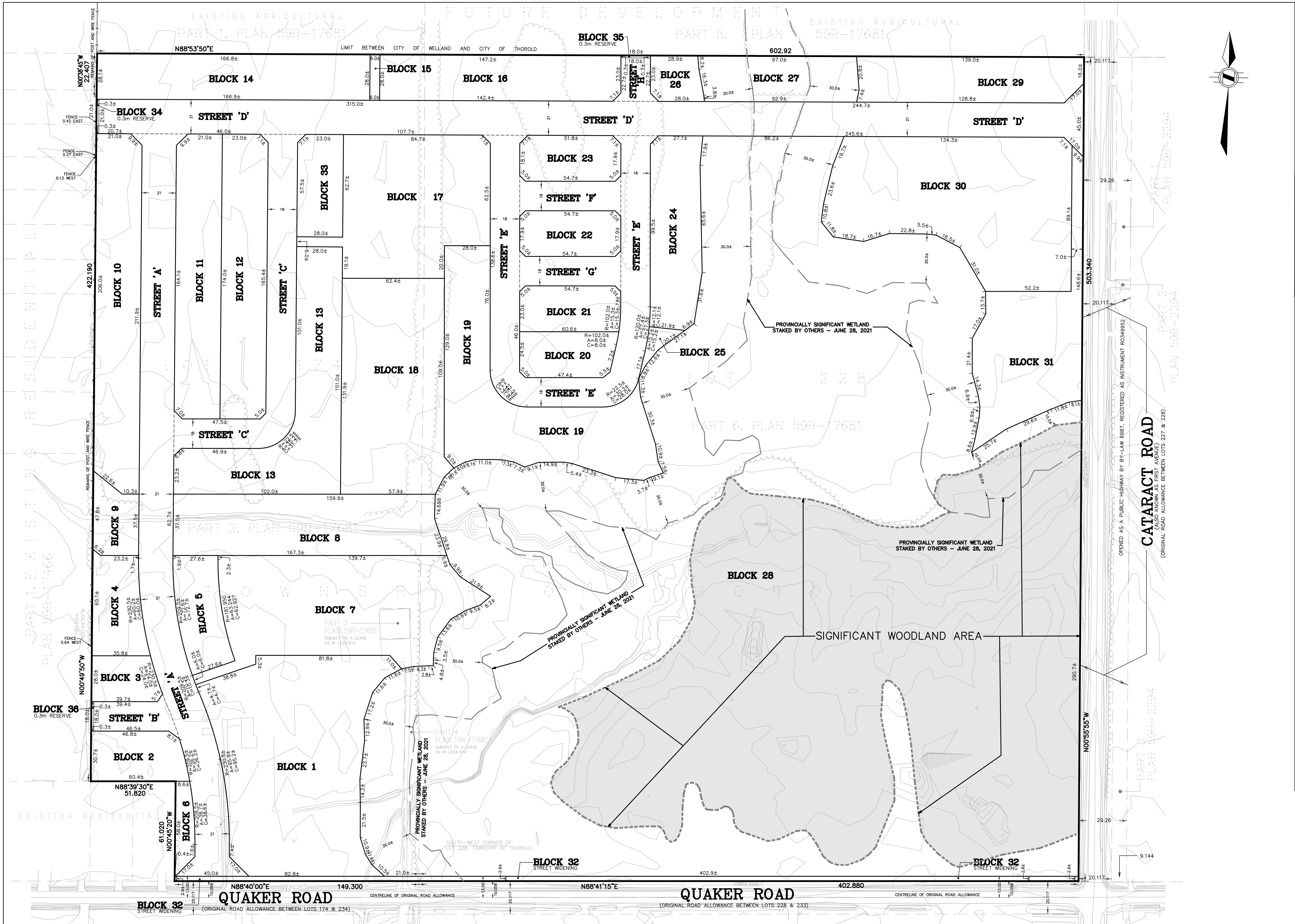
SCALE:	N.T.S	DATE:	2024-04-05
DRAWN BY:	ES	PROJECT NO.:	2022-0091-10
CHECKED BY:	JO	FILE:	2022-0091-10 SDAP

SHEET NO.:

FIG 7.2

APPENDIX A

A.T McLaren Limited Draft Plan of Subdivision

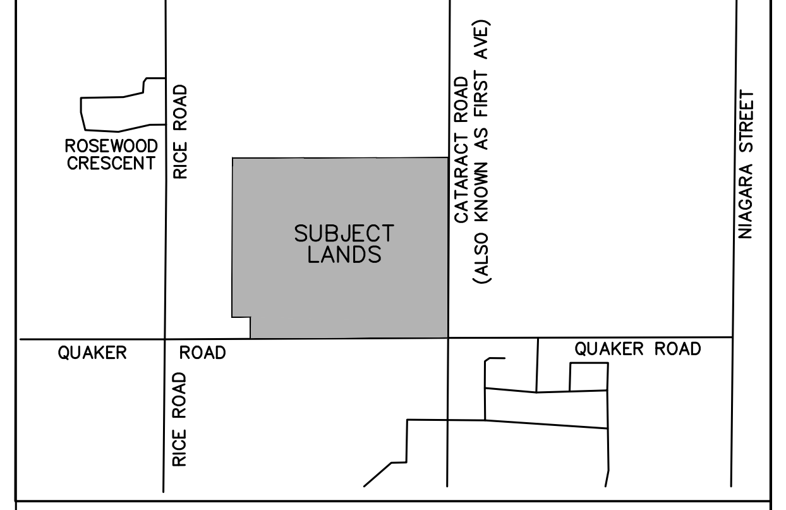


DRAFT PLAN OF SUBDIVISION

PRIMONT (THOROLD / WELLAND) INC.

PART OF TOWNSHIP LOTS 174 AND 228,
GEOGRAPHIC TOWNSHIP OF THOROLD,
IN THE CITY OF WELLAND, REGIONAL
MUNICIPALITY OF NIAGARA

SCALE 1:1000 METRIC



KEY MAP - NOT TO SCALE

INFORMATION REQUIRED

UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O. 1990. c.P.13
AS AMENDED FEBRUARY 21, 2024

(a) - AS SHOWN
(b) - AS SHOWN
(c) - AS SHOWN
(d) - AS LISTED BELOW
(e) - AS SHOWN
(f) - AS SHOWN
(g) - AS SHOWN
(h) - MUNICIPAL WATER
(i) - CLAY LOAM
(j) - AS SHOWN
(k) - MUNICIPAL SANITARY AND STORM SEWERS
(l) - AS SHOWN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

SIGNED ____________________
ROB A. McLAREN, O.L.S
A.T.McLAREN LIMITED

DATE ____________

OWNER'S CERTIFICATE

I HEREBY CONSENT TO THE FILING OF THIS PLAN

SIGNED ____________________

DATE ____________

LAND USE SCHEDULE

LAND USE	LOTS/BLOCKS	UNITS	AREA
LOW DENSITY RESIDENTIAL (FREEHOLD)	BLOCKS 2-5, 10-14, 16, 19, 20-24, 26, 29, & 33	245-275±	6.187± Ha.
LOW DENSITY RESIDENTIAL (CONDOMINIUM)	BLOCK 1	44±	1.197± Ha.
MEDIUM DENSITY RESIDENTIAL	BLOCK 30	422±	1.109± Ha.
PARK LAND	BLOCK 17		0.749± Ha.
OPEN SPACE	BLOCKS 6, 15, 25		0.101± Ha.
STORM WATER MANAGEMENT	BLOCKS 7, 18, & 31		2.307± Ha.
ENVIRONMENTAL AREA	BLOCKS 27 & 28		13.833± Ha.
CHANNEL	BLOCKS 8 & 9		0.723± Ha.
ROADS, RESERVES & WIDENINGS	STREETS A, B, C, D, E, F, G, & H AND BLOCKS 32, 33, 34, 35 & 36		3.937± Ha.
TOTAL		711-741±	30.143± Ha.

METRIC NOTE:
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

No.	DESCRIPTION	DATE	BY
3	ADDED WETLAND/WOODLAND	JULY 11, 2024	KM
2	UPDATED STORMWATER BLOCKS	JUNE 13, 2024	KM
1	ORIGINAL DRAWING	MARCH 15,2024	KM

REVISIONS

A.T. McLaren Limited
LEGAL AND ENGINEERING SURVEYS
69 JOHN STREET SOUTH, SUITE 230
HAMILTON, ONTARIO, L8N 2B9
PHONE (905) 527-8559 FAX (905) 527-0032

Drawn	Checked	Crew Chief	Scale	
KM	RBM	SM	1:1000	Dwg.No. 36920-DP

APPENDIX B

Sanitary Sewer Design Sheet

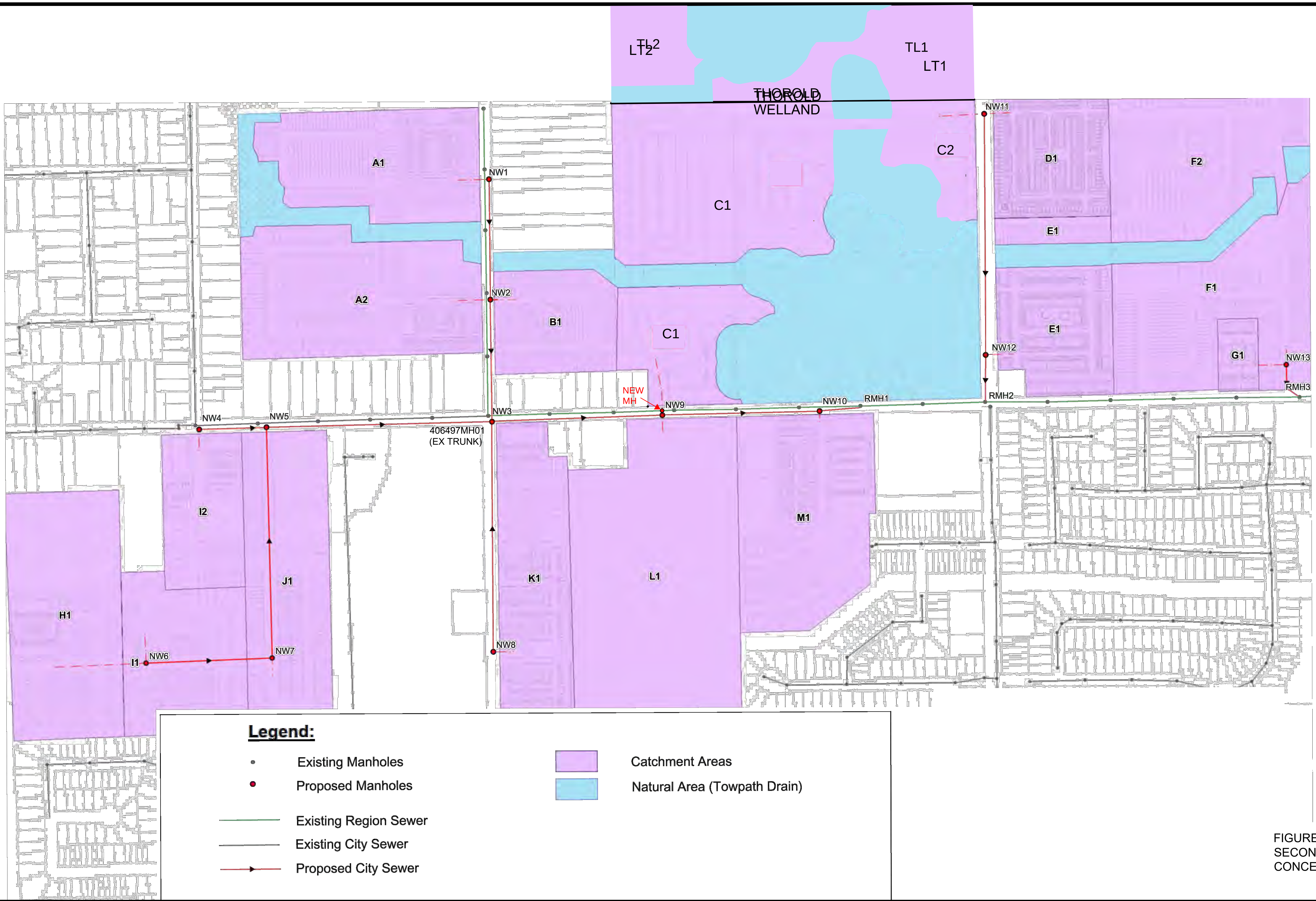


FIGURE 1 TAKEN FROM NORTHWEST WELLAND
SECONDARY PLAN MUNICIPAL SERVICING
CONCEPTUAL DESIGN REPORT, MARCH 22

P:\2022\0091\10\03-RPRT\06 2024.02.20 FSR & SWM
Report\Appendix\Drawings\2022-0091-10_SAN DR AREA; Layout1; None; Eric Salembier;
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PROJECT:

PRIMONT
436 QUAKER ROAD WELLAND

TITLE:

NORTHWEST SECONDARY PLAN MUNICIPAL SERVICING
SANITARY SEWER DESIGN

WALTERFEDY
HAMILTON OFFICE
20 Hughson Street South, Suite 1000, Hamilton, Ontario, L8N 2A1
T: 289.799.3547 Toll Free: 800.685.1378 walterfedy.com

SCALE: NTS
DATE: 2024-03-22
DRAWN BY: ES
PROJECT NO.: 2022-0091-10
CHECKED BY: JO
FILE: 2022-0091-10_SAN DR AREA
SHEET NO.:

FIGURE 1

SANITARY SEWER DESIGN CALCULATIONS

Project:	Primont Lands - Draft Plan Servicing with External Lands in Thorold		
Project No:	2022-0091-10		
Date:	2024-07-19		
Designed By:	E.S.	Checked By:	J.O.

Design Data

Min. Velocity	0.6	m/s
Max. Velocity	3.0	m/s
Manning's 'n'	0.013	
Infiltration	0.286	l/s/ha

Residential

Peaking Factor	Harmon	
Avg. Daily Flow	255	L/c/d

		Pipe Data			**Residential**				**Cumulative**			**Design Flows**				**Infiltration**			**Design Data**				
	Area Number	From	To	Length (m)	Area (ha)	Units	Density (ppu)	Population (people)	Area (ha)	Population (people)	Peak Factor	**DW Flow (L/s)**	**Peak DW Flow (L/s)**	**Add. Peak Flow from the Model (L/s)**	**Cum. Add. Peak Flow from the Model (L/s)**	Area (ha)	Infiltration (L/s)	**Total Flow (L/s)**	Diameter (mm)	Slope (%)	Q_{FULL} (L/s)	V_{FULL} (m/s)	% Full Flow
Rice Rd (N of Quaker)	A1	NW1	NW2	200	6.0			**532**	6.0	532	**3.96**	1.6	6.2	0.0	0.0	6.0	1.7	**7.9**	200	0.64	**26.24**	**0.84**	**30.2%**
Rice Rd (N of Quaker to Quaker)	A2, B1	NW2	NW3	197	10.6			**868**	16.6	1400	**3.70**	4.1	15.3	0.0	0.0	16.6	4.7	**20.0**	250	0.47	**40.77**	**0.83**	**49.2%**
Quaker Rd (W of Rice)	I2	NW4	NW5	112	3.4			**330**	3.4	330	**4.06**	1.0	4.0	0.0	0.0	3.4	1.0	**4.9**	200	0.89	**30.94**	**0.98**	**15.9%**
NWSP (W of Rice, S of Quaker)	H1, I1	NW6	NW7	210	13.8			**938**	13.8	938	**3.82**	2.8	10.6	0.0	0.0	13.8	3.9	**14.5**	200	0.48	**22.72**	**0.72**	**63.9%**
NWSP (W of Rice, S of Quaker)	A4	NW7	NW3	389	7.0			**454**	20.8	1392	**3.70**	4.1	15.2	0.0	0.0	20.8	5.9	**21.2**	250	0.39	**37.14**	**0.76**	**57.0%**
Quaker Road (W of Rice)	-	NW5	NW3	370	-				24.2	1722	**3.64**	5.1	18.5	0.0	0.0	24.2	6.9	**25.4**	250	1.00	**59.47**	**1.21**	**42.7%**
Rice Road, S of Quaker to Quaker	K1	NW8	NW3	387	5.7			**1229**	5.7	1229	**3.74**	3.6	13.6	0.0	0.0	5.7	1.6	**15.2**	200	1.14	**35.02**	**1.11**	**43.4%**
Quaker Road (Rice to W of First)	-	NW3	NW9	287	-			**-**	46.5	4351	**3.30**	12.8	42.4	0.0	0.0	46.5	13.3	**55.7**	375	0.30	**96.03**	**0.87**	**58.0%**
Quaker Road Subject Lands	C1,	NW9	NW10		12.9			**694**															
Quaker Road Primont Lands in Thorold	TL2	NW9	NW10		5.0			**342**															
Quaker Road (Rice to W of First)	L1	NW9	NW10	261	13.0			**1400**	77.4	6787	**3.12**	20.0	62.5	0.0	0.0	77.4	22.1	**84.6**	450	0.20	**127.50**	**0.80**	**66.4%**
Quaker Road (Rice to W of First)	M1	NW10	416547MH01 (RMH1)	69	7.1			**661**	84.5	7448	**3.08**	22.0	67.7	0.0	0.0	84.5	24.2	**91.9**	450	0.20	**127.50**	**0.80**	**72.1%**
Flows from Hurricane SPS/Rice Road (North) - Flow Only			406497MH01											125.0	125.0			***125.0***					
Flows from West of Quaker and Rice			406497MH01											119.0	119.0			***119.0***					
Quaker Road (Region Trunk E of Rice)		406497MH01	416457MH01 (RMH1)	618										0.0	244.0			***244.0***	750	0.22	**522.17**	**1.18**	**46.7%**
Quaker Road (W of First Ave)		416457MH01 (RMH1)	416457MH01 (RMH2)	207					84.5	7448	**3.08**	22.0	67.7	0.0	244.0	84.5	24.2	**268.2**	750	0.16	**445.31**	**1.01**	**60.2%**
Quaker Road (W of First Ave)																							
First Avenue (N of Quaker) Subject lands	C2	NW11	NW12	393	2.6			**716**															
First Avenue (N of Quaker) Primont Lands in Thorold	LT1	NW11	NW12	393	4.2			**219**															
First Avenue (N of Quaker)	D1, F2	NW11	NW12	393	12.2			**1526**	19.0	2461	**3.51**	7.3	25.5	0.0	0.0	19.0	5.4	**31.0**	375	0.25	**87.67**	**0.79**	**35.3%**
First Avenue (N of Quaker)	E1	NW12	416487MH01 (RMH2)	80	4.8			**1123**	23.8	3584	**3.38**	10.6	35.7	0.0	0.0	23.8	6.8	**42.5**	375	0.20	**78.41**	**0.71**	**54.2%**
Quaker Road (First to W of Niagara)	-	416487MH01 (RMH2)	416487MH01 (RMH3)	521	-			**-**	108.3	11032	**2.91**	32.6	94.8	3.0	247.0	108.3	31.0	**372.8**	750	0.23	**533.91**	**1.21**	**69.8%**
NWSP (W of Cataract, N of Quaker)	F1, G1	NW13	416487MH01 (RMH3)	50	10.9			**980**	10.9	980	**3.81**	2.9	11.0	0.0	0.0	10.9	3.1	**14.1**	200	0.44	**21.76**	**0.69**	**64.9%**
NWSP (W of Cataract, N of Quaker)	-	NW14	426407MH03	1320	-			**-**	119.2	12012	**2.88**	35.5	101.9	23.0	270.0	119.2	34.1	**406.0**	750	0.40	**704.10**	**1.59**	**57.7%**
Towpath (to SPS)		426407MH03	426407MH01	1002	-			**-**	119.2	12012	**2.88**	35.5	101.9	50.0	320.0	119.2	34.1	**456.0**	900	0.16	**724.12**	**1.14**	**63.0%**

APPENDIX C

Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report

REPORT

City of Welland

Northwest Welland Secondary Plan
Municipal Servicing
Conceptual Design Report

DECEMBER 2023

REVISIONS PAGE

Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report	
Client:	Engineer:
Upper Canada Consultants	Associated Engineering (Ont.) Ltd.

Revision/ Issue	Date	Description	Prepared by/ Reviewed by	Client Review
1	2023-11-22	Municipal Servicing Report_v1	AL & BB/ RC &MG	
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	Click or tap to enter a date.			
	Click or tap to enter a date.			
	Click or tap to enter a date.			

TABLE OF CONTENTS

SECTION PAGE NO.

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The City of Welland identified the development of the Northwest Secondary Plan as a priority to provide for detailed land use planning policies for a mix of uses, including policies that address infrastructure requirements, and natural and cultural heritage considerations. The Northwest Welland Secondary Plan (NWSP) will guide future growth and development within the study area. This report (previously issued May 2021) reviews background information and provides capacity analysis for existing water, sanitary, and storm sewer servicing in the study area. In addition, an initial assessment was completed for proposed conceptual water, sanitary, and storm servicing. These analyses were used to develop general recommendations for municipal water, sanitary, and storm servicing requirements in the Secondary Area.

1.1 Study Area

The study area (Figure 1-1) includes the land within the urban area boundary of Welland that is bounded by Clare Avenue to the west, Niagara Street to the east, land on the south side of Quaker Road to a depth of approximately 500m to the south and 500m to the north and comprises approximately 190ha. Quaker Road bisects through the Study Area and is identified as an arterial road and all other streets are considered local roads.

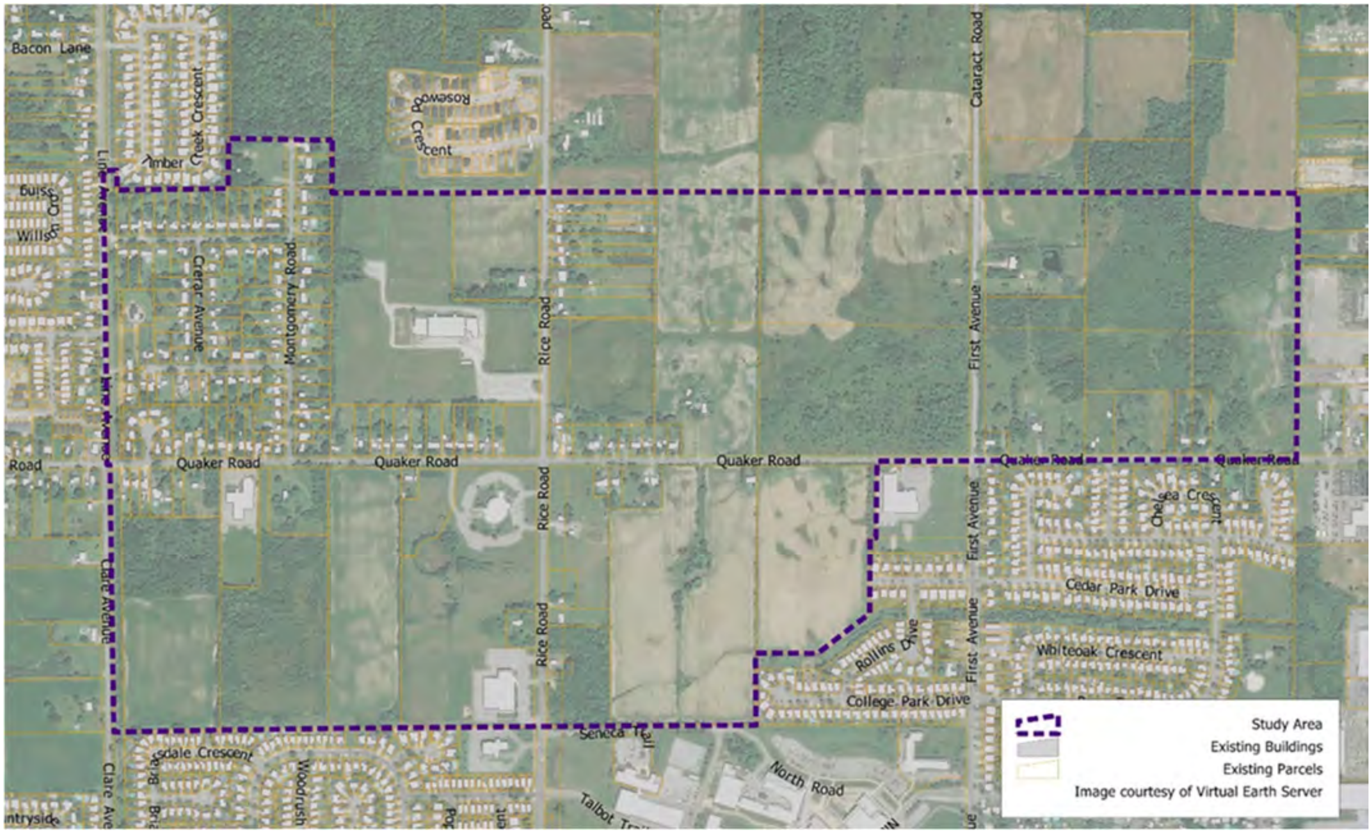


Figure 1-1: Northwest Welland Secondary Plan Study Area

Existing land uses are primarily residential, institutional, agricultural, and open space. Currently, municipal services for water, sanitary and storm exist in parts of the NWSP area, which will be leveraged to accommodate the NWSP area.

1.2 Proposed Secondary Plan

Figure 1-2 shows the proposed NWSP layout provided by Upper Canada Consultants (September 2023). Based on the proposed layout, population and unit numbers for each development block were also provided by Upper Canada Consultants. Projected units and populations are summarized in Table 1-1.

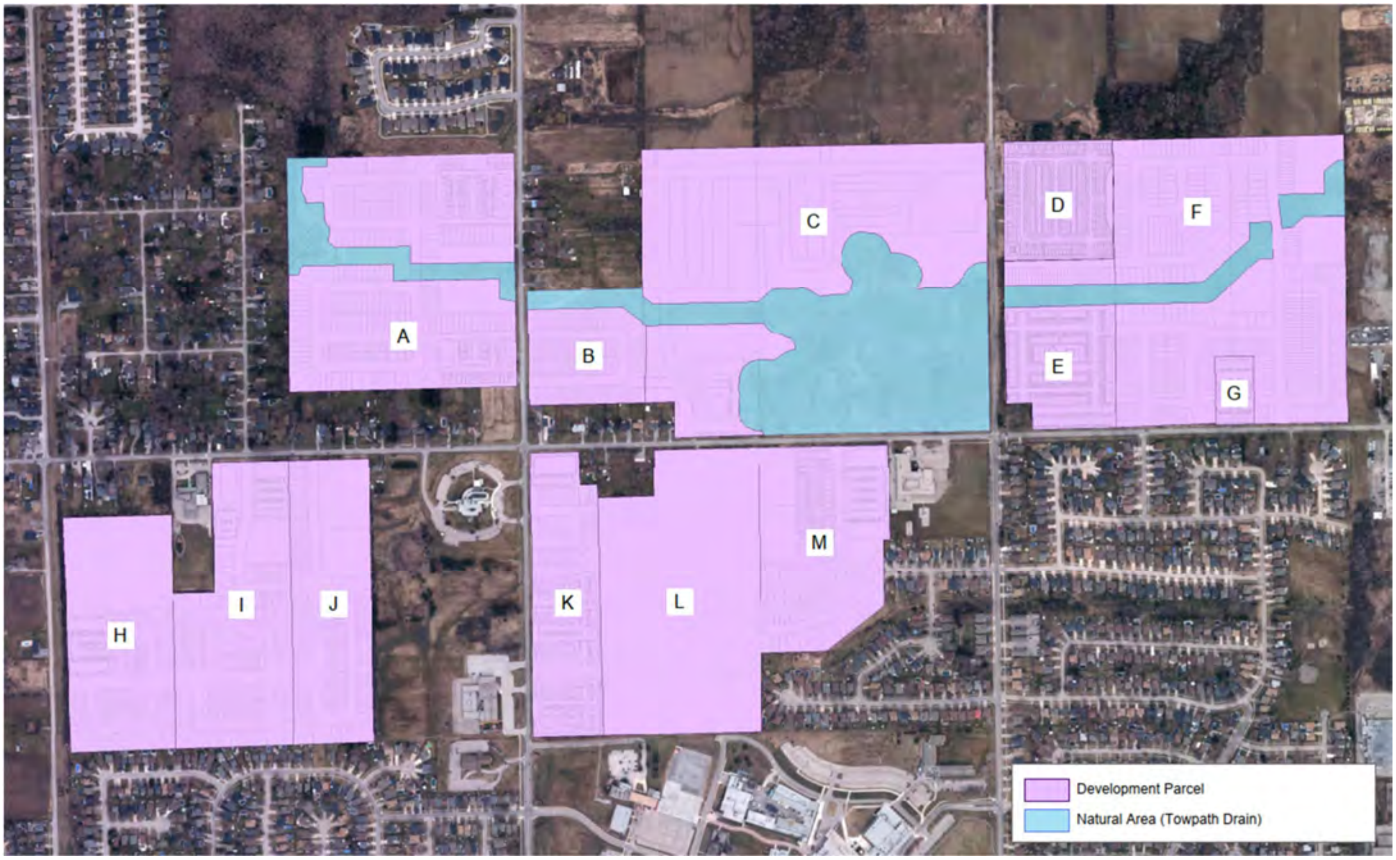


Figure 1-2: NWSP Proposed Population and Unit Plan

Table 1-1: NWSP Population and Unit Numbers

Block Number	Area (ha)	Units	Population (+/-)
A	13.25	386	1,081
B	3.36	114	319
C	18.15	800	2,240
D	4.05	360	1,008
E	4.77	401	1,123
F	17.71	403	1,128
G	0.80	96	269

Block Number	Area (ha)	Units	Population (+/-)
H	8.40	226	633
I	8.79	227	636
J	7.04	162	454
K	5.73	439	1,229
L	13.02	500	1,400
M	7.05	236	661

2 BACKGROUND INFORMATION

2.1 Sources

Table 2-1 provides a list of sources used to aid in completing the analysis of water, wastewater, and stormwater servicing for the NWSP area.

Table 2-1: Water, Sanitary and Storm Data Sources

System	Description	File Type(s)	Author(s)
All	City of Welland Northwest Area Planning and Servicing Study Municipal Class EA	PDF	Earth Tech
All	1m Elevation Contours	SHP	City of Welland
All	City of Welland GIS Data	GIS	City of Welland
All	City of Welland Official Plan	PDF	Dillon Consulting
All	Key Directions Report for the Northwest Welland Secondary Plan Area	PDF	SGL
All	City of Welland Municipal Standards, 2013	PDF	City of Welland
Water/Wastewater	2016 Water and Wastewater Master Servicing Plan Update Hydraulic Model for City of Welland, May 2017	PDF	GM Blue Plan
Water	Welland Water Model (part of the Niagara Region Water Model for the 2017 Niagara Region Master Servicing Plan), 2017	InfoWater	Niagara Region
*Water	City of Welland All Pipe Water Model	InfoWater	City of Welland
Water	Design Guidelines for Drinking-Water Systems, 2008	PDF	MECP
Water	City of Welland Fire Flow Requirements – By Building Zone	PDF	AE

System	Description	File Type(s)	Author(s)
Wastewater	Welland All Pipe Wastewater Model	InfoSWMM	City of Welland/ Niagara Region
*Wastewater	City of Welland Pollution Prevention Control Plan Update & Wastewater Master Servicing Plan, 2020	PDF	GM Blue Plan
*Wastewater	Niagara Region Water and Wastewater Master Servicing Plan Update, 2021	PDF	GM Blue Plan
*Storm	Northwest Welland Stormwater Management Implementation Plan, 2022	PDF	Upper Canada Consultants

*additional/updated data sources since May 2021 Report

2.2 Data Gaps

Data gaps are presented in Table 2-2, which summarizes missing, relevant information that would provide a clearer picture of the existing and future needs of the systems in future steps of this process (i.e. confirmation of criteria to be used in future design of systems).

Table 2-2: Data Gaps

System	Data Gaps	Justification
All	Detailed topographic survey	To confirm elevations for servicing

3 WATER

As the Northwest Welland Secondary Plan (NWSP) has been further developed since the previous study (issued in May 2021), the water service requirements and the hydraulic analysis for the NWSP area have been revisited to reflect these changes. The new site layout information is provided in Figure 1-2 and Table 1-1 of this report which indicate the change/increase in the population and unit numbers. In general, the existing configuration and operation of the water network surrounding the NWSP area has not changed since the issue of the original report which is described below.

Water servicing in the Niagara Region is a two-tiered approach; Niagara Region has jurisdiction over the drinking water supply for homes and businesses throughout the Region and is responsible for treatment, storage, pumping, and trunk watermains. The City of Welland is responsible for the local distribution system.

Currently, the area surrounding the proposed development is pipe fed from the Welland Water Treatment Plant (WTP) to the Shoalt’s Drive Reservoir and surrounding area. During periods where the WTP is offline, the area is predominately supplied by gravity from the Shoalt’s Reservoir. The Welland system also has an elevated storage tank (Bemis) located in the southern portion of the distribution system.

The existing system configuration within the study area, including existing pipe diameters, is shown in Figure 3-1. Within this area there is a small existing development east of Line Avenue and north of Quaker Road. This area, which was built in 2002, consists of 150mm PVC watermain connecting to both the 750mm CPP on Line Avenue to the west and the 300mm CI on Quaker Road to the south. In addition, there is a 150mm existing main on Rice Road (north of Quaker

Road) which appeared to serve few properties. There are also existing properties along Quaker Road, which are serviced off the 300mm main.

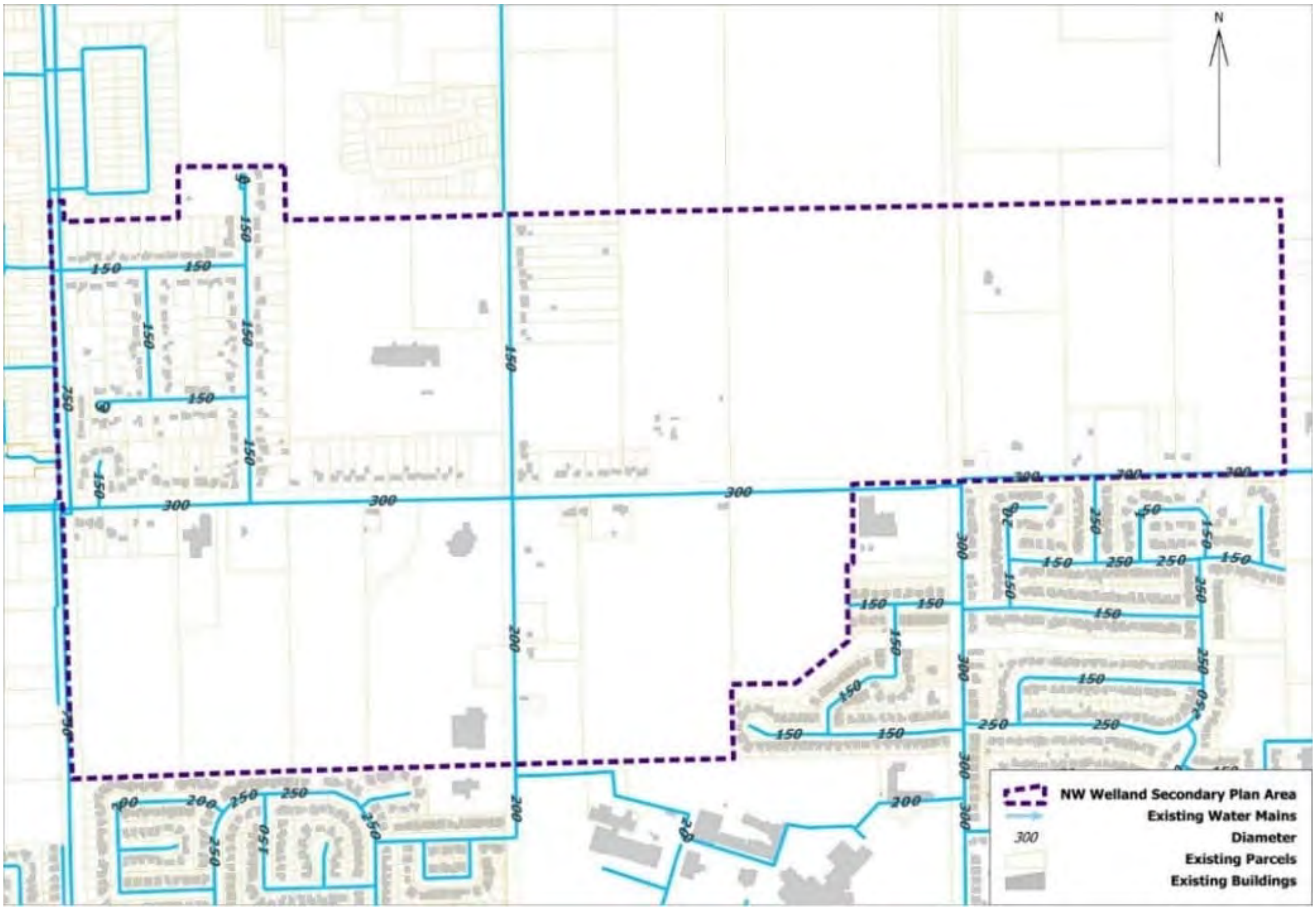


Figure 3-1: Existing Configuration of Watermains in Study Area

3.1 Design Criteria

The design criteria used for the analysis of the existing water system, includes:

- Target normal operating pressures:
  - Preferred system pressure between 350 kPa to 550 kPa (50 to 80 psi)
  - Minimum system pressure to be greater than 275 kPa (40 psi)
  - Maximum system pressure to be less than 700 kPa (100 psi)
- Fire flow requirements during MDD with 140 kPa (20 psi) residual system pressure:
  - Parks: 67 L/s
  - Low Density Residential (Single Family Residential): 67 L/s
  - Medium Density Residential (Townhomes): 133 L/s
  - Multi-Use: 133 L/s
- Per capita demand: 320 L/cap-day
- Peaking factors as per the City of Welland Model, as follows:
  - Maximum Day Demand peaking factor: 1.5
  - Peak Hour Demand peaking factor: 1.87 (2.81 x Average Day Demand)

- ADD and MDD demand patterns as per City of Welland Model
- C-Factor for new pipes: 140

3.1.1 NWSP Demands

Table 3-1 summarizes the new demands assigned within the model for the NWSP area. These demands were calculated based on the newly proposed populations/units previously identified in Table 1-1 and design criteria noted in Section 3.1.

Table 3-1: New NWSP Demands

Junction ID	ADD (L/s)	MDD (L/s)	PHD (L/s)
814	1.18	1.77	3.32
951	5.19	7.78	14.57
1700	1.00	1.50	2.80
3952	2.35	3.52	6.59
8338	2.00	3.00	5.63
8622	4.55	6.83	12.79
8623	2.77	4.15	7.77
J_FUT_47	3.73	5.60	10.49
J_NWSP_1	2.36	3.53	6.62
J_NWSP_3	1.68	2.52	4.73
J_NWSP_6	2.00	3.00	5.63
J_NWSP_8	2.77	4.15	7.77
J_NWSP_9	2.77	4.15	7.77
J_NWSP_10	4.16	6.24	11.69
J_NWSP_13	4.18	6.27	11.74
J_NWSP_16	2.45	3.67	6.88
TOTAL	45.12	67.69	126.80

3.2 Existing System Conditions

The City of Welland (City) provided Associated Engineering (Associated) with their most up-to-date InfoWater model (WELLAND_WATER_2023, dated October 23, 2023) for this analysis. The City's model includes both existing and future Average Day Demand (ADD) and Maximum Day Demand (MDD) extended period simulation scenarios. Model data sets suggest that the existing demand scenarios in the model were last reviewed and updated in 2022.

The earlier study reviewed and commented on the Niagara Region & City of Welland InfoWater models for their future development growth, giving an insight into the future development areas of the region. It has been assumed that this information still applies despite the time passed since that report.

No quality control checks were conducted on the City's model; it was assumed that the model is sufficiently calibrated for the purpose of this analysis and is indicative of the current system.

Figures for this section can be found in Appendix A. Table 3-2 shows the existing and current future pumping schemes from the City's model (on/off settings) at the WTP for both ADD and MDD scenarios. No changes were made to these settings for the development analysis.

Table 3-2: Existing and Future WTP Pump Settings – City's InfoWater Model

Pump	Existing ADD	Existing MDD	Future ADD	Future MDD
Low Flow Pump #1	On at 0:00 Off at 6:00	Off at 0:00	Off at 0:00 On at 11:00	Off at 0:00 On at 20:00 Off at 22:00
Low Flow Pump #2	Off at 0:00	Off at 0:00	Off at 0:00 On at 20:00	Off at 0:00
High Flow Pump #1	Off at 0:00 On at 13:00	On at 0:00 Off at 7:00	On at 0:00	On at 0:00 Off at 2:00 On at 5:00
High Flow Pump #2	Off at 0:00	Off at 0:00 On at 12:00	On at 0:00 Off at 3:00 On at 6:00 Off at 20:00	On at 0:00 Off at 2:00 On at 5:00

3.2.1 Current Hydraulic Conditions

A hydraulic analysis of the existing system was completed to provide a baseline level of service to compare to the future development scenarios.

Figures A-1 and A-2 show the minimum pressure during existing ADD and MDD in the study limits and surrounding area. At certain locations within the study area, pressures are lower than the required minimum pressure of 275 kPa (40 psi). These low-pressure nodes are in proximity to the Shoalt's reservoir and occur during peak periods; simulation time 11am to 12 noon for ADD and 10am to 11am for MDD. The observed minimum pressures in this portion of the study area for ADD and MDD are 233 kPa and 211 kPa, respectively, and are thought to be due to high ground elevations (maximum of 193m) and fluctuations of the Shoalt's Drive Reservoir head (between 217.0m and 219.0m). As to be expected during higher demands, more low-pressure nodes were observed in the surrounding study area during MDD scenario than ADD. There were also few low-pressure nodes observed in the other future growth areas of the system.

Figure A-3 shows the available fire flow during MDD at a residual pressure of 140 kPa (20 psi). Certain portions of the study area, specifically Rice Road north of Quaker Road, and the dead ends on Montgomery Road, Topham Boulevard, and Crerar Avenue have available fire flows less than 67 L/s (as low as 13L/s). The low availability of fire flows is due to both the high ground elevation and the size of the watermains supplying these hydrants. There are also other nearby areas with less than 67 L/s of available fire flow for similar reasons.

3.2.2 Future Conditions without NWSP Development

In the existing model from the City, it was observed that the future model scenario included NWSP infrastructure and demands based on the previous study. A total of 48.7 L/s for future ADD and 73.1 L/s for future MDD was allocated in the NWSP region at the model junctions summarized in Table 3-3 below.

Table 3-3: Identified Previous NWSP Demands from the City's Model

Junction ID	Future ADD (L/s)	Future MDD (L/s)
3952	1.00	1.07
567	3.15	4.72
812	2.52	3.77
815	3.86	5.79
818	4.01	6.02
8622	1.18	1.77
8623	5.35	8.03
J-FUT-47	10.10	15.16
J-FUT-48	2.14	3.21
J-FUT-49	5.58	8.37
J-FUT-50	6.08	9.12
J-FUT-51	4.03	6.05
Total	49.00	73.08

To prevent "doubling up" on NWSP demands, the previously proposed infrastructure for NWSP has been removed from the future analysis.

Figures A-4 and A-5 show the minimum pressure during future ADD and MDD, without the NWSP development. As these figures show, a significant improvement in pressures was noted in the surrounding study area when compared to the existing scenarios, with only a small number of low-pressure nodes noted. This is due to the change in the pumping procedure at the WTP for the future scenario. The existing and future pump operations at the WTP have been summarized in Table 3-2 above.

Figures 3-2 and 3-3 below show the hydraulic grade (HG) for Shoalt's and Bemis tanks for the existing and future MDD Scenarios. The pumping operating procedure at the WTP for the existing scenario shuts down the pumps mid-morning, coinciding with periods of higher system demand. During this mid-morning WTP shutdown, both the Shoalt's Drive Reservoir and the Bemis Elevated Tank levels are drawn down; this draw down is sharp and reaches its lowest hydraulic grade level (HG) around noon. However, with the current future pumping scheme at WTP, the HG at Shoalt's and Bemis shows a sustained hydraulic head after 6 am showing improved pressures in the surrounding study area.

The future pumping schemes in the model for ADD and MDD scenarios showed improved pressures surrounding the study area which appeared to resolve most of the low-pressure nodes that were highlighted in existing scenarios. A few low-pressure nodes still persisted surrounding the study area particularly nodes close to the Shoalt's reservoir.

An attempt was made to assess the future system by changing the current future pumping scheme for MDD scenario by altering the pumping hours at pump H-1 (On at 0:00 and Off at 2:00) which showed improved pressures in the reservoir area but not completely eliminated. As modification of pumping schemes is outside of the scope of this analysis, this would need to be confirmed by the City when adjusting the overall system configuration and settings.

Figure A-6 shows the available fire flow during future MDD prior to the proposed development. Parts of the surrounding study area on the south and east sides showed sufficient fire flows as required for multi-family residential housing (133 L/s) however, the nodes at Shoalt's reservoir area have less than the design standard of 67L/s as needed for the single-family housing.

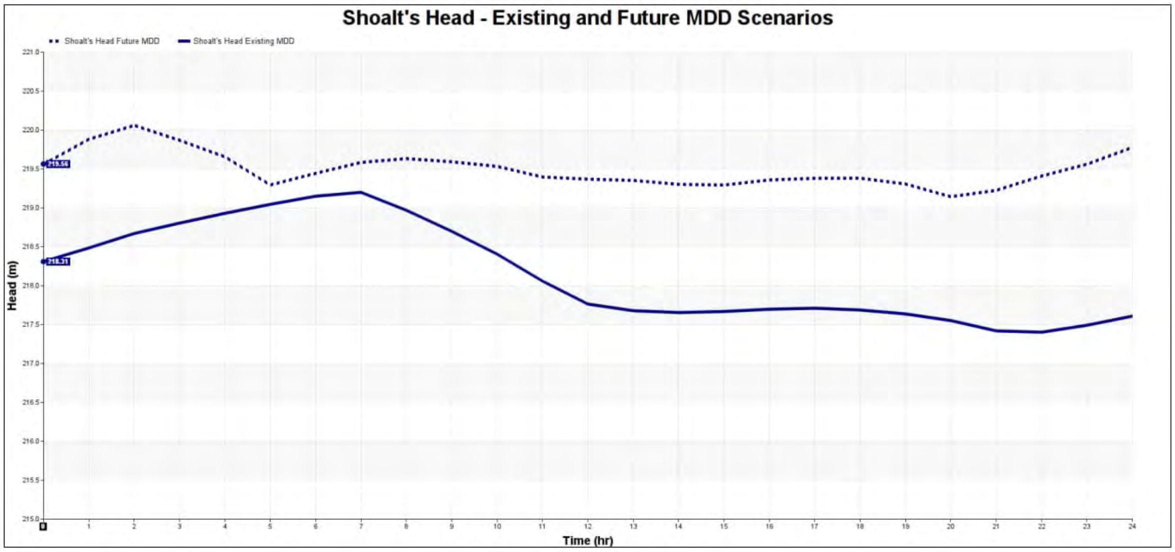


Figure 3-2: Shoalt's Head – Existing and Future MDD Scenarios

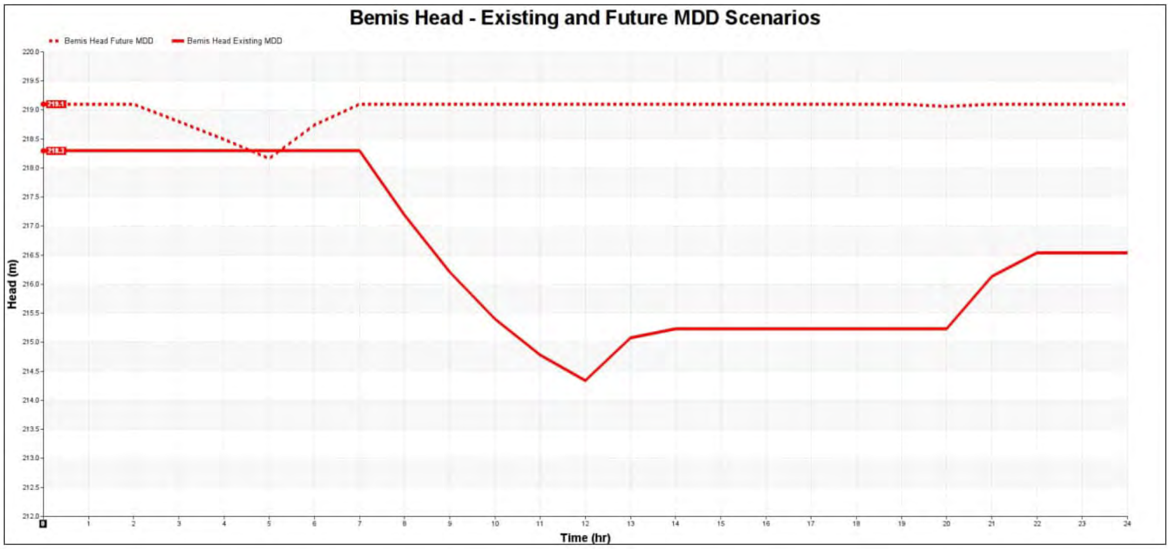


Figure 3-3: Bemis Tank Head – Existing and Future MDD Scenarios

3.3 Proposed Development

Several pipes and junctions were added to the City of Welland InfoWater model to represent future servicing of the NWSP area. The hydraulic analysis was conducted by adding the proposed NWSP infrastructure to the "Future ADD and MDD Scenario" and the associated development demands were imposed on the newly added junctions as shown in Figure 3-4 below.

The proposed pipe routing is laid based on new NWSP site layout as shown in Figure 1-2 in Section 1.0 of this report. As the existing 300mm main on Quaker Road acts as a main supply line for this study area, the proposed mains for NWSP were mainly branched and looped out from this main to service the proposed development. Note that only significant pipes that will connect the NWSP site were included in the model. There will be additional future piping required along local roads upon finalization of the site layout.

Junction elevations for the newly added nodes in the study area were assigned based on the City of Welland 1 m contours. Pipe sizing shown was established as part of the hydraulic analysis.

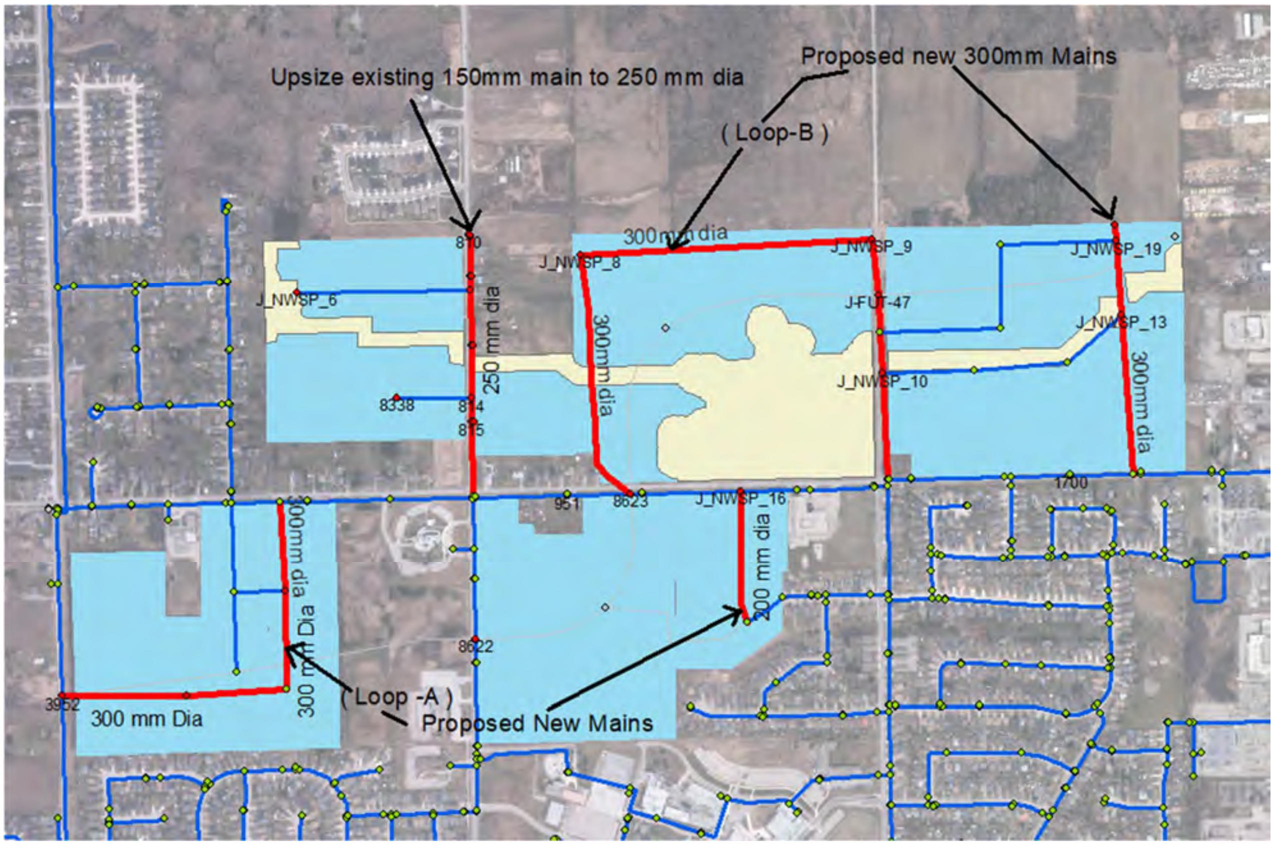


Figure 3-4: Proposed Junctions and Pipes

3.3.1 Storage Requirements Review

A review of the City of Welland's overall storage capacity and existing and future storage requirements was conducted to determine the impact of the NWSP area on future storage needs. As per the MECP Design Guidelines for Drinking Water Systems, storage requirements for a water distribution system are as follows:

- Equalization Storage (A) = 25% of Maximum Day Demand
- Fire Storage (B) = 378 L/s for 6 hours (Based on MECP Equivalent Population Fire Flow Requirement)
- Emergency Storage (C) = 25% of A +B

Table 3-4 summarizes the total available storage identified in the Region Master Plan (as used in the previous report) and the calculated existing and future storage needs for the system based on the City of Welland model demands. As shown, there is sufficient storage in the Welland system to allow for the addition of the NWSP area. The total additional storage required for the addition of the NWSP area is 1.8 ML.

Table 3-4: Available and Required Water Storage

Description	Storage (ML)
Total Available Storage	37.0
Existing Required Storage	19.7
Future Required Storage without NWSP (a)	26.4
Future Required Storage with NWSP (b)	28.2
Required Additional Storage for NWSP (b-a)	1.8

3.3.2 Hydraulic Analysis

As discussed in Section 3.1.1 and 3.3, the ADD and MDD demands for the proposed NWSP development have been added to the Futures ADD and MDD scenarios. The hydraulic analysis then was carried out with NWSP future demands to identify the impact of this proposed development on the future system and to confirm the required pipe size to support the future NWSP development.

Figures A-7 and A-8 show the minimum pressure during ADD and MDD EPS, and Figure A-9 shows the available fire flow, with the NWSP area serviced with the proposed watermain sizes identified.

As these figures show, the addition of NWSP area to the future system does not significantly impact the surrounding system pressures, instead the proposed servicing has shown improved pressures over Future ADD and MDD when no NWSP development was added. However, as with the other modelled scenarios, there are low pressure nodes near Shoalt’s Drive Reservoir area, however no exacerbation of low pressures was noted when the NWSP development was added.

To supply suitable fire flow to the NWSP areas that will be serviced off Rice Road, the existing 150 mm diameter watermain on Rice Road needs to be upgraded to 250 mm diameter. Additionally, to supply south-west part of the proposed NWSP development, a new 300 mm diameter interconnection (Loop-A) is required to connect the existing 750mm regional trunk main on Clare Avenue to the existing 300mm main on Quaker Road. A new 300mm diameter main (Loop -B) branching off from Quaker Road and looping back to supply north of the NWSP development will also be required.

Figure A-9 shows that most of the NWSP study area meets fire flow requirements of 67 L/s for single family housing and 133 L/s for medium density housing. A detailed site layout for NWSP currently is not available and it is assumed that the proposed development will have a mix of single family and multi family housing.

Overall, with the proposed NWSP development the system shows improved operating pressures except in the low-pressure areas previously identified. Improved fire flows were also noted around the NWSP study area with the proposed pipe servicing, both within and outside the development boundaries.

4 SANITARY

Sanitary servicing in Niagara Region is based on a two-tiered approach. The Region is responsible for the wastewater treatment plants, trunk sewers, pumping stations and forcemains. The City of Welland is responsible for the local gravity sewer system.

The sanitary sewage from the NWSP area will ultimately be treated at the Welland Wastewater Treatment Plant (WWTP). This WWTP services the City of Welland, Town of Pelham, and the Port Robinson area of the City of Thorold.

The existing sanitary services in the NWSP area includes a regional main down Rice Road, local main in the Montgomery subdivision, and local and regional (trunk) sanitary sewer along Quaker Road. Primary sanitary sewage flows south down Rice Road, and then east down Quaker Road to Towpath Road. Sanitary sewage then flows northeast along Towpath Road to Towpath Sewage Pumping Station (SPS). Towpath SPS receives gravity flow from the regional trunk sanitary sewer along Quaker Road and flows from Hurricane Road SPS (Rice Road). Sewage from Towpath SPS is pumped through a forcemain across the Welland River to a gravity system, which ultimately flows to the Welland WWTP. A schematic of the existing sanitary servicing within the NWSP study area is provided in Figure 4-1.

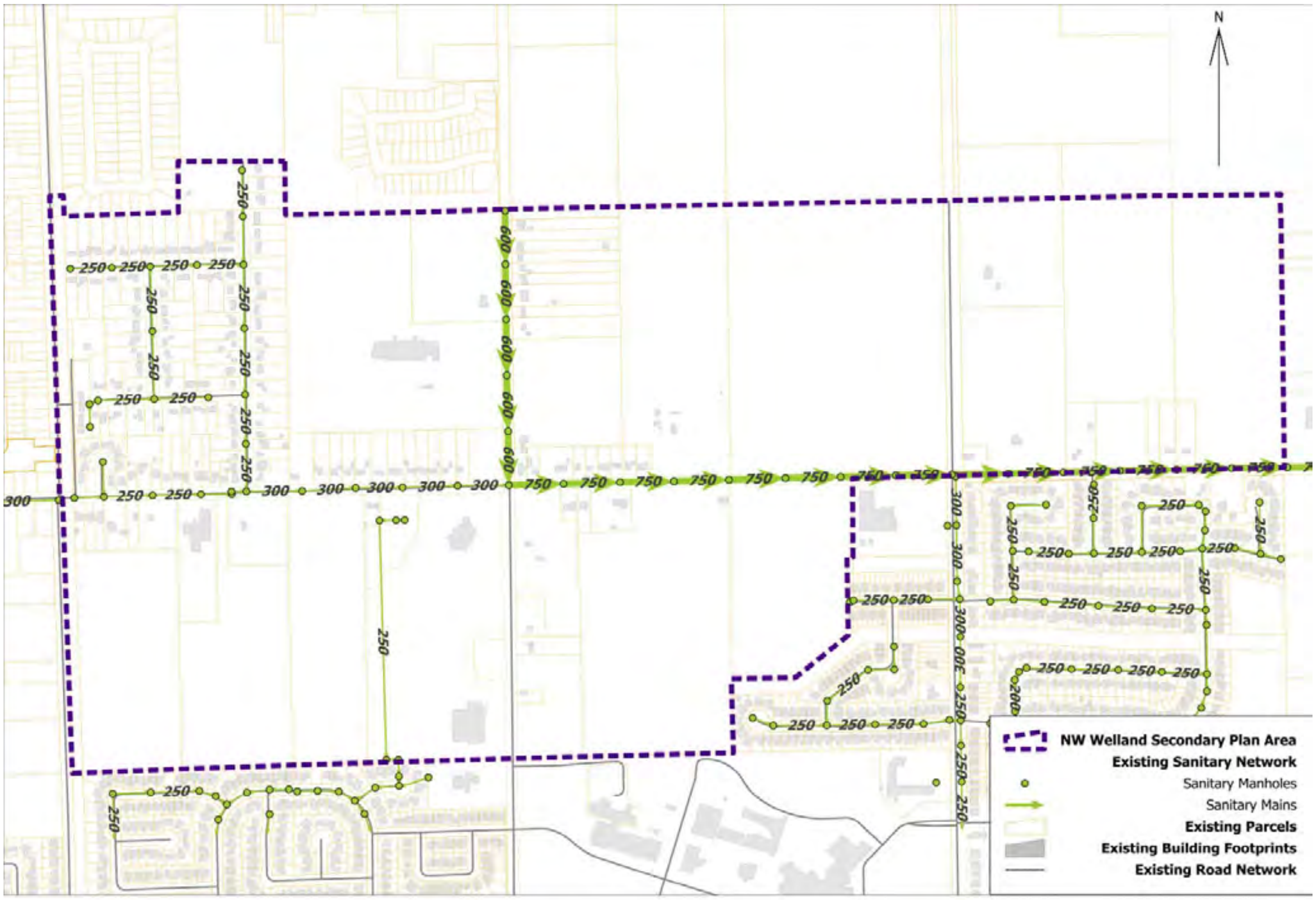


Figure 4-1: Schematic of Existing Sanitary System in NWSP Study Area

4.1 Design Criteria

Existing and future peak flows conveyed by the trunk sewer on Quaker Road to the Towpath SPS were assumed to be equivalent to the flows represented in the City's all-pipe InfoSWMM model.

Additional flows contributed to the Quaker Road trunk sewer, and ultimately the Towpath SPS, by the NWSP area were calculated using the following design criteria:

- Extraneous flows = 0.286 L/s/ha
- Roughness coefficient = 0.013
- Residential per capita flow rate (for sewage generation) = 275 L/cap/day
- Peaking factor = Calculated based on Harmon formula with values between 2.0 and 4.0

4.2 Existing System Capacity

4.2.1 Trunk Sewer

The available capacity of the existing trunk sewer along Quaker Road from Rice Road to the Towpath SPS was reviewed using the City's all pipe InfoSWMM model.

Currently Line Avenue is the break point in the collection system, with areas west of Line Avenue flowing west and then south, contributing to the Welland WWTP drainage area. However, the Region Master Servicing Plan Update (MSPU) identified a new 600mm diameter connection (WW-SS-002) along Quaker Road from Line Avenue to Rice Road, which would redirect approximately 100L/s of flows from Pelham (north-west of Line Avenue) to the Quaker Road trunk sewer, and ultimately the Towpath SPS. Given this change in flows through the Quaker Road trunk sewer, the available capacity of this sewer was reviewed with this new connection. This completed available capacity assessment, based on the InfoSWMM model outputs, is attached in Appendix B. In general, the Quaker Road trunk sewer has significant available capacity – with future available capacity ranging from 130L/s to 3,224L/s with the new Line Avenue connection.

4.2.2 Towpath SPS and Forcemain

The Region MSPU identified that Towpath SPS has existing and future deficiencies based on existing and design peak wet weather flows. As such, the Region MSPU identified a capital project to upgrade the Towpath SPS during the timeframe of 2022 – 2026 from 118L/s to 600L/s (WW-SPS-037).

The Region MSPU also indicates that the existing Towpath SPS forcemain has current capacity; however, will have a projected capacity deficit for 2051 growth. There is already a constructed 600mm diameter forcemain that can be commissioned in line with Towpath upgrades, as identified in the Region MSPU capital projects during the timeframe of 2032-2036 (WW-FM-022).

4.2.3 Welland WWTP

The Region MSPU identified that the existing Welland WWTP has surplus capacity available to treat existing and future flows at the plant, with the plant reaching 80% capacity around the 2041 time horizon.

4.3 Proposed System Requirements

4.3.1 NWSP Sanitary Drainage Areas and Proposed Collection System

As requested, two sanitary servicing options were prepared and reviewed for feasibility for the NWSP area, including: 1) development blocks on the east and west side of First Avenue are connected to a new city trunk located on First Avenue and 2) development blocks on the east and west side of First Avenue are connected through the development blocks to a new city trunk located on Quaker Road.

Figure 4-2 and Figure 4-3 (also provided in Appendix B as Figure B-1 and B-2, respectively) show the approximate location of future city trunk sanitary gravity sewers within the NWSP area and the location where the city trunks will connect to the existing Region trunk sewer on Quaker Road for each servicing option. Figure 4-2 and Figure 4-3 also show identifying numbers for the individual NWSP drainage areas, which are referenced in the sewer design sheets provided in Appendix B.

The design sheets for the proposed sanitary sewers have been prepared with the new Line Avenue connection included. Note that the inverts and pipe lengths assigned to the existing trunk sewer in the proposed design sheets are from the City's InfoSWMM model. Existing peak flows into the trunk sewer, input at existing manhole locations in the design sheets, are also as per the City's InfoSWMM model. All inverts and pipe lengths of the proposed city trunk sewers have been assigned based on preliminary modeling and the existing ground contours of the area. Note that, it is assumed that any other sanitary sewer required on future local roads servicing the NWSP area, will be 200 mm diameter.

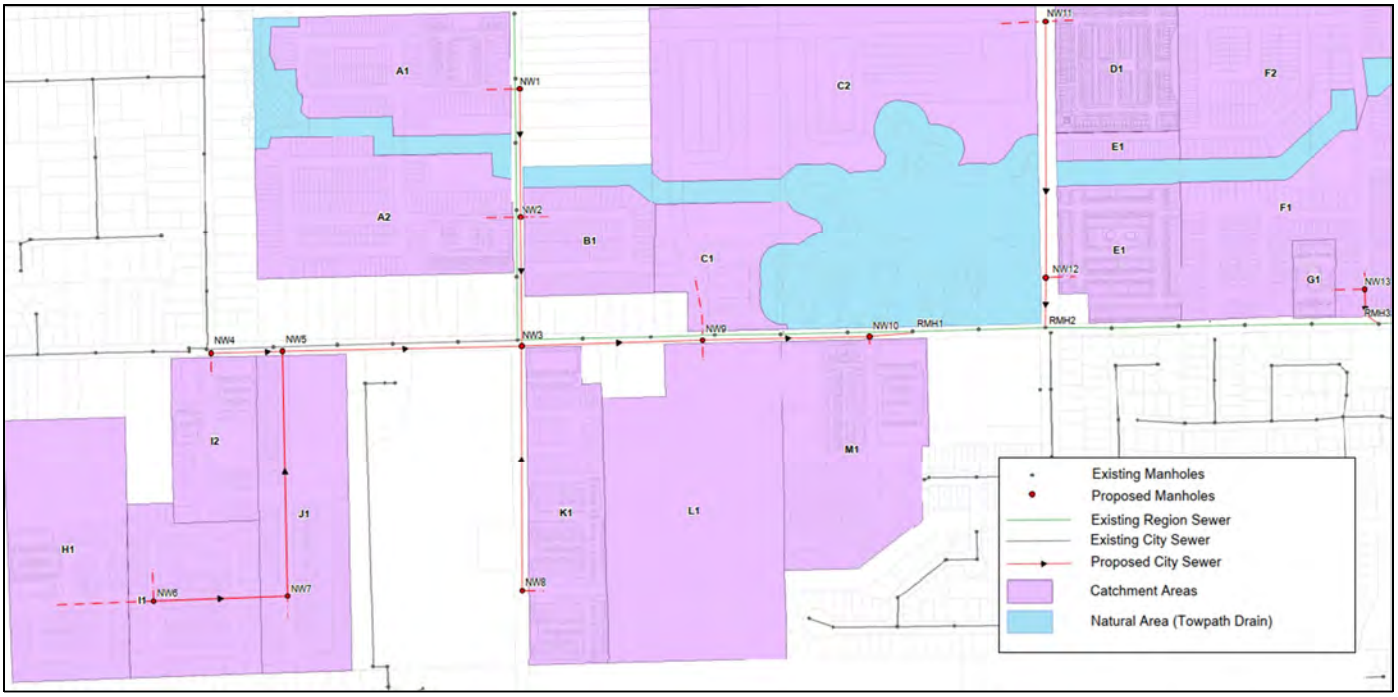


Figure 4-2: Proposed Sanitary System and Drainage Areas – Option 1

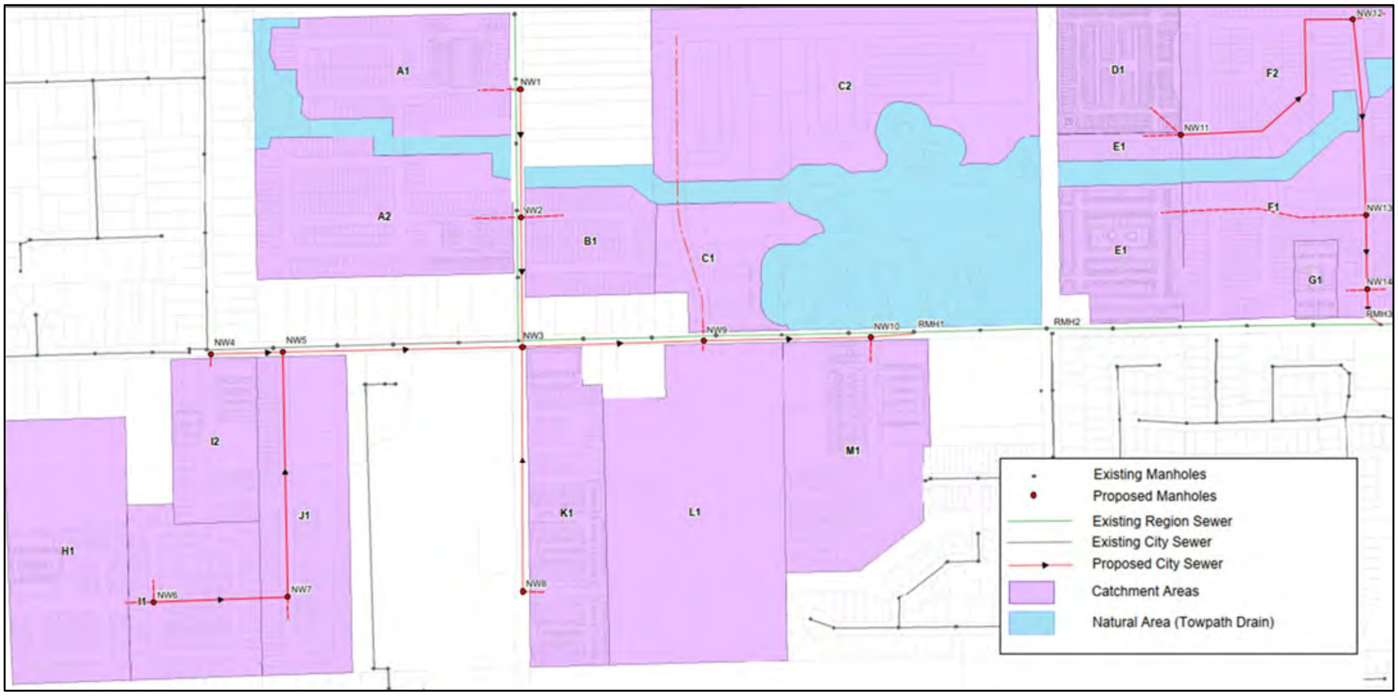


Figure 4-3: Proposed Sanitary System and Drainage Areas – Option 2

For servicing Option 2, the proposed trunk sewer within the quadrant east of First Avenue and north of Quaker Road (from NW12 to NW13) must cross the proposed Towpath Drain. For this preliminary assessment, using the existing ground contours and referencing the Towpath Drain Re-Alignment drawing package (Upper Canada Consultants, 2022) it appears that the proposed trunk sewer will be in direct conflict with the proposed box culvert and new creek bottom, making this servicing option not achievable. Further review and confirmation, based on proposed development details, will be required to determine viability of this servicing option moving forward.

As shown in the appended design sheets, the NWSP drainage area contributes overall an additional 143.3L/s of peak flow to the Quaker Road trunk sewer. Based on the capacity review of the existing trunk sewer on Quaker Road (provided in Appendix B), there are two (2) pipe segments that have an available capacity below 143L/s. The first pipe segment (19001376) is located between Rice Road and RMH1 (as shown on Figures 4-2 and 4-3 above). Since this segment will not receive sanitary flow from the NWSP area, this segment is not a concern. The second pipe segment (19001405) is located further downstream on Towpath Road between Grisdale Road and the Towpath Road SPS. Model analysis indicates this segment has 130L/s of available capacity with the Line Avenue trunk sewer connection. Further review and confirmation of available capacity within this segment should be completed prior to full build out of the NWSP area.

Although the phasing of future development within the NWSP area is not currently known, the proposed layout of this area and the associated sanitary design is such that the individual quadrants (defined as: areas west of Rice Road and north of Quaker Road (catchment area A); areas west of Rice Road and south of Quaker Road (catchment areas H, I, J); areas east of Rice Road and south of Quaker Road (catchment areas K, L, M); areas east of Rice Road and north of Quaker Road (catchment areas B, C1); areas east of First Avenue and north of Quaker Road (catchment areas D, E, F, G); and areas west of First Avenue (catchment area C2)) can mostly be developed independently of each other. Several exceptions to this include:

- the proposed city trunk sewer on Quaker Road (from NW3 to RMH1) must be constructed prior to any of the development west of Rice Road (catchment areas A, H, I J), catchment area B and catchment area K occurring;
- a portion of the proposed city trunk sewer on Quaker Road (from NW9 to RMH1) must be constructed prior to any development occurring within catchment areas C1 (and C2 for servicing Option 2), L, and M.
- for servicing Option 1, the proposed city trunk sewer on First Avenue (from NW11 to RMH2) must be constructed prior to development within catchment areas C2, D, and E.

The remainder of the city trunk sewers within each development quadrant should be constructed as development occurs in that quadrant starting from the downstream end.

Alternatively, to eliminate duplication of trunk infrastructure along Quaker Road and Rice Road, additional connections can be considered directly to the regional trunk main in order to eliminate the need for a ‘local’ trunk system. This approach would also eliminate most of the phasing exceptions noted above, as the local trunk would not need to be constructed.

4.3.2 Towpath SPS and Forcemain

The Welland NWSP area will contribute an additional 143.3L/s of peak flow to the Towpath SPS. As previously noted, the Region MSPU identified a planned upgrade to this SPS. The SPS upgrades will be required to address existing and future capacity and will be required to be completed before significant development can occur within the NWSP area.

The Towpath SPS forcemain has sufficient existing and future capacity to accommodate flows from the Welland NWSP area, provided the constructed 600mm diameter forcemain is commissioned prior to 2051 flows and build-out.

4.3.3 Welland WWTP and Downstream System

As previously noted, the Welland WWTP currently has a capacity surplus, and the NWSP area can be added. The Region MSPU did indicate the plant will reach 80% capacity around 2041. The post-2051 flows are expected to exceed the plant capacity; however, the plant can accommodate flows to 2051.

Additionally, the trunk sewer that the Towpath SPS forcemain discharges to has available capacity between the discharge point and the WWTP to accept an increase in flow. The design of the future Towpath SPS upgrade should confirm the capacity of the downstream trunk sewer when determining SPS outflow rates.

5 STORM

The existing NWSP area topography is quite flat and drains in a west to east direction. The land use is mainly pasture/ agricultural land interspersed with country residential homes. The plan area is significantly developed all around the boundary as well as within the plan area itself. The west side of the study area is already developed with country residential homes. There are two (2) major drainage channels that flow through the site – Towpath Drain within the northern portion of the development area and a tributary to Welland Recreational Canal within the southern portion of the development area. These two (2) channels are identified by the Niagara Peninsula Conservation Authority (NPCA) as requiring approval for any development draining to the channels. The existing stormwater drainage paths are shown in Figure 5-1.

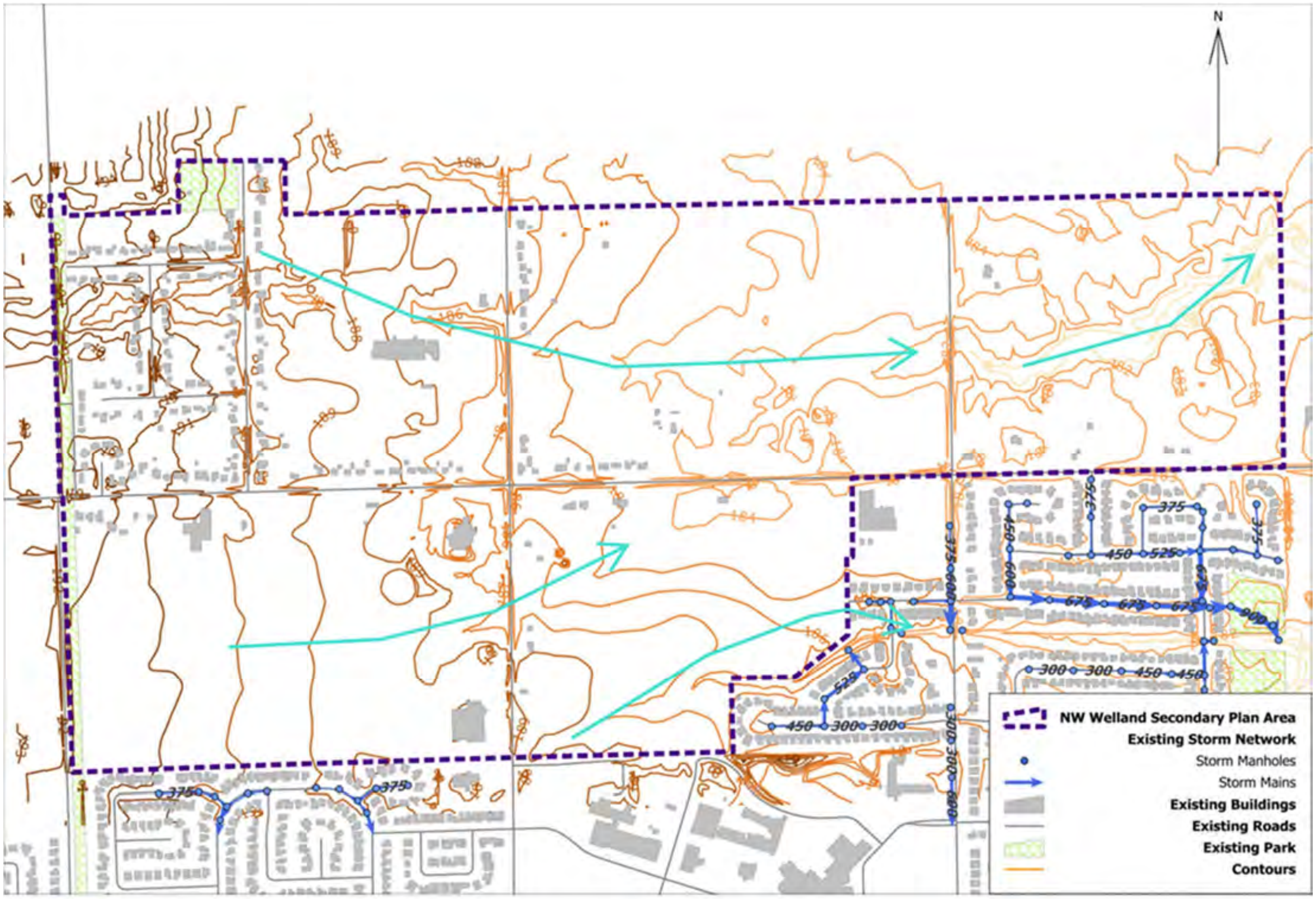


Figure 5-1: Schematic of Existing Stormwater Drainage Path

5.1 Design Criteria

The overall stormwater management plan for the NWSP area was initially developed by Aquafor Beech (2020) and updated and refined by Upper Canada Consultants (2022). The focus of this report is the identification of gravity sewer servicing requirements. The following design criteria were used in identifying these servicing requirements:

- Pipes were sized using the rational method with the City of Welland's 5-Year IDF curve values (a = 830, b =0.777, c = 7.3)
- Friction factor = 0.013
- Run-off coefficients (as per City of Welland's Design Standards) of:
    - Low Density Residential (i.e.: Single Family) = 0.40
    - Medium Density Residential (i.e.: Semi-Detached) = 0.50
    - High Density Residential (i.e.: Townhouses) = 0.60

5.2 Existing System Capacity

Since the proposed servicing, which is the focus of this report, will not leverage any existing gravity storm sewers in the area, no review of existing system capacity was conducted.

5.3 Proposed System Requirements

5.3.1 Proposed Stormwater Management Pond Locations

The stormwater management plan developed by Upper Canada Consultants identified approximate locations for eight (8) storm ponds, which will outlet to the Towpath Drain (channel north of Quaker Road), while one (1) storm pond will outlet to the tributary to Welland Recreational Canal (channel south of Quaker Road). The intent of the stormwater management plan is that all runoff from the proposed NWSP area will be directed to these storm pond locations through new gravity sewers installed on existing and future roads.

The approximate location of these proposed storm ponds is shown on the Ultimate Stormwater Management Plan figure from the Upper Canada Consultants Stormwater Management Implementation Plan (October 2022), which is included in Appendix C for reference. These pond locations were used to identify approximate outlet locations for the gravity sewers that will be required to service the NWSP area.

5.3.2 Proposed Gravity Sewers

Figure 5-2 (also provided in Appendix C as Figure C-2) shows the approximate location of future trunk storm gravity sewer outlets to the proposed storm ponds within the NWSP area. Figure 5-2 also shows identifying numbers for the individual NWSP drainage areas, which are referenced in the sewer design sheet found in Appendix C. Note, the design sheet was used primarily to identify outlet pipe sizing. Pipe sizes/lengths for the remainder of the future system were also approximated for preliminary costing (see Section 6), with a conservative assumption of a minimum pipe size of 450mm.

Figure 5-2: Proposed Storm System and Drainage Areas

Based on the results of the completed sewer design sheet found in Appendix C, Table 5-1 shows the identified required outlet sizes for each approximate pond location.

Table 5-1: Required Outlet Size

Outlet #	Size (mm)
SWM1	900
SWM2	900
SWM3	1050
SWM4	1200
SWM5	1350
SWM6	750
SWM7	1350
SWM8	1200
SWM9	1200

Note that pipe slopes identified in the design sheet were assigned based on the existing ground contours for the area and the required outlet elevations, with the intent of ensuring suitable cover over all proposed pipes.

6 PRELIMINARY COSTING

Preliminary costing for the conceptual water, sanitary, and stormwater servicing is provided in Table 6-1. Note – neither road works, utilities (including hydro, gas and communications servicing), nor restoration cost (asphalt) for works proposed on existing roads (Rice Road, Quaker Road, and First Avenue) are included in this estimate. A more detailed breakdown of these preliminary cost estimates can be found in Appendix D.

Table 6-1: Preliminary Cost Estimate for Municipal Servicing

Item	Scope of Work	Cost
Water Distribution System	Watermain (150mm to 300mm) including services, valves, and hydrants	$26,005,010
Sanitary Collection Servicing	Sanitary Sewer (200mm to 450mm), including laterals and structures	$37,598,910
Storm Collection Servicing	Storm Sewer (450mm to 1350mm), including structures	$19,136,475
Sub-total	Water/Sanitary/Storm	$82,740,395
Engineering	10% of Capital	$8,274,200
Contingency	15% of Capital	$12,411,200
TOTAL		$103,425,795

7 CONCLUSIONS

The conclusions from the water, sanitary, and storm servicing capacity assessments are as follows:

Water:

- The addition of the NWSP development to the City's system does not negatively impact the surrounding system, and instead should improve pressures and fire flows in the system.
- The existing system has sufficient storage to support the future NWSP development.
- Proposed pipe servicing details for the development are provided in Figure 3-4. These include:
    - To supply fire flows for the development, the existing 150mm diameter main on Rice Road needs to be upgraded to a minimum of 250mm diameter.
    - To supply water and adequate fire flows to the south-west portion of the development, a new 300mm diameter interconnection (Loop-A) is required to connect the existing 750mm regional trunk main on Clare Avenue to the existing 300mm main on Quaker Road.
    - A new 300mm diameter main (Loop-B) branching off from Quaker Road will be required to supply the north area of the development.
- The proposed development does not negatively impact the existing low-pressure areas identified near Shoalt's Reservoir.

Sanitary:

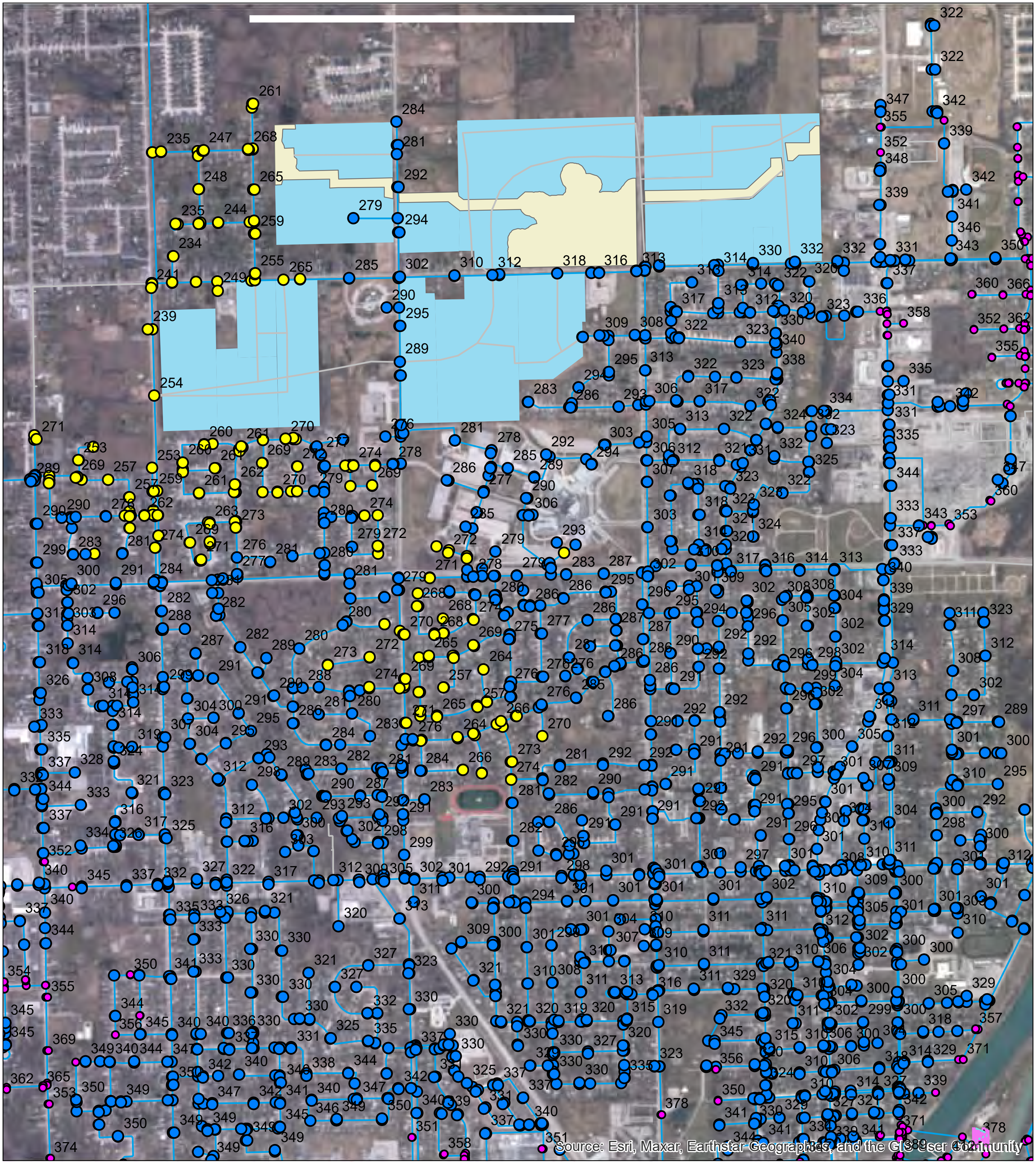
- The existing trunk along Quaker Road, which conveys flows to the Towpath SPS, has sufficient capacity to accept the additional 143.3 L/s peak flow generated by the NWSP area, with the exception of pipe segment 19001405 on Towpath Road between Grisdale Road and the Towpath Road SPS. Model results indicate this segment has only 130L/s of available capacity.
- The Towpath SPS was identified in the Region MSPU as requiring an upgrade due to both growth north of the study area and the redirection of a portion of the flows from Pelham (north-west of Line Avenue) to the Towpath SPS through the Quaker Road trunk sewer. The timing of the Towpath SPS upgrade is 2022-2026 and will be required to be completed before significant development can occur within the NWSP area.
- The Towpath SPS forcemain has sufficient existing capacity; however, will have a projected capacity deficit for 2051 growth. There is already a constructed 600mm diameter forcemain that will require commissioning in line with Towpath SPS upgrades during the timeframe of 2032-2036 (WW-FM-022).
- The trunk sewer that the Towpath SPS forcemain discharges to has available capacity between the discharge point and the WWTP to accept an increase in flow.
- The WWTP has sufficient capacity to allow for the addition of the NWSP area.
- Future sanitary sewer sizing will range from 200 mm diameter to 450 mm diameter. Sizing to be confirmed during design.
- The phasing of future development within the NWSP area is not currently known; however, the proposed layout of this area is such that the individual quadrants (defined as: areas west of Rice Road and north of Quaker Road; areas west of Rice Road and south of Quaker Road; areas east of Rice Road and south of Quaker Road; areas east of Rice Road and north of Quaker Road; areas east of First Avenue and north of Quaker Road; and areas west of First Avenue) can mostly be developed independently of each other, with exceptions noted below.
    - The proposed city trunk sewer on Quaker Road (from NW3 to RMH1) must be constructed prior to any of the development west of Rice Road and lands fronting the east side of Rice Road both north and south of Quaker Road.

  - A portion of the proposed city trunk sewer on Quaker Road (from NW9 to RMH1) must be constructed prior to any development occurring east of Rice Road and west of First Avenue.
  - For servicing Option 1, the proposed city trunk sewer on First Avenue (from NW11 to RMH2) must be constructed prior to development occurring immediately east and west of First Avenue.
- Alternatively, to eliminate duplication of trunk infrastructure along Quaker Road and Rice Road, additional connections can be considered directly to the regional trunk main in order to eliminate the need for a ‘local’ trunk system and most of the phasing exceptions noted above.

Storm:

- The stormwater management plan developed by Upper Canada Consultants identified approximate locations for nine (9) new storm water ponds to service the NWSP area. Gravity sewers along the existing and future roads will direct runoff to these pond locations. Outlet sizing for the ponds will range from approximately 750 mm diameter to 1350 mm diameter. Sizing to be confirmed during design.

APPENDIX A - WATER



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

Legend: Minimum Pressure

- ● < 140 kPa
- ● 140 - 275 kPa
- ● 275 - 350 kPa
- ● 350 - 550 kPa
- ● 550 - 700 kPa
- ● >700 kPa

Existing Watermain

▭ Proposed Development

Associated Engineering

BEST MANAGED COMPANIES CANADA

Platinum member

Northwest Secondary Plan Municipal Servicing

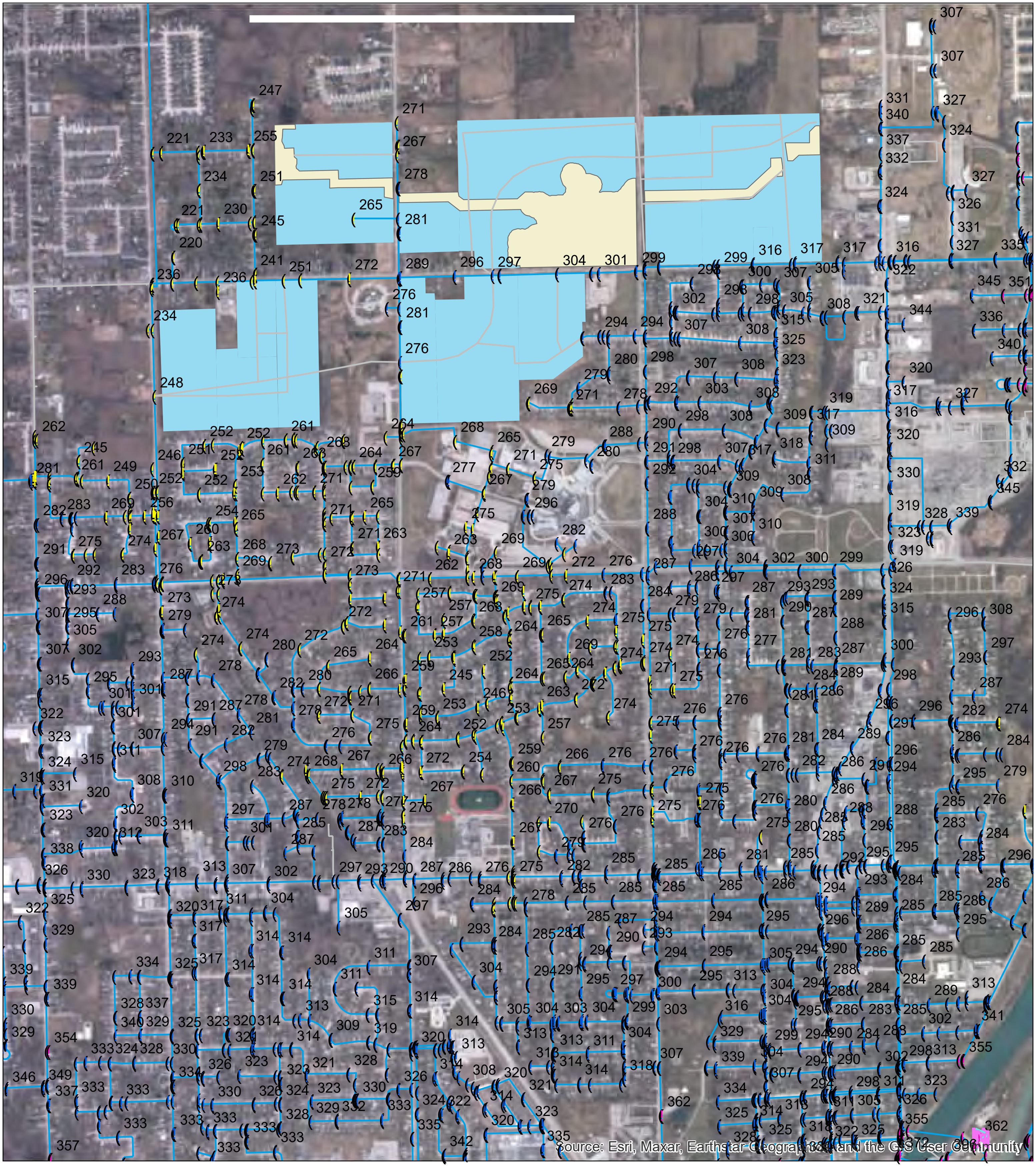
Northwest Secondary Plan Municipal Servicing

Existing Min Pressure during ADD EPS

Project No: 2023-5773

Date: November 2023

Figure A-1



Legend: Minimum Pressure

(	< 140 kPa
(	140 - 275 kPa
(	275 - 350 kPa
(	350 - 550 kPa
(	550 - 700 kPa
(	>700 kPa
—	Existing Watermain
▭	Proposed Development

Associated Engineering

CANADA BEST MANAGED COMPANIES
Platinum member

Northwest Secondary Plan Municipal Servicing

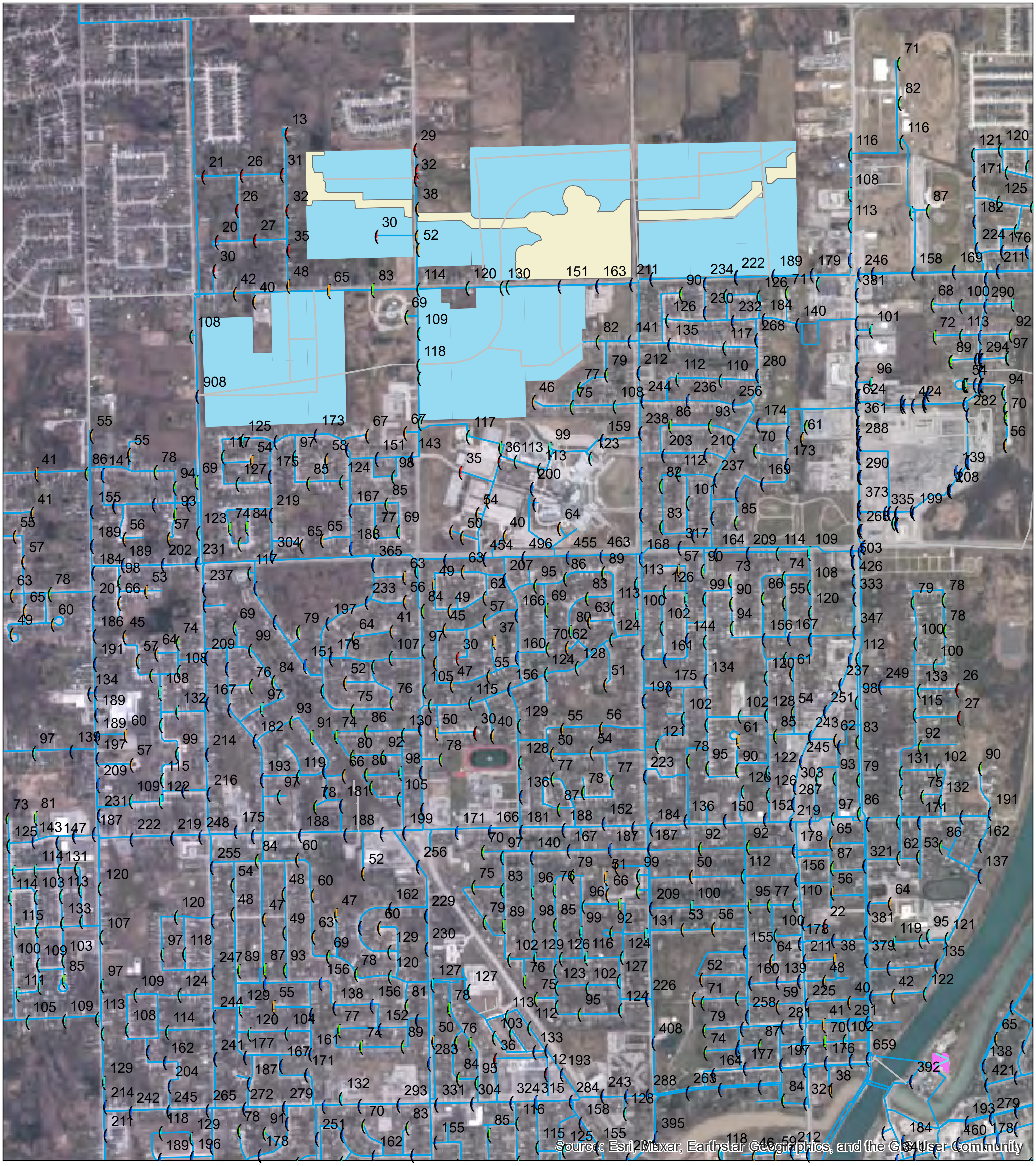
Northwest Secondary Plan Municipal Servicing

Existing Min Pressure during MDD EPS

Project No: 2023-5773

Date: November 2023

Figure A-2


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

Legend: Available Fire Flow

- (< 37 L/s
- (37 - 67 L/s
- (67 - 95 L/s
- (95 - 133 L/s
- (>133 L/s

— Existing Watermain

▭ Proposed Development

Associated Engineering

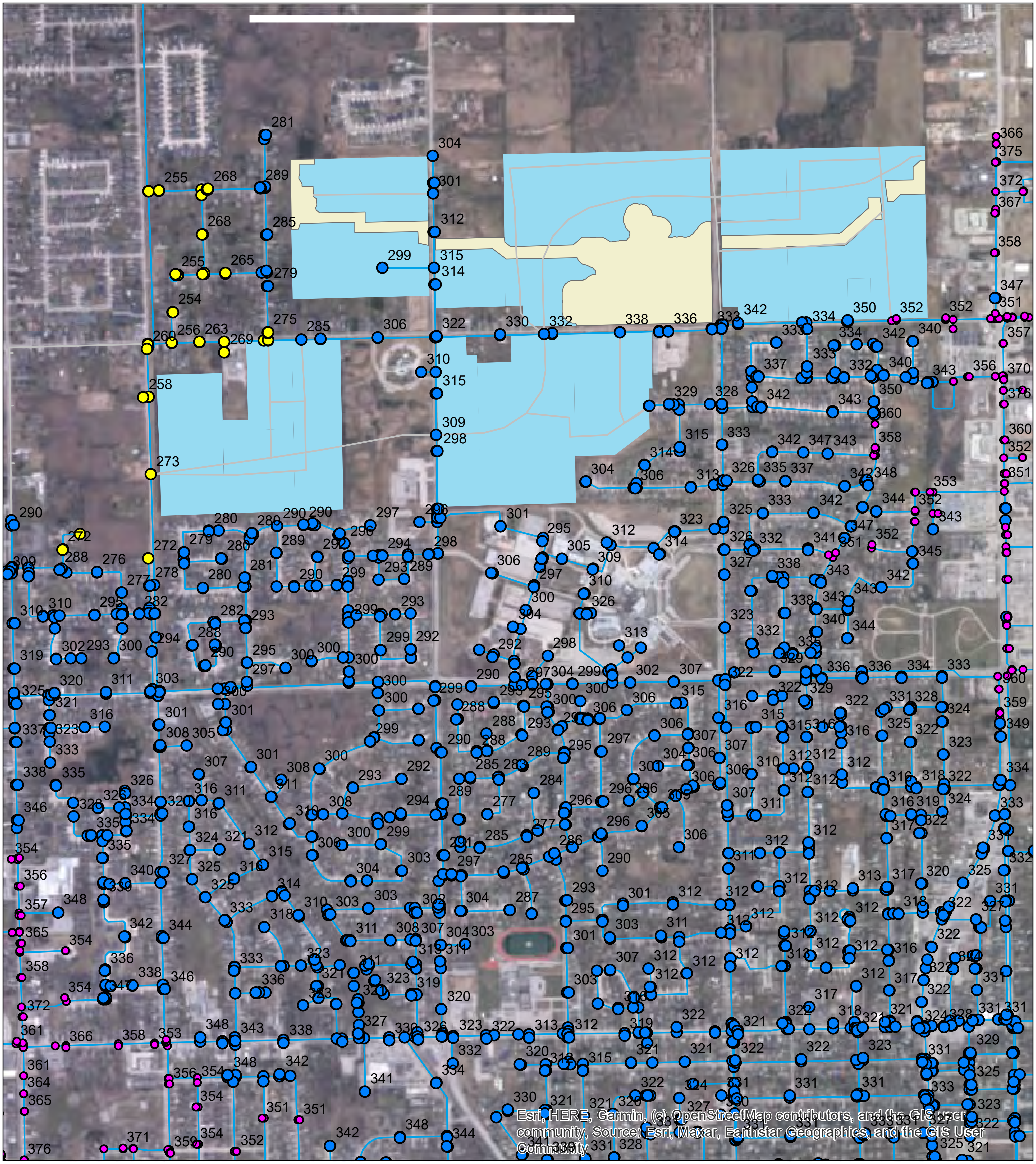
BEST MANAGED COMPANIES CANADA
Platinum member

Northwest Secondary Plan
Municipal Servicing

Municipal Servicing

Existing Available Fire Flow during MDD

Project No: 2023-5773	**Figure A-3**
Date: November 2023	



Legend: Minimum Pressure

- ● < 140 kPa
- ● 140 - 275 kPa
- ● 275 - 350 kPa
- ● 350 - 550 kPa
- ● 550 - 700 kPa
- ● >700 kPa

— Existing Watermain

▨ Proposed Development

Associated Engineering

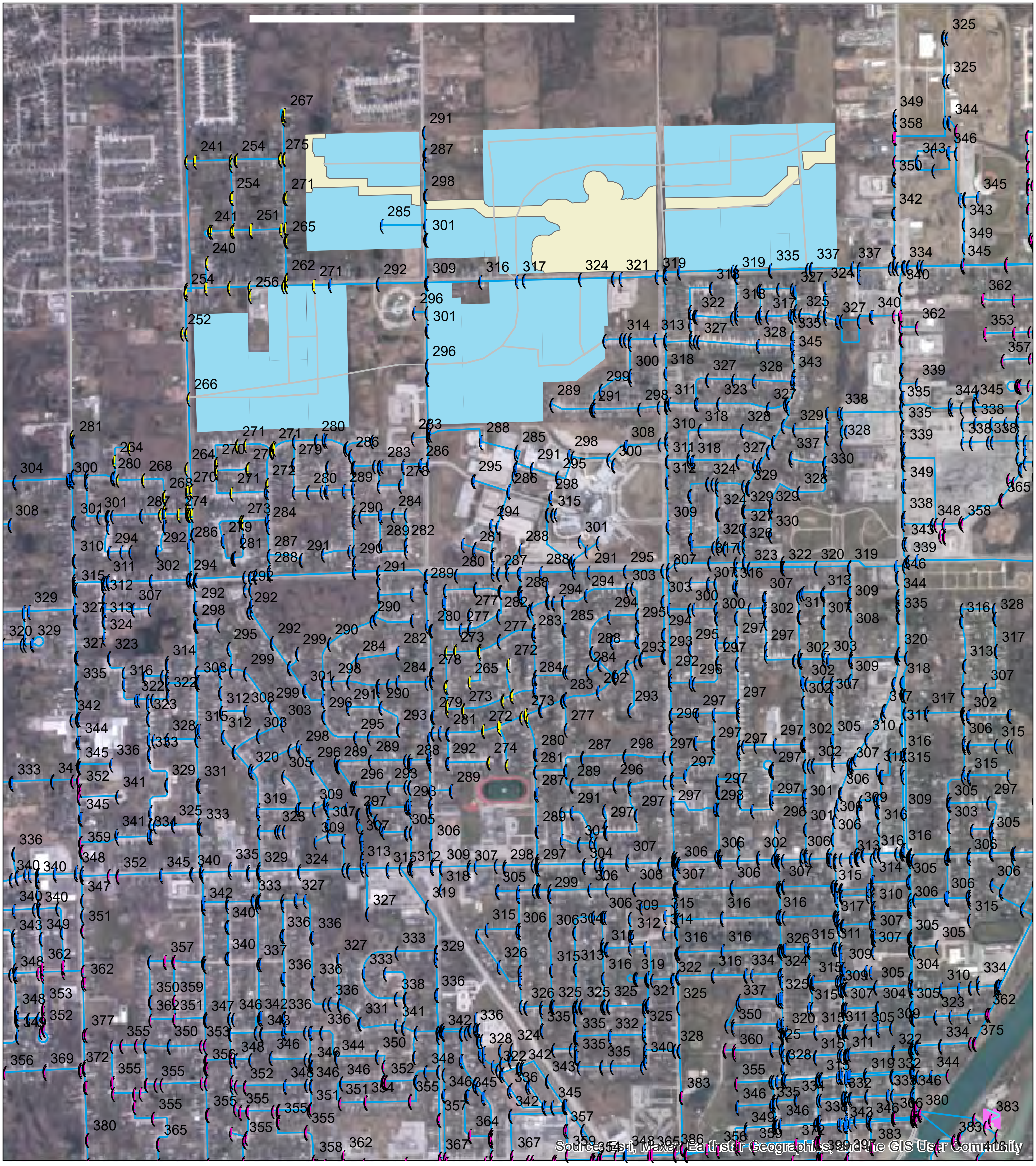
BEST MANAGED COMPANIES CANADA Platinum member

Northwest Secondary Plan Municipal Servicing

Northwest Secondary Plan Municipal Servicing

Future Min Pressure during ADD EPS - Without NWSP

Project No: 2023-5773	**Figure A-4**
Date: November 2023	



Legend: Minimum Pressure

- (< 140 kPa
- (140 - 275 kPa
- (275 - 350 kPa
- (350 - 550 kPa
- (550 - 700 kPa
- (>700 kPa

—	Existing Watermain
🟦	Proposed Development

Associated Engineering

CANADA BEST MANAGED COMPANIES Platinum member

Northwest Secondary Plan Municipal Servicing

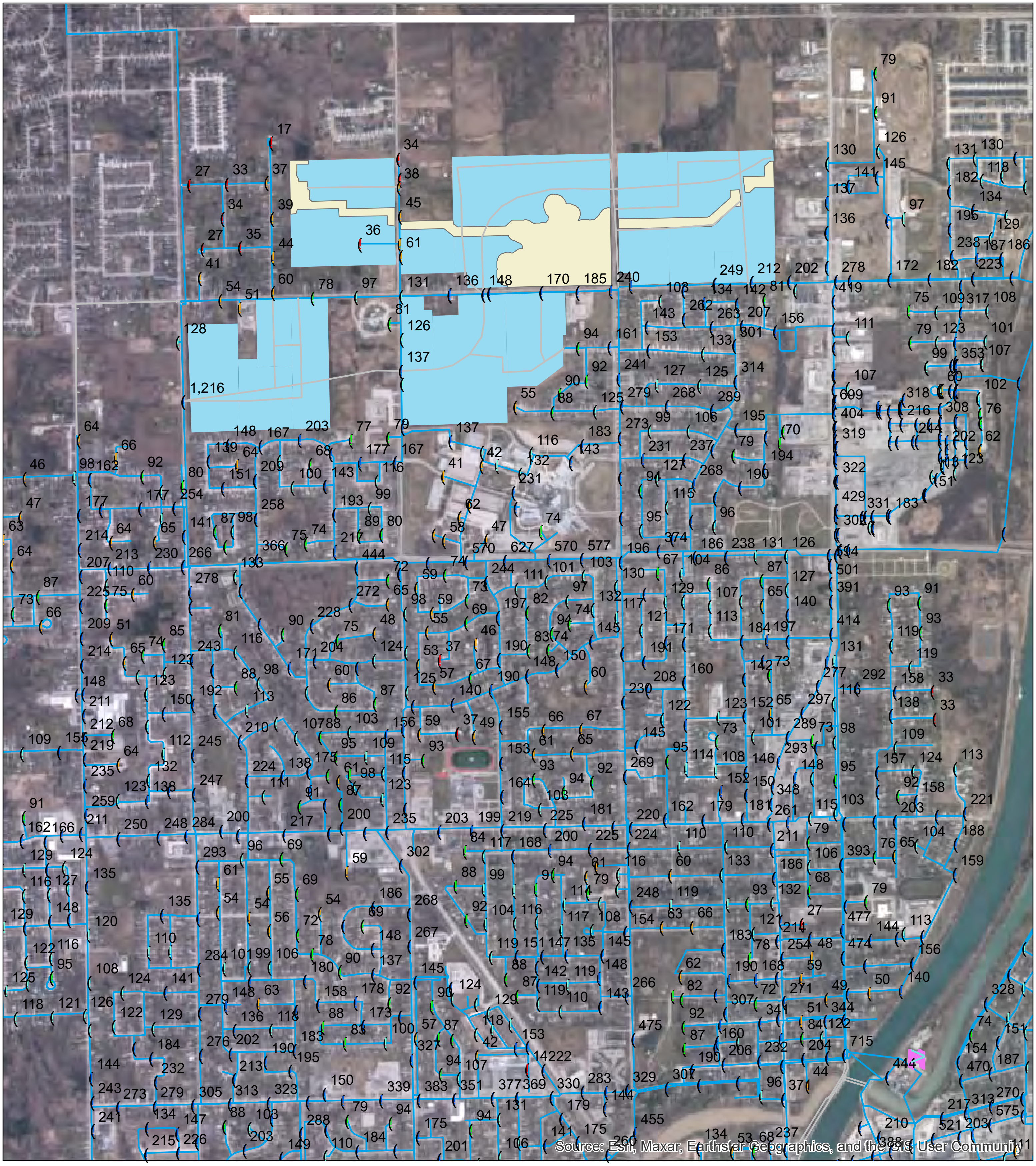
Northwest Secondary Plan Municipal Servicing

Future Min Pressure during MDD EPS - Without NWSP

Project No: 2023-5773

Date: November 2023

Figure A-5


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

Legend: Available Fire Flow

- (< 37 L/s
- (37 - 67 L/s
- (67 - 95 L/s
- (95 - 133 L/s
- (>133 L/s

— Existing Watermain

▨ Proposed Development

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

Northwest Secondary Plan Municipal Servicing

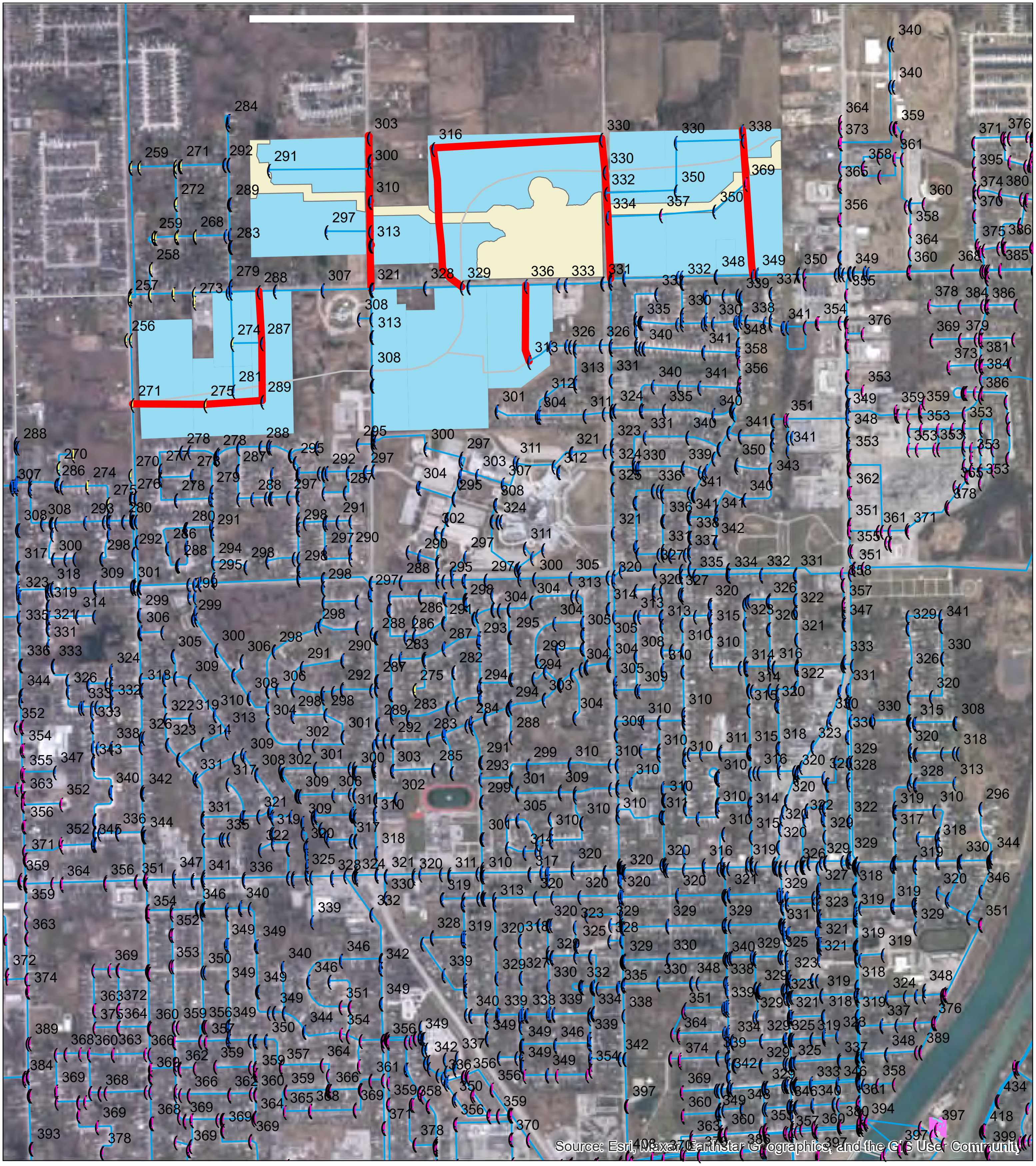
Northwest Secondary Plan Municipal Servicing

Available Fire Flow during Future MDD - Without NWSP

Project No: 2023-5773

Date: November 2023

Figure A-6



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

Legend: Minimum Pressure

- (< 140 kPa
- (140 - 275 kPa
- (275 - 350 kPa
- (350 - 550 kPa
- (550 - 700 kPa
- (>700 kPa

Existing Watermain

▨ Proposed Development

Associated Engineering

BEST MANAGED COMPANIES CANADA

Platinum member

Northwest Secondary Plan
Municipal Servicing

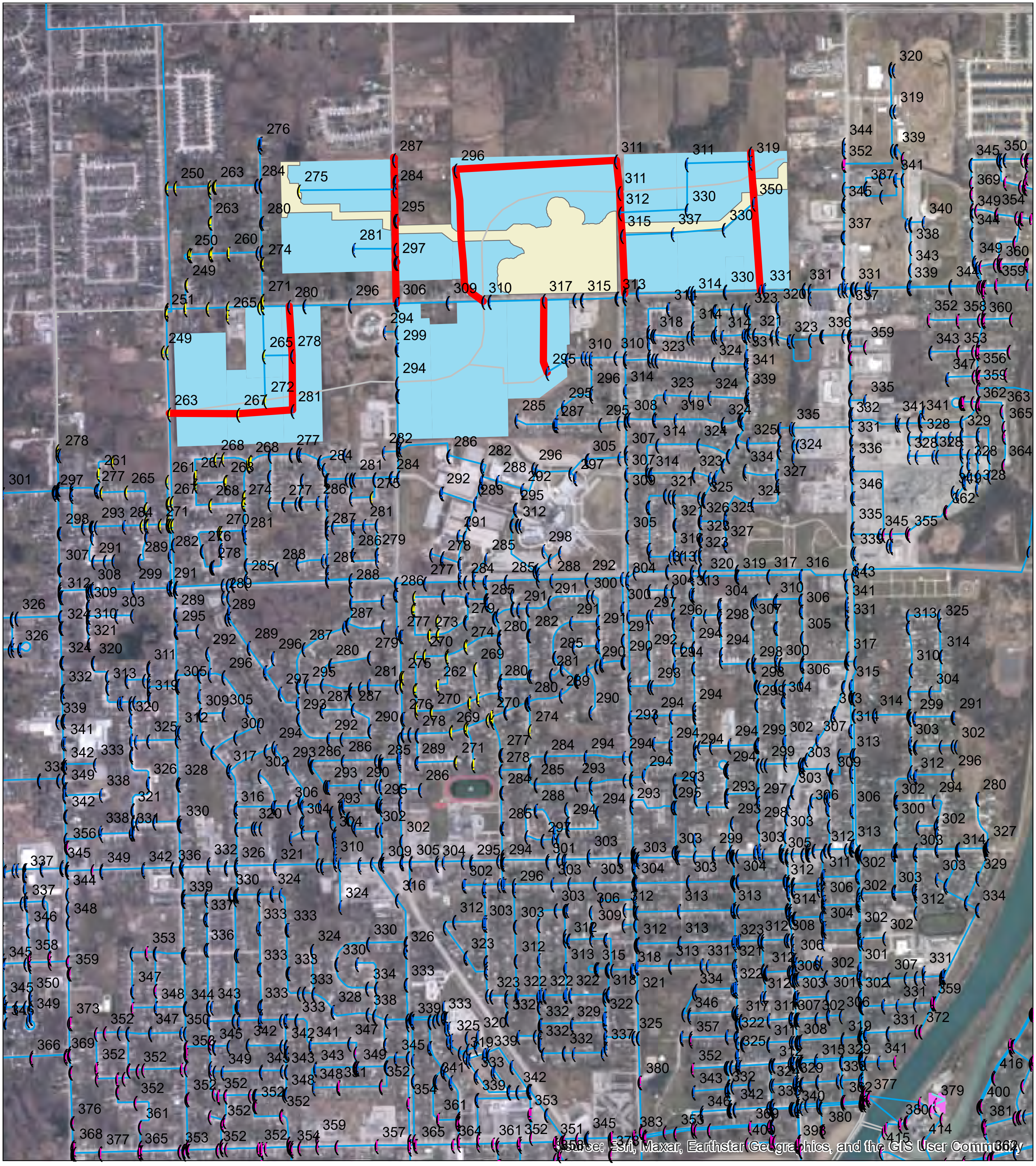
Northwest Secondary Plan
Municipal Servicing

Future Min Pressure during ADD EPS - With NWSP

Project No: 2023-5773

Date: November 2023

Figure A-7


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

Legend: Minimum Pressure

(	< 140 kPa
(	140 - 275 kPa
(	275 - 350 kPa
(	350 - 550 kPa
(	550 - 700 kPa
(	>700 kPa

—	Existing Watermain
▭	Proposed Development

Associated Engineering

BEST MANAGED COMPANIES
CANADA
Platinum member

Northwest Secondary Plan Municipal Servicing

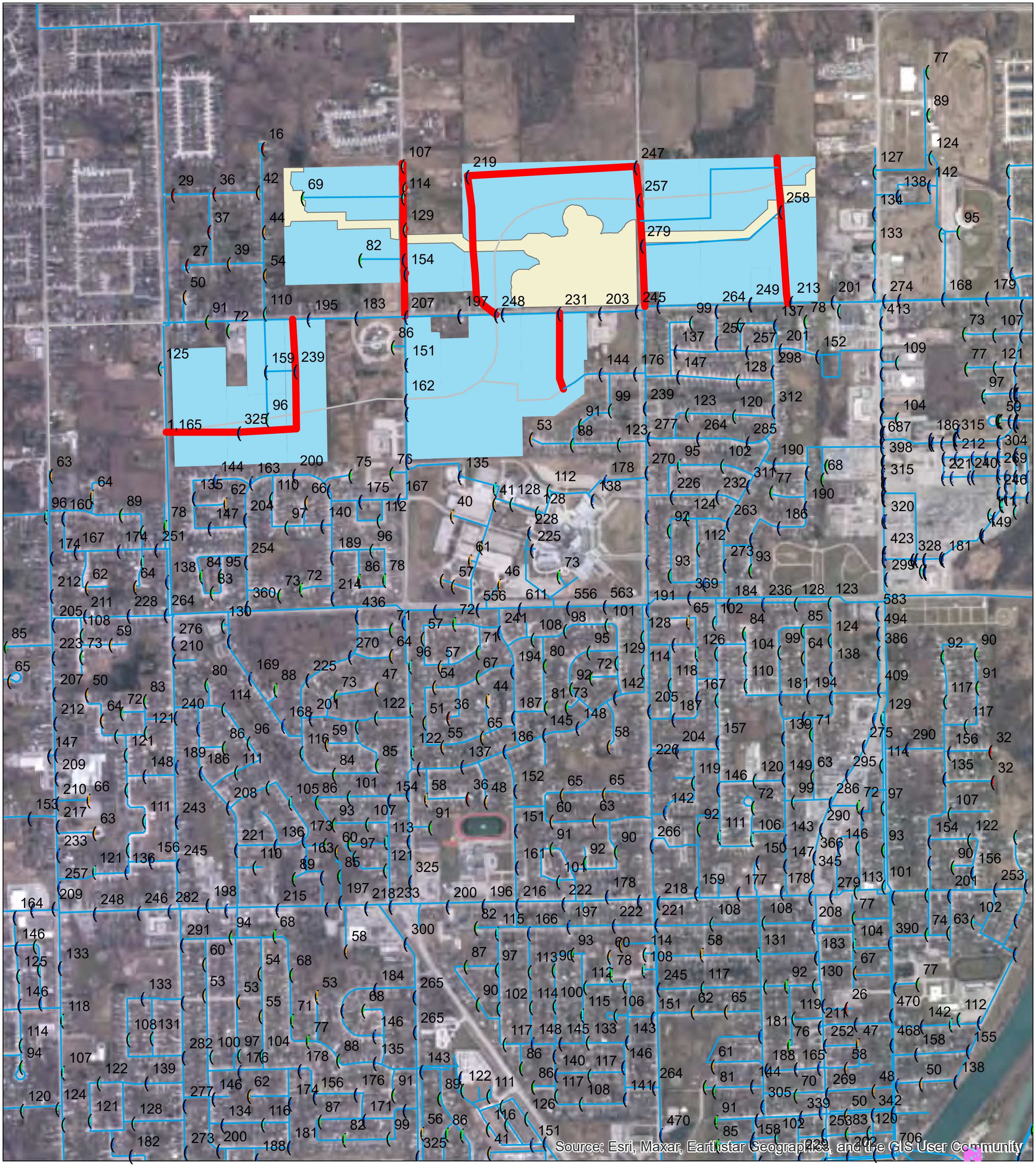
Northwest Secondary Plan Municipal Servicing

Future Min Pressure during MDD EPS - With NWSP

Project No: 2023-5773

Date: November 2023

Figure A-8



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

Legend: Available Fire Flow

(	< 37 L/s
(	37 - 67 L/s
(	67 - 95 L/s
(	95 - 133 L/s
(	> 133 L/s

—	Existing Watermain
▭	Proposed Development

Associated Engineering

CANADA BEST MANAGED COMPANIES Platinum member

Northwest Secondary Plan Municipal Servicing

Northwest Secondary Plan Municipal Servicing

Future Available Fire Flow during MDD EPS - With NWSP

Project No: 2023-5773

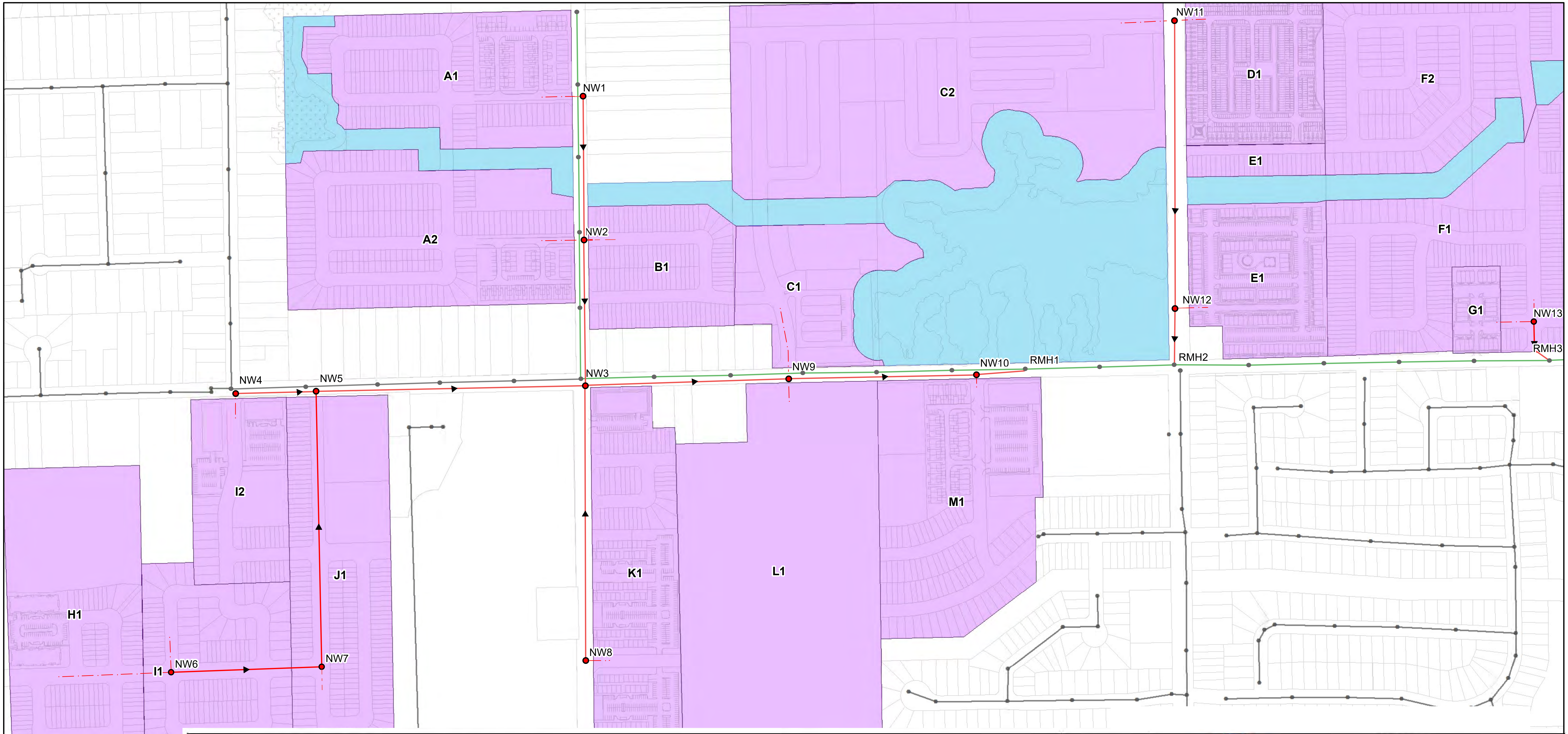
Date: November 2023

Figure A-9

APPENDIX B - SANITARY

Northwest Secondary Plan
Municipal Servicing
2041 Quaker Road to Towpath SPS Trunk Sewer Available Capacity

Pipe Segment ID	Full Flow Capacity (L/s)	2041 without Line Avenue Connection		2041 with Line Avenue Connection	
		Peak Flow 2041 (L/s)	Available Capacity (L/s)	Peak Flow 2041 (L/s)	Available Capacity (L/s)
19001374	608	146	462	246	362
19001375	547	146	401	246	301
19001376	383	147	236	247	136
19001377	495	147	348	247	248
19001378	446	147	299	247	199
19001366	282	125	157	124	158
19001367	327	126	201	125	202
19001365	313	124	189	124	189
19001364	370	124	246	123	247
19001363	353	123	230	122	231
19001379	639	147	492	247	392
19001380	623	147	476	247	376
19001381	540	148	392	248	292
19001382	729	148	581	248	481
19001383	452	148	304	248	204
19001384	720	149	571	249	471
19001385	747	149	598	249	498
19001386	638	149	489	249	389
19001387	588	149	439	249	339
19001388	638	150	488	250	388
19001389	816	150	666	250	566
19001390	671	170	501	270	401
19001391	731	170	561	270	461
19001392	718	170	548	270	448
19001393	731	170	561	270	461
19001394	717	170	547	270	447
19001395	714	170	544	270	444
19001396	733	170	563	270	463
19001397	844	170	674	270	574
19001398	708	170	538	270	438
19001399	740	170	570	270	470
19001400	718	170	548	270	448
19001401	718	170	548	270	448
19001402	918	170	748	270	648
19001403	917	170	747	270	647
19001404	907	170	737	270	637
19001405	401	171	230	271	130
19001406	923	171	752	271	652
19001407	1143	177	966	277	866
19001408	914	177	737	277	637
19001409	914	177	737	277	637
19001410	912	177	735	277	635
19001411	914	177	737	277	637
19001412	1125	220	905	320	805
19001413	889	220	669	320	569
19001519	3470	220	3250	320	3150
19001520	3544	220	3324	320	3224



Legend:

- Existing Manholes
- Proposed Manholes
- Existing Region Sewer
- Existing City Sewer
- Proposed City Sewer
- Catchment Areas
- Natural Area (Towpath Drain)

Associated Engineering

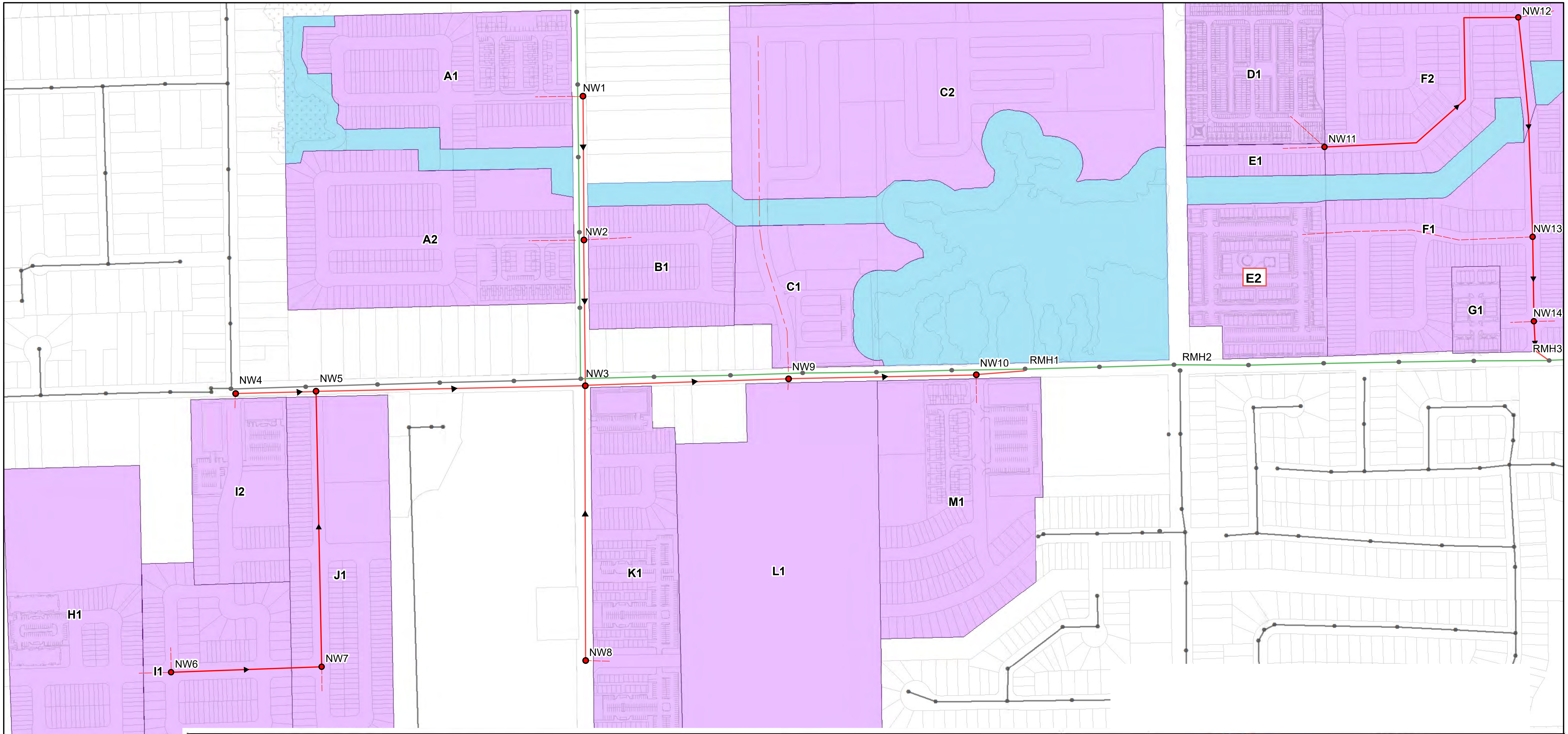
CANADA BEST MANAGED COMPANIES
Platinum member

Northwest Secondary Plan
Municipal Servicing

Sanitary Sewer Design - Option 1

Project No: 2023-5773
Date: November 2023

Figure B-1



Legend:

•	Existing Manholes	🟪	Catchment Areas
●	Proposed Manholes	🟦	Natural Area (Towpath Drain)
—	Existing Region Sewer		
—	Existing City Sewer		
—▸—	Proposed City Sewer		

Associated Engineering

CANADA BEST MANAGED COMPANIES
Platinum member

Northwest Secondary Plan
Municipal Servicing

Sanitary Sewer Design - Option 2

Project No: 2023-5773
Date: November 2023

Figure B-2

SANITARY SEWER DESIGN SHEET

Design Option - 1

Project: Welland Northwest Secondary Plan
Location:

Roughness Coefficient (n) = 0.013
Residential Per Capita Flow Rate = 0.00318287 L/cap/s (275 L/cap/day)
Infiltration Rate= 0.286 L/s/ha

LOCATION							**NWSP POPULATION AND FLOW DATA**									**EX TRUNK FLOW**		**TOTAL (NWSP + EX)**	**SEWER DESIGN**											
DESCRIPTION	DRAINAGE AREA	MANHOLE		INVERTS		LENGTH	AREA	POP	CUMULATIVE		AVG. DAILY FLOW	PEAKING FACTOR (PF = 1+14/(4+P^1/2))	PEAK FLOW (NO INFIL.)	INFILT. FLOW	PEAK FLOW (W/ INFIL.)	ADDITIONAL PEAK FLOW (FROM MODEL)	CUMULATIVE PEAK FLOW (FROM MODEL)	TOTAL PEAK FLOW	PIPE SIZE	ACTUAL SLOPE	APPROX. CRITICAL SLOPE	DESIGN SLOPE	Act. Dia.	PIPE AREA	HYD. RAD.	FULL FLOW VELOCITY	FULL FLOW CAPACITY	PERCENT FULL	CAPACITY CHECK	ACTUAL VELOCITY
				U/S	D/S				AREA	POP. Served																				
STREET	ID	FROM	TO			m	(ha)	(ppl)	(ha)	(ppl)	(l/s)	(dmnl)	(L/s)	(L/s)	(L/s)	(L/s)		(L/s)	(mm)	(%)	(%)	(%)	(mm)	(m^2)	(m)	(m/s)	(L/s)	(%)		(m/s)
Rice Road (N of Quaker)	A1	NW1	NW2	182.30	181.02	200	6.0	532	6.0	532	1.69	3.96	6.71	1.72	8.43	0.0	0.0	**8.4**	200	0.64	1.54	0.64	203.2	0.032	0.051	0.84	**27.4**	30.8	OK	0.65
Rice Road (N of Quaker)	A2, B1	NW2	NW3	181.02	180.10	197	10.6	868	16.6	1400	4.46	3.70	16.49	4.76	21.25	0.0	0.0	**21.2**	250	0.47	1.43	0.47	254.0	0.051	0.064	0.84	**42.5**	50.0	OK	0.74
Quaker Road (W of Rice)	I2	NW4	NW5	184.80	183.80	112	3.4	330	3.4	330	1.05	4.00	4.21	0.98	5.18	0.0	0.0	**5.2**	200	0.89	1.54	0.89	203.2	0.032	0.051	1.00	**32.3**	16.1	OK	0.64
NWSP (W of Rice, S of Quaker)	H1, I1	NW6	NW7	186.30	185.30	210	13.8	938	13.8	938	2.99	3.82	11.40	3.94	15.34	0.0	0.0	**15.3**	200	0.48	1.54	0.48	203.2	0.032	0.051	0.73	**23.7**	64.7	OK	0.69
NWSP (W of Rice, S of Quaker)	J1	NW7	NW5	185.30	183.80	389	7.0	454	20.8	1392	4.43	3.70	16.41	5.96	22.36	0.0	0.0	**22.4**	250	0.39	1.43	0.39	254.0	0.051	0.064	0.76	**38.7**	57.7	OK	0.70
Quaker Road (W of Rice)	-	NW5	NW3	183.80	180.10	370	-	-	24.2	1722.6	5.48	3.64	19.93	6.93	26.87	0.0	0.0	**26.9**	250	1.00	1.43	1.00	254.0	0.051	0.064	1.22	**62.0**	43.3	OK	1.04
Rice Road (S of Quaker)	K1	NW8	NW3	184.50	180.10	387	5.7	1229	5.7	1229	3.91	3.74	14.63	1.64	16.27	0.0	0.0	**16.3**	200	1.14	1.54	1.14	203.2	0.032	0.051	1.13	**36.5**	44.5	OK	0.96
Quaker Road (Rice to W of First)	-	NW3	NW9	180.10	179.24	287	-	-	46.6	4351.4	13.85	3.30	45.71	13.33	59.04	0.0	0.0	**59.0**	375	0.30	1.25	0.30	381.0	0.114	0.095	0.88	**100.2**	58.9	OK	0.81
Quaker Road (Rice to W of First)	C1, L1	NW9	NW10	179.24	178.72	261	16.6	1842	63.2	6193	19.71	3.16	62.25	18.09	80.33	0.0	0.0	**80.3**	450	0.20	1.17	0.20	457.2	0.164	0.114	0.81	**133.0**	60.4	OK	0.75
Quaker Road (Rice to W of First)	M1	NW10	416457MH01 (RMH1)	178.72	178.58	69	7.1	661	70.3	6854	21.82	3.12	67.97	20.10	88.07	0.0	0.0	**88.1**	450	0.20	1.17	0.20	457.2	0.164	0.114	0.81	**133.0**	66.2	OK	0.77
Flows from Hurricane SPS/Rice Road (North)	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-	125.0	125.0	**125.0**	-	-	-		-	-	-	-	**-**	-	-	
Flows from West of Quaker and Rice	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-	119.0	119.0	**119.0**	-	-	-		-	-	-	-	**-**	-	-	-
Quaker Road (Region Trunk E of Rice)	-	406497MH01	416457MH01 (RMH1)	179.94	178.58	618	-	-	-	-	-	-	-	-	-	0.0	244.0	**244.0**	750	0.22	0.99	0.22	762.0	0.456	0.191	1.19	**544.8**	44.8	OK	1.02
Quaker Road (W of First to First)	-	416457MH01 (RMH1)	416487MH01 (RMH2)	178.58	178.25	207	-	-	70.3	6854	21.82	3.12	67.97	20.10	88.07	0.0	244.0	**332.1**	750	0.16	0.99	0.16	762.0	0.456	0.191	1.02	**464.6**	71.5	OK	0.99
First Ave (N of Quaker)	C2, D1, F2	NW11	NW12	179.40	178.41	393	26.1	3223	26.1	3223	10.26	3.42	35.04	7.47	42.51	0.0	0.0	**42.5**	375	0.25	1.25	0.25	381.0	0.114	0.095	0.80	**91.5**	46.5	OK	0.69
First Ave (N of Quaker)	E1	NW12	416487MH01 (RMH2)	178.41	178.25	80	4.8	1123	30.9	4346	13.83	3.30	45.66	8.83	54.49	0.0	0.0	**54.5**	375	0.20	1.25	0.20	381.0	0.114	0.095	0.72	**81.8**	66.6	OK	0.68
Quaker Road (First to W of Niagara)	-	416487MH01 (RMH2)	426427MH01 (RMH3)	178.25	177.07	521	-	-	101.2	11200	35.65	2.91	103.58	28.93	132.52	3.0	247.0	**379.5**	750	0.23	0.99	0.23	762.0	0.456	0.191	1.22	**557.0**	68.1	OK	1.17
NWSP (N of Quaker, E of First)	F1, G1	NW13	426427MH01 (RMH3)	177.29	177.07	50	10.9	980	10.9	980	3.12	3.81	11.87	3.13	15.00	0.0	0.0	**15.0**	200	0.44	1.54	0.44	203.2	0.032	0.051	0.70	**22.7**	66.1	OK	0.67
Quaker Road (W of Niagara to Towpath)	-	426427MH01 (RMH3)	436437MH03	177.07	171.78	1320	-	-	112.1	12181	38.77	2.87	111.23	32.07	143.30	23.0	270.0	**413.3**	750	0.40	0.99	0.40	762.0	0.456	0.191	1.61	**734.5**	56.3	OK	1.47
Towpath (to SPS)	-	436540MH01	446525MH01	171.05	169.40	1002	-	-	112.1	12181	38.77	2.87	111.23	32.07	143.30	50.0	320.0	**463.3**	900	0.16	0.93	0.16	914.4	0.657	0.229	1.15	**755.4**	61.3	OK	1.07

Notes:

1. Residential design flows as per UCC
2. Slopes approximate; calculated based on length
3. Infiltration rate is 0.286 as per Region Master Plan Update 2021
4. Peak Factors for NWSP Flows as per Harmon's Formula
5. Population for NWSP as per UCC
6. All other peak flows as per All Pipe Model

SANITARY SEWER DESIGN SHEET

Design Option - 2

Project: Welland Northwest Secondary Plan
Location:

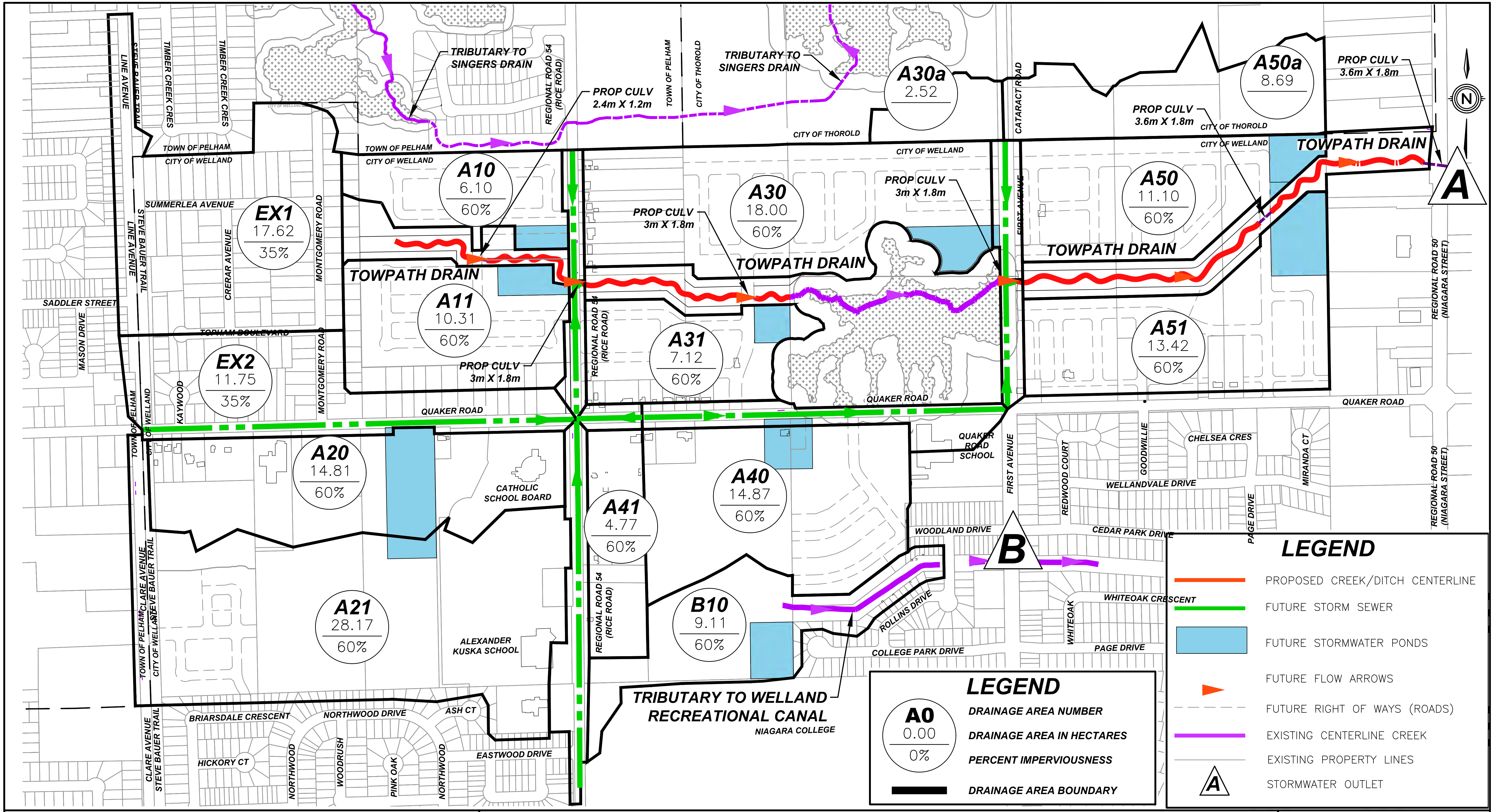
Roughness Coefficient (n) = 0.013
Residential Per Capita Flow Rate = 0.00318287 L/cap/s (275 L/cap/day)
Infiltration Rate= 0.286 L/s/ha

LOCATION							NWSP POPULATION AND FLOW DATA									EX TRUNK FLOW		TOTAL (NWSP + EX)	SEWER DESIGN											
DESCRIPTION	DRAINAGE AREA	MANHOLE		INVERTS		LENGTH	AREA	POP	CUMULATIVE		AVG. DAILY FLOW	PEAKING FACTOR (PF = 1+14/(4+P^1/2))	PEAK FLOW (NO INFIL.)	INFILT. FLOW	PEAK FLOW (W/ INFIL.)	ADDITIONAL PEAK FLOW (FROM MODEL)	CUMULATIVE PEAK FLOW (FROM MODEL)	TOTAL PEAK FLOW	PIPE SIZE	ACTUAL SLOPE	APPROX. CRITICAL SLOPE	DESIGN SLOPE	Act. Dia.	PIPE AREA	HYD. RAD.	FULL FLOW VELOCITY	FULL FLOW CAPACITY	PERCENT FULL	CAPACITY CHECK	ACTUAL VELOCITY
				U/S	D/S				AREA	POP. Served																				
STREET	ID	FROM	TO			m	(ha)	(ppl)	(ha)	(ppl)	(l/s)	(dmnl)	(L/s)	(L/s)	(L/s)	(L/s)		(L/s)	(mm)	(%)	(%)	(%)	(mm)	(m^2)	(m)	(m/s)	(L/s)	(%)		(m/s)
Rice Road (N of Quaker)	A1	NW1	NW2	182.30	181.02	200	6.0	532	6.0	532	1.69	3.96	6.71	1.72	8.43	0.0	0.0	**8.4**	200	0.64	1.54	0.64	203.2	0.032	0.051	0.84	**27.4**	30.8	OK	0.65
Rice Road (N of Quaker)	A2, B1	NW2	NW3	181.02	180.10	197	10.6	868	16.6	1400	4.46	3.70	16.49	4.76	21.24	0.0	0.0	**21.2**	250	0.47	1.43	0.47	254.0	0.051	0.064	0.84	**42.5**	50.0	OK	0.74
Quaker Road (W of Rice)	I2	NW4	NW5	184.80	183.80	112	3.4	330	3.4	330	1.05	4.00	4.21	0.98	5.18	0.0	0.0	**5.2**	200	0.89	1.54	0.89	203.2	0.032	0.051	1.00	**32.3**	16.1	OK	0.64
NWSP (W of Rice, S of Quaker)	H1, I1	NW6	NW7	186.30	185.30	210	13.8	938	13.8	938	2.99	3.82	11.40	3.95	15.35	0.0	0.0	**15.3**	200	0.48	1.54	0.48	203.2	0.032	0.051	0.73	**23.7**	64.7	OK	0.69
NWSP (W of Rice, S of Quaker)	J1	NW7	NW5	185.30	183.80	389	7.0	454	20.8	1392	4.43	3.70	16.41	5.96	22.37	0.0	0.0	**22.4**	250	0.39	1.43	0.39	254.0	0.051	0.064	0.76	**38.7**	57.7	OK	0.70
Quaker Road (W of Rice)	-	NW5	NW3	183.80	180.10	370	-	-	24.3	1722.6	5.48	3.64	19.93	6.94	26.87	0.0	0.0	**26.9**	250	1.00	1.43	1.00	254.0	0.051	0.064	1.22	**62.0**	43.3	OK	1.04
Rice Road (S of Quaker)	K1	NW8	NW3	184.50	180.10	387	5.7	1229	5.7	1229	3.91	3.74	14.63	1.64	16.27	0.0	0.0	**16.3**	200	1.14	1.54	1.14	203.2	0.032	0.051	1.13	**36.5**	44.5	OK	0.96
Quaker Road (Rice to W of First)	-	NW3	NW9	180.10	179.24	287	-	-	46.6	4351.4	13.85	3.30	45.71	13.33	59.04	0.0	0.0	**59.0**	375	0.30	1.25	0.30	381.0	0.114	0.095	0.88	**100.2**	58.9	OK	0.81
Quaker Road (Rice to W of First)	C1, C2, L1	NW9	NW10	179.24	178.72	261	31.2	3640	77.8	7991	25.44	3.05	77.60	22.25	99.84	0.0	0.0	**99.8**	450	0.20	1.17	0.20	457.2	0.164	0.114	0.81	**133.0**	75.1	OK	0.80
Quaker Road (Rice to W of First)	M1	NW10	416457MH01 (RMH1)	178.72	178.58	51	7.1	661	84.8	8652	27.54	3.02	83.08	24.26	107.34	0.0	0.0	**107.3**	450	0.27	1.17	0.27	457.2	0.164	0.114	0.94	**154.6**	69.5	OK	0.91
Flows from Hurricane SPS/Rice Road (North)	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-	125.0	125.0	**125.0**	-	-	-		-	-	-	-	-	-	-	
Flows from West of Quaker and Rice	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-	119.0	119.0	**119.0**	-	-	-		-	-	-	-	-	-	-	-
Quaker Road (Region Trunk E of Rice)	-	406497MH01	416457MH01 (RMH1)	179.94	178.58	618	-	-	-	-	-	-	-	-	-	0.0	244.0	**244.0**	750	0.22	0.99	0.22	762.0	0.456	0.191	1.19	**544.8**	44.8	OK	1.02
Quaker Road (W of First to W of Niagara)	-	416457MH01 (RMH1)	426427MH01 (RMH3)	178.58	177.07	728	-	-	84.8	8652	27.54	3.02	83.08	24.26	107.34	3.0	247.0	**354.3**	750	0.21	0.99	0.21	762.0	0.456	0.191	1.17	**532.2**	66.6	OK	1.11
NWSP (N of Quaker, E of First)	D1, E1	NW11	NW12	179.99	178.32	408	4.9	1089	4.9	1089	3.47	3.78	13.09	1.40	14.49	0.0	0.0	**14.5**	200	0.41	1.54	0.41	203.2	0.032	0.051	0.68	**21.9**	66.1	OK	0.64
NWSP (N of Quaker, E of First)	F2	NW12	NW13	178.32	177.40	306	7.4	417	12.3	1506	4.79	3.68	17.64	3.53	21.17	0.0	0.0	**21.2**	300	0.30	1.34	0.30	304.8	0.073	0.076	0.76	**55.3**	38.3	OK	0.62
NWSP (N of Quaker, E of First)	E2, F1	NW13	NW14	177.40	177.17	117	14.2	1753	26.5	3259	10.37	3.41	35.39	7.58	42.97	0.0	0.0	**43.0**	375	0.20	1.25	0.20	381.0	0.114	0.095	0.72	**81.8**	52.5	OK	0.64
NWSP (N of Quaker, E of First)	G1	NW14	426427MH01 (RMH3)	177.17	177.07	50	0.8	269	27.3	3528	11.23	3.38	37.97	7.81	45.78	0.0	0.0	**45.8**	375	0.20	1.25	0.20	381.0	0.114	0.095	0.72	**81.8**	56.0	OK	0.65
Quaker Road (W of Niagara to Towpath)	-	426427MH01 (RMH3)	436437MH03	177.07	171.78	1320	-	-	112.1	12181	38.77	2.87	111.23	32.07	143.30	23.0	270.0	**413.3**	750	0.40	0.99	0.40	762.0	0.456	0.191	1.61	**734.5**	56.3	OK	1.47
Towpath (to SPS)	-	436540MH01	446525MH01	171.05	169.40	1002	-	-	112.1	12181	38.77	2.87	111.23	32.07	143.30	50.0	320.0	**463.3**	900	0.16	0.93	0.16	914.4	0.657	0.229	1.15	**755.4**	61.3	OK	1.07

Notes:

1. Residential design flows as per UCC
2. Slopes approximate; calculated based on length
3. Infiltration rate is 0.286 as per Region Master Plan Update 2021
4. Peak Factors for NWSP Flows as per Harmon's Formula
5. Population for NWSP as per UCC
6. All other peak flows as per All Pipe Model

APPENDIX C - STORM



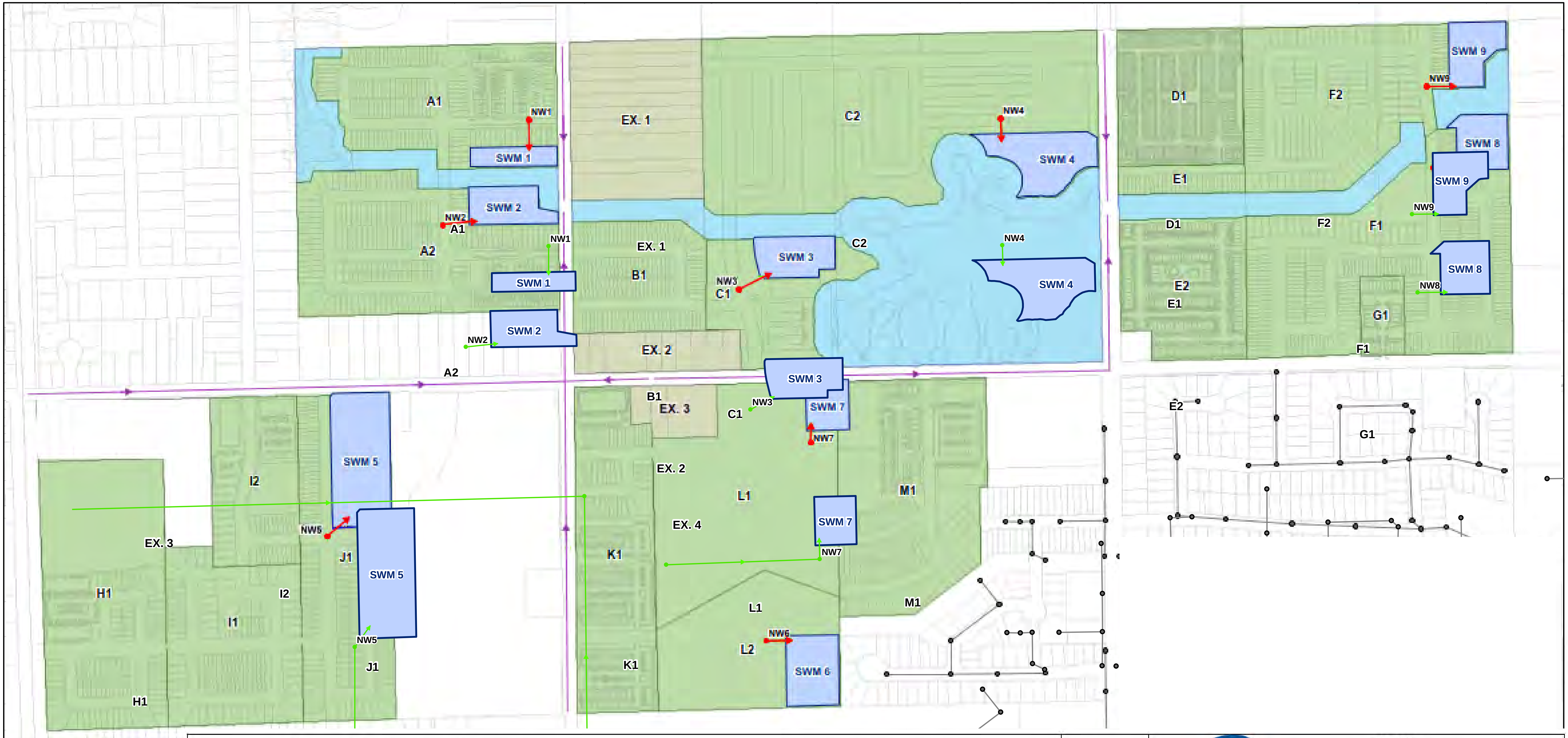
UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

NORTHWEST WELLAND STORMWATER MANAGEMENT IMPLEMENTATION PLAN

CITY OF WELLAND

ULTIMATE STORMWATER MANAGEMENT PLAN

DATE	2022-10-12
SCALE	1:7000
REF No.	21243
DWG No.	FIGURE 10



Legend:

● Proposed Manholes

→ Proposed Storm Outlet

→ Future Trunk Storm

● Existing Manholes

— Existing Storm Sewer

🟦 Proposed SWM Ponds

🟩 Proposed SWM Catchment

▨ Existing SWM Catchment

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

Northwest Secondary Plan
Municipal Servicing

Storm Sewer Design

Project No: 2023-5773

Date: November 2023

Figure C-2

STORM SEWER DESIGN SHEET

Associated Engineering GLOBAL PERSPECTIVE. LOCAL FOCUS.

Q=2.78AiR	Storm Event = 5.00		Years
A = Area (ha)	a	b	c
R = Runoff Coefficient	830	0.777	7.3
T_c = Time of Concentration	n = 0.013		
i = Avg Rainfall Intensity (mm/hr) = a / $(T_c+c)^b$			

Northwest Secondary Plan
Municipal Servicing

JOB No.: 2023-5773

DEVELOPMENT DATA				DESIGN DATA						PIPE DATA								
AREA NO	FROM	TO	AREA (ha)	RUNOFF COEFF. R	A * R	ACCUM A * R	TIME OF CONC. (min)	INTENSITY i (mm/hr)	PEAK FLOW (l/s)	PIPE DIA (mm)	SLOPE (%)	CRITICAL SLOPE (%)	DESIGN SLOPE (%)	LENGTH (m)	FLOW FULL (l/s)	VEL FULL (m/s)	TRAVEL TIME (min)	% FULL
Pond 1																		
A1	NW1	SWM 1	5.70	0.53	3.006	3.006	12.00	83.21	**695.399**	900	0.20	0.93	0.20	40	**809.60**	1.27	0.52	85.89
Pond 2																		
A2	NW2	SWM2	7.33	0.52	3.775	3.775	12.00	83.21	**873.297**	900	0.30	0.93	0.30	40	**991.55**	1.56	0.43	88.07
Pond 3																		
B1, Ex.2, C1	NW3	SWM3	8.50	0.49	4.193	4.193	12.00	83.21	**969.880**	1050	0.30	0.89	0.30	40	**1495.68**	1.73	0.39	64.85
Pond 4																		
Ex. 1, C2	NW4	SWM4	18.00	0.50	9.034	9.034	15.00	74.38	**1867.971**	1200	0.30	0.85	0.30	40	**2135.42**	1.89	0.35	87.48
Pond 5																		
H1, I1, I2, J1	NW5	SWM5	21.77	0.51	11.131	11.131	15.00	74.38	**2301.570**	1350	0.30	0.81	0.30	40	**2923.42**	2.04	0.33	78.73
Pond 6																		
L2	NW6	SWM6	3.88	0.50	1.940	1.940	12.00	83.21	**448.794**	750	0.30	0.99	0.30	40	**609.77**	1.38	0.48	73.60
Pond 7																		
K1, Ex.3, L1, M1	NW7	SWM7	22.90	0.53	12.041	12.041	15.00	74.38	**2489.732**	1350	0.30	0.81	0.30	40	**2923.42**	2.04	0.33	85.17
Pond 8																		
E2, F1, G1	NW8	SWM8	14.31	0.53	7.634	7.634	15.00	74.38	**1578.491**	1200	0.30	0.85	0.30	116	**2135.42**	1.89	1.02	73.92
Pond 9																		
D1, E1, F2	NW9	SWM9	13.14	0.53	6.975	6.975	15.00	74.38	**1442.229**	1200	0.30	0.85	0.30	116	**2135.42**	1.89	1.02	67.54

APPENDIX D - COST ESTIMATE DETAIL

Northwest Welland Secondary Plan
Municipal Servicing

Preliminary Cost Estimate

Watermain				
Item	Quantity	Unit	Unit Price	Cost
150mm PVC DR18 Watermain	10772	m	$455	$4,901,260
150mm Gate Valve & Box	94	each	$3,250	$305,500
200 mm PVC DR18 Watermain	360	m	$520	$187,200
200mm Gate Valve & Box	3	each	$4,225	$12,675
250 mm PVC DR18 Watermain	520	m	$620	$322,400
250mm Gate Valve & Box	4	each	$5,200	$20,800
300mm PVC DR18 Watermain	2755	m	$845	$2,327,975
300mm Gate Valve & Box	29	each	$7,150	$207,350
Water Services	4350	each	$2,600	$11,310,000
Hydrants	97	each	$9,750	$945,750
Connect to Existing	9	each	$6,500	$58,500
Granular A	86900	t	$35	$3,041,500
Other General Construction	1	LS	$2,364,100	$2,364,100
Subtotal				$26,005,010
Contingency (15% of subtotal)				$3,900,800
Engineering (10% of subtotal)				$2,600,600
Total				$32,506,410
Rounded Total				$32,600,000

Sanitary Sewer				
Item	Quantity	Unit	Unit Price	Cost
200mm PVC DR35	13,732	m	$490	$6,728,680
250mm PVC DR35	956	m	$585	$559,260
375mm PVC DR35	760	m	$975	$741,000
450mm PVC DR35	330	m	$1,175	$387,750
Maintenance Hole Structure	136	each	$13,000	$1,768,000
Sanitary Laterals	4,350	each	$3,900	$16,965,000
Connect to Existing Trunk	3	each	$6,500	$19,500
Granular A	182,300	t	$35	$6,380,500
Flush & CCTV (end of construction)	15,778	m	$20	$315,560
Flush & CCTV (end of maintenance)	15,778	m	$20	$315,560
Other General Construction	1	LS	$3,418,100	$3,418,100
Subtotal				$37,598,910
Contingency (15% of subtotal)				$5,639,900
Engineering (10% of subtotal)				$3,759,900
Total				$46,998,710
Rounded Total				$47,000,000

Northwest Welland Secondary Plan
Municipal Servicing

Preliminary Cost Estimate

Storm Sewer				
450mm PVC DR35 Ultra Rib	2204	m	$455	$1,002,820
525mm PVC DR35 Ultra Rib	2515	m	$520	$1,307,800
600mm CONC	2661	m	$585	$1,556,685
675mm CONC	81	m	$815	$66,015
750mm CONC	902	m	$1,025	$924,550
825mm CONC	554	m	$1,175	$650,950
900mm CONC	1015	m	$1,380	$1,400,700
1050mm CONC	941	m	$1,775	$1,670,275
1200mm CONC	332	m	$2,190	$727,080
1350mm CONC	80	m	$2,795	$223,600
1200mm Diameter MH	68	each	$13,000	$884,000
1500mm Diameter CBMH	13	each	$18,200	$236,600
1800mm Diameter CBMH	18	each	$20,800	$374,400
2400mm Diameter CBMH	2	each	$24,700	$49,400
Catchbasin	380	each	$4,175	$1,586,500
Catchbasin leads	1900	m	$490	$931,000
Granular A	95800	t	$35	$3,353,000
Flush & CCTV (end of construction)	11285	m	$20	$225,700
Flush & CCTV (end of maintenance)	11285	m	$20	$225,700
Other General Construction	1	LS	$1,739,700	$1,739,700
Subtotal				$19,136,475
Contingency (15% of subtotal)				$2,870,500
Engineering (10% of subtotal)				$1,913,700
Total				$23,920,675
Rounded Total				$24,000,000

APPENDIX D

Stormwater Management Information

PRE-DEVELOPMENT

Time to Peak Calculations - Pre-Development Conditions

Time to peak (Tp) values derived from time of concentration (Tc) calculations based on the Airport Method Equation:

$$T_c = \frac{3.26(1.1 - C)L^{0.5}}{S_W^{\ 0.33}}$$

(MTO Drainage Manual Design Chart 1.12)

T_c = Overland flow time of concentration (min)
L = Flow travel length (m)
S = Basin slope (%)
C = Runoff coefficient

From this, **Time-to-peak (Tp) = 0.67 Tc**

The time to peak values used in the NASHYD command for the existing conditions hydrologic modeling are shown below.

Catchment ID	Area (ha)	Length (m)	"C"	Slope (m/m)	Tc (min)	Tp	
						(min)	**(hrs)**
901	3.06	160	0.20	0.0030	55.22	37.00	**0.62**
902	3.50	200	0.20	0.0075	45.63	30.57	**0.51**
903	9.49	250	0.20	0.0040	62.77	42.06	**0.70**
904	3.47	160	0.20	0.0100	37.11	24.87	**0.41**
905	2.55	130	0.20	0.0075	36.78	24.65	**0.41**
906	0.39	35	0.20	0.0050	21.82	14.62	**0.24**

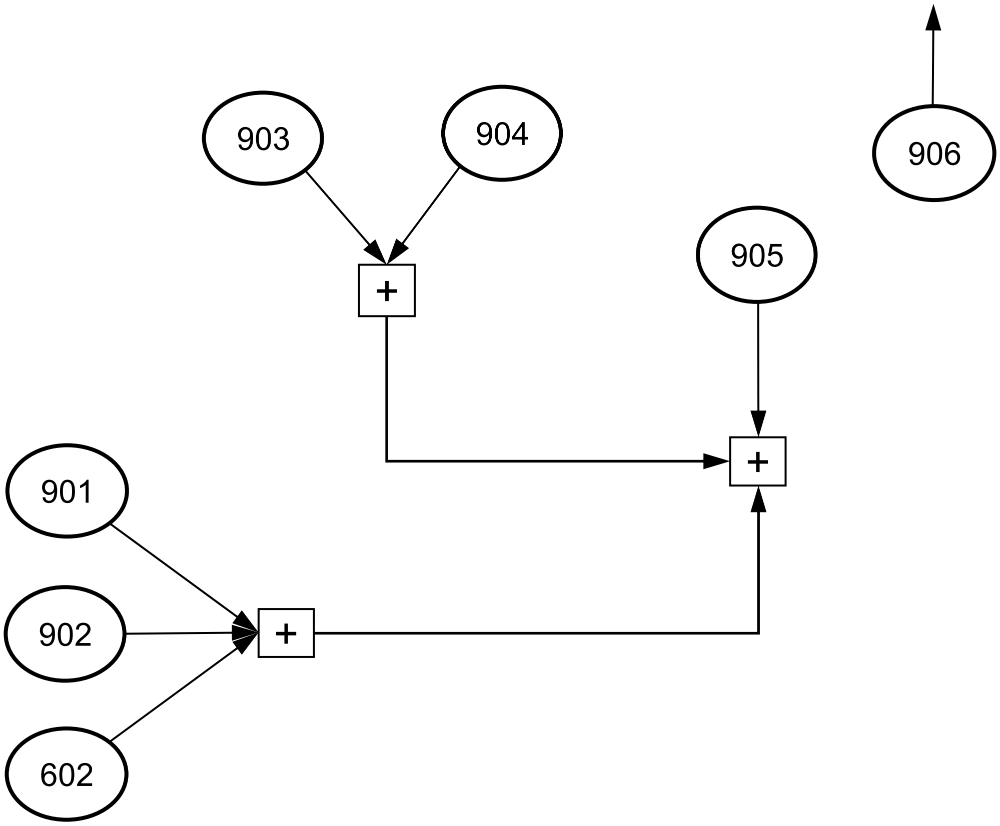
SWMHYMO HYDROLOGIC MODELING PARAMETERS

PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING PARAMETERS

Catchment ID	Catchment Description	Hydrograph Method	Area (ha)	Perv. CN	Perv. Ia (mm)	Impervious (%)		Flow Length (m)		Manning "n"		Slope (%)		Time to Peak Tp (hrs)
						TIMP	XIMP	Perv.	Imperv.	Perv.	Imperv.	Perv.	Imperv.	
Lands on south side of Towpath Drain														
901	Undeveloped Primont lands south of watercourse	NASHYD	3.06	74	8.924									0.62
902	Undevelopmed Mountainview lands west of Primont	NASHYD	3.50	74	8.924									0.51
602	Rear-yards for existing lots fronting Quaker Road	STANDHYD	1.00	74	8.924	30	30	10	30	0.250	0.015	2.0	0.5	
		Total	**7.56**											
Lands on north side of Towpath Drain														
903	Undevelopmed Primont lands north of watercourse	NASHYD	9.49	74	8.924									0.70
904	Undeveloped lands west of Primont	NASHYD	3.47	74	8.924									0.41
905	Undeveloped Primont lands on east east side adjacent First Ave.	NASHYD	2.55	74	8.924									0.41
		Total	**15.51**											
Lands on north side draining to Singers Drain														
906	Portion of north subcatchment located of Primont lands draining north to Singers Drain	NASHYD	**0.36**	74	8.924									0.24
		Total Drainage Area	**23.43**											

- Pervious Initial Abstraction (Perv. Ia) set at 5.0mm. More conservative (lower) than the typical Ia = 0.1 x S , where S = (25400 / CN) - 254
- Depression Storage over Impervious areas (DPSI) = 1.0 mm

PRE-DEVELOPMENT CONDITIONS
SWMHYMO HYDROLOGIC MODELING SCHEMATIC



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*#                 WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
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*#        ==============================================
*#         Pre-development catchments match post-developmnet catchments
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                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.62]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
CALIB NASHYD        ID=[2], NHYD=["902"], DT=[1]min, AREA=[3.50](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.51]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
CALIB STANDHYD      ID=[3], NHYD=["602"], DT=[1](min), AREA=[1.0](ha),
                    XIMP=[0.30], TIMP=[0.30], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
ADD HYD             IDsum=[4], NHYD=["PRE-1"], IDs to add=[1 2 3]
*%-----------------|-----------------------------------------------------------|
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
CALIB NASHYD        ID=[1], NHYD=["903"], DT=[1]min, AREA=[9.49](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.70]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
CALIB NASHYD        ID=[2], NHYD=["904"], DT=[1]min, AREA=[3.47](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
ADD HYD             IDsum=[5], NHYD=["PRE-2"], IDs to add=[1 2]
*%-----------------|-----------------------------------------------------------|
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
CALIB NASHYD        ID=[1], NHYD=["905"], DT=[1]min, AREA=[2.55](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*#*****************************************************************************|
*%-----------------|-----------------------------------------------------------|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
ADD HYD             IDsum=[7], NHYD=["PRETOT"], IDs to add=[4 5 1]
*%-----------------|-----------------------------------------------------------|
*#*****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
CALIB NASHYD        ID=[1], NHYD=["906"], DT=[1]min, AREA=[0.39](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.24]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
ADD HYD             IDsum=[2], NHYD=["906TOT"], IDs to add=[1]
*#*****************************************************************************|
*%-----------------|-----------------------------------------------------------|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                    WELL4005.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                    WELL4010.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                    WELL4025.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                    WELL4050.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                    WELL4100.STM
*
```

```
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[125]
                    25MM.STM
*
*%-----------------|-----------------------------------------------------------|
FINISH







*%-----------------|-----------------------------------------------------------|
*#****************************************************************************|
*#****************************************************************************|
*#****************************************************************************|
*#****************************************************************************|
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#****************************************************************************|
*
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 201 - PRIMONT LANDS
CALIB STANDHYD      ID=[1], NHYD=["201"], DT=[1](min), AREA=[2.6](ha),
                    XIMP=[0.65], TIMP=[0.75], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 301 - MOUNTAINVIEW LANDS
CALIB STANDHYD      ID=[2], NHYD=["301"], DT=[1](min), AREA=[2.9](ha),
                    XIMP=[0.60], TIMP=[0.70], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENTS 401A and 401B - EXTERNAL NEIGHBOURING LANDS EXISTIGN CONDITIONS
CALIB STANDHYD      ID=[3], NHYD=["301"], DT=[1](min), AREA=[1.0](ha),
                    XIMP=[0.30], TIMP=[0.30], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL FLOW - FULL AREA - TO BE ROUTED THROUGH WETPOND ROUTE RESERVOIR
ADD HYD             IDsum=[5], NHYD=["SWMW2-W"], IDs to add=[1 2 3]
*%-----------------|-----------------------------------------------------------|
*# ROUTE THROUGH WET POND W2 - FULL AREA - PRIMONT, MOUNTAINVIEW AND EXTERNAL
ROUTE RESERVOIR     IDout=[7],   NHYD=["WET-W2"],  IDin=[5],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
  0.0000 0
  0.0111 0.0400
  0.0184 0.0858
  0.0234 0.1353
  0.0276 0.1885
  0.1176 0.2453
  0.2272 0.3058
  0.2813 0.3700
  0.3046 0.4045
                                      -1       -1   (max twenty pts)
                          IDovf=[8], NHYDovf=["OVFW2W"]
*%-----------------|-----------------------------------------------------------|
*
*%-----------------|-----------------------------------------------------------|
*#****************************************************************************|
*
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                    WELL4005.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                    WELL4010.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                    WELL4025.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                    WELL4050.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                    WELL4100.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[125]
                    25MM.STM
*
*%-----------------|-----------------------------------------------------------|
FINISH



*# CATCHMENT 401A - EXTERNAL AREA DRAINING INTO PRIMONT LANDS
CALIB STANDHYD      ID=[3], NHYD=["401A"], DT=[1](min), AREA=[0.23](ha),
                    XIMP=[0.01], TIMP=[0.30], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[30](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[10](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
```

```
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 401B - EXTERNAL AREA DRAINING INTO MOUNTAINVIEW LANDS
CALIB STANDHYD      ID=[4], NHYD=["401A"], DT=[1](min), AREA=[0.87](ha),
                    XIMP=[0.01], TIMP=[0.30], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[30](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[10](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|



*%-----------------|-----------------------------------------------------------|
* ROUTE THROUGH DRY POND W2 - PRIMONT AND EXTERNAL ONLY
ROUTE RESERVOIR     IDout=[7],   NHYD=["DRY-W2"],  IDin=[6],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
  0.0000     0.0000
  0.0045     0.0126
  0.0069     0.0273
  0.0087     0.0442
  0.0102     0.0635
  0.0114     0.0854
  0.0349     0.1100
  0.1060     0.1375
  0.1475     0.1680
  0.1792     0.2017
  0.2060     0.2389
  0.2181     0.2588
                                      -1       -1   (max twenty pts)
                          IDovf=[8], NHYDovf=["OVFW2D"]
```

```
================================================================================

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999   999   =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9 9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ## 9   9 9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O      9999  9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO          9     9   =========
                                                       9   9 9   9   # 2018430
        StormWater Management HYdrologic Model          999   999   =========

 *******************************************************************************
 ***************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                OTTHYMO-83 and OTTHYMO-89.                   *********
 *******************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.           *********
 *********                  Ottawa,  Ontario: (613) 836-3884           *********
 *********                  Gatineau, Quebec: (819) 243-6858           *********
 *********                  E-Mail: swmhymo@jfsa.Com                   *********
 *******************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: WalterFedy                                  +++++++++
 +++++++++                Kitchener             SERIAL#:2018430        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *******************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *********
 *********           Maximum value for ID numbers  :     10            *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 *******************************************************************************


 **********************   D E T A I L E D   O U T P U T   *********************
 *******************************************************************************
 *         DATE: 2024-03-12     TIME: 11:16:18     RUN COUNTER: 000832         *
 *******************************************************************************
 * Input   filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-PRE.dat             *
 * Output  filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-PRE.out             *
 * Summary filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-PRE.sum             *
 * User comments:                                                              *
 * 1:__________________________________________________________________________*
 * 2:__________________________________________________________________________*
 * 3:__________________________________________________________________________*
 *******************************************************************************

--------------------------------------------------------------------------------
001:0001------------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*****************************************************************************|
*
  ** END OF RUN :   1

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
           #  1=WELL4002.STM
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*****************************************************************************|
*
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 2-YR CHICAGO STORM - 4
| Ptotal=  38.97 mm|    Comments: CITY OF WELLAND - 2-YR CHICAGO STORM - 4
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.463 |   1.17   6.918 |   2.17   9.580 |   3.17   3.458
               .33   2.735 |   1.33  10.551 |   2.33   7.286 |   3.33   3.149
               .50   3.084 |   1.50  23.484 |   2.50   5.909 |   3.50   2.896
               .67   3.551 |   1.67  77.186 |   2.67   4.992 |   3.67   2.683
               .83   4.208 |   1.83  27.322 |   2.83   4.336 |   3.83   2.503
              1.00   5.207 |   2.00  14.150 |   3.00   3.843 |   4.00   2.347

--------------------------------------------------------------------------------
002:0003------------------------------------------------------------------------
*
*#*****************************************************************************|
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#         Pre-development catchments match post-developmnet catchments
```

```
*#*****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .034 (i)
     TIME TO PEAK    (hrs)=    2.533
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .043 (i)
     TIME TO PEAK    (hrs)=    2.383
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        12.82
               over (min)        2.00         9.00
     Storage Coeff.  (min)=       1.85 (ii)    8.83 (ii)
     Unit Hyd. Tpeak (min)=       2.00         9.00
     Unit Hyd. peak  (cms)=        .59          .13
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .06          .02           .072 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.80          1.667
     RUNOFF VOLUME    (mm)=      37.97         7.57         16.691
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .19           .428

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:901           3.06      .034    2.53   7.57    .000
                    +ID2 02:902           3.50      .043    2.38   7.57    .000
                    +ID3 03:602           1.00      .072    1.67  16.69    .000
                     ==========================================================
                     SUM 04:PRE-1         7.56      .088    2.35   8.78    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0007------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .096 (i)
     TIME TO PEAK    (hrs)=    2.650
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410
```

```
     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .049 (i)
     TIME TO PEAK    (hrs)=    2.233
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0009-----------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:903            9.49      .096    2.65   7.57    .000
                    +ID2 02:904            3.47      .049    2.23   7.57    .000
                     ==========================================================
                     SUM 05:PRE-2         12.96      .137    2.48   7.57    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0010-----------------------------------------------------------------------
*
*#***************************************************************************|
*#***************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .036 (i)
     TIME TO PEAK    (hrs)=    2.233
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0011-----------------------------------------------------------------------
*#***************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:PRE-1          7.56      .088    2.35   8.78    .000
                    +ID2 05:PRE-2         12.96      .137    2.48   7.57    .000
                    +ID3 01:905            2.55      .036    2.23   7.57    .000
                     ==========================================================
                     SUM 07:PRETOT        23.07      .258    2.40   7.96    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0012-----------------------------------------------------------------------
*#***************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .007 (i)
     TIME TO PEAK    (hrs)=    1.983
     RUNOFF VOLUME    (mm)=    7.568
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
002:0013-----------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906             .39      .007    1.98   7.57    .000
                     ==========================================================
                     SUM 02:906TOT         3.47      .049    2.23   7.57    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
002:0014-----------------------------------------------------------------------
*#***************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
  ** END OF RUN :   4

******************************************************************************



--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
```

```
    NSTORM=   1
           #  1=WELL4005.STM
-------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------
*#***************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                       WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#***************************************************************************|
*
-------------------------------------------------------------------------------
005:0002-----------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 5-YR CHICAGO STORM - 4
| Ptotal=  45.88 mm|    Comments: CITY OF WELLAND - 5-YR CHICAGO STORM - 4
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   3.010 |   1.17   8.198 |   2.17  11.245 |   3.17   4.186
               .33   3.333 |   1.33  12.350 |   2.33   8.621 |   3.33   3.823
               .50   3.746 |   1.50  27.081 |   2.50   7.037 |   3.50   3.523
               .67   4.294 |   1.67  90.598 |   2.67   5.976 |   3.67   3.272
               .83   5.063 |   1.83  31.458 |   2.83   5.213 |   3.83   3.057
              1.00   6.224 |   2.00  16.443 |   3.00   4.637 |   4.00   2.872

-------------------------------------------------------------------------------
005:0003-----------------------------------------------------------------------
*
*#***************************************************************************|
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ================================================
*#         Pre-development catchments match post-developmnet catchments
*#***************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .048 (i)
     TIME TO PEAK    (hrs)=    2.500
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
005:0004-----------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .063 (i)
     TIME TO PEAK    (hrs)=    2.350
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
005:0005-----------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        21.53
                over (min)       2.00         7.00
     Storage Coeff.  (min)=       1.73 (ii)    7.41 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .61          .16
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .08          .03            .094 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75           1.667
     RUNOFF VOLUME    (mm)=      44.88        10.82          21.037
     TOTAL RAINFALL   (mm)=      45.88        45.88          45.876
     RUNOFF COEFFICIENT   =        .98          .24            .459

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
005:0006-----------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
```

```
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:901            3.06     .048    2.50  10.82    .000
                    +ID2 02:902            3.50     .063    2.35  10.82    .000
                    +ID3 03:602            1.00     .094    1.67  21.04    .000
                     ==========================================================
                     SUM 04:PRE-1          7.56     .125    2.33  12.17    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0007------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .139 (i)
     TIME TO PEAK    (hrs)=    2.617
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .071 (i)
     TIME TO PEAK    (hrs)=    2.217
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:903            9.49     .139    2.62  10.82    .000
                    +ID2 02:904            3.47     .071    2.22  10.82    .000
                     ==========================================================
                     SUM 05:PRE-2         12.96     .198    2.45  10.82    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0010------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .052 (i)
     TIME TO PEAK    (hrs)=    2.217
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0011------------------------------------------------------------------------
*#*****************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:PRE-1          7.56     .125    2.33  12.17    .000
                    +ID2 05:PRE-2         12.96     .198    2.45  10.82    .000
                    +ID3 01:905            2.55     .052    2.22  10.82    .000
                     ==========================================================
                     SUM 07:PRETOT        23.07     .371    2.35  11.26    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0012------------------------------------------------------------------------
*#*****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .011 (i)
```

```
     TIME TO PEAK    (hrs)=    1.967
     RUNOFF VOLUME    (mm)=   10.819
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906             .39     .011    1.97  10.82    .000
                     ==========================================================
                     SUM 02:906TOT         3.47     .071    2.22  10.82    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0014------------------------------------------------------------------------
*#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
*
  ** END OF RUN :   9

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 010
    NSTORM=   1
           #  1=WELL4010.STM
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                      WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 10-YR CHICAGO STORM -
| Ptotal=  51.47 mm|    Comments: CITY OF WELLAND - 10-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   3.524 |   1.17   9.273 |   2.17  12.580 |   3.17   4.849
               .33   3.889 |   1.33  13.772 |   2.33   9.734 |   3.33   4.441
               .50   4.355 |   1.50  29.639 |   2.50   8.005 |   3.50   4.104
               .67   4.970 |   1.67 101.288 |   2.67   6.837 |   3.67   3.820
               .83   5.827 |   1.83  34.358 |   2.83   5.993 |   3.83   3.578
              1.00   7.111 |   2.00  18.178 |   3.00   5.353 |   4.00   3.368

--------------------------------------------------------------------------------
010:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#         Pre-development catchments match post-developmnet catchments
*#****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .062 (i)
     TIME TO PEAK    (hrs)=    2.483
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .080 (i)
     TIME TO PEAK    (hrs)=    2.333
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267
```

```
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        27.91
               over (min)       2.00         7.00
     Storage Coeff.  (min)=       1.66 (ii)    6.77 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .63          .17
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .08          .04           .111 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75          1.667
     RUNOFF VOLUME    (mm)=      50.47        13.74         24.758
     TOTAL RAINFALL   (mm)=      51.47        51.47         51.474
     RUNOFF COEFFICIENT   =        .98          .27           .481

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 01:901           3.06     .062    2.48  13.74    .000
                       +ID2 02:902           3.50     .080    2.33  13.74    .000
                       +ID3 03:602           1.00     .111    1.67  24.76    .000
                        ===========================================================
                        SUM 04:PRE-1         7.56     .158    2.33  15.20    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0007------------------------------------------------------------------------
*
*#****************************************************************************|
*#****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .176 (i)
     TIME TO PEAK    (hrs)=    2.600
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .091 (i)
     TIME TO PEAK    (hrs)=    2.200
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 01:903           9.49     .176    2.60  13.74    .000
                       +ID2 02:904           3.47     .091    2.20  13.74    .000
                        ===========================================================
                        SUM 05:PRE-2        12.96     .252    2.43  13.74    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0010------------------------------------------------------------------------
*
*#****************************************************************************|
*#****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .067 (i)
     TIME TO PEAK    (hrs)=    2.200
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0011------------------------------------------------------------------------
*#****************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 04:PRE-1         7.56     .158    2.33  15.20    .000
                       +ID2 05:PRE-2        12.96     .252    2.43  13.74    .000
                       +ID3 01:905           2.55     .067    2.20  13.74    .000
                        ===========================================================
                        SUM 07:PRETOT       23.07     .471    2.35  14.22    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0012------------------------------------------------------------------------
*#****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .014 (i)
     TIME TO PEAK    (hrs)=    1.950
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                        ID1 01:906            .39     .014    1.95  13.74    .000
                        ===========================================================
                        SUM 02:906TOT        3.47     .091    2.20  13.74    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0014------------------------------------------------------------------------
*#****************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*
  ** END OF RUN :  24

*******************************************************************************





--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 025
    NSTORM=   1
           #  1=WELL4025.STM
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 25-YR CHICAGO STORM -
| Ptotal=  59.72 mm|    Comments: CITY OF WELLAND - 25-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.295 |   1.17  10.803 |   2.17  14.436 |   3.17   5.829
               .33   4.721 |   1.33  15.732 |   2.33  11.313 |   3.33   5.360
               .50   5.260 |   1.50  32.988 |   2.50   9.395 |   3.50   4.970
               .67   5.968 |   1.67 118.514 |   2.67   8.087 |   3.67   4.640
               .83   6.945 |   1.83  38.130 |   2.83   7.134 |   3.83   4.357
```

```
              1.00   8.394 |   2.00  20.514 |   3.00   6.406 |   4.00   4.112

--------------------------------------------------------------------------------
025:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#       PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#       ==============================================
*#        Pre-development catchments match post-developmnet catchments
*#****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .083 (i)
     TIME TO PEAK    (hrs)=    2.467
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .107 (i)
     TIME TO PEAK    (hrs)=    2.317
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        40.27
                over (min)       2.00         6.00
     Storage Coeff.  (min)=       1.55 (ii)    5.97 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .65          .19
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .10          .05           .143 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.73          1.667
     RUNOFF VOLUME    (mm)=      58.72        18.42         30.511
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .31           .511

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:901           3.06      .083    2.47  18.42    .000
                    +ID2 02:902           3.50      .107    2.32  18.42    .000
                    +ID3 03:602           1.00      .143    1.67  30.51    .000
                     ===========================================================
                     SUM 04:PRE-1         7.56      .210    2.33  20.02    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0007------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .237 (i)
     TIME TO PEAK    (hrs)=    2.583
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309
```

```
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .123 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:903           9.49      .237    2.58  18.42    .000
                    +ID2 02:904           3.47      .123    2.17  18.42    .000
                     ===========================================================
                     SUM 05:PRE-2        12.96      .339    2.42  18.42    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0010------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .090 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0011------------------------------------------------------------------------
*#*****************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:PRE-1         7.56      .210    2.33  20.02    .000
                    +ID2 05:PRE-2        12.96      .339    2.42  18.42    .000
                    +ID3 01:905           2.55      .090    2.17  18.42    .000
                     ===========================================================
                     SUM 07:PRETOT       23.07      .631    2.33  18.95    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0012------------------------------------------------------------------------
*#*****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .019 (i)
     TIME TO PEAK    (hrs)=    1.933
     RUNOFF VOLUME    (mm)=   18.422
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .308

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906            .39      .019    1.93  18.42    .000
                     ===========================================================
                     SUM 02:906TOT        3.47      .123    2.17  18.42    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0014------------------------------------------------------------------------
*#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
```

```
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
  ** END OF RUN :  49

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
           #  1=WELL4050.STM
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                 WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 50-YR CHICAGO STORM -
| Ptotal=  66.95 mm|    Comments: CITY OF WELLAND - 50-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.962 |   1.17  12.287 |   2.17  16.332 |   3.17   6.702
               .33   5.446 |   1.33  17.768 |   2.33  12.858 |   3.33   6.171
               .50   6.057 |   1.50  36.743 |   2.50  10.713 |   3.50   5.729
               .67   6.859 |   1.67 130.180 |   2.67   9.247 |   3.67   5.355
               .83   7.961 |   1.83  42.379 |   2.83   8.175 |   3.83   5.033
              1.00   9.591 |   2.00  23.055 |   3.00   7.353 |   4.00   4.754

--------------------------------------------------------------------------------
050:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#         Pre-development catchments match post-developmnet catchments
*#****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .103 (i)
     TIME TO PEAK    (hrs)=    2.450
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .133 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        49.36
                over (min)       1.00         6.00
     Storage Coeff.  (min)=       1.50 (ii)    5.57 (ii)
     Unit Hyd. Tpeak (min)=       1.00         6.00
     Unit Hyd. peak  (cms)=        .83          .20
                                                              *TOTALS*
```

```
     PEAK FLOW       (cms)=        .11          .07           .167 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.72          1.667
     RUNOFF VOLUME    (mm)=      65.95        22.86         35.790
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .34           .535

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:901            3.06      .103    2.45  22.86    .000
                   +ID2 02:902            3.50      .133    2.30  22.86    .000
                   +ID3 03:602            1.00      .167    1.67  35.79    .000
                    ==========================================================
                    SUM 04:PRE-1          7.56      .260    2.33  24.57    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0007------------------------------------------------------------------------
*
*#****************************************************************************|
*#****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .294 (i)
     TIME TO PEAK    (hrs)=    2.567
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .342

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .152 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:903            9.49      .294    2.57  22.86    .000
                   +ID2 02:904            3.47      .152    2.17  22.86    .000
                    ==========================================================
                    SUM 05:PRE-2         12.96      .420    2.40  22.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0010------------------------------------------------------------------------
*
*#****************************************************************************|
*#****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .112 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0011------------------------------------------------------------------------
*#****************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 04:PRE-1          7.56      .260    2.33  24.57    .000
                   +ID2 05:PRE-2         12.96      .420    2.40  22.86    .000
```

```
                    +ID3 01:905            2.55     .112    2.17  22.86    .000
                     ==========================================================
                     SUM 07:PRETOT        23.07     .783    2.33  23.42    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0012------------------------------------------------------------------------
*#*****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .024 (i)
     TIME TO PEAK    (hrs)=    1.933
     RUNOFF VOLUME    (mm)=   22.863
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906            .39     .024    1.93  22.86    .000
                     ==========================================================
                     SUM 02:906TOT         3.47     .152    2.17  22.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0014------------------------------------------------------------------------
*#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
  ** END OF RUN :  99

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 100
    NSTORM=   1
           #  1=WELL4100.STM
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                  WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 100-YR CHICAGO STORM -
| Ptotal=  73.21 mm|    Comments: CITY OF WELLAND - 100-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.494 |   1.17  13.439 |   2.17  17.787 |   3.17   7.393
               .33   6.023 |   1.33  19.325 |   2.33  14.054 |   3.33   6.815
               .50   6.691 |   1.50  39.636 |   2.50  11.742 |   3.50   6.333
               .67   7.564 |   1.67 142.985 |   2.67  10.156 |   3.67   5.924
               .83   8.763 |   1.83  45.671 |   2.83   8.994 |   3.83   5.572
              1.00  10.529 |   2.00  24.984 |   3.00   8.102 |   4.00   5.266

--------------------------------------------------------------------------------
100:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        =============================================
*#         Pre-development catchments match post-developmnet catchments
*#****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620
```

```
     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .121 (i)
     TIME TO PEAK    (hrs)=    2.450
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .158 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        60.67
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.44 (ii)    5.19 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .85          .22
                                                         *TOTALS*
     PEAK FLOW       (cms)=        .12          .09           .197 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      72.21        26.92         40.504
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .37           .553

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:901           3.06     .121    2.45  26.92    .000
                    +ID2 02:902           3.50     .158    2.30  26.92    .000
                    +ID3 03:602           1.00     .197    1.67  40.50    .000
                     ==========================================================
                     SUM 04:PRE-1         7.56     .306    2.33  28.71    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0007------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .347 (i)
     TIME TO PEAK    (hrs)=    2.550
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .181 (i)
     TIME TO PEAK    (hrs)=    2.150
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
```

```
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:903           9.49      .347    2.55  26.92    .000
                    +ID2 02:904           3.47      .181    2.15  26.92    .000
                     ==========================================================
                     SUM 05:PRE-2        12.96      .498    2.40  26.92    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0010------------------------------------------------------------------------
*
*#*************************************************************************|
*#*************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .133 (i)
     TIME TO PEAK    (hrs)=    2.150
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0011------------------------------------------------------------------------
*#*************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:PRE-1         7.56      .306    2.33  28.71    .000
                    +ID2 05:PRE-2        12.96      .498    2.40  26.92    .000
                    +ID3 01:905           2.55      .133    2.15  26.92    .000
                     ==========================================================
                     SUM 07:PRETOT       23.07      .925    2.33  27.51    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0012------------------------------------------------------------------------
*#*************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .028 (i)
     TIME TO PEAK    (hrs)=    1.917
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906            .39      .028    1.92  26.92    .000
                     ==========================================================
                     SUM 02:906TOT        3.47      .181    2.15  26.92    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0014------------------------------------------------------------------------
*#*************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
  ** END OF RUN : 124

*******************************************************************************
```

```
--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 125
    NSTORM=   1
           #  1=25MM.STM
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024 - FSR
*#    Revised   :
*#    Company   : WALTER FEDY
*#       File   : PRI-PRE.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*****************************************************************************|
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: 25mm 4-hr CHICAGO STORM
| Ptotal=  25.04 mm|    Comments: 25mm 4-hr CHICAGO STORM
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   1.476 |   1.17   4.128 |   2.17   5.720 |   3.17   2.070
               .33   1.638 |   1.33   6.306 |   2.33   4.347 |   3.33   1.886
               .50   1.847 |   1.50  14.454 |   2.50   3.527 |   3.50   1.734
               .67   2.125 |   1.67  55.558 |   2.67   2.982 |   3.67   1.608
               .83   2.515 |   1.83  16.925 |   2.83   2.592 |   3.83   1.500
              1.00   3.109 |   2.00   8.495 |   3.00   2.299 |   4.00   1.407

--------------------------------------------------------------------------------
125:0003------------------------------------------------------------------------
*
*#*****************************************************************************|
*#         PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#         ==============================================
*#          Pre-development catchments match post-developmnet catchments
*#*****************************************************************************|
*
*# CATCHMENT 901 - EXISTING PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.06   Curve Number   (CN)=74.00
| 01:901    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .620

     Unit Hyd Qpeak  (cms)=     .189

     PEAK FLOW       (cms)=     .010 (i)
     TIME TO PEAK    (hrs)=    2.617
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0004------------------------------------------------------------------------
*# CATCHMENT 902 - MOUNTAINVIEW LANDS UNDER EXISTING CONDITIONS
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.50   Curve Number   (CN)=74.00
| 02:902    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .510

     Unit Hyd Qpeak  (cms)=     .262

     PEAK FLOW       (cms)=     .013 (i)
     TIME TO PEAK    (hrs)=    2.450
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0005------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 03:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30         .70
     Dep. Storage     (mm)=       1.00        8.92
     Average Slope     (%)=        .50        2.00
     Length            (m)=      30.00       10.00
     Mannings n          =       .015        .250

     Max.eff.Inten.(mm/hr)=      55.56        3.47
                over (min)       2.00       14.00
     Storage Coeff.  (min)=       2.11 (ii)   13.89 (ii)
     Unit Hyd. Tpeak (min)=       2.00       14.00
     Unit Hyd. peak  (cms)=        .54         .08
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .05         .00          .046 (iii)
     TIME TO PEAK    (hrs)=       1.67        2.00         1.667
     RUNOFF VOLUME    (mm)=      24.04        2.47         8.938
     TOTAL RAINFALL   (mm)=      25.04       25.04        25.041
     RUNOFF COEFFICIENT   =        .96         .10          .357

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
```

```
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0006------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS SOUTH OF WATERCOURSE
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#1
------------------------
| ADD HYD (PRE-1     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:901           3.06      .010    2.62   2.47    .000
                    +ID2 02:902           3.50      .013    2.45   2.47    .000
                    +ID3 03:602           1.00      .046    1.67   8.94    .000
                     ===========================================================
                     SUM 04:PRE-1         7.56      .047    1.67   3.32    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0007------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 903 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (WEST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    9.49   Curve Number   (CN)=74.00
| 01:903    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .700

     Unit Hyd Qpeak  (cms)=     .518

     PEAK FLOW       (cms)=     .030 (i)
     TIME TO PEAK    (hrs)=    2.733
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0008------------------------------------------------------------------------
*# CATCHMENT 904 - EXISTING LANDS WEST OF PRIMONT
----------------------
| CALIB NASHYD       |   Area    (ha)=    3.47   Curve Number   (CN)=74.00
| 02:904    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .323

     PEAK FLOW       (cms)=     .015 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0009------------------------------------------------------------------------
*# TOTAL EXISTING CONDITIONS NORTH OF WATERCOURSE ON WEST SIDE OF PRIMONT LANDS
*# PEAK FLOWS TO BE USED AS CONTROL CRITERIA FOR SWMF#2
------------------------
| ADD HYD (PRE-2     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:903           9.49      .030    2.73   2.47    .000
                    +ID2 02:904           3.47      .015    2.30   2.47    .000
                     ===========================================================
                     SUM 05:PRE-2        12.96      .043    2.57   2.47    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0010------------------------------------------------------------------------
*
*#*****************************************************************************|
*#*****************************************************************************|
*# CATCHMENT 905 - EXISTING PRIMONT LANDS NORTH OF WATERCOURSE (EAST SIDE)
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.55   Curve Number   (CN)=74.00
| 01:905    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .238

     PEAK FLOW       (cms)=     .011 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0011------------------------------------------------------------------------
*#*****************************************************************************|
*# TOTAL EXISTING CONDITIONS DISCHARGE TO TOWPATH FROM PRIMONT AND EXTERNAL
*# LANDS TO EXISTING WATERCOURSE
------------------------
| ADD HYD (PRETOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:PRE-1         7.56      .047    1.67   3.32    .000
                    +ID2 05:PRE-2        12.96      .043    2.57   2.47    .000
                    +ID3 01:905           2.55      .011    2.30   2.47    .000
                     ===========================================================
                     SUM 07:PRETOT       23.07      .081    2.48   2.75    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0012------------------------------------------------------------------------
*#*****************************************************************************|
*# CATCHMENT 906 - AREA DRAINING NORTH TO SINGERS DRAIN
```

```
----------------------
| CALIB NASHYD       |   Area    (ha)=     .39   Curve Number   (CN)=74.00
| 01:906    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .240

     Unit Hyd Qpeak  (cms)=     .062

     PEAK FLOW       (cms)=     .002 (i)
     TIME TO PEAK    (hrs)=    2.033
     RUNOFF VOLUME    (mm)=    2.464
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0013------------------------------------------------------------------------
------------------------
| ADD HYD (906TOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:906            .39      .002    2.03   2.46    .000
                     ===========================================================
                     SUM 02:906TOT        3.47      .015    2.30   2.47    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0014------------------------------------------------------------------------
*#*****************************************************************************|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2024-03-12     at 11:16:20
================================================================================
```

POST-DEVELOPMENT

Primont
Welland, Ontario

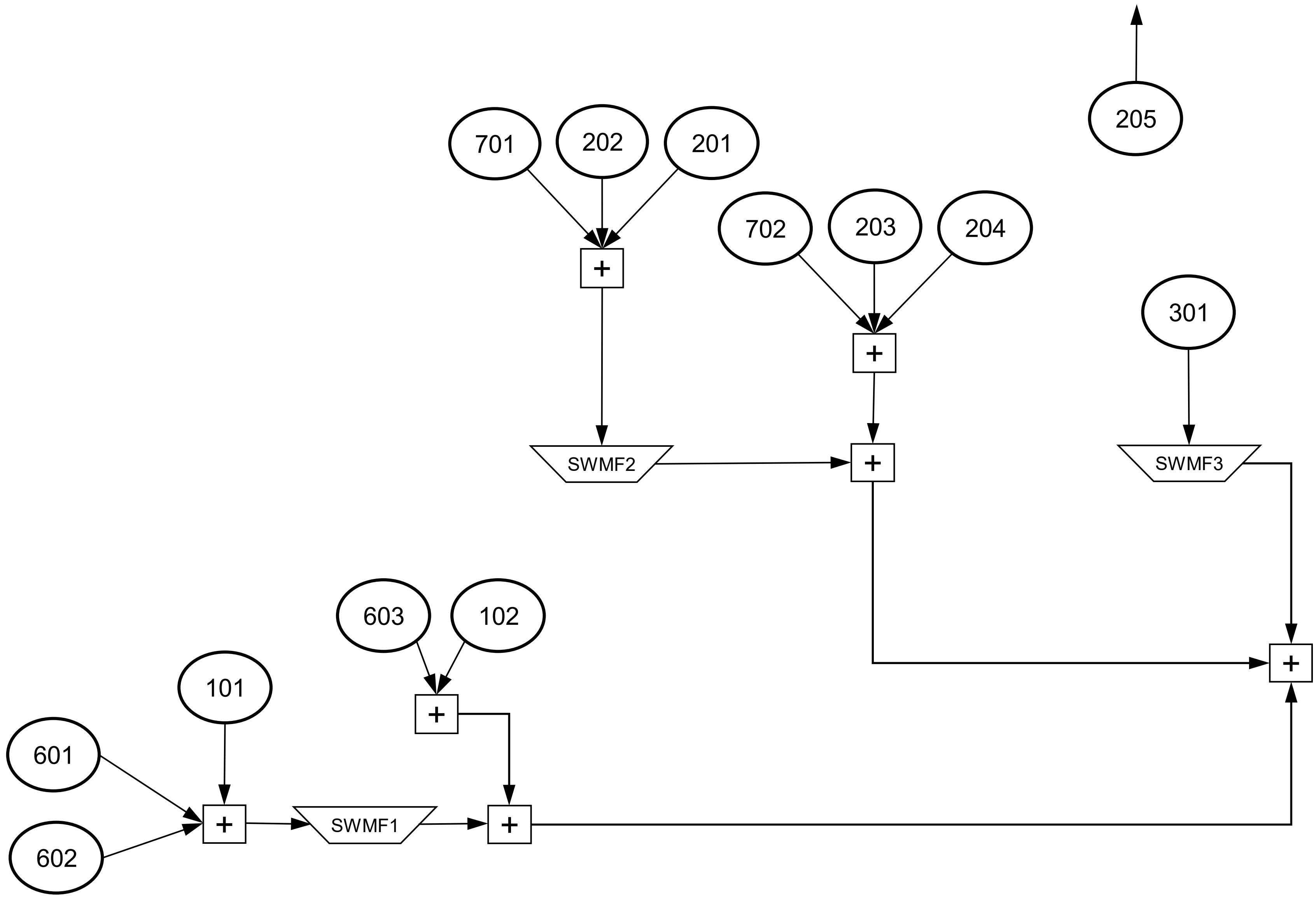
SWMHYMO HYDROLOGIC MODELING PARAMETERS

POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING PARAMETERS

Catchment ID	Catchment Description	Hydrograph Method	Area (ha)	Perv. CN	Perv. Ia (mm)	Impervious (%)		Flow Length (m)		Manning "n"		Slope (%)		Time to Peak Tp (hrs)
						TIMP	XIMP	Perv.	Imperv.	Perv.	Imperv.	Perv.	Imperv.	
Lands on south side of Towpath Drain - Drainage to SWMF #1 or Directly to Drain														
101	Proposed Primont development south of watercourse draining to SWMF #1	STANDHYD	2.67	74	8.924	70	60	10	30	0.250	0.015	2.0	0.5	
102	Primot development draining uncontrolled to Quaker Rd	STANDHYD	0.39	74	8.924	65	60	10	70	0.250	0.015	2.0	2.5	
601	Future Mountainview development draining thru Primont to SWMF #1	STANDHYD	3.13	74	8.924	70	55	10	30	0.250	0.015	2.0	0.5	
602	Rear-yards for existing lots fronting Quaker Road draining to SWMF #1	STANDHYD	1.00	74	8.924	30	30	10	30	0.250	0.015	2.0	0.5	
603	Mountainview development draining uncontrolled to Towpath Drain	STANDHYD	0.37	74	8.924	40	25	20	10	0.250	0.015	2.0	0.5	
		Total	**7.56**											
Lands on north side of Towpath Drain - Drainage to SWMF #2 or SWMF #3 or Directly to Drain														
201	Proposed Primont development north of watercourse draining to SWMF #2	STANDHYD	8.16	74	8.924	65	50	10	30	0.250	0.015	2.0	2.0	
202	Proposed Primont rear-yard areas draining to SWMF #2	STANDHYD	0.12	74	8.924	40	25	7	7	0.250	0.015	2.0	2.0	
203	Proposed Primont rear-yard areas draining to Towpath Drain	STANDHYD	0.19	74	8.924	40	25	7	7	0.250	0.015	2.0	2.0	
204	Primont ucontrolled rear-yard areas draining to Towpath Drain	STANDHYD	0.66	74	8.924	40	25	7	7	0.250	0.015	2.0	2.0	
701	External lands draining to Primont and SWMF #2	NASHYD	2.43	74	8.924									0.41
702	External lands draining to Towpath Drain	NASHYD	1.93	74	8.924									0.41
301	Proposed Primont development on east east side adjacent First Ave. draing to SWMF #3	STANDHYD	2.55	74	8.924	75	70	10	30	0.250	0.015	2.0	0.5	0.41
		Total	**16.04**											
Lands on north side draining to Singers Drain														
205	Primont rear-yard areas draining to Singers Drain	STANDHYD	0.44	74	8.924	40	25	7	7	0.250	0.015	2.0	2.0	
Total Drainage Area			**24.04**											

- Pervious Initial Abstraction (Perv. Ia) set at 5.0mm. More conservative (lower) than the typical Ia = 0.1 x S ,   where S = (25400 / CN) - 254
- Depression Storage over Impervious areas (DPSI) = 1.0 mm

POST-DEVELOPMENT CONDITIONS
SWMHYMO HYDROLOGIC MODELING SCHEMATIC



STORMWATER MANAGEMENT WATER QUALITY CALCULATIONS

SWMF#1 - WETPOND - FULL BUILDOUT (PRIMONT + MOUNTAINVIEW + EXTERNAL)

Areas Contributing to SWM Pond for WQ Event

Sub-Catchment ID	Area (ha)	Percent Impervious (%)
101 - Primont Lands	2.67	70.0
601 - External (Mountainview)	3.13	70.0
602 - External (Quaker Rd.)	1.00	30.0
TOTAL	**6.80**	**64.1**

SWM Pond

Required protection level: Enhanced
Contributing drainage area: 6.80 ha
Impervious level: 64.1 %

Total required water quality storage volume per hectare: 211 m^3/ha
Required permanent pool volume per hectare: 171 m^3/ha
Required extended detention storage volume per hectare: 40 m^3/ha

Required permanent pool volume: 1,165 m^3
Provided permanent pool volume: 2,008 m^3

Required MOE extended detention storage volume: 272 m^3
Provided extended detention volume during water quality event: 272 m^3

25mm Storm - Required storage volume: 901 m^3
28mm Storm - Required storage volume: 1009 m^3 (25mm Vol x 1.12)
28mm Storm - Provided volume: 1,073 m^3

Total pond storage volume during water quality event: 3,081 m^3

MECP SWM Design Manual Table 3.2

Protection Level	**SWMP Type**	**Storage Volume (m^3/ha) for Impervious Level**			
		35%	*55%*	*70%*	*85%*
Enhanced (80% long-term S.S. removal)	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal (70% long-term S.S. removal)	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic (60% long-term S.S. removal)	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

SWMF#1 - Wet Pond - Stage-Storage-Discharge

Outlet Device No. 1 (Quality & Erosion)	
Type:	Circular Orifice
Diameter (mm)	100
Area (m^2)	0.00785
Invert Elev. (m)	182.65
C/L Elev. (m)	182.70
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Outlet Device No. 2 (Quantity)	
Type:	Circular Orifice
Diameter (mm)	375
Area (m^2)	0.11045
Invert Elev. (m)	183.05
C/L Elev. (m)	183.24
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Outlet Device No. 3	
Type: N/A	Circular Orifice
Diameter (mm)	0
Area (m^2)	0.00000
Invert Elev. (m)	0.00
C/L Elev. (m)	0.00
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1
Spill into structure at elev. (m)	0.00

Outlet No. 4 (Quantity)	
Type:	Broad crested overflow weir
Sill Elevation (m)	184.10
Length (m)	8.0
Discharge (Q) =	$1.67 L H^{1.5}$

		SWM Pond Volumes				Outlet No. 1		Outlet No. 2		Outlet No. 3		Outlet No. 4		
	Elevation m	Area m^2	Incremental Volume m^3	Cumulative Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	Total Discharge m^3/s
Bottom of Pond	181.65	1544	0	0	0									
Top Permanent Pool	182.65	2473	2008	2008	0	0.000	0.000							0.0000
	182.75	2576	252	2261	252	0.100	0.0027							0.0027
	182.85	2681	263	2524	515	0.200	0.0076							0.0076
	182.95	2787	273	2797	789	0.300	0.0101							0.0101
Ext. Det. - 28mm	183.05	2895	284	3081	1073	0.400	0.0121	0.000	0.0000					0.0121
	183.15	3005	295	3376	1368	0.500	0.0137	0.100	0.0067					0.0204
	183.25	3117	306	3682	1674	0.600	0.0152	0.200	0.0251					0.0403
	183.35	3230	317	4000	1991	0.700	0.0166	0.300	0.0505					0.0671
	183.45	3345	329	4328	2320	0.800	0.0179	0.400	0.1136					0.1315
	183.55	3461	340	4669	2660	0.900	0.0191	0.500	0.1467					0.1658
	183.65	3579	352	5021	3012	1.000	0.0202	0.600	0.1736					0.1938
	183.75	3699	364	5385	3376	1.100	0.0212	0.700	0.1969					0.2181
	183.85	3820	376	5760	3752	1.200	0.0222	0.800	0.2177					0.2399
	183.95	3943	388	6149	4140	1.300	0.0232	0.900	0.2366					0.2598
	184.05	4068	401	6549	4541	1.400	0.0241	1.000	0.2542					0.2783
Weir Sill	184.10	4138	205	6754	4746	1.450	0.0245	1.050	0.2625			0.000	0.0000	0.2871
	184.20	4265	420	7175	5166	1.550	0.0254	1.150	0.2784			0.100	0.4225	0.7264
	184.30	4394	433	7607	5599	1.650	0.0263	1.250	0.2935			0.200	1.1950	1.5147
Top of Pond	184.40	4524	446	8053	6045	1.750	0.0271	1.350	0.3078			0.300	2.1953	2.5302

SWMF#1 - Drawdown Calculations

Pond drawdown time can be estimated using Equation 4.10
(MOEE SWMP Planning & Design Manual)

$$t = \frac{2A_p}{C A_o (2g)^{0.5}} (h_1^{0.5} - h_2^{0.5})$$

t	= drawdown time in seconds	=	to be calculated	
Ap	= surface area of the pond (m^2)	=	**2684**	(Avg. Surface Area between h_1 & h_2)
C	= discharge coefficient	=	0.60	
D	= diameter of controlling orifice (m)	=	**0.100**	
Ao	= cross-sectional area of orifice (m^2)	=	0.00785	
g	= acceleration due to gravity (m/s^2)	=	9.81	
	Orifice invert elevation (m)	=	***182.600***	(Permanent Pool Elev.)
	Orifice centreline elevation (m)	=	***182.650***	
	Extended detention elevation (m)	=	***183.050***	(Runoff volume for 28 mm event.)
h_1	= starting water level above orifice (m)	=	0.4000	
h_2	= ending water level above orifice (m)	=	0.00	

t = 162649 seconds = $\boxed{\textbf{45.2 hours}}$

SWMF#1 - Forebay Sizing

Based on MOEE SWMP Planning & Design Manual

Length Based on Settling Velocity

$$L = \sqrt{\frac{r\,Q_p}{v_s}}$$

r : 1 = length to width ratio	r =	3
Q_p = peak SWM outflow during quality storm (25mm storm)	Q_p =	0.011
v_s = settling velocity for 0.15 mm particles (m/s)	v_s =	0.0003

L = 10.49 m

Dispersion Length

$$L_D = \frac{8\,Q}{d\,v_f}$$

Q = Inlet pipe to SWMF - 5-yr Inflow per SWMHYMO (m^3/s)	Q =	1.065
d = depth of perm pool in forebay (m)	d =	1
v_f = desired vel in forebay (m/s)	v_f =	0.5

L_D = 17.04 m

Check Scour Velocity

v = Q/A

v = **0.11 m/s**

b = bottom width (avg) of forebay (m)	b =	7
Q = inlet flow (m^3/s)	Q =	1.065
A = cross-sectional area (m^2)	A =	10
Target velocity = 0.15 m/s	V_{targ} =	0.15

Therefore, **Velocity Target Satisfied**

Required Forebay Length = 17.04 m

STORMWATER MANAGEMENT WATER QUALITY CALCULATIONS

SWMF#2 - WETPOND - PRIMONT LANDS + EXTERNAL ON WEST SIDE

Areas Contributing to SWM Pond for WQ Event

Sub-Catchment ID	Area (ha)	Percent Impervious (%)
201 - Primont Lands	8.16	65.0
202 - Primont Lands	0.12	50.0
701 - External (West)	2.43	0.0
TOTAL	**10.71**	**50.1**

SWM Pond

Required protection level: Enhanced
Contributing drainage area: 10.71 ha
Impervious level: 50.1 %

Total required water quality storage volume per hectare: 179 m^3/ha
Required permanent pool volume per hectare: 139 m^3/ha
Required extended detention storage volume per hectare: 40 m^3/ha

Required permanent pool volume: 1,484 m^3
Provided permanent pool volume: 3,127 m^3

Required MOE extended detention storage volume: 428 m^3
Provided extended detention volume during water quality event: 428 m^3

25mm Storm - Required storage volume: 1,016 m^3
28mm Storm - Required storage volume: 1138 m^3 (25mm Vol x 1.12)
28mm Storm - Provided volume: 1,616 m^3

Total pond storage volume during water quality event: 4,743 m^3

MECP SWM Design Manual Table 3.2

Protection Level	**SWMP Type**	**Storage Volume (m^3/ha) for Impervious Level**			
		35%	*55%*	*70%*	*85%*
Enhanced (80% long-term S.S. removal)	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal (70% long-term S.S. removal)	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic (60% long-term S.S. removal)	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

SWMF#2 - Wet Pond - Stage-Storage-Discharge

Outlet Device No. 1 (Quality & Erosion)		Outlet Device No. 2 (Quantity)			Outlet Device No. 3		Outlet No. 4 (Quantity)	
Type:	Circular Orifice	Type:	Circular Orifice		Type: N/A	Circular Orifice	Type:	Broad crested overflow weir
Diameter (mm)	125	Diameter (mm)	300	400	Diameter (mm)	0	Sill Elevation (m)	184.10
Area (m^2)	0.01227	Area (m^2)	0.07069		Area (m^2)	0.00000	Length (m)	8.0
Invert Elev. (m)	182.65	Invert Elev. (m)	183.05		Invert Elev. (m)	0.00	Discharge (Q) =	$1.67\ L\ H^{1.5}$
C/L Elev. (m)	182.71	C/L Elev. (m)	183.20		C/L Elev. (m)	0.00		
Disch. Coeff. (C_d)	0.6	Disch. Coeff. (C_d)	0.6		Disch. Coeff. (C_d)	0.6		
Discharge (Q) =	$C_d\ A\ (\ 2\ g\ H\ )^{0.5}$	Discharge (Q) =	$C_d\ A\ (\ 2\ g\ H\ )^{0.5}$		Discharge (Q) =	$C_d\ A\ (\ 2\ g\ H\ )^{0.5}$		
Number of Orifices:	1	Number of Orifices:	1		Number of Orifices:	1		
					Spill into structure at elev. (m)	0.00		

		SWM Pond Volumes				Outlet No. 1		Outlet No. 2		Outlet No. 3		Outlet No. 4		
	Elevation m	Area m^2	Incremental Volume m^3	Cumulative Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	Total Discharge m^3/s
Bottom of Pond	181.65	2494	0	0	0									
Top Permanent Pool	182.65	3760	3127	3127	0	0.000	0.000							0.0000
	182.75	3898	383	3510	383	0.100	0.0032							0.0032
	182.85	4038	397	3907	780	0.200	0.0111							0.0111
	182.95	4180	411	4318	1191	0.300	0.0152							0.0152
Ext. Det. - 28mm	183.05	4324	425	4743	1616	0.400	0.0184	0.000	0.0000					0.0184
	183.15	4470	440	5182	2056	0.500	0.0211	0.100	0.0060					0.0271
	183.25	4617	454	5637	2510	0.600	0.0234	0.200	0.0212					0.0446
	183.35	4767	469	6106	2979	0.700	0.0256	0.300	0.0421					0.0677
	183.45	4918	484	6590	3463	0.800	0.0276	0.400	0.0840					0.1116
	183.55	5071	499	7090	3963	0.900	0.0295	0.500	0.1029					0.1324
	183.65	5226	515	7604	4478	1.000	0.0312	0.600	0.1188					0.1500
	183.75	5383	530	8135	5008	1.100	0.0329	0.700	0.1328					0.1657
	183.85	5542	546	8681	5554	1.200	0.0345	0.800	0.1455					0.1800
	183.95	5703	562	9243	6117	1.300	0.0360	0.900	0.1572					0.1931
	184.05	5865	578	9822	6695	1.400	0.0374	1.000	0.1680					0.2054
Weir Sill	184.10	5956	296	10117	6990	1.450	0.0381	1.050	0.1732			0.000	0.0000	0.2113
	184.20	6121	604	10721	7594	1.550	0.0395	1.150	0.1831			0.100	0.4225	0.6451
	184.30	6289	621	11342	8215	1.650	0.0408	1.250	0.1925			0.200	1.1950	1.4283
Top of Pond	184.40	6459	637	11979	8852	1.750	0.0421	1.350	0.2014			0.300	2.1953	2.4388

SWMF#2 - Drawdown Calculations

Pond drawdown time can be estimated using Equation 4.10
(MOEE SWMP Planning & Design Manual)

$$t = \frac{2A_p}{CA_o(2g)^{0.5}}(h_1^{0.5} - h_2^{0.5})$$

t = drawdown time in seconds = to be calculated
Ap = surface area of the pond (m^2) = **4042** (Avg. Surface Area between h_1 & h_2)
C = discharge coefficient = 0.60
D = diameter of controlling orifice (m) = **0.125**
Ao = cross-sectional area of orifice (m^2) = 0.01227
g = acceleration due to gravity (m/s^2) = 9.81
Orifice invert elevation (m) = ***182.600*** (Permanent Pool Elev.)
Orifice centreline elevation (m) = ***182.663***
Extended detention elevation (m) = ***183.050*** (Runoff volume for 28 mm event.)
h_1 = starting water level above orifice (m) = 0.3875
h_2 = ending water level above orifice (m) = 0.00

t = 154295 seconds = 42.9 hours

SWMF#2 - Forebay Sizing

Based on MOEE SWMP Planning & Design Manual

Length Based on Settling Velocity

$$L = \sqrt{\frac{r\,Q_p}{v_s}}$$

L = 11.83 m

r : 1 = length to width ratio	r =	3
Q_p = peak SWM outflow during quality storm (25mm storm)	Q_p =	0.014
v_s = settling velocity for 0.15 mm particles (m/s)	v_s =	0.0003

Dispersion Length

$$L_D = \frac{8\,Q}{d\;v_f}$$

L_D = 20.32 m

Q = Inlet pipe to SWMF - 5-yr Inflow per SWMHYMO (m^3/s)	Q =	1.27
d = depth of perm pool in forebay (m)	d =	1
v_f = desired vel in forebay (m/s)	v_f =	0.5

Check Scour Velocity

v = Q/A

v = **0.13 m/s**

b = bottom width (avg) of forebay (m)	b =	7
Q = inlet flow (m^3/s)	Q =	1.27
A = cross-sectional area (m^2)	A =	10
Target velocity = 0.15 m/s	V_{targ} =	0.15

Therefore, **Velocity Target Satisfied**

Required Forebay Length = 20.32 m

STORMWATER MANAGEMENT WATER QUALITY CALCULATIONS

SWMF#3 - DRY POND

Areas Contributing to SWM Pond for WQ Event

Sub-Catchment ID	Area (ha)	Percent Impervious (%)
301 - Primont Lands	2.55	75.0
TOTAL	**2.55**	**75.0**

SWM Pond

Required protection level:		Basic	
Contributing drainage area:		2.55	ha
Impervious level:		75.0	%
Total required water quality storage volume per hectare:		217	m^3/ha
Required permanent pool volume per hectare:	n/a		m^3/ha
Required extended detention storage volume per hectare:		217	m^3/ha
Required permanent pool volume:	n/a		m^3
Provided permanent pool volume:	n/a		m^3
Required MOE extended detention storage volume:		553	m^3
Provided extended detention volume during water quality event:		747	m^3 (governs)
25mm Storm - Required storage volume:		385	m^3
28mm Storm - Required storage volume:		431	m^3 (25mm Vol x 1.12)
Total pond storage volume during water quality event:		0	m^3

MECP SWM Design Manual Table 3.2

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	*55%*	*70%*	*85%*
Enhanced (80% long-term S.S. removal)	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal (70% long-term S.S. removal)	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic (60% long-term S.S. removal)	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

SWMF#3 - Dry Pond

Outlet Device No. 1 (Quality & Erosion)

Type:	Circular Orifice
Diameter (mm)	75
Area (m^2)	0.00442
Invert Elev. (m)	180.70
C/L Elev. (m)	180.74
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Outlet Device No. 2 (Quantity)

Type:	Circular Orifice
Diameter (mm)	200
Area (m^2)	0.03142
Invert Elev. (m)	181.50
C/L Elev. (m)	181.60
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Outlet Device No. 3

Type: N/A	Circular Orifice
Diameter (mm)	0
Area (m^2)	0.00000
Invert Elev. (m)	0.00
C/L Elev. (m)	0.00
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1
Spill into structure at elev. (m)	0.00

Outlet No. 4 (Quantity)

Type:	Broad crested overflow weir
Sill Elevation (m)	183.10
Length (m)	8.0
Discharge (Q) =	$1.67 L H^{1.5}$

		SWM Pond Volumes				Outlet No. 1		Outlet No. 2		Outlet No. 3		Outlet No. 4		
	Elevation m	Area m^2	Incremental Volume m^3	Cumulative Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	H m	Discharge m^3/s	Total Discharge m^3/s
Bottom of Pond	180.70	701	0	0	0	0.000	0.0000							0.0000
	180.90	811	151	151	151	0.200	0.0045							0.0045
	181.10	928	174	325	325	0.400	0.0069							0.0069
	181.30	1052	198	523	523	0.600	0.0087							0.0087
Ext. Det. - MECP	181.50	1184	224	747	747	0.800	0.0102	0.000	0.0000					0.0102
	181.70	1337	252	999	999	1.000	0.0114	0.200	0.0153					0.0267
	181.90	1488	282	1281	1281	1.200	0.0126	0.400	0.0431					0.0557
	182.10	1647	313	1595	1595	1.400	0.0136	0.600	0.0570					0.0707
	182.30	1813	346	1941	1941	1.600	0.0146	0.800	0.0682					0.0828
	182.50	1986	380	2320	2320	1.800	0.0155	1.000	0.0777					0.0933
	182.70	2333	432	2752	2752	2.000	0.0164	1.200	0.0862					0.1026
	182.90	2714	505	3257	3257	2.200	0.0172	1.400	0.0940					0.1112
	183.10	3101	581	3838	3838	2.400	0.0180	1.600	0.1011					0.1191
Weir Sill	183.20	3297	320	4158	4158	2.500	0.0184	1.700	0.1045			0.100	0.4225	0.5454
	183.30	3495	340	4498	4498	2.600	0.0187	1.800	0.1078			0.200	1.1950	1.3215
	183.40	3694	359	4857	4857	2.700	0.0191	1.900	0.1110			0.300	2.1953	2.3254
Top of Pond	183.50	3895	379	5237	5237	2.800	0.0195	2.000	0.1141			0.400	3.3798	3.5134

SWMF#3 - Drawdown Calculations

Pond drawdown time can be estimated using Equation 4.10
(MOEE SWMP Planning & Design Manual)

$$t=\frac{2\,A_p}{C\,A_o\,(2g)^{0.5}}\,(h_1^{0.5}-h_2^{0.5})$$

t	= drawdown time in seconds	=	to be calculated	
Ap	= surface area of the pond (m^2)	=	**942**	(Avg. Surface Area between h_1 & h_2)
C	= discharge coefficient	=	0.60	
D	= diameter of controlling orifice (m)	=	**0.075**	
Ao	= cross-sectional area of orifice (m^2)	=	0.00442	
g	= acceleration due to gravity (m/s^2)	=	9.81	
	Orifice invert elevation (m)	=	***180.700***	(Permanent Pool Elev.)
	Orifice centreline elevation (m)	=	***180.738***	
	Extended detention elevation (m)	=	***181.500***	(Full MOE volume)
h_1	= starting water level above orifice (m)	=	0.7625	
h_2	= ending water level above orifice (m)	=	0.00	

t = 140116 seconds = 38.9 hours

Catchment 301 - SWM Quality Control

The small drainage area for Catchment 301 is not suitable for the implementation of wet pond facility for quality control. Water quality will be achieved through a treatment train process utilizing an inline oil/grit unit that will outlet to a dry pond that will provide extended detention and release of the MOE water quality volume. A continuous flow dry pond is capable of achieving 60% annual TSS removal. The implementation of a Hydrostorm HS-6 units (see below) will achieve 57% annual TSS removal assuming the ETV particle size distribution. The overall TSS removal for the oil/grit unit and dry pond SWM facility in series can be determined using the equation below:

$$R = A + B - [(A \times B) / 100]$$

Where:

R = Total TSS Removal Rate

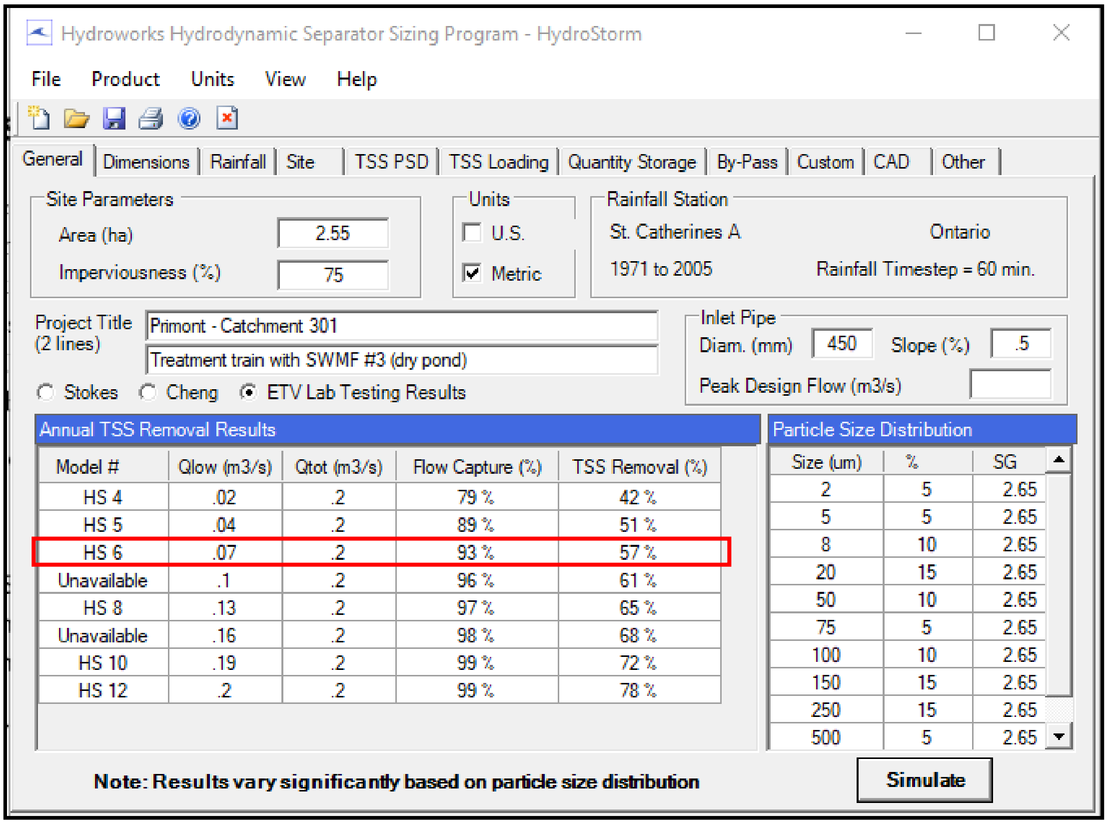
A = TSS Removal Rate of the First or Upstream BMP ***(Oil/grit unit = 57%)***

B = TSS Removal Rate of the Second or Downstream BMP ***(Dry Pond = 60%)***

Source: New Jersey Stormwater Best Management Practices Manual (February 2004)

Total TSS Removal = 82%

Therefore, the use of the oil/grit unit and dry pond in series will results in an annual TSS removal that exceeds the minimum 70% required for Normal water quality protection.



Site Parameters

Area (ha) 2.55

Imperviousness (%) 75

Units

☐ U.S.

☑ Metric

Rainfall Station

St. Catherines A Ontario

1971 to 2005 Rainfall Timestep = 60 min.

Project Title (2 lines) Primont - Catchment 301

Treatment train with SWMF #3 (dry pond)

○ Stokes ○ Cheng ● ETV Lab Testing Results

Inlet Pipe

Diam. (mm) 450 Slope (%) .5

Peak Design Flow (m3/s)

Annual TSS Removal Results

Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)
HS 4	.02	.2	79 %	42 %
HS 5	.04	.2	89 %	51 %
HS 6	.07	.2	93 %	57 %
Unavailable	.1	.2	96 %	61 %
HS 8	.13	.2	97 %	65 %
Unavailable	.16	.2	98 %	68 %
HS 10	.19	.2	99 %	72 %
HS 12	.2	.2	99 %	78 %

Particle Size Distribution

Size (um)	%	SG
2	5	2.65
5	5	2.65
8	10	2.65
20	15	2.65
50	10	2.65
75	5	2.65
100	10	2.65
150	15	2.65
250	15	2.65
500	5	2.65

Note: Results vary significantly based on particle size distribution

```
2     Metric units
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                 WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
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START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
                    WELL4002.STM
*
READ STORM          STORM_FILENAME "STORM.001"
*
*#****************************************************************************|
*%-----------------|-----------------------------------------------------------|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
*#****************************************************************************|
*
*#*****************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
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                    XIMP=[0.55], TIMP=[0.70], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
CALIB STANDHYD      ID=[2], NHYD=["602"], DT=[1](min), AREA=[1.0](ha),
                    XIMP=[0.30], TIMP=[0.30], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
CALIB STANDHYD      ID=[3], NHYD=["201"], DT=[1](min), AREA=[2.67](ha),
                    XIMP=[0.60], TIMP=[0.70], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
ADD HYD             IDsum=[4], NHYD=["TOT-1A"], IDs to add=[1 2 3]
*%-----------------|-----------------------------------------------------------|
*# ROUTE THROUGH SWMF #1
ROUTE RESERVOIR     IDout=[5],   NHYD=["SWM1"],  IDin=[4],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                     0.0000  0
                                     0.0027  0.0252
                                     0.0076  0.0515
                                     0.0101  0.0789
                                     0.0121  0.1073
                                     0.0204  0.1368
                                     0.0403  0.1674
                                     0.0671  0.1991
                                     0.1315  0.2320
                                     0.1658  0.2660
                                     0.1938  0.3012
                                     0.2181  0.3376
                                     0.2399  0.3752
                                     0.2598  0.4140
                                     0.2783  0.4541
                                     0.2871  0.4746
                                     0.7264  0.5166
                                     1.5147  0.5599
                                     2.5302  0.6045
                                      -1       -1   (max twenty pts)
                          IDovf=[6], NHYDovf=["OVF1"]
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
CALIB STANDHYD      ID=[1], NHYD=["603"], DT=[1](min), AREA=[0.37](ha),
                    XIMP=[0.25], TIMP=[0.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[20](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[10](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
CALIB STANDHYD      ID=[2], NHYD=["102"], DT=[1](min), AREA=[0.39](ha),
                    XIMP=[0.60], TIMP=[0.65], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.5](%),
                                         LGI=[70](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL UNCONTROLLED FLOW
ADD HYD             IDsum=[3], NHYD=["TOT-2A"], IDs to add=[1 2]
*%-----------------|-----------------------------------------------------------|
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
ADD HYD             IDsum=[4], NHYD=["T-PST1"], IDs to add=[5 6 3]
*%-----------------|-----------------------------------------------------------|
*
*
*#*****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
CALIB NASHYD        ID=[1], NHYD=["701"], DT=[1]min, AREA=[2.43](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 202 - PRIMONT REAR YARDS
CALIB STANDHYD      ID=[2], NHYD=["202"], DT=[1](min), AREA=[0.12](ha),
                    XIMP=[0.25], TIMP=[0.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[7](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[7](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 201 - PRIMONT LANDS
CALIB STANDHYD      ID=[3], NHYD=["201"], DT=[1](min), AREA=[8.16](ha),
                    XIMP=[0.50], TIMP=[0.65], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
ADD HYD             IDsum=[8], NHYD=["TOT-1B"], IDs to add=[1 2 3]
*%-----------------|-----------------------------------------------------------|
*# ROUTE THROUGH SWMF #2
ROUTE RESERVOIR     IDout=[9],   NHYD=["SWM2"],  IDin=[8],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                         0.0000  0
                                         0.0032  0.0383
                                         0.0111  0.0780
                                         0.0152  0.1191
                                         0.0184  0.1616
                                         0.0271  0.2056
                                         0.0446  0.2510
                                         0.0677  0.2979
                                         0.1116  0.3463
                                         0.1324  0.3963
                                         0.1500  0.4478
                                         0.1657  0.5008
                                         0.1800  0.5554
                                         0.1931  0.6117
                                         0.2054  0.6695
                                         0.2113  0.6990
                                         0.6451  0.7594
                                         1.4283  0.8215
                                         2.4388  0.8852
                                      -1       -1   (max twenty pts)
                          IDovf=[10], NHYDovf=["OVF2"]
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
CALIB NASHYD        ID=[1], NHYD=["702"], DT=[1]min, AREA=[1.93](ha),
                    DWF=[0](cms),  CN/C=[74], IA=[8.924](mm),
                    N=[3], TP=[0.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
CALIB STANDHYD      ID=[2], NHYD=["203"], DT=[1](min), AREA=[0.19](ha),
                    XIMP=[0.25], TIMP=[0.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[7](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[7](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
CALIB STANDHYD      ID=[3], NHYD=["204"], DT=[1](min), AREA=[0.66](ha),
                    XIMP=[0.25], TIMP=[0.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[7](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[7](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# TOTAL UNCONTROLLED FLOWS
ADD HYD             IDsum=[5], NHYD=["TOT-2B"], IDs to add=[1 2 3]
*%-----------------|-----------------------------------------------------------|
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
ADD HYD             IDsum=[6], NHYD=["T-PST2"], IDs to add=[9 10 5]
*%-----------------|-----------------------------------------------------------|
*
*
*#*****************************************************************************|
*%-----------------|-----------------------------------------------------------|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
CALIB STANDHYD      ID=[10], NHYD=["205"], DT=[1](min), AREA=[0.44](ha),
                    XIMP=[0.25], TIMP=[0.40], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
```

```
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[7](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
                                         LGI=[7](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
ADD HYD             IDsum=[10], NHYD=["205"], IDs to add=[1]
*#*****************************************************************************|
*
*
*#*****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
CALIB STANDHYD      ID=[1], NHYD=["301"], DT=[1](min), AREA=[2.55](ha),
                    XIMP=[0.70], TIMP=[0.75], DWF=[0](cms), LOSS=[2],
                    SCS curve number CN=[74],
                    Pervious   surfaces: IAper=[8.924](mm), SLPP=[2.0](%),
                                         LGP=[10](m), MNP=[0.250], SCP=[0](min),
                    Impervious surfaces: IAimp=[1.0](mm), SLPI=[0.5](%),
                                         LGI=[30](m), MNI=[0.015], SCI=[0](min),
                    RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# ROUTE THROUGH SWMF #3
ROUTE RESERVOIR     IDout=[2],   NHYD=["SWM3"],  IDin=[1],
                    RDT=[1](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
  0.0000     0.0000
  0.0045     0.0151
  0.0069     0.0325
  0.0087     0.0523
  0.0102     0.0747
  0.0267     0.0999
  0.0557     0.1281
  0.0707     0.1595
  0.0828     0.1941
  0.0933     0.2320
  0.1026     0.2752
  0.1112     0.3257
  0.1191     0.3838
  0.5454     0.4158
  1.3215     0.4498
  2.3254     0.4857
  3.5134     0.5237
                                      -1       -1   (max twenty pts)
                          IDovf=[3], NHYDovf=["OVF3"]
*%-----------------|-----------------------------------------------------------|
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
ADD HYD             IDsum=[7], NHYD=["PSTTOT"], IDs to add=[4 6 2 3]
*%-----------------|-----------------------------------------------------------|
*%-----------------|-----------------------------------------------------------|
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
                    WELL4005.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
                    WELL4010.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
                    WELL4025.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
                    WELL4050.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
                    WELL4100.STM
*
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[125]
                    25MM.STM
*
*%-----------------|-----------------------------------------------------------|
FINISH
```

```
================================================================================

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999   999   =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9 9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ## 9   9 9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O      9999  9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO          9     9   =========
                                                       9   9 9   9   # 2018430
        StormWater Management HYdrologic Model          999   999    =========

 *******************************************************************************
 ***************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors      *********
 *********                OTTHYMO-83 and OTTHYMO-89.                   *********
 *******************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.           *********
 *********                  Ottawa,  Ontario: (613) 836-3884            *********
 *********                  Gatineau, Quebec: (819) 243-6858            *********
 *********                  E-Mail: swmhymo@jfsa.Com                    *********
 *******************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: WalterFedy                                   +++++++++
 +++++++++                Kitchener             SERIAL#:2018430        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *******************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *********
 *********           Maximum value for ID numbers  :     10            *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 *******************************************************************************


 *********************   D E T A I L E D   O U T P U T   *********************
 *******************************************************************************
 *         DATE: 2024-05-23     TIME: 14:45:13     RUN COUNTER: 000923         *
 *******************************************************************************
 * Input   filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-POST.dat            *
 * Output  filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-POST.out            *
 * Summary filename: C:\USERS\JORESK~1\DESKTOP\Primont\Pri-POST.sum            *
 * User comments:                                                              *
 * 1:__________________________________________________________________________*
 * 2:__________________________________________________________________________*
 * 3:__________________________________________________________________________*
 *******************************************************************************

--------------------------------------------------------------------------------
001:0001------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*************************************************************************|
*
  ** END OF RUN :   1

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 002
    NSTORM=   1
           #  1=WELL4002.STM
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*************************************************************************|
*
--------------------------------------------------------------------------------
002:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 2-YR CHICAGO STORM - 4
| Ptotal=  38.97 mm|    Comments: CITY OF WELLAND - 2-YR CHICAGO STORM - 4
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   2.463 |   1.17   6.918 |   2.17   9.580 |   3.17   3.458
               .33   2.735 |   1.33  10.551 |   2.33   7.286 |   3.33   3.149
               .50   3.084 |   1.50  23.484 |   2.50   5.909 |   3.50   2.896
               .67   3.551 |   1.67  77.186 |   2.67   4.992 |   3.67   2.683
               .83   4.208 |   1.83  27.322 |   2.83   4.336 |   3.83   2.503
              1.00   5.207 |   2.00  14.150 |   3.00   3.843 |   4.00   2.347

--------------------------------------------------------------------------------
002:0003------------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
```

```
*#
*#*************************************************************************|
*
*#**************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#**************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        38.48
                over (min)       2.00         6.00
     Storage Coeff.  (min)=       1.85 (ii)    6.35 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .59          .18
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .37          .07           .423 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.73          1.667
     RUNOFF VOLUME    (mm)=      37.97        11.79         26.190
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .30           .672

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        12.82
                over (min)       2.00         9.00
     Storage Coeff.  (min)=       1.85 (ii)    8.83 (ii)
     Unit Hyd. Tpeak (min)=       2.00         9.00
     Unit Hyd. peak  (cms)=        .59          .13
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .06          .02           .072 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.80          1.667
     RUNOFF VOLUME    (mm)=      37.97         7.57         16.691
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .19           .428

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        28.74
                over (min)       2.00         7.00
     Storage Coeff.  (min)=       1.85 (ii)    6.90 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .59          .16
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .34          .04           .373 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75          1.667
     RUNOFF VOLUME    (mm)=      37.97        10.50         26.985
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .27           .692

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:601           3.13      .423    1.67  26.19    .000
                    +ID2 02:602           1.00      .072    1.67  16.69    .000
                    +ID3 03:201           2.67      .373    1.67  26.99    .000
                     ==========================================================
                     SUM 04:TOT-1A        6.80      .869    1.67  25.11    .000
```

```
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |   (cms)    (ha.m.)
                           .000  .0000E+00   |     .194  .3012E+00
                           .003  .2520E-01   |     .218  .3376E+00
                           .008  .5150E-01   |     .240  .3752E+00
                           .010  .7890E-01   |     .260  .4140E+00
                           .012  .1073E+00   |     .278  .4541E+00
                           .020  .1368E+00   |     .287  .4746E+00
                           .040  .1674E+00   |     .726  .5166E+00
                           .067  .1991E+00   |    1.515  .5599E+00
                           .132  .2320E+00   |    2.530  .6045E+00
                           .166  .2660E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     -------------------        (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (TOT-1A)       6.80      .869     1.667     25.105
     OUTFLOW<05: (SWM1  )       6.80      .029     4.017     25.105
    OVERFLOW<06: (OVF1  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.348
                   TIME SHIFT OF PEAK FLOW         (min)=   141.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1501E+00

--------------------------------------------------------------------------------
002:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        22.43
                over (min)        1.00         9.00
     Storage Coeff.  (min)=        .63 (ii)    9.10 (ii)
     Unit Hyd. Tpeak (min)=       1.00         9.00
     Unit Hyd. peak  (cms)=       1.35          .12
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .02          .01            .025 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.80           1.667
     RUNOFF VOLUME    (mm)=      37.97         9.82          16.856
     TOTAL RAINFALL   (mm)=      38.97        38.97          38.974
     RUNOFF COEFFICIENT   =        .97          .25            .433

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        19.09
                over (min)        2.00         8.00
     Storage Coeff.  (min)=       1.89 (ii)    7.85 (ii)
     Unit Hyd. Tpeak (min)=       2.00         8.00
     Unit Hyd. peak  (cms)=        .58          .14
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .05          .00            .053 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.77           1.667
     RUNOFF VOLUME    (mm)=      37.97         8.89          26.340
     TOTAL RAINFALL   (mm)=      38.97        38.97          38.974
     RUNOFF COEFFICIENT   =        .97          .23            .676

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
-----------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:603            .37      .025    1.67  16.86    .000
                    +ID2 02:102            .39      .053    1.67  26.34    .000
                     ==========================================================
                     SUM 03:TOT-2A         .76      .078    1.67  21.72    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
-----------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 05:SWM1          6.80      .029    4.02  25.10    .000
                    +ID2 06:OVF1           .00      .000     .00    .00    .000
                    +ID3 03:TOT-2A         .76      .078    1.67  21.72    .000
                     ==========================================================
                     SUM 04:T-PST1        7.56      .087    1.67  24.76    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0012------------------------------------------------------------------------
*
*
*#*************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
---------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .034 (i)
     TIME TO PEAK    (hrs)=    2.233
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        27.13
                over (min)        1.00         5.00
     Storage Coeff.  (min)=        .51 (ii)    4.69 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.46          .24
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .01          .00            .010 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.72           1.667
     RUNOFF VOLUME    (mm)=      37.97         9.82          16.856
     TOTAL RAINFALL   (mm)=      38.97        38.97          38.974
     RUNOFF COEFFICIENT   =        .97          .25            .433

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
---------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        33.39
                over (min)        2.00         7.00
     Storage Coeff.  (min)=       1.85 (ii)    6.61 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .59          .17
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .87          .18           1.007 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75           1.667
     RUNOFF VOLUME    (mm)=      37.97        11.25          24.612
     TOTAL RAINFALL   (mm)=      38.97        38.97          38.974
     RUNOFF COEFFICIENT   =        .97          .29            .632

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
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*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:701           2.43      .034    2.23   7.57    .000
                    +ID2 02:202            .12      .010    1.67  16.86    .000
                    +ID3 03:201           8.16     1.007    1.67  24.61    .000
                     ========================================================
                     SUM 08:TOT-1B       10.71     1.020    1.67  20.66    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .150  .4478E+00
                            .003  .3830E-01   |      .166  .5008E+00
                            .011  .7800E-01   |      .180  .5554E+00
                            .015  .1191E+00   |      .193  .6117E+00
                            .018  .1616E+00   |      .205  .6695E+00
                            .027  .2056E+00   |      .211  .6990E+00
                            .045  .2510E+00   |      .645  .7594E+00
                            .068  .2979E+00   |     1.428  .8215E+00
                            .112  .3463E+00   |     2.439  .8852E+00
                            .132  .3963E+00   |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)      10.71     1.020     1.667     20.658
     OUTFLOW<09: (SWM2  )      10.71      .026     4.067     20.657
    OVERFLOW<10: (OVF2  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.547
                   TIME SHIFT OF PEAK FLOW         (min)=   144.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1999E+00

--------------------------------------------------------------------------------
002:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW      (cms)=     .027 (i)
     TIME TO PEAK    (hrs)=    2.233
     RUNOFF VOLUME    (mm)=    7.569
     TOTAL RAINFALL   (mm)=   38.974
     RUNOFF COEFFICIENT   =     .194

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        27.13
                over (min)       1.00         5.00
     Storage Coeff.  (min)=        .51 (ii)    4.69 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.46          .24
                                                         *TOTALS*
     PEAK FLOW      (cms)=        .01          .01           .016 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.72          1.667
     RUNOFF VOLUME    (mm)=      37.97         9.82         16.856
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .25           .433

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250
```

```
     Max.eff.Inten.(mm/hr)=      77.19        27.13
                over (min)       1.00         5.00
     Storage Coeff.  (min)=        .51 (ii)    4.69 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.46          .24
                                                         *TOTALS*
     PEAK FLOW      (cms)=        .04          .02           .054 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.72          1.667
     RUNOFF VOLUME    (mm)=      37.97         9.82         16.856
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .25           .433

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .027    2.23   7.57    .000
                    +ID2 02:203            .19      .016    1.67  16.86    .000
                    +ID3 03:204            .66      .054    1.67  16.86    .000
                     ========================================================
                     SUM 05:TOT-2B        2.78      .072    1.67  10.41    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0021------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09:SWM2         10.71      .026    4.07  20.66    .000
                    +ID2 10:OVF2           .00      .000     .00    .00    .000
                    +ID3 05:TOT-2B        2.78      .072    1.67  10.41    .000
                     ========================================================
                     SUM 06:T-PST2       13.49      .084    1.67  18.55    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0022------------------------------------------------------------------------
*
*
*#****************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        27.13
                over (min)       1.00         5.00
     Storage Coeff.  (min)=        .51 (ii)    4.69 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.46          .24
                                                         *TOTALS*
     PEAK FLOW      (cms)=        .02          .01           .036 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.72          1.667
     RUNOFF VOLUME    (mm)=      37.97         9.82         16.856
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .25           .433

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0023------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .027    2.23   7.57    .000
                     ========================================================
                     SUM 10:205            .44      .036    1.67  16.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0024------------------------------------------------------------------------
*#****************************************************************************|
*
*
*#****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
```

```
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      77.19        22.62
                over (min)        2.00         7.00
     Storage Coeff.  (min)=       1.85 (ii)    7.41 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .59          .16
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .38          .03           .399 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75          1.667
     RUNOFF VOLUME    (mm)=      37.97         9.39         29.399
     TOTAL RAINFALL   (mm)=      38.97        38.97         38.974
     RUNOFF COEFFICIENT   =        .97          .24           .754

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
002:0025------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |    (cms)    (ha.m.)
                           .000  .0000E+00    |     .093  .2320E+00
                           .004  .1510E-01    |     .103  .2752E+00
                           .007  .3250E-01    |     .111  .3257E+00
                           .009  .5230E-01    |     .119  .3838E+00
                           .010  .7470E-01    |     .545  .4158E+00
                           .027  .9990E-01    |    1.321  .4498E+00
                           .056  .1281E+00    |    2.325  .4857E+00
                           .071  .1595E+00    |    3.513  .5237E+00
                           .083  .1941E+00    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )       2.55      .399     1.667     29.399
      OUTFLOW<02: (SWM3  )      2.55      .010     4.033     29.399
    OVERFLOW<03: (OVF3  )        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.411
                  TIME SHIFT OF PEAK FLOW         (min)=   142.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.6609E-01

--------------------------------------------------------------------------------
002:0026------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:T-PST1        7.56      .087    1.67  24.76    .000
                    +ID2 06:T-PST2       13.49      .084    1.67  18.55    .000
                    +ID3 02:SWM3          2.55      .010    4.03  29.40    .000
                    +ID4 03:OVF3           .00      .000     .00    .00    .000
                     ==========================================================
                     SUM 07:PSTTOT       23.60      .178    1.67  21.71    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
002:0027------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
  ** END OF RUN :   4

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 005
    NSTORM=   1
           #  1=WELL4005.STM
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
*#**************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#**************************************************************************|
*
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 5-YR CHICAGO STORM - 4
| Ptotal=  45.88 mm|    Comments: CITY OF WELLAND - 5-YR CHICAGO STORM - 4
--------------------
             TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
              hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
              .17   3.010 |   1.17   8.198 |   2.17  11.245 |   3.17   4.186
              .33   3.333 |   1.33  12.350 |   2.33   8.621 |   3.33   3.823
              .50   3.746 |   1.50  27.081 |   2.50   7.037 |   3.50   3.523
              .67   4.294 |   1.67  90.598 |   2.67   5.976 |   3.67   3.272
              .83   5.063 |   1.83  31.458 |   2.83   5.213 |   3.83   3.057
             1.00   6.224 |   2.00  16.443 |   3.00   4.637 |   4.00   2.872

--------------------------------------------------------------------------------
005:0003------------------------------------------------------------------------
*
*#**************************************************************************|
*#
*#       POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#       ===============================================
*#
*#**************************************************************************|
*
*#***************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#***************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        53.05
                over (min)        2.00         6.00
     Storage Coeff.  (min)=       1.73 (ii)    5.69 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .61          .20
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .43          .10           .516 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.72          1.667
     RUNOFF VOLUME    (mm)=      44.88        16.03         31.897
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .35           .695

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        21.53
                over (min)        2.00         7.00
     Storage Coeff.  (min)=       1.73 (ii)    7.41 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .61          .16
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .08          .03           .094 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75          1.667
     RUNOFF VOLUME    (mm)=      44.88        10.82         21.037
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .24           .459

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        42.06
                over (min)        2.00         6.00
     Storage Coeff.  (min)=       1.73 (ii)    6.08 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .61          .19
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .40          .07           .455 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.73          1.667
     RUNOFF VOLUME    (mm)=      44.88        14.47         32.713
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .32           .713

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
```

```
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:601            3.13      .516    1.67  31.90    .000
                   +ID2 02:602            1.00      .094    1.67  21.04    .000
                   +ID3 03:201            2.67      .455    1.67  32.71    .000
                    ============================================================
                    SUM 04:TOT-1A         6.80     1.065    1.67  30.62    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .194  .3012E+00
                            .003  .2520E-01   |      .218  .3376E+00
                            .008  .5150E-01   |      .240  .3752E+00
                            .010  .7890E-01   |      .260  .4140E+00
                            .012  .1073E+00   |      .278  .4541E+00
                            .020  .1368E+00   |      .287  .4746E+00
                            .040  .1674E+00   |      .726  .5166E+00
                            .067  .1991E+00   |     1.515  .5599E+00
                            .132  .2320E+00   |     2.530  .6045E+00
                            .166  .2660E+00   |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK        R.V.
     --------------------       (ha)     (cms)     (hrs)        (mm)
     INFLOW >04: (TOT-1A)       6.80     1.065     1.667      30.621
     OUTFLOW<05: (SWM1  )       6.80      .046     3.867      30.619
    OVERFLOW<06: (OVF1  )        .00      .000      .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.351
                   TIME SHIFT OF PEAK FLOW         (min)=   132.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1746E+00

--------------------------------------------------------------------------------
005:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        33.95
                over (min)       1.00         8.00
     Storage Coeff.  (min)=        .59 (ii)     7.76 (ii)
     Unit Hyd. Tpeak (min)=       1.00         8.00
     Unit Hyd. peak  (cms)=       1.39          .14
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .02          .01           .033 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.77          1.667
     RUNOFF VOLUME    (mm)=      44.88        13.63         21.438
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT  =         .98          .30           .467

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        29.20
                over (min)       2.00         7.00
     Storage Coeff.  (min)=       1.78 (ii)     6.80 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .60          .16
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .06          .01           .064 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75          1.667
     RUNOFF VOLUME    (mm)=      44.88        12.48         31.916
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT  =         .98          .27           .696
```

```
      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:603             .37      .033    1.67  21.44    .000
                   +ID2 02:102             .39      .064    1.67  31.92    .000
                    ============================================================
                    SUM 03:TOT-2A          .76      .097    1.67  26.82    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 05:SWM1           6.80      .046    3.87  30.62    .000
                   +ID2 06:OVF1            .00      .000     .00    .00    .000
                   +ID3 03:TOT-2A          .76      .097    1.67  26.82    .000
                    ============================================================
                    SUM 04:T-PST1         7.56      .107    1.67  30.24    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0012------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .050 (i)
     TIME TO PEAK    (hrs)=    2.217
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        39.55
                over (min)       1.00         4.00
     Storage Coeff.  (min)=        .48 (ii)     4.07 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.49          .28
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .01          .01           .013 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.70          1.667
     RUNOFF VOLUME    (mm)=      44.88        13.63         21.438
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT  =         .98          .30           .467

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        48.25
                over (min)       2.00         6.00
     Storage Coeff.  (min)=       1.73 (ii)     5.84 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .61          .19
                                                           *TOTALS*
```

```
     PEAK FLOW       (cms)=       1.02          .27          1.251 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.73          1.667
     RUNOFF VOLUME    (mm)=      44.88        15.38         30.129
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .34           .657

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:701          2.43      .050    2.22  10.82    .000
                      +ID2 02:202           .12      .013    1.67  21.44    .000
                      +ID3 03:201          8.16     1.251    1.67  30.13    .000
                       =========================================================
                       SUM 08:TOT-1B       10.71     1.270    1.67  25.65    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .150  .4478E+00
                            .003  .3830E-01   |      .166  .5008E+00
                            .011  .7800E-01   |      .180  .5554E+00
                            .015  .1191E+00   |      .193  .6117E+00
                            .018  .1616E+00   |      .205  .6695E+00
                            .027  .2056E+00   |      .211  .6990E+00
                            .045  .2510E+00   |      .645  .7594E+00
                            .068  .2979E+00   |     1.428  .8215E+00
                            .112  .3463E+00   |     2.439  .8852E+00
                            .132  .3963E+00   |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)      10.71     1.270     1.667     25.651
      OUTFLOW<09: (SWM2  )      10.71      .042     4.050     25.649
    OVERFLOW<10: (OVF2  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.289
                   TIME SHIFT OF PEAK FLOW         (min)=   143.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2436E+00

--------------------------------------------------------------------------------
005:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW       (cms)=     .040 (i)
     TIME TO PEAK    (hrs)=    2.217
     RUNOFF VOLUME    (mm)=   10.820
     TOTAL RAINFALL   (mm)=   45.876
     RUNOFF COEFFICIENT   =     .236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        39.55
               over (min)        1.00         4.00
     Storage Coeff.  (min)=        .48 (ii)    4.07 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.49          .28
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .01          .01           .021 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.70          1.667
     RUNOFF VOLUME    (mm)=      44.88        13.63         21.438
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .30           .467

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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005:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        39.55
               over (min)        1.00         4.00
     Storage Coeff.  (min)=        .48 (ii)    4.07 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.49          .28
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .04          .03           .073 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.70          1.667
     RUNOFF VOLUME    (mm)=      44.88        13.63         21.438
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .30           .467

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:702          1.93      .040    2.22  10.82    .000
                      +ID2 02:203           .19      .021    1.67  21.44    .000
                      +ID3 03:204           .66      .073    1.67  21.44    .000
                       =========================================================
                       SUM 05:TOT-2B        2.78      .099    1.67  14.07    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0021------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 09:SWM2         10.71      .042    4.05  25.65    .000
                      +ID2 10:OVF2           .00      .000     .00    .00    .000
                      +ID3 05:TOT-2B        2.78      .099    1.67  14.07    .000
                       =========================================================
                       SUM 06:T-PST2       13.49      .112    1.67  23.26    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0022------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        39.55
               over (min)        1.00         4.00
     Storage Coeff.  (min)=        .48 (ii)    4.07 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.49          .28
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .03          .02           .049 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.70          1.667
     RUNOFF VOLUME    (mm)=      44.88        13.63         21.438
     TOTAL RAINFALL   (mm)=      45.88        45.88         45.876
     RUNOFF COEFFICIENT   =        .98          .30           .467

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0023------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:702          1.93      .040    2.22  10.82    .000
                       =========================================================
                       SUM 10:205            .44      .049    1.67  21.44    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0024------------------------------------------------------------------------
```

```
*#*****************************************************************************|
*
*
*#*****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      90.60        32.48
                over (min)        2.00         7.00
     Storage Coeff.  (min)=       1.73 (ii)    6.55 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .61          .17
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .45          .04          .477 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75         1.667
     RUNOFF VOLUME    (mm)=      44.88        13.10        35.343
     TOTAL RAINFALL   (mm)=      45.88        45.88        45.876
     RUNOFF COEFFICIENT   =        .98          .29          .770

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
005:0025------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .093  .2320E+00
                           .004  .1510E-01   |     .103  .2752E+00
                           .007  .3250E-01   |     .111  .3257E+00
                           .009  .5230E-01   |     .119  .3838E+00
                           .010  .7470E-01   |     .545  .4158E+00
                           .027  .9990E-01   |    1.321  .4498E+00
                           .056  .1281E+00   |    2.325  .4857E+00
                           .071  .1595E+00   |    3.513  .5237E+00
                           .083  .1941E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )       2.55      .477     1.667     35.343
     OUTFLOW<02: (SWM3  )       2.55      .013     4.017     35.342
    OVERFLOW<03: (OVF3  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.798
                   TIME SHIFT OF PEAK FLOW         (min)=   141.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.7952E-01

--------------------------------------------------------------------------------
005:0026------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 04:T-PST1         7.56      .107    1.67  30.24    .000
                   +ID2 06:T-PST2        13.49      .112    1.67  23.26    .000
                   +ID3 02:SWM3           2.55      .013    4.02  35.34    .000
                   +ID4 03:OVF3            .00      .000     .00    .00    .000
                    =======================================================
                    SUM 07:PSTTOT        23.60      .227    1.67  26.80    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
005:0027------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
005:0002------------------------------------------------------------------------
*
  ** END OF RUN :   9

*******************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 010
    NSTORM=   1
           #  1=WELL4010.STM
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
```

```
*#*****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*****************************************************************************|
*
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 10-YR CHICAGO STORM -
| Ptotal=  51.47 mm|    Comments: CITY OF WELLAND - 10-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   3.524 |   1.17   9.273 |   2.17  12.580 |   3.17   4.849
               .33   3.889 |   1.33  13.772 |   2.33   9.734 |   3.33   4.441
               .50   4.355 |   1.50  29.639 |   2.50   8.005 |   3.50   4.104
               .67   4.970 |   1.67 101.288 |   2.67   6.837 |   3.67   3.820
               .83   5.827 |   1.83  34.358 |   2.83   5.993 |   3.83   3.578
              1.00   7.111 |   2.00  18.178 |   3.00   5.353 |   4.00   3.368

--------------------------------------------------------------------------------
010:0003------------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ==============================================
*#
*#*****************************************************************************|
*
*#******************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#******************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        67.53
                over (min)        2.00         5.00
     Storage Coeff.  (min)=       1.66 (ii)    5.25 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .63          .22
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .48          .13          .600 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70         1.667
     RUNOFF VOLUME    (mm)=      50.47        19.73        36.641
     TOTAL RAINFALL   (mm)=      51.47        51.47        51.474
     RUNOFF COEFFICIENT   =        .98          .38          .712

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        27.91
                over (min)        2.00         7.00
     Storage Coeff.  (min)=       1.66 (ii)    6.77 (ii)
     Unit Hyd. Tpeak (min)=       2.00         7.00
     Unit Hyd. peak  (cms)=        .63          .17
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .08          .04          .111 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.75         1.667
     RUNOFF VOLUME    (mm)=      50.47        13.74        24.758
     TOTAL RAINFALL   (mm)=      51.47        51.47        51.474
     RUNOFF COEFFICIENT   =        .98          .27          .481

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
```

```
     Average Slope     (%)=        .50        2.00
     Length            (m)=      30.00       10.00
     Mannings n           =       .015        .250

     Max.eff.Inten.(mm/hr)=     101.29       52.54
                over (min)        2.00        6.00
     Storage Coeff.  (min)=       1.66 (ii)    5.63 (ii)
     Unit Hyd. Tpeak (min)=       2.00        6.00
     Unit Hyd. peak  (cms)=        .63         .20
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .45         .08          .521 (iii)
     TIME TO PEAK    (hrs)=       1.67        1.72         1.667
     RUNOFF VOLUME    (mm)=      50.47       17.95        37.465
     TOTAL RAINFALL   (mm)=      51.47       51.47        51.474
     RUNOFF COEFFICIENT   =        .98         .35          .728

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:601           3.13     .600    1.67  36.64    .000
                    +ID2 02:602           1.00     .111    1.67  24.76    .000
                    +ID3 03:201           2.67     .521    1.67  37.46    .000
                     ===========================================================
                     SUM 04:TOT-1A         6.80    1.232    1.67  35.22    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |    (cms)    (ha.m.)
                           .000  .0000E+00   |     .194  .3012E+00
                           .003  .2520E-01   |     .218  .3376E+00
                           .008  .5150E-01   |     .240  .3752E+00
                           .010  .7890E-01   |     .260  .4140E+00
                           .012  .1073E+00   |     .278  .4541E+00
                           .020  .1368E+00   |     .287  .4746E+00
                           .040  .1674E+00   |     .726  .5166E+00
                           .067  .1991E+00   |    1.515  .5599E+00
                           .132  .2320E+00   |    2.530  .6045E+00
                           .166  .2660E+00   |     .000  .0000E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (TOT-1A)       6.80     1.232     1.667      35.217
     OUTFLOW<05: (SWM1  )       6.80      .062     3.533      35.216
    OVERFLOW<06: (OVF1  )        .00      .000      .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.065
                   TIME SHIFT OF PEAK FLOW         (min)=   112.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1936E+00

--------------------------------------------------------------------------------
010:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15         .22
     Dep. Storage     (mm)=       1.00        8.92
     Average Slope     (%)=       2.00        2.00
     Length            (m)=      10.00       20.00
     Mannings n           =       .015        .250

     Max.eff.Inten.(mm/hr)=     101.29       44.69
                over (min)        1.00        7.00
     Storage Coeff.  (min)=        .57 (ii)    6.99 (ii)
     Unit Hyd. Tpeak (min)=       1.00        7.00
     Unit Hyd. peak  (cms)=       1.41         .16
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .03         .02          .040 (iii)
     TIME TO PEAK    (hrs)=       1.63        1.75         1.667
     RUNOFF VOLUME    (mm)=      50.47       16.98        25.357
     TOTAL RAINFALL   (mm)=      51.47       51.47        51.474
     RUNOFF COEFFICIENT   =        .98         .33          .493

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
```

```
     Surface Area     (ha)=        .25         .14
     Dep. Storage     (mm)=       1.00        8.92
     Average Slope     (%)=       2.50        2.00
     Length            (m)=      70.00       10.00
     Mannings n           =       .015        .250

     Max.eff.Inten.(mm/hr)=     101.29       38.67
                over (min)        2.00        6.00
     Storage Coeff.  (min)=       1.70 (ii)    6.19 (ii)
     Unit Hyd. Tpeak (min)=       2.00        6.00
     Unit Hyd. peak  (cms)=        .62         .18
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .07         .01          .074 (iii)
     TIME TO PEAK    (hrs)=       1.67        1.73         1.667
     RUNOFF VOLUME    (mm)=      50.47       15.66        36.549
     TOTAL RAINFALL   (mm)=      51.47       51.47        51.474
     RUNOFF COEFFICIENT   =        .98         .30          .710

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:603            .37     .040    1.67  25.36    .000
                    +ID2 02:102            .39     .074    1.67  36.55    .000
                     ===========================================================
                     SUM 03:TOT-2A          .76     .114    1.67  31.10    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 05:SWM1           6.80     .062    3.53  35.22    .000
                    +ID2 06:OVF1            .00     .000     .00    .00    .000
                    +ID3 03:TOT-2A          .76     .114    1.67  31.10    .000
                     ===========================================================
                     SUM 04:T-PST1         7.56     .126    1.67  34.80    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0012------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .064 (i)
     TIME TO PEAK    (hrs)=    2.200
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05         .07
     Dep. Storage     (mm)=       1.00        8.92
     Average Slope     (%)=       2.00        2.00
     Length            (m)=       7.00        7.00
     Mannings n           =       .015        .250

     Max.eff.Inten.(mm/hr)=     101.29       49.40
                over (min)        1.00        4.00
     Storage Coeff.  (min)=        .46 (ii)    3.74 (ii)
     Unit Hyd. Tpeak (min)=       1.00        4.00
     Unit Hyd. peak  (cms)=       1.51         .29
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .01         .01          .016 (iii)
     TIME TO PEAK    (hrs)=       1.60        1.68         1.667
     RUNOFF VOLUME    (mm)=      50.47       16.98        25.357
     TOTAL RAINFALL   (mm)=      51.47       51.47        51.474
     RUNOFF COEFFICIENT   =        .98         .33          .493

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0014------------------------------------------------------------------------
```

```
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        61.74
                over (min)       2.00         5.00
     Storage Coeff.  (min)=       1.66 (ii)    5.38 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .63          .22
                                                               *TOTALS*
     PEAK FLOW       (cms)=       1.15          .35          1.465 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      50.47        18.99         34.734
     TOTAL RAINFALL   (mm)=      51.47        51.47         51.474
     RUNOFF COEFFICIENT   =        .98          .37           .675

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:701           2.43      .064    2.20  13.74    .000
                    +ID2 02:202            .12      .016    1.67  25.36    .000
                    +ID3 03:201           8.16     1.465    1.67  34.73    .000
                     ==========================================================
                     SUM 08:TOT-1B       10.71     1.490    1.67  29.86    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |      .150  .4478E+00
                            .003  .3830E-01   |      .166  .5008E+00
                            .011  .7800E-01   |      .180  .5554E+00
                            .015  .1191E+00   |      .193  .6117E+00
                            .018  .1616E+00   |      .205  .6695E+00
                            .027  .2056E+00   |      .211  .6990E+00
                            .045  .2510E+00   |      .645  .7594E+00
                            .068  .2979E+00   |     1.428  .8215E+00
                            .112  .3463E+00   |     2.439  .8852E+00
                            .132  .3963E+00   |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)      10.71     1.490     1.667     29.865
      OUTFLOW<09: (SWM2  )     10.71      .058     4.033     29.863
    OVERFLOW<10: (OVF2  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.883
                   TIME SHIFT OF PEAK FLOW         (min)=   142.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2779E+00

--------------------------------------------------------------------------------
010:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW       (cms)=     .051 (i)
     TIME TO PEAK    (hrs)=    2.200
     RUNOFF VOLUME    (mm)=   13.737
     TOTAL RAINFALL   (mm)=   51.474
     RUNOFF COEFFICIENT   =     .267

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250
```

```
     Max.eff.Inten.(mm/hr)=     101.29        49.40
                over (min)       1.00         4.00
     Storage Coeff.  (min)=        .46 (ii)    3.74 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.51          .29
                                                               *TOTALS*
     PEAK FLOW       (cms)=        .01          .01           .025 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.68          1.667
     RUNOFF VOLUME    (mm)=      50.47        16.98         25.357
     TOTAL RAINFALL   (mm)=      51.47        51.47         51.474
     RUNOFF COEFFICIENT   =        .98          .33           .493

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        49.40
                over (min)       1.00         4.00
     Storage Coeff.  (min)=        .46 (ii)    3.74 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.51          .29
                                                               *TOTALS*
     PEAK FLOW       (cms)=        .05          .04           .088 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.68          1.667
     RUNOFF VOLUME    (mm)=      50.47        16.98         25.357
     TOTAL RAINFALL   (mm)=      51.47        51.47         51.474
     RUNOFF COEFFICIENT   =        .98          .33           .493

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .051    2.20  13.74    .000
                    +ID2 02:203            .19      .025    1.67  25.36    .000
                    +ID3 03:204            .66      .088    1.67  25.36    .000
                     ==========================================================
                     SUM 05:TOT-2B        2.78      .120    1.67  17.29    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0021------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09:SWM2         10.71      .058    4.03  29.86    .000
                    +ID2 10:OVF2           .00      .000     .00    .00    .000
                    +ID3 05:TOT-2B        2.78      .120    1.67  17.29    .000
                     ==========================================================
                     SUM 06:T-PST2       13.49      .134    1.67  27.27    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0022------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        49.40
                over (min)       1.00         4.00
     Storage Coeff.  (min)=        .46 (ii)    3.74 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.51          .29
                                                               *TOTALS*
     PEAK FLOW       (cms)=        .03          .03           .058 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.68          1.667
     RUNOFF VOLUME    (mm)=      50.47        16.98         25.357
     TOTAL RAINFALL   (mm)=      51.47        51.47         51.474
     RUNOFF COEFFICIENT   =        .98          .33           .493

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0023------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .051    2.20  13.74    .000
                     ===========================================================
                     SUM 10:205            .44      .058    1.67  25.36    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0024------------------------------------------------------------------------
*#*****************************************************************************|
*
*
*#*****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     101.29        42.70
                over (min)        2.00         6.00
     Storage Coeff.  (min)=       1.66 (ii)    5.97 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .63          .19
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .50          .05            .545 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.73           1.667
     RUNOFF VOLUME    (mm)=      50.47        16.38          40.245
     TOTAL RAINFALL   (mm)=      51.47        51.47          51.474
     RUNOFF COEFFICIENT   =        .98          .32            .782

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
010:0025------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)    (ha.m.)
                           .000  .0000E+00    |     .093  .2320E+00
                           .004  .1510E-01    |     .103  .2752E+00
                           .007  .3250E-01    |     .111  .3257E+00
                           .009  .5230E-01    |     .119  .3838E+00
                           .010  .7470E-01    |     .545  .4158E+00
                           .027  .9990E-01    |    1.321  .4498E+00
                           .056  .1281E+00    |    2.325  .4857E+00
                           .071  .1595E+00    |    3.513  .5237E+00
                           .083  .1941E+00    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )       2.55      .545     1.667     40.245
     OUTFLOW<02: (SWM3  )       2.55      .019     4.017     40.245
    OVERFLOW<03: (OVF3  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.490
                   TIME SHIFT OF PEAK FLOW         (min)=   141.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.8817E-01

--------------------------------------------------------------------------------
010:0026------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:T-PST1        7.56      .126    1.67  34.80    .000
                    +ID2 06:T-PST2       13.49      .134    1.67  27.27    .000
                    +ID3 02:SWM3          2.55      .019    4.02  40.24    .000
                    +ID4 03:OVF3           .00      .000     .00    .00    .000
                     ===========================================================
                     SUM 07:PSTTOT       23.60      .268    1.67  31.08    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
010:0027------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
010:0002------------------------------------------------------------------------
*
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010:0002------------------------------------------------------------------------
*
  ** END OF RUN :  24

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--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 025
    NSTORM=   1
           #  1=WELL4025.STM
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 25-YR CHICAGO STORM -
| Ptotal=  59.72 mm|    Comments: CITY OF WELLAND - 25-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.295 |   1.17  10.803 |   2.17  14.436 |   3.17   5.829
               .33   4.721 |   1.33  15.732 |   2.33  11.313 |   3.33   5.360
               .50   5.260 |   1.50  32.988 |   2.50   9.395 |   3.50   4.970
               .67   5.968 |   1.67 118.514 |   2.67   8.087 |   3.67   4.640
               .83   6.945 |   1.83  38.130 |   2.83   7.134 |   3.83   4.357
              1.00   8.394 |   2.00  20.514 |   3.00   6.406 |   4.00   4.112

--------------------------------------------------------------------------------
025:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
*#****************************************************************************|
*
*#*****************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        88.73
                over (min)        2.00         5.00
     Storage Coeff.  (min)=       1.55 (ii)    4.78 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .65          .23
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .57          .18            .729 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70           1.667
     RUNOFF VOLUME    (mm)=      58.72        25.52          43.780
     TOTAL RAINFALL   (mm)=      59.72        59.72          59.717
     RUNOFF COEFFICIENT   =        .98          .43            .733

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN* =  74.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        40.27
                over (min)        2.00         6.00
     Storage Coeff.  (min)=       1.55 (ii)    5.97 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .65          .19
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .10          .05            .143 (iii)
```

```
     TIME TO PEAK    (hrs)=       1.67         1.73          1.667
     RUNOFF VOLUME    (mm)=      58.72        18.42         30.511
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .31           .511

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        72.10
                over (min)        2.00         5.00
     Storage Coeff.  (min)=       1.55 (ii)    5.06 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .65          .22
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .53          .12           .635 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      58.72        23.44         44.605
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .39           .747

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:601           3.13      .729    1.67  43.78    .000
                    +ID2 02:602           1.00      .143    1.67  30.51    .000
                    +ID3 03:201           2.67      .635    1.67  44.61    .000
                     ===========================================================
                     SUM 04:TOT-1A        6.80     1.508    1.67  42.15    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
----------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE  |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)  |    (cms)    (ha.m.)
                            .000  .0000E+00  |     .194  .3012E+00
                            .003  .2520E-01  |     .218  .3376E+00
                            .008  .5150E-01  |     .240  .3752E+00
                            .010  .7890E-01  |     .260  .4140E+00
                            .012  .1073E+00  |     .278  .4541E+00
                            .020  .1368E+00  |     .287  .4746E+00
                            .040  .1674E+00  |     .726  .5166E+00
                            .067  .1991E+00  |    1.515  .5599E+00
                            .132  .2320E+00  |    2.530  .6045E+00
                            .166  .2660E+00  |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (TOT-1A)       6.80     1.508     1.667     42.153
     OUTFLOW<05: (SWM1  )       6.80      .103     3.000     42.151
    OVERFLOW<06: (OVF1  )        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    6.802
                  TIME SHIFT OF PEAK FLOW         (min)=    80.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.2172E+00

--------------------------------------------------------------------------------
025:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        62.22
                over (min)        1.00         6.00
     Storage Coeff.  (min)=        .53 (ii)    6.16 (ii)
     Unit Hyd. Tpeak (min)=       1.00         6.00
     Unit Hyd. peak  (cms)=       1.44          .19
```

```
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .03          .03           .053 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.72          1.667
     RUNOFF VOLUME    (mm)=      58.72        22.30         31.403
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .37           .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        52.49
                over (min)        2.00         6.00
     Storage Coeff.  (min)=       1.60 (ii)    5.57 (ii)
     Unit Hyd. Tpeak (min)=       2.00         6.00
     Unit Hyd. peak  (cms)=        .64          .20
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .08          .01           .089 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.72          1.667
     RUNOFF VOLUME    (mm)=      58.72        20.73         43.521
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .35           .729

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:603            .37      .053    1.67  31.40    .000
                    +ID2 02:102            .39      .089    1.67  43.52    .000
                     ===========================================================
                     SUM 03:TOT-2A         .76      .142    1.67  37.62    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 05:SWM1          6.80      .103    3.00  42.15    .000
                    +ID2 06:OVF1           .00      .000     .00    .00    .000
                    +ID3 03:TOT-2A         .76      .142    1.67  37.62    .000
                     ===========================================================
                     SUM 04:T-PST1        7.56      .158    1.67  41.70    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0012------------------------------------------------------------------------
*
*
*#****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#****************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .086 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250
```

```
     Max.eff.Inten.(mm/hr)=     118.51        67.64
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .43 (ii)    3.33 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.53          .35
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .01          .01          .021 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.68         1.667
     RUNOFF VOLUME    (mm)=      58.72        22.30        31.403
     TOTAL RAINFALL   (mm)=      59.72        59.72        59.717
     RUNOFF COEFFICIENT   =        .98          .37          .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        81.50
                over (min)        2.00         5.00
     Storage Coeff.  (min)=       1.55 (ii)    4.89 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .65          .23
                                                        *TOTALS*
     PEAK FLOW       (cms)=       1.34          .49         1.790 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70         1.667
     RUNOFF VOLUME    (mm)=      58.72        24.66        41.688
     TOTAL RAINFALL   (mm)=      59.72        59.72        59.717
     RUNOFF COEFFICIENT   =        .98          .41          .698

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:701            2.43      .086    2.17  18.42    .000
                   +ID2 02:202             .12      .021    1.67  31.40    .000
                   +ID3 03:201            8.16     1.790    1.67  41.69    .000
                    ============================================================
                    SUM 08:TOT-1B        10.71     1.824    1.67  36.29    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .150  .4478E+00
                            .003  .3830E-01   |     .166  .5008E+00
                            .011  .7800E-01   |     .180  .5554E+00
                            .015  .1191E+00   |     .193  .6117E+00
                            .018  .1616E+00   |     .205  .6695E+00
                            .027  .2056E+00   |     .211  .6990E+00
                            .045  .2510E+00   |     .645  .7594E+00
                            .068  .2979E+00   |    1.428  .8215E+00
                            .112  .3463E+00   |    2.439  .8852E+00
                            .132  .3963E+00   |     .000  .0000E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)     10.71     1.824     1.667     36.294
     OUTFLOW<09: (SWM2  )     10.71      .092     4.017     36.292
    OVERFLOW<10: (OVF2  )       .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.029
                   TIME SHIFT OF PEAK FLOW         (min)=   141.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3244E+00

--------------------------------------------------------------------------------
025:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
---------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180
```

```
     PEAK FLOW       (cms)=     .068 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   18.423
     TOTAL RAINFALL   (mm)=   59.717
     RUNOFF COEFFICIENT   =     .309

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        67.64
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .43 (ii)    3.33 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.53          .35
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .02          .02          .033 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.68         1.667
     RUNOFF VOLUME    (mm)=      58.72        22.30        31.403
     TOTAL RAINFALL   (mm)=      59.72        59.72        59.717
     RUNOFF COEFFICIENT   =        .98          .37          .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        67.64
                over (min)        1.00         3.00
     Storage Coeff.  (min)=        .43 (ii)    3.33 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.53          .35
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .05          .06          .115 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.68         1.667
     RUNOFF VOLUME    (mm)=      58.72        22.30        31.403
     TOTAL RAINFALL   (mm)=      59.72        59.72        59.717
     RUNOFF COEFFICIENT   =        .98          .37          .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:702            1.93      .068    2.17  18.42    .000
                   +ID2 02:203             .19      .033    1.67  31.40    .000
                   +ID3 03:204             .66      .115    1.67  31.40    .000
                    ============================================================
                    SUM 05:TOT-2B         2.78      .159    1.67  22.39    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0021------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 09:SWM2          10.71      .092    4.02  36.29    .000
                   +ID2 10:OVF2            .00      .000     .00    .00    .000
                   +ID3 05:TOT-2B         2.78      .159    1.67  22.39    .000
                    ============================================================
                    SUM 06:T-PST2        13.49      .176    1.67  33.43    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0022------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
```

```
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        67.64
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .43 (ii)    3.33 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.53          .35
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .04          .04           .077 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.68          1.667
     RUNOFF VOLUME    (mm)=      58.72        22.30         31.403
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .37           .526

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0023------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:702          1.93     .068    2.17  18.42    .000
                       =========================================================
                       SUM 10:205           .44     .077    1.67  31.40    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0024------------------------------------------------------------------------
*#*****************************************************************************|
*
*
*#*****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
---------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     118.51        59.43
                over (min)       2.00         5.00
     Storage Coeff.  (min)=       1.55 (ii)    5.34 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .65          .22
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .59          .08           .655 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      58.72        21.58         47.576
     TOTAL RAINFALL   (mm)=      59.72        59.72         59.717
     RUNOFF COEFFICIENT   =        .98          .36           .797

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
025:0025------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .093  .2320E+00
                           .004  .1510E-01    |     .103  .2752E+00
                           .007  .3250E-01    |     .111  .3257E+00
                           .009  .5230E-01    |     .119  .3838E+00
                           .010  .7470E-01    |     .545  .4158E+00
                           .027  .9990E-01    |    1.321  .4498E+00
                           .056  .1281E+00    |    2.325  .4857E+00
                           .071  .1595E+00    |    3.513  .5237E+00
                           .083  .1941E+00    |     .000  .0000E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )      2.55      .655     1.667     47.576
     OUTFLOW<02: (SWM3  )      2.55      .027     3.867     47.575
    OVERFLOW<03: (OVF3  )       .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.141
                   TIME SHIFT OF PEAK FLOW         (min)=   132.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1003E+00

--------------------------------------------------------------------------------
025:0026------------------------------------------------------------------------
```

```
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 04:T-PST1       7.56     .158    1.67  41.70    .000
                      +ID2 06:T-PST2      13.49     .176    1.67  33.43    .000
                      +ID3 02:SWM3         2.55     .027    3.87  47.58    .000
                      +ID4 03:OVF3          .00     .000     .00    .00    .000
                       =========================================================
                       SUM 07:PSTTOT      23.60     .342    1.67  37.60    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0027------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002------------------------------------------------------------------------
*
  ** END OF RUN :  49

*******************************************************************************





--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
           #  1=WELL4050.STM
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*#****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#****************************************************************************|
*
--------------------------------------------------------------------------------
050:0002------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 50-YR CHICAGO STORM -
| Ptotal=  66.95 mm|    Comments: CITY OF WELLAND - 50-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   4.962 |   1.17  12.287 |   2.17  16.332 |   3.17   6.702
               .33   5.446 |   1.33  17.768 |   2.33  12.858 |   3.33   6.171
               .50   6.057 |   1.50  36.743 |   2.50  10.713 |   3.50   5.729
               .67   6.859 |   1.67 130.180 |   2.67   9.247 |   3.67   5.355
               .83   7.961 |   1.83  42.379 |   2.83   8.175 |   3.83   5.033
              1.00   9.591 |   2.00  23.055 |   3.00   7.353 |   4.00   4.754

--------------------------------------------------------------------------------
050:0003------------------------------------------------------------------------
*
*#****************************************************************************|
*#
*#         POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#         ===============================================
*#
*#****************************************************************************|
*
*#*****************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
---------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18       107.50
                over (min)       1.00         4.00
     Storage Coeff.  (min)=       1.50 (ii)    4.48 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=        .83          .26
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .62          .22           .834 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.68          1.667
     RUNOFF VOLUME    (mm)=      65.95        30.88         50.171
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .46           .749

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
```

```
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        49.36
                over (min)       1.00         6.00
     Storage Coeff.  (min)=       1.50 (ii)    5.57 (ii)
     Unit Hyd. Tpeak (min)=       1.00         6.00
     Unit Hyd. peak  (cms)=        .83          .20
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .11          .07           .167 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.72          1.667
     RUNOFF VOLUME    (mm)=      65.95        22.86         35.790
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .34           .535

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        86.13
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.50 (ii)    4.76 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .83          .23
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .58          .15           .715 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      65.95        28.55         50.990
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .43           .762

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:601           3.13      .834    1.67  50.17    .000
                    +ID2 02:602           1.00      .167    1.67  35.79    .000
                    +ID3 03:201           2.67      .715    1.67  50.99    .000
                     ===========================================================
                     SUM 04:TOT-1A        6.80     1.715    1.67  48.38    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .194  .3012E+00
                            .003  .2520E-01   |     .218  .3376E+00
                            .008  .5150E-01   |     .240  .3752E+00
                            .010  .7890E-01   |     .260  .4140E+00
                            .012  .1073E+00   |     .278  .4541E+00
                            .020  .1368E+00   |     .287  .4746E+00
                            .040  .1674E+00   |     .726  .5166E+00
                            .067  .1991E+00   |    1.515  .5599E+00
                            .132  .2320E+00   |    2.530  .6045E+00
                            .166  .2660E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK      TPEAK        R.V.
     --------------------       (ha)     (cms)      (hrs)        (mm)
     INFLOW >04: (TOT-1A)       6.80     1.715      1.667      48.378
     OUTFLOW<05: (SWM1  )       6.80      .137      2.733      48.376
    OVERFLOW<06: (OVF1  )        .00      .000       .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =         0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=       .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=       .00
```

```
                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    7.997
                   TIME SHIFT OF PEAK FLOW         (min)=    64.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2376E+00

--------------------------------------------------------------------------------
050:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        74.88
                over (min)       1.00         6.00
     Storage Coeff.  (min)=        .51 (ii)    5.74 (ii)
     Unit Hyd. Tpeak (min)=       1.00         6.00
     Unit Hyd. peak  (cms)=       1.46          .19
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .03          .03           .062 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.72          1.667
     RUNOFF VOLUME    (mm)=      65.95        27.27         36.938
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .41           .552

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        65.47
                over (min)       2.00         5.00
     Storage Coeff.  (min)=       1.54 (ii)    5.18 (ii)
     Unit Hyd. Tpeak (min)=       2.00         5.00
     Unit Hyd. peak  (cms)=        .66          .22
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .08          .02           .101 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      65.95        25.49         49.767
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .38           .743

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:603            .37      .062    1.67  36.94    .000
                    +ID2 02:102            .39      .101    1.67  49.77    .000
                     ===========================================================
                     SUM 03:TOT-2A         .76      .164    1.67  43.52    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 05:SWM1          6.80      .137    2.73  48.38    .000
                    +ID2 06:OVF1           .00      .000     .00    .00    .000
                    +ID3 03:TOT-2A         .76      .164    1.67  43.52    .000
                     ===========================================================
                     SUM 04:T-PST1        7.56      .187    1.67  47.89    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0012------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410
```

```
     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .107 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD      |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        80.75
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .41 (ii)    3.11 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.55          .37
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .01          .01           .024 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.68          1.667
     RUNOFF VOLUME    (mm)=      65.95        27.27         36.938
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .41           .552

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD      |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        96.92
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.50 (ii)    4.61 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .83          .24
                                                              *TOTALS*
     PEAK FLOW       (cms)=       1.47          .60          2.030 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      65.95        29.92         47.934
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .45           .716

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                   ID1 01:701            2.43      .107    2.17  22.86    .000
                  +ID2 02:202             .12      .024    1.67  36.94    .000
                  +ID3 03:201            8.16     2.030    1.67  47.93    .000
                   ==========================================================
                   SUM 08:TOT-1B        10.71     2.074    1.67  42.12    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
050:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |    (cms)    (ha.m.)
                           .000  .0000E+00    |      .150  .4478E+00
                           .003  .3830E-01    |      .166  .5008E+00
                           .011  .7800E-01    |      .180  .5554E+00
                           .015  .1191E+00    |      .193  .6117E+00
                           .018  .1616E+00    |      .205  .6695E+00
                           .027  .2056E+00    |      .211  .6990E+00
                           .045  .2510E+00    |      .645  .7594E+00
                           .068  .2979E+00    |     1.428  .8215E+00
                           .112  .3463E+00    |     2.439  .8852E+00
                           .132  .3963E+00    |      .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)      10.71     2.074     1.667     42.123
     OUTFLOW<09: (SWM2  )      10.71      .119     4.000     42.120
    OVERFLOW<10: (OVF2  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.714
                   TIME SHIFT OF PEAK FLOW        (min)=   140.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3629E+00

--------------------------------------------------------------------------------
050:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW       (cms)=     .085 (i)
     TIME TO PEAK    (hrs)=    2.167
     RUNOFF VOLUME    (mm)=   22.864
     TOTAL RAINFALL   (mm)=   66.952
     RUNOFF COEFFICIENT   =     .341

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD      |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        80.75
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .41 (ii)    3.11 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.55          .37
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .02          .02           .039 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.68          1.667
     RUNOFF VOLUME    (mm)=      65.95        27.27         36.938
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .41           .552

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD      |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        80.75
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .41 (ii)    3.11 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.55          .37
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .06          .07           .134 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.68          1.667
     RUNOFF VOLUME    (mm)=      65.95        27.27         36.938
     TOTAL RAINFALL   (mm)=      66.95        66.95         66.952
     RUNOFF COEFFICIENT   =        .99          .41           .552

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
050:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                   ID1 01:702            1.93      .085    2.17  22.86    .000
                  +ID2 02:203             .19      .039    1.67  36.94    .000
                  +ID3 03:204             .66      .134    1.67  36.94    .000
                   ==========================================================
                   SUM 05:TOT-2B         2.78      .188    1.67  27.17    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
---------------------------------------------------------------------------------
050:0021-------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09:SWM2         10.71     .119    4.00  42.12    .000
                    +ID2 10:OVF2           .00     .000     .00    .00    .000
                    +ID3 05:TOT-2B        2.78     .188    1.67  27.17    .000
                     ============================================================
                     SUM 06:T-PST2       13.49     .207    1.67  39.04    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
050:0022-------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        80.75
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .41 (ii)    3.11 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.55          .37
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .04          .05             .090 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.68            1.667
     RUNOFF VOLUME    (mm)=      65.95        27.27           36.938
     TOTAL RAINFALL   (mm)=      66.95        66.95           66.952
     RUNOFF COEFFICIENT   =        .99          .41             .552

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
050:0023-------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93     .085    2.17  22.86    .000
                     ============================================================
                     SUM 10:205            .44     .090    1.67  36.94    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
050:0024-------------------------------------------------------------------------
*#*****************************************************************************|
*
*
*#*****************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*****************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     130.18        71.53
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.50 (ii)    5.01 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .83          .23
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .64          .09             .732 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70            1.667
     RUNOFF VOLUME    (mm)=      65.95        26.46           54.103
     TOTAL RAINFALL   (mm)=      66.95        66.95           66.952
     RUNOFF COEFFICIENT   =        .99          .40             .808

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
050:0025-------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>01:(301   )    |
| OUT<02:(SWM3  )    |    =========  OUTFLOW STORAGE TABLE  =========
---------------------     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |     .093  .2320E+00
                             .004  .1510E-01   |     .103  .2752E+00
                             .007  .3250E-01   |     .111  .3257E+00
                             .009  .5230E-01   |     .119  .3838E+00
                             .010  .7470E-01   |     .545  .4158E+00
                             .027  .9990E-01   |    1.321  .4498E+00
                             .056  .1281E+00   |    2.325  .4857E+00
                             .071  .1595E+00   |    3.513  .5237E+00
                             .083  .1941E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )       2.55      .732     1.667     54.103
     OUTFLOW<02: (SWM3  )       2.55      .037     3.433     54.102
    OVERFLOW<03: (OVF3  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.058
                   TIME SHIFT OF PEAK FLOW         (min)=   106.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1099E+00

---------------------------------------------------------------------------------
050:0026-------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:T-PST1        7.56     .187    1.67  47.89    .000
                    +ID2 06:T-PST2       13.49     .207    1.67  39.04    .000
                    +ID3 02:SWM3          2.55     .037    3.43  54.10    .000
                    +ID4 03:OVF3           .00     .000     .00    .00    .000
                     ============================================================
                     SUM 07:PSTTOT       23.60     .404    1.67  43.50    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
050:0027-------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
---------------------------------------------------------------------------------
050:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
050:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
050:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
050:0002-------------------------------------------------------------------------
*
  ** END OF RUN :  99

********************************************************************************




--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 100
    NSTORM=   1
           #  1=WELL4100.STM
---------------------------------------------------------------------------------
100:0002-------------------------------------------------------------------------
*#*****************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                      WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*****************************************************************************|
*
---------------------------------------------------------------------------------
100:0002-------------------------------------------------------------------------
*
--------------------
| READ STORM       |    Filename: CITY OF WELLAND - 100-YR CHICAGO STORM -
| Ptotal=  73.21 mm|    Comments: CITY OF WELLAND - 100-YR CHICAGO STORM -
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   5.494 |   1.17  13.439 |   2.17  17.787 |   3.17   7.393
               .33   6.023 |   1.33  19.325 |   2.33  14.054 |   3.33   6.815
               .50   6.691 |   1.50  39.636 |   2.50  11.742 |   3.50   6.333
               .67   7.564 |   1.67 142.985 |   2.67  10.156 |   3.67   5.924
               .83   8.763 |   1.83  45.671 |   2.83   8.994 |   3.83   5.572
              1.00  10.529 |   2.00  24.984 |   3.00   8.102 |   4.00   5.266

---------------------------------------------------------------------------------
100:0003-------------------------------------------------------------------------
*
*#*****************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
*#*****************************************************************************|
*
*#******************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#******************************************************************************|
```

```
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
----------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99       124.91
                over (min)       1.00         4.00
     Storage Coeff.  (min)=       1.44 (ii)    4.25 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=        .85          .27
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .68          .26           .936 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.68          1.667
     RUNOFF VOLUME    (mm)=      72.21        35.69         55.774
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .49           .762

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
----------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        60.67
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.44 (ii)    5.19 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .85          .22
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .12          .09           .197 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      72.21        26.92         40.504
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .37           .553

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99       103.09
                over (min)       1.00         4.00
     Storage Coeff.  (min)=       1.44 (ii)    4.48 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=        .85          .26
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .64          .18           .808 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.68          1.667
     RUNOFF VOLUME    (mm)=      72.21        33.15         56.586
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .45           .773

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
------------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:601            3.13      .936    1.67  55.77    .000
                   +ID2 02:602            1.00      .197    1.67  40.50    .000
                   +ID3 03:201            2.67      .808    1.67  56.59    .000
                    ============================================================
                    SUM 04:TOT-1A         6.80     1.942    1.67  53.85    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
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```
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .194  .3012E+00
                            .003  .2520E-01   |     .218  .3376E+00
                            .008  .5150E-01   |     .240  .3752E+00
                            .010  .7890E-01   |     .260  .4140E+00
                            .012  .1073E+00   |     .278  .4541E+00
                            .020  .1368E+00   |     .287  .4746E+00
                            .040  .1674E+00   |     .726  .5166E+00
                            .067  .1991E+00   |    1.515  .5599E+00
                            .132  .2320E+00   |    2.530  .6045E+00
                            .166  .2660E+00   |     .000  .0000E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (TOT-1A)      6.80     1.942     1.667     53.847
     OUTFLOW<05: (SWM1  )      6.80      .159     2.683     53.844
    OVERFLOW<06: (OVF1  )       .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.172
                   TIME SHIFT OF PEAK FLOW        (min)=    61.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2589E+00

--------------------------------------------------------------------------------
100:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        90.36
                over (min)       1.00         5.00
     Storage Coeff.  (min)=        .49 (ii)    5.34 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=       1.48          .22
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .04          .04           .075 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.70          1.667
     RUNOFF VOLUME    (mm)=      72.21        31.75         41.867
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .43           .572

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n          =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        77.29
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.48 (ii)    4.89 (ii)
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .83          .23
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .09          .02           .113 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      72.21        29.81         55.247
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .41           .755

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                    ID1 01:603             .37      .075    1.67  41.87    .000
                   +ID2 02:102             .39      .113    1.67  55.25    .000
                    ============================================================
                    SUM 03:TOT-2A          .76      .188    1.67  48.73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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100:0011------------------------------------------------------------------------
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*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK  R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)  (mm)   (cms)
                     ID1 05:SWM1          6.80      .159    2.68  53.84    .000
                    +ID2 06:OVF1           .00      .000     .00    .00    .000
                    +ID3 03:TOT-2A         .76      .188    1.67  48.73    .000
                     ==========================================================
                     SUM 04:T-PST1        7.56      .222    1.67  53.33    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0012------------------------------------------------------------------------
*
*
*#*****************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#*****************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .126 (i)
     TIME TO PEAK    (hrs)=    2.150
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        94.55
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .40 (ii)    2.93 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.56          .38
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .01          .02           .028 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.67          1.667
     RUNOFF VOLUME    (mm)=      72.21        31.75         41.867
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .43           .572

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     142.99       115.46
                over (min)       1.00         4.00
     Storage Coeff.  (min)=       1.44 (ii)    4.34 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=        .85          .27
                                                           *TOTALS*
     PEAK FLOW       (cms)=       1.62          .72          2.321 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.68          1.667
     RUNOFF VOLUME    (mm)=      72.21        34.64         53.425
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .47           .730

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK  R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)  (mm)   (cms)
                     ID1 01:701           2.43      .126    2.15  26.92    .000
                    +ID2 02:202            .12      .028    1.67  41.87    .000
                    +ID3 03:201           8.16     2.321    1.67  53.42    .000
                     ==========================================================
                     SUM 08:TOT-1B       10.71     2.374    1.67  47.28    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)    (ha.m.)
                           .000  .0000E+00    |     .150  .4478E+00
                           .003  .3830E-01    |     .166  .5008E+00
                           .011  .7800E-01    |     .180  .5554E+00
                           .015  .1191E+00    |     .193  .6117E+00
                           .018  .1616E+00    |     .205  .6695E+00
                           .027  .2056E+00    |     .211  .6990E+00
                           .045  .2510E+00    |     .645  .7594E+00
                           .068  .2979E+00    |    1.428  .8215E+00
                           .112  .3463E+00    |    2.439  .8852E+00
                           .132  .3963E+00    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >08: (TOT-1B)      10.71     2.374     1.667     47.281
     OUTFLOW<09: (SWM2  )      10.71      .134     4.000     47.278
    OVERFLOW<10: (OVF2  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.655
                   TIME SHIFT OF PEAK FLOW         (min)=   140.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.4017E+00

--------------------------------------------------------------------------------
100:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW       (cms)=     .100 (i)
     TIME TO PEAK    (hrs)=    2.150
     RUNOFF VOLUME    (mm)=   26.916
     TOTAL RAINFALL   (mm)=   73.207
     RUNOFF COEFFICIENT   =     .368

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        94.55
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .40 (ii)    2.93 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.56          .38
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .02          .03           .045 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.67          1.667
     RUNOFF VOLUME    (mm)=      72.21        31.75         41.867
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .43           .572

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0019------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        94.55
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .40 (ii)    2.93 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.56          .38
```

```
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .07          .09           .155 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.67          1.667
     RUNOFF VOLUME    (mm)=      72.21        31.75         41.867
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .43           .572

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0020------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .100    2.15  26.92    .000
                    +ID2 02:203            .19      .045    1.67  41.87    .000
                    +ID3 03:204            .66      .155    1.67  41.87    .000
                     ==========================================================
                     SUM 05:TOT-2B        2.78      .219    1.67  31.49    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0021------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09:SWM2         10.71      .134    4.00  47.28    .000
                    +ID2 10:OVF2           .00      .000     .00    .00    .000
                    +ID3 05:TOT-2B        2.78      .219    1.67  31.49    .000
                     ==========================================================
                     SUM 06:T-PST2       13.49      .242    1.67  44.02    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0022------------------------------------------------------------------------
*
*
*#*************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        94.55
                over (min)       1.00         3.00
     Storage Coeff.  (min)=        .40 (ii)    2.93 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.56          .38
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .04          .06           .103 (iii)
     TIME TO PEAK    (hrs)=       1.60         1.67          1.667
     RUNOFF VOLUME    (mm)=      72.21        31.75         41.867
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .43           .572

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0023------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .100    2.15  26.92    .000
                     ==========================================================
                     SUM 10:205            .44      .103    1.67  41.87    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0024------------------------------------------------------------------------
*#*************************************************************************|
*
*
*#*************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=     142.99        84.20
                over (min)       1.00         5.00
     Storage Coeff.  (min)=       1.44 (ii)    4.73 (ii)
```

```
     Unit Hyd. Tpeak (min)=       1.00         5.00
     Unit Hyd. peak  (cms)=        .85          .23
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .71          .11           .814 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.70          1.667
     RUNOFF VOLUME    (mm)=      72.21        30.87         59.805
     TOTAL RAINFALL   (mm)=      73.21        73.21         73.207
     RUNOFF COEFFICIENT   =        .99          .42           .817

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
100:0025------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)   |   (cms)    (ha.m.)
                           .000  .0000E+00   |     .093  .2320E+00
                           .004  .1510E-01   |     .103  .2752E+00
                           .007  .3250E-01   |     .111  .3257E+00
                           .009  .5230E-01   |     .119  .3838E+00
                           .010  .7470E-01   |     .545  .4158E+00
                           .027  .9990E-01   |    1.321  .4498E+00
                           .056  .1281E+00   |    2.325  .4857E+00
                           .071  .1595E+00   |    3.513  .5237E+00
                           .083  .1941E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )       2.55      .814     1.667      59.805
     OUTFLOW<02: (SWM3  )       2.55      .046     3.200      59.805
    OVERFLOW<03: (OVF3  )        .00      .000      .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.597
                   TIME SHIFT OF PEAK FLOW         (min)=    92.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1182E+00

--------------------------------------------------------------------------------
100:0026------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:T-PST1        7.56      .222    1.67  53.33    .000
                    +ID2 06:T-PST2       13.49      .242    1.67  44.02    .000
                    +ID3 02:SWM3          2.55      .046    3.20  59.80    .000
                    +ID4 03:OVF3           .00      .000     .00    .00    .000
                     ==========================================================
                     SUM 07:PSTTOT       23.60      .475    1.67  48.71    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
100:0027------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
100:0002------------------------------------------------------------------------
*
  ** END OF RUN : 124

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--------------------
| START            |  Project  dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
--------------------  Rainfall dir.: C:\USERS\JORESK~1\DESKTOP\Primont\
    TZERO =   .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 125
    NSTORM=   1
           #  1=25MM.STM
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: PRIMONT HOMES
*#                     WELLAND AND THOROLD, ONTARIO
*#  JOB NUMBER  : 2022-0091-10
*#       Date   : MARCH 2024
*#    Revised   : MAY 2024
*#    Company   : WALTER FEDY
*#       File   : PRI-POST.DAT  CN=74 to match UCC, Ia = 8.924mm
*#*************************************************************************|
```

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*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------
| READ STORM        |    Filename: 25mm 4-hr CHICAGO STORM
| Ptotal=  25.04 mm|    Comments: 25mm 4-hr CHICAGO STORM
--------------------
              TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
               .17   1.476 |   1.17   4.128 |   2.17   5.720 |   3.17   2.070
               .33   1.638 |   1.33   6.306 |   2.33   4.347 |   3.33   1.886
               .50   1.847 |   1.50  14.454 |   2.50   3.527 |   3.50   1.734
               .67   2.125 |   1.67  55.558 |   2.67   2.982 |   3.67   1.608
               .83   2.515 |   1.83  16.925 |   2.83   2.592 |   3.83   1.500
              1.00   3.109 |   2.00   8.495 |   3.00   2.299 |   4.00   1.407

--------------------------------------------------------------------------------
125:0003------------------------------------------------------------------------
*
*#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING
*#        ===============================================
*#
*#*************************************************************************|
*
*#**************************************************************************|
*# SWMF #1 - SOUTH SIDE OF TOWPATH DRAIN
*#**************************************************************************|
*# CATCHMENT 601 - FUTURE DEVELOPED MOUNTAINVIEW LANDS SERVICED VIA PRIMONT
---------------------
| CALIB STANDHYD     |   Area    (ha)=    3.13
| 01:601    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   55.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.19          .94
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56        13.25
                over (min)        2.00         9.00
     Storage Coeff.  (min)=       2.11 (ii)    9.00 (ii)
     Unit Hyd. Tpeak (min)=       2.00         9.00
     Unit Hyd. peak  (cms)=        .54          .13
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .26          .02            .274 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.80           1.667
     RUNOFF VOLUME    (mm)=      24.04         4.64          15.310
     TOTAL RAINFALL   (mm)=      25.04        25.04          25.041
     RUNOFF COEFFICIENT   =        .96          .19            .611

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0004------------------------------------------------------------------------
*# CATCHMENT 602 - BACKYARDS OF EXISTING RESIDENTIAL FRONTING QUAKER ROAD
---------------------
| CALIB STANDHYD     |   Area    (ha)=    1.00
| 02:602    DT= 1.00 |   Total Imp(%)=   30.00   Dir. Conn.(%)=   30.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .30          .70
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         3.47
                over (min)        2.00        14.00
     Storage Coeff.  (min)=       2.11 (ii)   13.89 (ii)
     Unit Hyd. Tpeak (min)=       2.00        14.00
     Unit Hyd. peak  (cms)=        .54          .08
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .05          .00            .046 (iii)
     TIME TO PEAK    (hrs)=       1.67         2.00           1.667
     RUNOFF VOLUME    (mm)=      24.04         2.47           8.938
     TOTAL RAINFALL   (mm)=      25.04        25.04          25.041
     RUNOFF COEFFICIENT   =        .96          .10            .357

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0005------------------------------------------------------------------------
*# CATCHMENT 101 - PRIMONT LANDS SOUTH OF WATERCOURSE
---------------------
| CALIB STANDHYD     |   Area    (ha)=    2.67
| 03:201    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   60.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.87          .80
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         9.14
                over (min)        2.00        10.00
     Storage Coeff.  (min)=       2.11 (ii)   10.10 (ii)
     Unit Hyd. Tpeak (min)=       2.00        10.00
     Unit Hyd. peak  (cms)=        .54          .11
```

```
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .25          .01            .250 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.82           1.667
     RUNOFF VOLUME    (mm)=      24.04         3.95          16.003
     TOTAL RAINFALL   (mm)=      25.04        25.04          25.041
     RUNOFF COEFFICIENT   =        .96          .16            .639

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0006------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #1
-----------------------
| ADD HYD (TOT-1A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
-----------------------                    (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:601           3.13      .274    1.67  15.31    .000
                    +ID2 02:602           1.00      .046    1.67   8.94    .000
                    +ID3 03:201           2.67      .250    1.67  16.00    .000
                     ===========================================================
                     SUM 04:TOT-1A        6.80      .570    1.67  14.64    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0007------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #1
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>04:(TOT-1A)   |
| OUT<05:(SWM1  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .194  .3012E+00
                            .003  .2520E-01   |     .218  .3376E+00
                            .008  .5150E-01   |     .240  .3752E+00
                            .010  .7890E-01   |     .260  .4140E+00
                            .012  .1073E+00   |     .278  .4541E+00
                            .020  .1368E+00   |     .287  .4746E+00
                            .040  .1674E+00   |     .726  .5166E+00
                            .067  .1991E+00   |    1.515  .5599E+00
                            .132  .2320E+00   |    2.530  .6045E+00
                            .166  .2660E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >04: (TOT-1A)       6.80      .570     1.667     14.645
     OUTFLOW<05: (SWM1  )       6.80      .011     4.033     14.644
    OVERFLOW<06: (OVF1  )        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    1.910
                   TIME SHIFT OF PEAK FLOW         (min)=   142.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.9008E-01

--------------------------------------------------------------------------------
125:0008------------------------------------------------------------------------
*# CATCHMENT 603 - MOUNTAINVIEW REAR YARDS DRAINING UNCONTROLLED TO TOWPATH DRAI
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .37
| 01:603    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .15          .22
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      10.00        20.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         6.82
                over (min)        1.00        14.00
     Storage Coeff.  (min)=        .72 (ii)   14.35 (ii)
     Unit Hyd. Tpeak (min)=       1.00        14.00
     Unit Hyd. peak  (cms)=       1.28          .08
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .01          .00            .015 (iii)
     TIME TO PEAK    (hrs)=       1.65         1.95           1.667
     RUNOFF VOLUME    (mm)=      24.04         3.59           8.702
     TOTAL RAINFALL   (mm)=      25.04        25.04          25.041
     RUNOFF COEFFICIENT   =        .96          .14            .348

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0009------------------------------------------------------------------------
*# CATCHMENT 102 - PRIMONT LANDS UNCONTROLLED TO QUAKER RD DITCH AND TOWPATH
---------------------
| CALIB STANDHYD     |   Area    (ha)=     .39
| 02:102    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   60.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .25          .14
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.50         2.00
     Length            (m)=      70.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         5.45
                over (min)        2.00        12.00
     Storage Coeff.  (min)=       2.16 (ii)   12.00 (ii)
```

```
     Unit Hyd. Tpeak (min)=       2.00        12.00
     Unit Hyd. peak  (cms)=        .53          .09
                                                       *TOTALS*
     PEAK FLOW       (cms)=        .04          .00          .036 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.92         1.667
     RUNOFF VOLUME    (mm)=      24.04         3.12        15.671
     TOTAL RAINFALL   (mm)=      25.04        25.04        25.041
     RUNOFF COEFFICIENT   =        .96          .12          .626

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0010------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOW
------------------------
| ADD HYD (TOT-2A    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:603            .37      .015    1.67   8.70    .000
                    +ID2 02:102            .39      .036    1.67  15.67    .000
                     ===========================================================
                     SUM 03:TOT-2A         .76      .051    1.67  12.28    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0011------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN FROM SOUTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST1    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 05:SWM1          6.80      .011    4.03  14.64    .000
                    +ID2 06:OVF1           .00      .000     .00    .00    .000
                    +ID3 03:TOT-2A         .76      .051    1.67  12.28    .000
                     ===========================================================
                     SUM 04:T-PST1        7.56      .057    1.67  14.41    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0012------------------------------------------------------------------------
*
*
*#***************************************************************************|
*# SWMF #2 - NORTH SIDE OF TOWPATH DRAIN
*#***************************************************************************|
*# CATCHMENT 701 - EXISTING LANDS WEST OF PRIMONT
*#  CAPTURED IN REARYARD CB'S. THIS AREA TO HAVE ITS OWN FUTURE SWM WITH OUTLET
*#  TO WATECOURSE
----------------------
| CALIB NASHYD       |   Area    (ha)=    2.43   Curve Number   (CN)=74.00
| 01:701    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .226

     PEAK FLOW       (cms)=     .010 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0013------------------------------------------------------------------------
*# CATCHMENT 202 - PRIMONT REAR YARDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .12
| 02:202    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .05          .07
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         8.92
               over (min)        1.00         7.00
     Storage Coeff.  (min)=        .58 (ii)     7.10 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.40          .16
                                                       *TOTALS*
     PEAK FLOW       (cms)=        .00          .00          .005 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.77         1.667
     RUNOFF VOLUME    (mm)=      24.04         3.59         8.702
     TOTAL RAINFALL   (mm)=      25.04        25.04        25.041
     RUNOFF COEFFICIENT   =        .96          .14          .348

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0014------------------------------------------------------------------------
*# CATCHMENT 201 - PRIMONT LANDS
----------------------
| CALIB STANDHYD     |   Area    (ha)=    8.16
| 03:201    DT= 1.00 |   Total Imp(%)=   65.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       5.30         2.86
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
```

```
     Length            (m)=      30.00        10.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56        11.62
               over (min)        2.00         9.00
     Storage Coeff.  (min)=       2.11 (ii)    9.37 (ii)
     Unit Hyd. Tpeak (min)=       2.00         9.00
     Unit Hyd. peak  (cms)=        .54          .12
                                                       *TOTALS*
     PEAK FLOW       (cms)=        .62          .06          .650 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.80         1.667
     RUNOFF VOLUME    (mm)=      24.04         4.35        14.194
     TOTAL RAINFALL   (mm)=      25.04        25.04        25.041
     RUNOFF COEFFICIENT   =        .96          .17          .567

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0015------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT FLOWS TO SWMF #2
*#  PRIMONT LANDS + EXTERNAL LANDS UNDER EXISTING CONDITIONS
------------------------
| ADD HYD (TOT-1B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:701           2.43      .010    2.30   2.47    .000
                    +ID2 02:202            .12      .005    1.67   8.70    .000
                    +ID3 03:201           8.16      .650    1.67  14.19    .000
                     ===========================================================
                     SUM 08:TOT-1B       10.71      .656    1.67  11.47    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
125:0016------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #2
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>08:(TOT-1B)   |
| OUT<09:(SWM2  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |     .150  .4478E+00
                            .003  .3830E-01   |     .166  .5008E+00
                            .011  .7800E-01   |     .180  .5554E+00
                            .015  .1191E+00   |     .193  .6117E+00
                            .018  .1616E+00   |     .205  .6695E+00
                            .027  .2056E+00   |     .211  .6990E+00
                            .045  .2510E+00   |     .645  .7594E+00
                            .068  .2979E+00   |    1.428  .8215E+00
                            .112  .3463E+00   |    2.439  .8852E+00
                            .132  .3963E+00   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK        R.V.
     --------------------       (ha)     (cms)     (hrs)        (mm)
     INFLOW >08: (TOT-1B)      10.71      .656     1.667      11.471
     OUTFLOW<09: (SWM2  )      10.71      .014     4.050      11.470
    OVERFLOW<10: (OVF2  )        .00      .000      .000        .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.186
                   TIME SHIFT OF PEAK FLOW         (min)=   143.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1104E+00

--------------------------------------------------------------------------------
125:0017------------------------------------------------------------------------
*# CATCHMENT 702 - EXISTING LANDS WEST OF PRIMONT DRAINING TO TOWPATH DRAIN
----------------------
| CALIB NASHYD       |   Area    (ha)=    1.93   Curve Number   (CN)=74.00
| 01:702    DT= 1.00 |   Ia      (mm)=   8.924   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .410

     Unit Hyd Qpeak  (cms)=     .180

     PEAK FLOW       (cms)=     .008 (i)
     TIME TO PEAK    (hrs)=    2.300
     RUNOFF VOLUME    (mm)=    2.465
     TOTAL RAINFALL   (mm)=   25.041
     RUNOFF COEFFICIENT   =     .098

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
125:0018------------------------------------------------------------------------
*# CATCHMENT 203 - PRIMONT REAR YARDS DRAINING TO TOWPATH DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .19
| 02:203    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .08          .11
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n          =        .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         8.92
               over (min)        1.00         7.00
     Storage Coeff.  (min)=        .58 (ii)     7.10 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.40          .16
                                                       *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .008 (iii)
     TIME TO PEAK    (hrs)=       1.62         1.77         1.667
```

```
     RUNOFF VOLUME    (mm)=      24.04         3.59          8.702
     TOTAL RAINFALL   (mm)=      25.04        25.04         25.041
     RUNOFF COEFFICIENT   =        .96          .14           .348

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
125:0019-------------------------------------------------------------------------
*# CATCHMENT 204 - PRIMONT REAR YARDS - VARIOUS LOCATIONS DRAINING
*#  DRAINING TO TOWPATH DRAIN OR WETLAND
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .66
| 03:204    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .26          .40
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         8.92
                over (min)        1.00         7.00
     Storage Coeff.  (min)=        .58 (ii)    7.10 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.40          .16
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .03          .01           .029 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.77          1.667
     RUNOFF VOLUME    (mm)=      24.04         3.59          8.702
     TOTAL RAINFALL   (mm)=      25.04        25.04         25.041
     RUNOFF COEFFICIENT   =        .96          .14           .348

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
125:0020-------------------------------------------------------------------------
*# TOTAL UNCONTROLLED FLOWS
------------------------
| ADD HYD (TOT-2B    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .008    2.30   2.47    .000
                    +ID2 02:203            .19      .008    1.67   8.70    .000
                    +ID3 03:204            .66      .029    1.67   8.70    .000
                     ============================================================
                     SUM 05:TOT-2B        2.78      .038    1.67   4.37    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
125:0021-------------------------------------------------------------------------
*# TOTAL POST-DEV FLOWS TO TOWPATH DRAIN/WETLAND FROM NORTH SIDE
*#  CONTROLLED + UNCONTROLLED
------------------------
| ADD HYD (T-PST2    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 09:SWM2         10.71      .014    4.05  11.47    .000
                    +ID2 10:OVF2           .00      .000     .00    .00    .000
                    +ID3 05:TOT-2B        2.78      .038    1.67   4.37    .000
                     ============================================================
                     SUM 06:T-PST2       13.49      .043    1.67  10.01    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
125:0022-------------------------------------------------------------------------
*
*
*#*******************************************************************************|
*# CATCHMENT 205 - PRIMONT REAR YARDS DRAINING NORTH TO SINGERS DRAIN
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .44
| 10:205    DT= 1.00 |   Total Imp(%)=   40.00   Dir. Conn.(%)=   25.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .18          .26
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       7.00         7.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         8.92
                over (min)        1.00         7.00
     Storage Coeff.  (min)=        .58 (ii)    7.10 (ii)
     Unit Hyd. Tpeak (min)=       1.00         7.00
     Unit Hyd. peak  (cms)=       1.40          .16
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .02          .00           .019 (iii)
     TIME TO PEAK    (hrs)=       1.63         1.77          1.667
     RUNOFF VOLUME    (mm)=      24.04         3.59          8.702
     TOTAL RAINFALL   (mm)=      25.04        25.04         25.041
     RUNOFF COEFFICIENT   =        .96          .14           .348

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
125:0023-------------------------------------------------------------------------
------------------------
| ADD HYD (205       ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:702           1.93      .008    2.30   2.47    .000
                     ============================================================
                     SUM 10:205            .44      .019    1.67   8.70    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
125:0024-------------------------------------------------------------------------
*#*******************************************************************************|
*
*
*#*******************************************************************************|
*# SWMF #3 - NORTH SIDE OF WATERCOURSE, EAST SIDE OF PRIMONT LANDS
*#*******************************************************************************|
*# CATCHMENT 301 - PRIMONT LANDS ON EAST SIDE AJACENT FIRST AVENUE
----------------------
| CALIB STANDHYD     |   Area    (ha)=    2.55
| 01:301    DT= 1.00 |   Total Imp(%)=   75.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.91          .64
     Dep. Storage     (mm)=       1.00         8.92
     Average Slope     (%)=        .50         2.00
     Length            (m)=      30.00        10.00
     Mannings n           =       .015         .250

     Max.eff.Inten.(mm/hr)=      55.56         6.50
                over (min)        2.00        11.00
     Storage Coeff.  (min)=       2.11 (ii)   11.27 (ii)
     Unit Hyd. Tpeak (min)=       2.00        11.00
     Unit Hyd. peak  (cms)=        .54          .10
                                                            *TOTALS*
     PEAK FLOW       (cms)=        .27          .01           .275 (iii)
     TIME TO PEAK    (hrs)=       1.67         1.87          1.667
     RUNOFF VOLUME    (mm)=      24.04         3.37         17.839
     TOTAL RAINFALL   (mm)=      25.04        25.04         25.041
     RUNOFF COEFFICIENT   =        .96          .13           .712

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---------------------------------------------------------------------------------
125:0025-------------------------------------------------------------------------
*# ROUTE THROUGH SWMF #3
---------------------
| ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
|  IN>01:(301   )   |
| OUT<02:(SWM3  )   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)     (ha.m.)
                           .000  .0000E+00    |     .093  .2320E+00
                           .004  .1510E-01    |     .103  .2752E+00
                           .007  .3250E-01    |     .111  .3257E+00
                           .009  .5230E-01    |     .119  .3838E+00
                           .010  .7470E-01    |     .545  .4158E+00
                           .027  .9990E-01    |    1.321  .4498E+00
                           .056  .1281E+00    |    2.325  .4857E+00
                           .071  .1595E+00    |    3.513  .5237E+00
                           .083  .1941E+00    |     .000  .0000E+00

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >01: (301   )      2.55      .275     1.667     17.839
      OUTFLOW<02: (SWM3  )     2.55      .007     4.017     17.839
    OVERFLOW<03: (OVF3  )       .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    2.716
                   TIME SHIFT OF PEAK FLOW         (min)=   141.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.3876E-01

---------------------------------------------------------------------------------
125:0026-------------------------------------------------------------------------
*# TOTAL POST-DEVELOPMENT CONDITIONS DISCHARGE TO TOWPATH DRAIN FROM PRIMONT
*# AND EXTERNAL LANDS TO EXISTING WATERCOURSE (CONTROLLED + UNCONTROLLED)
------------------------
| ADD HYD (PSTTOT    ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:T-PST1        7.56      .057    1.67  14.41    .000
                    +ID2 06:T-PST2       13.49      .043    1.67  10.01    .000
                    +ID3 02:SWM3          2.55      .007    4.02  17.84    .000
                    +ID4 03:OVF3           .00      .000     .00    .00    .000
                     ============================================================
                     SUM 07:PSTTOT       23.60      .105    1.67  12.26    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---------------------------------------------------------------------------------
125:0027-------------------------------------------------------------------------
* RUN REMAINING DESIGN STORMS (WELLAND DESIGN STORMS 5 TO 100-YR)
*
---------------------------------------------------------------------------------
125:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
125:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
125:0002-------------------------------------------------------------------------
*
---------------------------------------------------------------------------------
125:0002-------------------------------------------------------------------------
*
```

```
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
125:0002------------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2024-05-23     at 14:45:16
================================================================================
```

APPENDIX E

FUS Fire Protection Calculations

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 2020)

WALTERFEDY

Project	Primont, Welland - Phase 1 South of
Project #	2022-0091-10
Designer	
Address	Quaker Lane, Welland
Description	Proposed Fire Demand - Site Plan Townhomes

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Ordinary Construction	**C =**	1.0
Description	Brick and Masonry Walls, Combustible Interiors		

Total Floor Area	275	m^2
# Storeys	2	
Fire Resistant Building?	NO	

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	550	m^2
Description	Total Floor Area	
Required Fire Flow	5000	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-750	L/min
Required Fire Flow	4250	L/min		

Automated Sprinker Protection	NO		
Designed to NFPA 13 Standard	YES	0%	
Standard Water Supply to Sprinklers and Standpipes	YES	0%	
Fully Supervised System	YES	0%	
Fire Flow Adjustment		0	L/min

Exposure 1 (North)	**Distance**	0	m	**Charge**	0%
Description	SWM facility. Open space				
Exposure 2 (East)	**Distance**	0	m	**Charge**	0%
Description	Open space				
Exposure 3 (West)	**Distance**	2.4	m	**Charge**	25%
Description	Neighbouring block				
Exposure 4 (South)	**Distance**	18	m	**Charge**	15%
Description	Units across the street				

Total Exposure Charge	40%	
Fire Flow Adjustment	1700	L/min

Total Required Fire Flow	6000	L/min
Total Required Fire Flow	1585	U.S. GPM
Total Required Fire Flow	100	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 2020)

WALTERFEDY

Project	Primont, Welland - Phase 1 South of
Project #	2022-0091-10
Designer	
Address	Quaker Lane, Welland
Description	Proposed Fire Demand - Street Townhomes - 4 units

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Ordinary Construction	**C =**	1.0
Description	**Brick and Masonry Walls, Combustible Interiors**		

Total Floor Area	385	m^2
# Storeys	2	
Fire Resistant Building?	NO	

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	770	m^2
Description	Total Floor Area	
Required Fire Flow	**6000**	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-900	L/min
Required Fire Flow	**5100**	L/min		

Automated Sprinkler Protection	NO		
Designed to NFPA 13 Standard	YES	**0%**	
Standard Water Supply to Sprinklers and Standpipes	YES	**0%**	
Fully Supervised System	YES	**0%**	
Fire Flow Adjustment		**0**	L/min

Exposure 1 (North)	**Distance**	0	m	**Charge**	**0%**
Description	Creek block				
Exposure 2 (East)	**Distance**	37	m	**Charge**	**0%**
Description					
Exposure 3 (West)	**Distance**	14	m	**Charge**	**15%**
Description					
Exposure 4 (South)	**Distance**	2.4	m	**Charge**	**25%**
Description	Neighbouring block				

Total Exposure Charge	**40%**	
Fire Flow Adjustment	**2040**	L/min

Total Required Fire Flow	**7000**	L/min
Total Required Fire Flow	**1849**	U.S. GPM
Total Required Fire Flow	**117**	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 2020)

WALTERFEDY

Project	Primont, Welland - Phase 1 South of
Project #	2022-0091-10
Designer	
Address	Quaker Lane, Welland
Description	Proposed Fire Demand - Back-to-Back Site Plan Units

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Ordinary Construction	**C =**	1.0
Description	**Brick and Masonry Walls, Combustible Interiors**		

Total Floor Area	255	m^2	**1 firewall dividing block**
# Storeys	3		
Fire Resistant Building?	**NO**		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	765	m^2
Description	Total Floor Area	
Required Fire Flow	**6000**	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	**-15%**	**OR**	**-900**	L/min
Required Fire Flow	**5100**	L/min		

Automated Sprinkler Protection	NO		
Designed to NFPA 13 Standard	YES	**0%**	
Standard Water Supply to Sprinklers and Standpipes	YES	**0%**	
Fully Supervised System	YES	**0%**	
Fire Flow Adjustment		**0**	L/min

Exposure 1 (North)	**Distance**	18	m	**Charge**	**15%**
Description	Units across the street				
Exposure 2 (East)	**Distance**	0	m	**Charge**	**0%**
Description	Open space area				
Exposure 3 (West)	**Distance**	0	m	**Charge**	**0%**
Description	Firewall. Fully protected. No charge.				
Exposure 4 (South)	**Distance**	17	m	**Charge**	**15%**
Description	Units across street to south				

Total Exposure Charge	**30%**	
Fire Flow Adjustment	**1530**	L/min

Total Required Fire Flow	**7000**	L/min
Total Required Fire Flow	**1849**	U.S. GPM
Total Required Fire Flow	**117**	L/s

APPENDIX F

Geotechnical Investigation

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
401 Grays Road · Hamilton, ON · L8E 2Z3
www.soil-mat.ca info@soil-mat.ca 905.318.7440 / 800.243.1922 (*toll free*) 905.318.7455

PROJECT NO.: SM 220530-G

April 14, 2023
Revised: June 14, 2024

PRIMONT (THOROLD/WELLAND) INC.
9130 Leslie Street, Suite 301
Richmond Hill, Ontario
L4B 0B9

Attention: Ian MacPherson, P.Eng.
Vice President Land Development

GEOTECHNICAL INVESTIGATION AND HYDROGEOLOGICAL CONSIDERATIONS
PROPOSED RESIDENTIAL DEVELOPMENT
QUAKER ROAD AND FIRST AVENUE
WELLAND, ONTARIO

Dear Mr. MacPherson,

Further to your authorisation, SOIL-MAT ENGINEERS & CONSULTANTS LTD. has completed the fieldwork, laboratory testing, and report preparation in connection with the above noted project. The scope of work was completed in general accordance with our proposal P220530, dated October 25, 2022. Our comments and recommendations based on our findings at the thirteen [13] borehole locations are presented in the following paragraphs.

1. INTRODUCTION

We understand that the project will involve the construction of a residential development consisting of low-rise buildings [townhouse and single family dwellings], as well as possibly a number of mid-rise buildings up to perhaps 8 to 12 stories and 1 to 2 basement levels. The development will involve regrading of the site, including placement of engineered fill, installation of municipal services and roadway construction, along with associated storm water management ponds. It is noted that, a preliminary geotechnical report has been prepared for the site by DS Consultants Ltd [Project No. 21-339-300, dated July 22, 2022]. The information presented in that report has been referenced in the planning and reporting of this supplemental geotechnical investigation.

The purpose of this supplemental geotechnical investigation work is to further assess the subsurface soil conditions, and to provide our comments and recommendations with respect to the design and construction of the proposed development, from a geotechnical point of view.
This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with the applicable codes

and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, this office must be consulted to review the new design with respect to the results of this investigation.

2. PROCEDURE

A total of thirteen [13] sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole Location Plan. These are in addition to nineteen [19] boreholes previously advanced and reported by DS Consultants Ltd. The current boreholes were advanced using continuous flight power auger equipment from December 6 to 9, 2022 under the direction and supervision of a staff member of SOIL-MAT ENGINEERS & CONSULTANTS LTD., to termination depths of approximately 6.7 to 20.4 metres below the existing ground surface.

Upon completion of drilling, ground water monitoring wells were installed at Borehole Nos. 5, 7, and 11 to allow for future measurements of the groundwater level. The monitoring wells consist of 50-millimetre diameter PVC pipe, screened in the lower 3.0 metres. The wells were encased in well filter sand up to approximately 0.3 metres above the screened portion, then with bentonite ‘hole plug’ up to the surface and fitted with a protective steel ‘stick up’ casing. The remainder of the boreholes were backfilled in general accordance with Ontario Regulation 903, and the grade reinstated even with the surrounding ground surface. It is noted that a total of thirteen [13] monitoring wells were installed as part of the previous investigation by DS Consultants Ltd. and are found to still be intact and have been utilized in preparation of this report.

Representative samples of the subsoils were recovered from the borings at selected depth intervals using split barrel sampling equipment driven in accordance with the requirements of ASTM test specification D1586, Standard Penetration Resistance Testing. After undergoing a general field examination, the soil samples were preserved and transported to the SOIL-MAT laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were preformed on all soil samples recovered from the borings, with hand penetrometer testing conducted on all cohesive samples. Additionally, six [6] selected soil samples were subject to grain size analysis.

The boreholes were located in the field by representatives of SOIL-MAT ENGINEERS & CONSULTANTS LTD., based on accessibility over the site and clearance of underground utilities. The ground surface elevation at the borehole locations has been referenced to the geodetic elevations of existing monitoring wells, installed by DS consultants Ltd., during their preliminary site investigation.
Details of the conditions encountered in the boreholes, together with the results of the field and laboratory tests, are presented in Log of Boreholes Nos. 1 to 13 inclusive, following

the text of this report. It is noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made while drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed at the exact depths of geological change.

3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The subject site is located at the north-west of the intersection of Quaker Road and First Avenue, in Welland, Ontario. The subject site is bounded to the North by wetlands, to the east by First Avenue, to the south by Quaker Road and to the west by Rice Road and some residential properties. The subject site has relatively flat and even topography, with an overall relief of approximately 2 to 3 metres across the site. The property is largely vacant agricultural land, with a large woodlot present over the northern portion. There are two natural drainage courses crossing east-west across the property.

The subsurface conditions encountered at the borehole locations are summarised as follows:

Topsoil

A surficial veneer of topsoil approximately 150 to 300 millimetres in thickness was encountered at all borehole locations. It is noted that the depth of topsoil may vary across the site and from the depths encountered at the borehole locations. It is also noted that the term ‘topsoil’ has been used from a geotechnical point of view, and does not necessarily reflect its nutrient content or ability to support plant life. Given the current use of the property is for agricultural purposes the upper levels of the soils would be expected to have a reworked nature with a variable topsoil depth based on historical working of the field, ranging from undiscernible to greater depths of topsoil. As such, it is recommended that a conservative approach be taken when estimating topsoil quantities across the site.

Silty Clay/Clayey Silt

Native silty clay/clayey silt was encountered beneath the topsoil veneer at all the borehole locations. The native cohesive soil was brown to reddish brown in colour, transitioning to grey below about 2.5 to 5 metres depth in most locations, contained occasional gravel, and was firm to very stiff in consistency. Some organics were noted in upper levels of silty clay/clayey silt soils, likely associated with historical tilling of the agricultural field. The silty clay was proven to depths of between approximately 2.2 and 8.6 metres below the existing ground surface at all borehole locations, and to termination in Borehole Nos. 5, 11 and 13. The silty clay exhibits the properties of a ‘weathered crust’ in the upper about 2.5 to 4 metres, stiff to very stiff in consistency, and good relative shear strength. With depth the silty clay deposit tends to become firm to soft, with lower shear strengths. This firm zone is variable across the site, ranging in thickness from effectively zero to as much as perhaps 3 to 4 metres, generally more over the central and eastern portion of the site. This is fairly typical of the overburden clays in the Niagara Peninsula, with the upper 'crust' typically being over consolidated, and the firm zone tending to be normally to only slightly over consolidated.

Sandy Silt/Silt

At all borehole locations, native sandy silt/silt soil was encountered beneath the native silty clay/clayey silt soil, with the exception of Borehole Nos. 5, 11 and 13. The native fine grained granular soil was reddish brown in colour, with occasional gravel, trace clay, and was generally in a compact state. The sandy silt/silt soil was proven to termination at depths of between approximately 6.7 and 20.4 metres at all borehole locations.

As noted above, grain size analyses were conducted on six selected samples of the native soils encountered. The results of this testing can be found appended to the end of this report, and are summarized as follows:

TABLE A – GRAIN SIZE ANALYSES

Sample ID	Depth	% Clay	% Silt	% Sand	% Gravel	Hydraulic Conductivity, k [cm/s]
BH1 SS6	4.5 m	60	39	1	0	10^{-7}
BH1 SS9	9.1 m	14	82	4	0	10^{-7}
BH3 SS5	3.0 m	11	78	11	0	10^{-6}
BH6 SS4	2.2 m	45	51	4	0	10^{-8}
BH7 SS3	1.5 m	61	38	1	0	10^{-8}
BH11 SS4	2.2 m	66	31	2	1	10^{-8}

The field and laboratory testing demonstrate the native soils within the upper few metres to predominantly consist of silty clay with traces of sand to silt to sandy silt with some clay at lower levels. According to the Unified Soil Classification System (USCS), the soils are classified as C.L. – inorganic clays of low to medium plasticity, silty clays to M.L. – Inorganic silts, with very fine sand or clayey silts with slight plasticity. The clay and silt soils would generally behave as a cohesive material with slight to medium plasticity, and low hydraulic conductivity, on the order of 10^{-7} to 10^{-8} cm/sec, and would be of low permeability to effectively impermeable.

These low permeable cohesive soils encountered would generally be considered suitable to provide an impermeable liner for the proposed stormwater management ponds, however further assessment in the area of the SWM pond at the depths of the proposed pond base would be warranted based on the increased silt content noted at depth.

A review of available published information [Quaternary Geology of Ontario, Southern Sheet Map 2556] indicate the subsurface soils to consist of fine-textured glaciolacustrine deposits of silt and clay with minor sand and gravel. This is consistent with our experience in the area, the above analyses, and our observations during drilling, as well as the conditions reported in the previous boreholes by DS Consultants.

Groundwater Observations

Borehole Nos. 2, 6, 8, 9, 10, 11, and 13 were recorded as being 'wet' upon completion of drilling at depths of approximately between 4.8 to 6.7 metres below existing ground surface. All other borehole locations were recorded as 'dry' upon completion of drilling. It is noted that insufficient time would have passed for the static groundwater level to stabilise in the open boreholes. As noted above, monitoring wells were installed at Borehole Nos. 5, 7 and 11 to allow for future measurements of the static groundwater level. The details of the monitoring well installation, as well as the groundwater measurements taken, have been summarised as follows:

TABLE B.1 – SUMMARY OF GROUNDWATER MEASUREMENTS
(SM 220530-G)

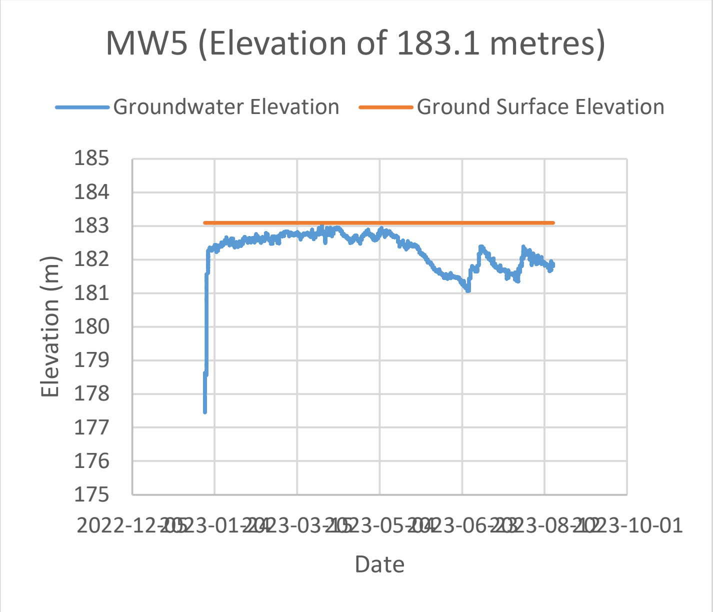
BH No.	Ground Surface Elev. (m)	Date of Observation	Groundwater Depth (m)	Groundwater Elevation (m)
BH5	183.1	Jan 18, 2023	0.80	182.32
		Feb 24, 2023	0.57	182.55
		August 17, 2023	1.22	181.88
BH7	183.5	Jan 3, 2023	1.60	181.65
		Jan 18, 2023	1.42	182.1
		Feb 24, 2023	1.28	182.24
		August 17, 2023	1.29	182.21
BH11	183.2	Jan 3, 2023	0.0	183.23
		Jan 18, 2023	**-0.22**	183.45
		Feb 24, 2023	**-0.12**	183.35
		August 17, 2023	**-0.11**	183.31

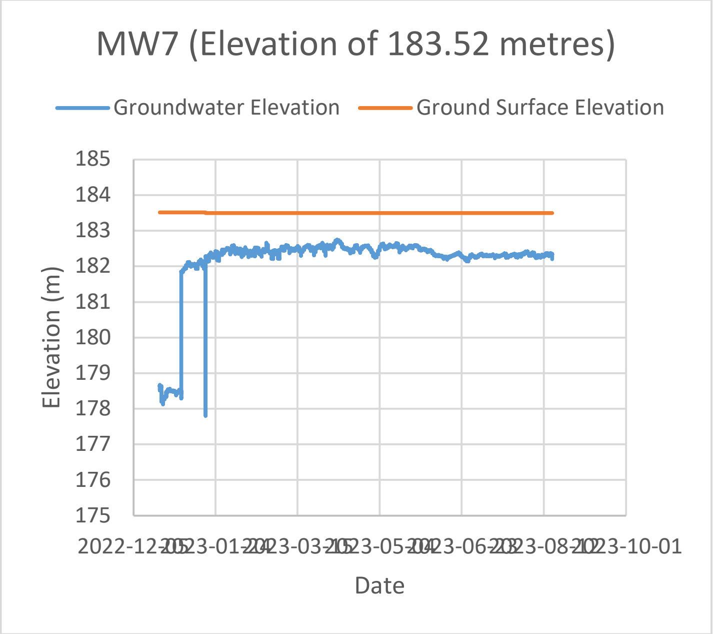
TABLE B.2 – SUMMARY OF GROUNDWATER MEASUREMENTS
(DS PROJECT NO. 21-339-300)

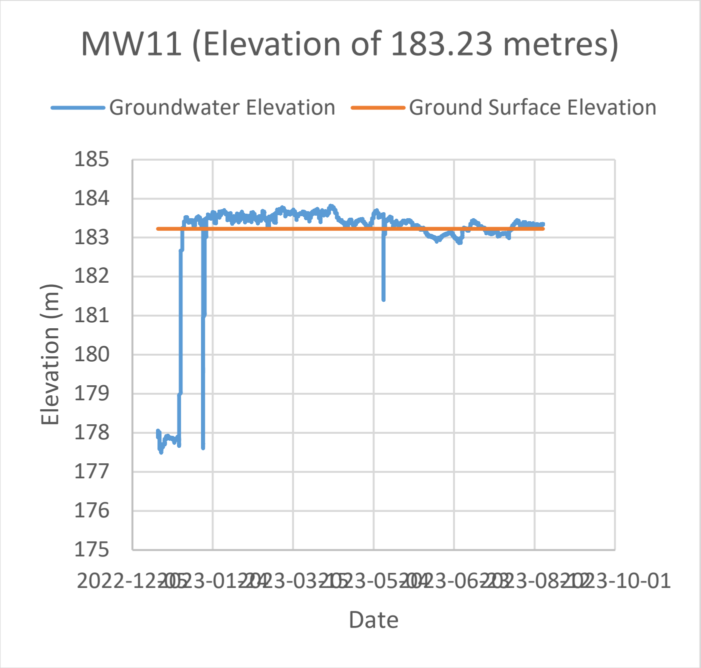
BH No.	Ground Surface Elev. (m)	Date of Observation	Groundwater Depth (m)	Groundwater Elevation (m)

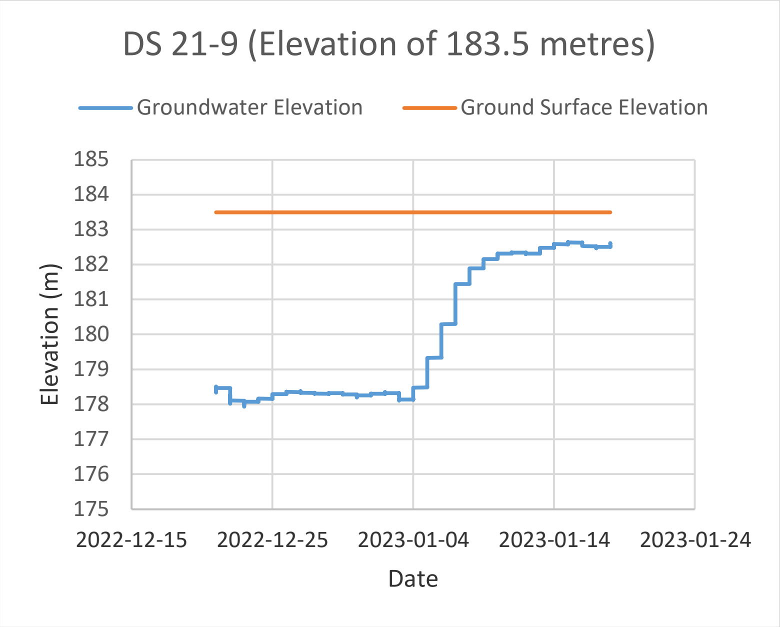
BH21-1	183.5	Nov 11, 2021	1.26	182.2
		May 10, 2022	**-0.80**	184.3
BH21-2	184.1	Nov 11, 2021	0.7	183.4
		May 10, 2022	0.68	183.4
		June 27, 2022	0.54	183.6
BH21-3	182.4	Nov 11, 2021	0.35	182.1
		May 10, 2022	0.52	181.9
BH21-6	184.1	Nov 11, 2021	0.54	183.6
		May 10, 2022	0.66	183.4
		June 27, 2022	0.78	183.3
BH21-8	183.6	Nov 11, 2021	1.37	182.2
		May 10, 2022	1.11	182.5
		June 27, 2022	1.12	182.5
BH21-9	183.5	Nov 11, 2021	0.25	183.3
		May 10, 2022	**-0.5**	184.0
		June 27, 2022	0.97	182.5
BH21-11	184.3	Nov 11, 2021	3.47	180.8
		May 10, 2022	0.77	183.5
		June 27, 2022	0.57	183.7
BH21-13	183.4	Nov 11, 2021	0.55	182.8
		May 10, 2022	0.52	182.9
BH21-14	183.6	Nov 11, 2021	0.56	183.1
		May 10, 2022	0.67	182.9
BH21-16	183.4	Nov 11, 2021	4.43	179.0
		May 10, 2022	0.54	182.9
		June 27, 2022	0.72	182.7
BH22-01	184.3	March 25, 2022	1.57	182.7
		April 12, 2022	1.33	183.0
		June 27, 2022	1.18	183.1
BH22-02	183.6	April 12, 2022	1.15	182.4
		June 27, 2022	0.17	183.4
BH22-03	184.0	March 25, 2022	0.15	183.8
		April 12, 2022	0.28	183.7
		June 27, 2022	0.87	183.1

Data loggers were also installed at selected monitoring well locations to allow for continuous measurement of the groundwater level between January 3, 2023 and January 18, 2023. Selected monitoring wells were purged dry and reinstalled with second set of data loggers on January 18, 2023 to allow continuous measurement of groundwater level between January 18, 2023 and August 17, 2023. The data obtained from these data loggers have been illustrated as follows:









The available ground water data to date indicates a groundwater level on the order of approximately 0.5 to 1.5 metres below the existing ground surface, varying with the physical topography. This corresponds to groundwater elevations of approximately 182.5 to 183.8 metres. It is noted that indication of a slight artesian condition was noted in well installed at Borehole No. 11 with ground water level noted above existing ground surface. Given the span of time and time of the year the readings have been taken, it is anticipated that the observed readings would be indicative of a 'seasonal' high during the wet spring season. Depending on the depth of the proposed excavation and timing of construction, it may be prudent to advance a series of test pits to assess first hand the effect groundwater conditions on the proposed excavations during earthworks and servicing.

4. EARTHWORKS AND GRADING CONSIDERATIONS

As noted above, the subsurface soils within the depths of construction, or influence of construction, are predominantly silty clay. The silty clay has a typical very stiff 'weathered crust' in the upper about 2.5 to 4 metres, underlain by a variable firm to soft zone ranging in thickness from effectively zero to as much as perhaps 4 metres. The very stiff 'crust' tends to be over consolidated, while the 'soft' zone tends to be normally to slightly over consolidated. The presence of the underlying normally to slightly over consolidated clay layer does present the potential for consolidation settlements as a result of stress change such as from the placement of fill to raise the grade.

Reviewing the current proposed grading plan the depth of fill placement over the site is on the order of approximately 0.5 to 3 metres, with isolated peak depths of as much as 4 metres. In general, the depth of fill placement over areas of the site where the 'soft' clay zone is present tend to be on the order of 2.5 metres and less. Such a modest raise in the grade is not considered likely to mobilise significant consolidation settlements, and can be readily accommodated through suitable planning and staging of the earthworks.

The degree of potential settlements associated with the proposed grading would be relatively low, though not zero. However, any such minor settlements would occur over a wide area, based on a wide area of fill placement, such that there would be essentially negligible potential for acute or significant differential settlements over a short distance. This further reduces the degree of concern for potential consolidation settlements that would affect the support of services, roads or foundations.

A further consideration with respect to potential for consolidation settlement of the underlying soft to firm clay, is the timeline of such settlements to occur. While larger potential settlements can take several months or even years to manifest, considering the degree of load change [i.e. raise in grade] any such minor consolidation settlements would be likely to occur within a timeframe on the order of perhaps 3 to 9 months. As such, it would be prudent to consider the schedule of earthworks and site development to further minimize the potential for settlements to impact the site development. In this case, the greatest depth of fill placement should be conducted at the outset of earthworks. Where possible the fill works should be conducted to pregrade level sufficiently in advance of site servicing, ideally allowing a delay of 3 to 6 months. This will allow the majority of any potential settlements to occur prior to the completion of site servicing and roadway construction, such that support for proposed houses would be unaffected.

As noted above, the static groundwater level tends to be relatively shallow across much of the site, on the order of 0.5 to 1.5 metres below the existing grade, in the range of 182.5 to 183.8 metres elevation. In this regard, raising the grade of the site as much as possible will be helpful to reduce the potential for interaction with the groundwater during development. It is recommended that the design basement elevations be a minimum of 0.5 metres, and preferably greater as much as possible, above the establish groundwater level. The current preliminary grading plan indicates the grade to be rising by approximately 0.5 to as much as 3 metres. This should effectively raise the level of proposed foundations for low-rise residential buildings such that there would be no long-term interaction with the groundwater. For any proposed mid-rise buildings with underground parking levels it would be recommended to conduct a more detailed specific review the grading and groundwater conditions as part of the detailed design for a given building.

5. EXCAVATIONS

Excavations for the installation of foundations and underground services are anticipated to extend to depths of up to approximately 1 to 6 metres below the existing grade. Excavations through the native silty clay/clayey silt and sandy silt/silt soils above the groundwater level should be relatively straightforward, with the sides remaining stable for the short construction period at slopes of up to 45 to 60 degrees to the horizontal, respectively. However, where excavations extend below the static groundwater level, during periods of extended precipitation or during ‘wet’ times of the year, increased excavation instability should be anticipated, which may cause excavations to ‘slough in’ to as flat as 3 horizontal to 1 vertical, and as such, wider excavations should be anticipated, and the contractor should be prepared to work in the ‘wet’. Nevertheless, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act must be supported or a trench box must be provided, and a senior geotechnical engineer from this office should monitor the work. With respect to the Act, the majority of the soils would be considered as Type 3 soil, with the stiff native silty clay soils considered as Type 2 soil. Nonetheless, considering the variable depths of materials and ground water conditions across the site, the onsite soils should be conservatively be considered Type 3 soils for the purposes of excavation planning.

Excavation bases will be prone to disturbance and localized instability, largely as a function of the prevailing weather conditions, depth of excavation, and moisture condition of the subsurface soils. It should be anticipated that it may be necessary to provide base stabilization with additional bedding or ballast stone, or a layer of coarse crushed stone. This is best assessed in the field at the time of construction.

As noted above, the static groundwater level is estimated at a depth of approximately 0.5 to 1.5 metres below existing ground surface, elevation 182.5 to 183.8 metres, with excavations likely extending to or below this level. As noted above, where feasible, it would be prudent to raise the grade with engineered fill to raise dwelling foundations and roadways, and reduce the scale of the excavations which may be affected by shallow groundwater conditions.

Based on the preliminary grading plans provided to our office, the grade will be raised such that excavations for watermain and storm sewer installation will extend to depths on the order of 1.0 to 1.5 metres below the existing grade, at to slightly below the groundwater level. Excavations for sanitary sewers will extend as much as approximately 5 to 6 metres below the existing grade, well below the groundwater level.

Excavations should begin at the ‘low end’ of the sewer alignment to allow drainage away from the work area. Work should be coordinated so that a section of pipe is installed as quickly as possible after excavation, and is provided with an initial cover of at least 0.6 to 0.9 metres of backfill within the same day it is installed, in particular for sanitary sewer pipe in deeper excavations. Surface water should be directed away from the excavation.

The initial volume of infiltration may be greater, but would tend to reduce with time and pumping, depending on weather conditions during construction. The generally low permeability silty clay/clayey silt and sandy silt/silt soils should yield a relatively low rate of groundwater infiltration such that it should be possible to adequately control groundwater infiltration for the short construction period using conventional construction dewatering techniques for excavations extending near to as much as perhaps 1 to 3 metres below the static groundwater level. More water should be expected when connections are made to existing services. Surface water should be directed away from the excavations.

It is anticipated that typical temporary construction dewatering volumes would be below a rate of 50,000 L/day. For greater excavation depths, or lengths, the volume of dewatering may be greater, up to 400,000 L/day, such that an EASR notification may be warranted. The need for a Permit to Take Water [PTTW] is not expected to be required for site servicing. Buildings with basement levels to greater depth may have increased dewatering requirements, however these are best assessed during the design stage on a case by case basis for specific buildings.

Additionally, it is noted that the final grading of the site relative to the existing grade will affect the required depth of excavation below the existing grade and groundwater level, with an overall increase in the site grade being generally beneficial, tending to reduce the potential and extent of groundwater infiltration. This is particularly relevant with respect to establishing the founding level and basement level of proposed dwellings, to be above the established static groundwater level and avoid the potential for frequent or ongoing operation of sump pumps.

The base of the excavations in the native soils, above the groundwater level, encountered in the boreholes should generally remain firm and stable. As such, standard pipe bedding material as specified by the Ontario Provincial Standard Specification [OPSS] should be satisfactory, however as noted some base stabilisation may be required where excavations extend deeper, or where shallow groundwater conditions are encountered. The bedding should be well compacted to provide sufficient support to the pipes and components (i.e. valve chambers, manholes etc.), and to minimize settlements of the roadway above the service trenches. Special attention should be paid to compaction under the pipe haunches.

For service trenches extending below the groundwater level, consideration should be made for the provision of clay 'cut-offs' within the trench backfill. In particular within the deeper sanitary sewer trenches. The clay cut-offs would typically be installed just beyond manholes for a given section of sewer, and could consist of suitably plastic silty clay soil available on site and/or the use of a bentonite clay material mixed with granular. This later option is often more effective for the replacement of bedding and initial cover over the pipe, before switching to suitable clay soil fill.

6. SEISMIC DESIGN CONSIDERATIONS

The structure shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 332/12. Based on the subsurface soil conditions encountered in this investigation the applicable Site Classification for the seismic design is Site Class D, stiff soil, based on the average soil characteristics for this site. It is noted that a seismic site class of C may be available, however would need to be confirmed via site specific shear wave velocity testing.

The seismic data from Supplementary Standard SB-1 of the Ontario Building Code for Welland are as follows;

$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	$S_a(5.0)$	$S_a(10.0)$	PGA	PGV
0.308	0.150	0.069	0.0310	0.0074	0.0028	0.199	0.115

7. BACKFILL CONSIDERATIONS

The excavated materials will primarily consist of the silty clay/clayey silt and sandy silt/silt soils encountered in the boreholes, as described above. These soils are generally considered suitable for use as engineered fill, trench backfill, etc., provided they are free of organics, debris, or other deleterious material, and that their moisture contents can be controlled to within 3 percent of their standard Proctor optimum moisture content. Some selective sorting to remove organics, debris, and other unsuitable materials should be expected.

It is noted that the fine grained to cohesive soils encountered are not considered to be free draining, and should not be used where this characteristic is required. It is also noted that these soils present difficulties in achieving effective compaction where access with compaction equipment is restricted. The silty clay/clayey silt and sandy silt/silt soils are generally considered to be near to slightly 'wet' of their standard Proctor Optimum moisture content. Some moisture conditioning may be required depending upon the weather conditions at the time of construction. It is noted that these soils will become nearly impossible to compact when wet of its optimum moisture content. Any material that becomes wet to saturated should be spread out to allow to dry, or removed and discarded, or utilised in non-settlement sensitive areas.

The use of free draining, well-graded granular material, such as Ontario Provincial Standard Specification [OPSS] Granular 'B' Type II (crushed limestone bedrock), is recommended for backfill against the foundation walls or to raise the interior grade to the design subgrade level. This material is more readily compacted in restricted access areas, and generally presents a more positive support condition for interior floor slabs and exterior concrete sidewalks.

We note that where the backfill material is placed near or slightly above its optimum moisture content, the potential for long term settlements due to the ingress of groundwater and collapse of the fill structure is reduced. Correspondingly, the shear strength of the 'wet' backfill material is also lowered, thereby reducing its ability to support construction traffic and therefor impacting construction. If the soil is well dry of its optimum value, it will appear to be very strong when compacted, but will tend to settle with time as the moisture content in the fill increases to equilibrium condition. The fine grained to cohesive soils may require high compaction energy to achieve acceptable densities if the moisture content is not close to its standard Proctor Optimum value. It is therefore very important that the placement moisture content of the backfill soils be within 3 percent of their standard Proctor optimum moisture content during placement and compaction to minimise long term subsidence [settlement] of the fill mass. Any imported fill required in service trenches or to raise the subgrade elevation should have its moisture content within 3 percent of its optimum moisture content and meet the necessary environmental guidelines.

A representative of SOIL-MAT should be present on-site during the backfilling and compaction operations to confirm the uniform compaction of the backfill material to project specification requirements. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs'. All structural fill, backfill within service trenches, areas to be paved etc. should be compacted to a minimum of 98 percent of its SPMDD. The appropriate compaction equipment should be employed based on soil type, i.e., pad-toe for cohesive soils and smooth drum/vibratory plate for granular soils. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

8. MANHOLES, CATCH BASINS AND THRUST BLOCKS

Properly prepared bearing surfaces for manholes, valve chambers, etc. in the native competent soils, stabilised where required, will be practically non-yielding under the anticipated loads. Proper preparation of the founding soils will tend to accentuate the protrusion of these structures above the pavement surface if compaction of the fill around these structures is not adequate, causing settlement of the surrounding paved surfaces. Conversely, the pavement surfaces may rise above the valve chambers and around manholes under frost action. To alleviate the potential for these types of differential movements, free-draining, non-frost susceptible material should be employed as backfill around the structures located within the paved roadway limits, and compacted to 100 per cent of its standard Proctor maximum dry density.

The thrust blocks in the native soils may be conservatively sized as recommended by the applicable Ontario Provincial Standard Specification conservatively using a horizontal allowable bearing pressure of up to 150 kPa [~3,000 psf]. Any backfill required behind the blocks should be a well-graded granular product and should be compacted to 100 per cent of its standard Proctor maximum dry density.

9. STORM WATER MANAGEMENT POND CONSIDERATIONS

It is understood that multiple Storm Water Management [SWM] ponds are proposed for the proposed site. The base of the proposed ponds within the native silty clay/clayey silt soils should generally remain firm and stable. However, depending on the proposed depth of the pond the base may potentially become locally unstable as a function of the pond base elevation versus the groundwater level and prevailing weather conditions. Such instability would be exacerbated by repeated travel of heavy construction equipment. These conditions will be made worse during wet weather, and so it is recommended that site works be conducted during the dry summer months of the year, where possible. It would be reasonable to conduct the initial grading of the SWM pond to or slightly above the final base contours. These initial ‘pre-grade’ contours could then be maintained during construction of site grading and servicing and then the pond completed near the end of site servicing works. This would have the benefit of providing a demonstration of how the pond can be expected to perform in the long-term and allow any necessary changes to be made to the design prior to completion of construction.

Another design consideration in the long-term performance of the SWM pond will be the need to accommodate the infiltration/exfiltration of natural groundwater to allow the pond to provide the maximum storage volume for storm water detention. Given the observed static groundwater levels it is anticipated that groundwater movement will be either infiltration into the pond or exfiltration from the pond as a function of the design base elevation, permanent pool elevation and seasonal fluctuation in groundwater levels. The low permeable silty clay soils will yield a low rate of infiltration in the short-term, in the long-term [over yearly cycles] the groundwater must be expected to stabilize near the levels as estimated above.

Based on information available to date, it would appear that the most appropriate approach to the seepage conditions and storm water management on this site would be to provide a low permeability layer over the base of the pond to resist the infiltration or exfiltration of groundwater, and of sufficient weight to resist any hydrostatic uplift pressures. This could be readily accomplished through the use of a re-compacted clay liner or with a weighed down proprietary liner system, etc. The weight of the liner system would have to exceed the uplift pressure of the ground water during the most severe periods of the year, likely when maximum storage is required. In approximate terms for example, one metre of clay liner, or equivalent, would be required for about every two meters of water storage below static ground water level, i.e., when the water level [permanent pool elevation] in the pond is 2 metres below the static ground water table, the clay liner would have to be at least 1 metre thick; if 3 metres below the static level, then 1.5 metres thick, etc.

An impermeable compacted clay liner would consist of a sufficiently plastic clay soil, with a recommended minimum clay content of 20 per cent and plasticity index of 7 or more. Based on the grain size analyses presented above, the on-site silty clay soils would be considered suitable for use in the construction of a low permeable or impermeable liner at the base of the SWM pond to resist the infiltration/exfiltration of groundwater. This may be readily accomplished by working the silty clay in the base of the pond to a depth of perhaps 0.5 metres, such as with a heavy disc, to break apart any natural structure or layering. The liner material should be moisture conditioned to be within 2 per cent below to 4 per cent above optimum moisture content and compacted in place to 95 per cent of standard Proctor maximum dry density [SPMDD].

Alternatively, weighed down proprietary liners could be considered, however the material suppliers of such materials (such as Layfield, Terrafix, Suprema) would have to be consulted for recommendations on the appropriate product and installation methods for the site conditions. Such artificial liners would not require compaction efforts and could be weighed down with practically any available soil or granular material.

The final design interior pond slopes in the native overburden or constructed using the on-site silty clay should be at 4 horizontal to 1 vertical, or flatter, and the exterior slopes of any berms, where required, at 3 horizontal to 1 vertical, or flatter. Should steeper slopes be required it will be necessary to provide some form of stabilization, such as with the placement of coarse 'rip-rap' stone, or proprietary product such as Turfstone or Cable-Crete, or constructed as a reinforced earth embankment. It is recommended that all interior pond slopes be provided with at least some form of nominal stabilization/protection to control erosion/loss of ground. Above the extended pond level this may consist of appropriate vegetation.

Material utilised in construction of pond slopes must be free of significant organic deposits, or any other deleterious materials which would affect stability of the pond walls. Our office should be retained to review any imported material to the site, as well as to provide quality control services during construction.

It is also noted that appropriate care and effort will be required by the contractor around inlet and outlet structures to ensure the impermeable liner is continuous and avoid the potential of 'piping'. In this regard the clay liner should be completely constructed prior to the installation of inlet/outlet structures. If necessary, a bentonite clay material could be utilized within the fill around any structures to provide a continuous impermeable seal.

10. PAVEMENT DESIGN CONSIDERATIONS

All areas to be paved should be stripped of all organic or otherwise unsuitable materials. The exposed subgrade should be proof rolled with 3 to 4 passes of a loaded tandem truck in the presence of a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD., immediately prior to the placement of the sub-base material. Any areas of distress revealed by this or other means must be sub-excavated and replaced with suitable backfill material. Alternatively, the soft areas may be stabilized by placing coarse crushed stone and 'punching' it into the soft areas. Where the subgrade condition is poorer it may be necessary to implement more aggressive stabilization methods, such as the use of coarse aggregate [50-millimetre clear stone, 'rip rap', etc.] 'punched' into the soft areas, or the use of stabilizing geogrid and a geofabric separator. The need for the treatment of softened subgrade will be reduced if construction is undertaken during the dry summer months and careful attention is paid to the compaction operations. The fill over shallow utilities cut into or across paved areas such as telephone, hydro, gas, etc. must also be compacted to 100 per cent of its SPMDD.

Good drainage provisions will optimize the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and mitigate softening of the subgrade material. Surface water should not be allowed to pond adjacent to the outer limits of the paved areas.

The most severe loading conditions on the subgrade typically occur during the course of construction, therefore precautionary measures may have to be taken to ensure that the subgrade is not unduly disturbed by construction traffic. SOIL-MAT should be given the opportunity to review the final pavement structure design and subdrain scheme prior to construction to ensure that they are consistent with the recommendations of this report.

If construction is conducted under adverse weather conditions, additional subgrade preparation may be required. During wet weather conditions, such as during the Fall and Spring months, or during colder winter weather, it should be anticipated that additional subgrade preparation will be required, such as additional depth of Ontario Provincial Standard Specification [OPSS] Granular 'B', Type II (crushed limestone bedrock) sub-base material. It is also important that the sub-base and base granular layers of the pavement structure be placed as soon as possible after exposure, preparation, and approval of the exposed subgrade.

Where roads are to be assumed by the City of Welland the pavement structure should confirm to the appropriate municipal standard. The suggested pavement structures outlined in Table D below may also be considered. These are based on subgrade parameters estimated on the basis of visual and tactile examinations of the on-site soils and past experience. The outlined pavement structure may be expected to have an approximate fifteen to twenty year life, assuming that regular maintenance is performed. Should a more detailed pavement structure design be required, site specific traffic information would be needed, together with detailed laboratory testing of the subgrade soils.

TABLE D – TYPICAL SUGGESTED PAVEMENT STRUCTURES

LAYER DESCRIPTION	COMPACTION REQUIREMENTS	LIGHT DUTY SECTIONS	HEAVY DUTY [TRUCK ROUTE]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	Min. 92 % Marshall MRD	40 millimetres	40 millimetres
Binder Course OPSS HL 8	Min. 92 % Marshall MRD	50 millimetres	65 millimetres
Base Course OPSS Granular A	100% SPMDD	150 millimetres	150 millimetres
Sub-base Course OPSS Granular B Type II	100% SPMDD	300 millimetres	450 millimetres

* Marshall MRD denotes Maximum Relative Density.
* SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698.

Depending on the anticipated traffic, a reduced light duty asphalt structure consisting of 65 millimetres of HL3 surface course may also perform sufficiently. This would be reasonable in areas subjected only to light vehicles such as cars for parking. Such a structure may have a reduced lifespan if subjected to heavier vehicles, and would also not allow for ‘mill and pave’ type operations for future rehabilitation.

To minimize segregation of the finished asphalt mat, the asphalt temperature must be maintained uniform throughout the mat during placement and compaction. All too often, significant temperature gradients exist in the delivered and placed asphalt with the cooler portions of the mat resisting compaction and presenting a honeycomb surface. As the spreader moves forward, a responsible member of the paving crew should monitor the pavement surface, to ensure a smooth uniform surface. The contractor can mitigate the surface segregation by ‘back-casting’ or scattering shovels of the full mix material over the segregated areas and raking out the course particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the ‘back-casting’ to be performed.

11. FOUNDATION CONSIDERATIONS

11.1 HOUSE AND TOWNHOUSE CONSTRUCTION

It is anticipated that the design founding level for residential dwellings and townhouse blocks will extend to depths of up to approximately 0.5 to 1 metres below the existing grade. The construction of foundations at or above this depth should be relatively straightforward when above the static groundwater level. The static groundwater level, as noted above, is anticipated to be at depths ranging from 0.5 to 1.5 metre below the existing grade, roughly elevation 182.5 to 183.8 metres. Depending on the final grading of the property, and final founding elevations of the proposed residences, it would be prudent to raise the finish grade and/or founding level of the proposed structures to avoid potential interaction with the static groundwater level. It is noted that our office has been provided with the preliminary cut-fill plan of the proposed development, which indicates the grading to be rising such that the founding levels for townhouse blocks will be above the static groundwater level. This should be further reviewed as part of detailed design for the development.

The native soils encountered at these depths are considered capable of supporting the loads associated with typical residential dwelling and townhouse structures on conventional spread footings below any fill, organic, or otherwise unsuitable materials. Spread footings in the native silty clay/clayey silt soils, may be conservatively designed on the basis of bearing values of 150 kPa [~3,000 psf] SLS and 225 kPa [~4,500 psf] ULS. The founding surfaces must be hand cleaned of any loose or disturbed material, along with any ponded water, immediately prior to placement of foundation concrete.

In the event that site grading work results in engineered fill below founding elevations, the general recommendations presented in the Backfill Considerations above should be strictly adhered to, with compaction to 100 percent standard Proctor maximum dry density, verified by monitoring and testing by a representative of SOIL-MAT ENGINEERS present on a full time basis. The design bearing capacity for footings within the engineered fill should be limited to 100 kPa [~2,000 psf] SLS and 150 kPa [~3,000 psf] ULS, pending a more thorough evaluation of the engineered fill works. If there is a short fall in the volume of fill required, then the source of imported fill should be checked for gradation, Proctor value, and compatibility with existing fill and approved by this office.

If there is a short fall in the volume of suitable fill required, then the source(s) of imported fill should be reviewed for gradation, Proctor value, compatibility with existing fill, environmental characteristics and be approved by this office prior to use. Soil import would need to be conducted in accordance with Ontario Regulation 406/19, including the preparation of a Fill Management Plan and associated tracking, analytical testing, etc.

It is noted that the SLS value represents the Serviceability Limit State, which is governed by the tolerable deflection [settlement] based on the proposed building type, using unfactored load combinations. The ULS value represents the Ultimate Limit State and is intended to reflect and upper limit of the available bearing capacity of the founding soils in terms of geotechnical design, using factored load combinations. There is no direct relationship between ULS and SLS; rather they are a function of the soil type and the tolerable deflections for serviceability, respectively. Evidently, the bearing capacity would be lower for very settlement sensitive structures and larger for more flexible buildings.

The support conditions afforded by the native soils and/or engineered fill are generally not uniform across the building footprint, nor are the loads on the various foundations elements. As such it is recommended that consideration be given to the provision of nominal reinforcement in the footings and foundation walls to account for variable support and loading conditions. The use of nominal reinforcement is considered good construction practice as it will act to reduce the potential for cracking in the foundation walls due to minor settlements, heaving, shrinkage, etc. and will assist in resisting the pressures generated against the foundation walls by the backfill. Such nominal reinforcement is an economical approach to the reduction and prevention of costly foundation repairs after completion and later in the life of the buildings. This reinforcement would typically consist of two continuous 15M steel bars placed in the footings [directly below the foundation wall], and similarly two steel bars placed approximately 300 millimeters from the top of the foundation walls at a minimum, depending on ground conditions exposed during construction. These reinforcement bars would be bent to reinforce all corners and under basement windows, and be provided with sufficient overlap at staggered splice locations. At ‘steps’ in the foundations and at window locations, the reinforcing steel should transition diagonally, rather than at 90 degrees, to maintain the continuous tensile capacity of the reinforcement. Where footings are founded on, or partially on, engineered fill the above provision for nominal reinforcement would be required.

All basement foundation walls should be suitably damp proofed, including the provision of a ‘dimple board’ type drainage product, and provided with a perimeter drainage tile system outlet to a gravity sewer connection or positive sump pit a minimum of 150 millimetres below the basement floor slab. The clear stone material surrounding the weeping tile should be encased with a geotextile material to prevent the migration of fines from the foundation wall backfill into the clear stone product. In the event that sump pit systems are required we would recommend that the sump pump system should be constructed with an ‘oversized’ reservoir and a ‘back-flow’ prevention valve so that the sump pump will not cycle repeatedly within short time periods.

All footings exposed to the environment must be provided with a minimum of 1.2 meters of earth or equivalent insulation to protect against frost penetration. This frost protection would also be required if construction were undertaken during the winter months. All footings must be proportioned to satisfy the requirements of the Ontario Provincial Building Code.

In areas where it will be necessary to provide adjacent footings at different founding elevations, the lower footing should be constructed before the higher footing is constructed, if possible, and the higher footing should be set below and imaginary line drawn up from the lower footing at 10 horizontal to 7 vertical. This practice will limit stress transfer from the higher footings to lower footings.

With foundations designed as outlined above and as required by the Ontario Building Code, and with careful attention paid to construction detail, total and differential settlements should be well within normally tolerated limits of 25 and 20 millimetres respectively, for the type of building and occupancy expected.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations outlined in this report, and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

11.2 MID-RISE BUILDING CONSTRUCTION

It is understood that the project may involve the construction of mid-rise residential buildings with 1 to 2 basement parking levels on east side of the site. Given the potential for up to two basement levels, is it anticipated that foundations will be on the order of approximately 3 to 6 metres below the existing grade. These depths are such that it would be expected to be below the static groundwater level. As such it is recommended that basement levels would be designed to be water tight, pending more detail building specific review.

On a preliminary basis the following design considerations are provided for foundations, noting that building specific geotechnical evaluation, including additional investigations as warranted based on building details and location on the site, and updated geotechnical reporting should be undertaken.

Spread footings in the native soils may be conservatively designed on the basis of bearing values of 100 kPa [~2,000 psf] SLS and 150 kPa [~3,000 psf] ULS. Raft slabs founded on the native sandy silt/silt soils may be designed considering an allowable bearing pressure of 75 kPa [~1,500 psf] SLS, and 100 kPa [~2,00 psf] ULS. However, it is anticipated that these values would not be sufficient for the proposed structure, without being used in some combination with deep foundation schemes, or ground improvement methods, discussed below. Nonetheless, for lightly loaded accessory structures, these values may be acceptable.

Based on the proposed building and subsurface conditions, it is likely that a foundation design making use of ground improvement or deep foundation systems would be preferred. This would be a function of the height of the proposed buildings and is best evaluated on a building specific basis.

12. SOIL IMPORT CONSIDERATIONS

Ontario Regulation 406/19 has come into effect, which regulates the management of surplus soil generated as part of construction projects. The Regulation is volume based, requiring site specific environmental assessments and considerable background analytical testing of surplus soils to be exported from, or imported to, the site. In this case it is understood that a significant volume of fill import will be required for the project. With a fill import of greater than 10,000 m3, this would require the filling of a Notice in the Excess Soil Registry, along with proper planning documents and tracking as required by the Regulation. Soil-Mat Engineers can assist with the preparation of a formal Fill Management Plan to provide direction on the plan and requirements for managing the fill import, including review and approval of fill source sites, managing the soil registry notice, etc.

13. General Comments

The comments provided in this document are intended only for the guidance of the design team. The material in it reflects Soil-Mat Engineers' best judgement in light of the information available at the time of preparation. The subsurface descriptions and borehole information are intended to describe conditions at the borehole locations only. It is the contractors' responsibility to determine how these conditions will affect the scheduling and methods of construction for the project. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Soil-Mat Engineers accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
Soil-Mat Engineers & Consultants Ltd.

Chauhan

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Junior Engineer

IS

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June 20/24
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Enclosures:	Drawing No.1, Borehole Location Plan Log of Borehole Nos. 1 to 13, inclusive
Distribution:	Primont (Thorold/Welland) Inc. [1, plus pdf]

LEGEND

⊕ BH#	Borehole Location
⊕ BH#	Borehole Location of DS Consultants Investigation.

NOTES

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. Report No. SM 220530-G.

2. Borehole locations are approximate.

SOIL-MAT

ENGINEERS & CONSULTANTS LTD.

Proposed Residential Development
Quaker Road and First Avenue, Welland, Ontario

Borehole Location Plan

Project No. SM 220530-G

Date: December 2022

Drawn: IC | Checked: IS

SM 220530-G
Borehole Location Plan

Drawing No. 1

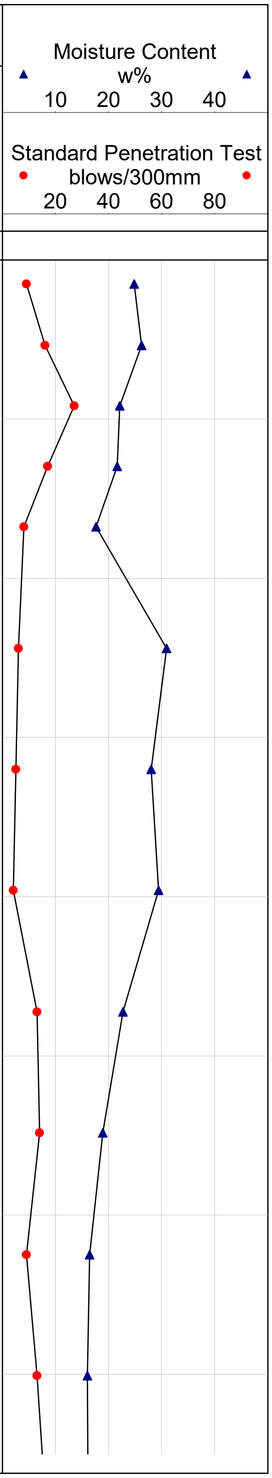
Log of Borehole No. 1

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765186
E: 641731

Depth	Elevation (m)	Description
ft 0 / m 0	183.32	Ground Surface
		Topsoil Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown to reddish brown, some organics in upper levels, firm to very stiff.
	179.82	Transition in colour to grey.
	174.64	**Sandy Silt/Silt** Reddish brown, occasional gravel, loose to very dense.

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,3,6,8	9	▨	<1.0	
SS	2	7,7,9,13	16	▨	>4.5	
SS	3	7,11,16,19	27	▨	>4.5	
SS	4	5,7,10,13	17	▨	2.5	
SS	5	4,3,5,6	8	▨	1.5	
SS	6	3,2,4,5	6	▨	<1.0	
SS	7	2,2,3,4	5	▨	<1.0	
SS	8	1,2,2,4	4	▨	<1.0	
SS	9	6,6,7,8	13	▨		
SS	10	6,7,7,6	14	▨		
SS	11	3,3,6,7	9	▨		
SS	12	4,6,7,10	13	▨		



Drill Method: Hollow Stem Augers
Drill Date: December 07, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Sheet: 1 of 2

Log of Borehole No. 1

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765186
E: 641731

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
51					SS	13	4,6,10,12	16	▨		
56					SS	14	6,6,8,8	14	▨		
61					SS	15	5,7,13,16	20	▨		
66	162.90				SS	16	9,24,48,50/5"	72	▨		
			End of Borehole								

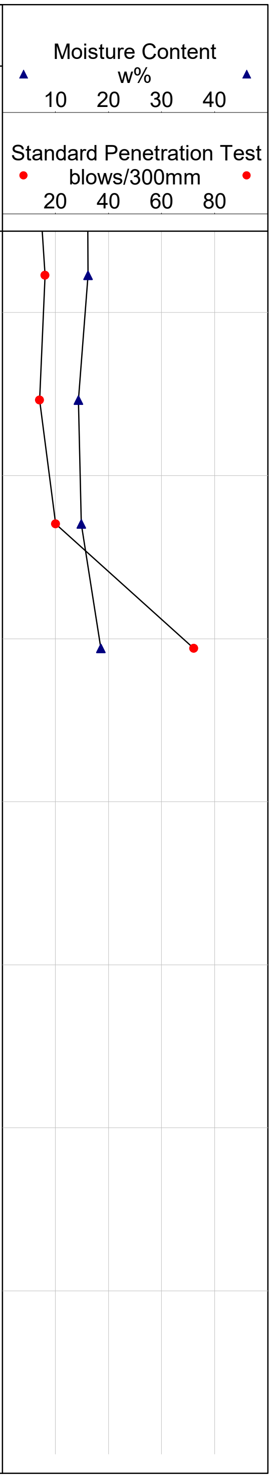
Depth: 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98

NOTES:

1. Borehole was advanced using solid stem auger equipment on December 07, 2022 to termination at a depth of 20.4 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.



Drill Method: Hollow Stem Augers
Drill Date: December 07, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Log of Borehole No. 2

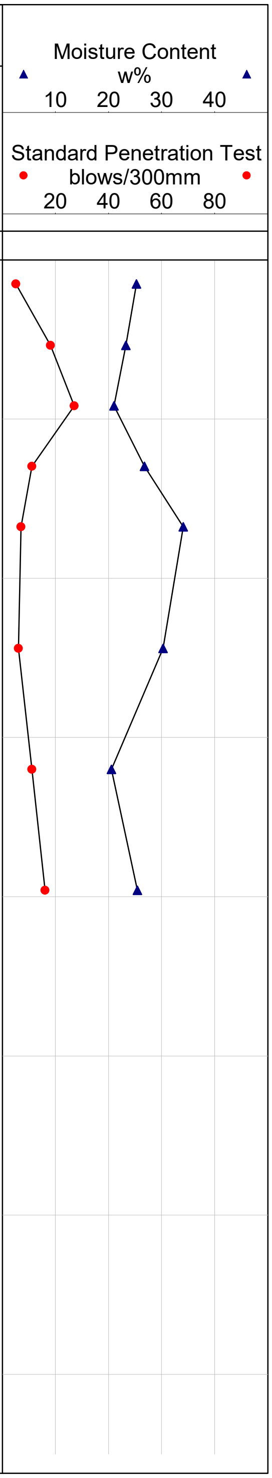
Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765226
E: 641680

Elevation (m)	Description
183.26	Ground Surface
182.96	**Topsoil** Approximately 300 millimetres of topsoil.
180.83	**Silty Clay/Clayey Silt** Brown, occasional gravel, firm to very stiff. Transition in colour to grey.
177.93	**Sandy Silt/Silt** Reddish brown, compact.
175.04	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,3,5	5	▨	2.0	
SS	2	5,7,11,14	18	▨	>4.5	
SS	3	6,11,16,21	27	▨	>4.5	
SS	4	4,5,6,7	11	▨	1.0	
SS	5	4,3,4,6	7	▨	1.5	
SS	6	2,3,3,5	6	▨	<1.0	
SS	7	5,5,6,10	11	▨		
SS	8	4,7,9,9	16	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 6.0 metres and 'Wet' at a depth of 4.8 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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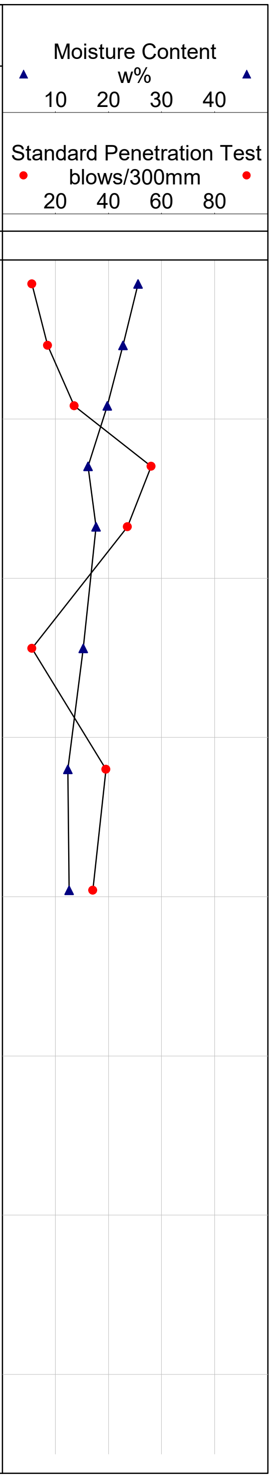
Log of Borehole No. 3

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765364
E: 641633

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	183.80		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	3,4,7,5	11	▨	>4.5	
			Silty Clay/Clayey Silt Brown, occasional gravel, firm to very stiff.		SS	2	5,7,10,12	17	▨	>4.5	
					SS	3	8,11,16,22	27	▨	>4.5	
2	181.60		**Sandy Silt/Silt** Reddish brown, more silt content with depth, trace clay, compact to dense.		SS	4	22,26,30,44	56	▨		
					SS	5	21,23,24,20	47	▨		
					SS	6	5,6,5,8	11	▨		
					SS	7	7,17,22,22	39	▨		
					SS	8	13,16,18,23	34	▨		
8	175.58		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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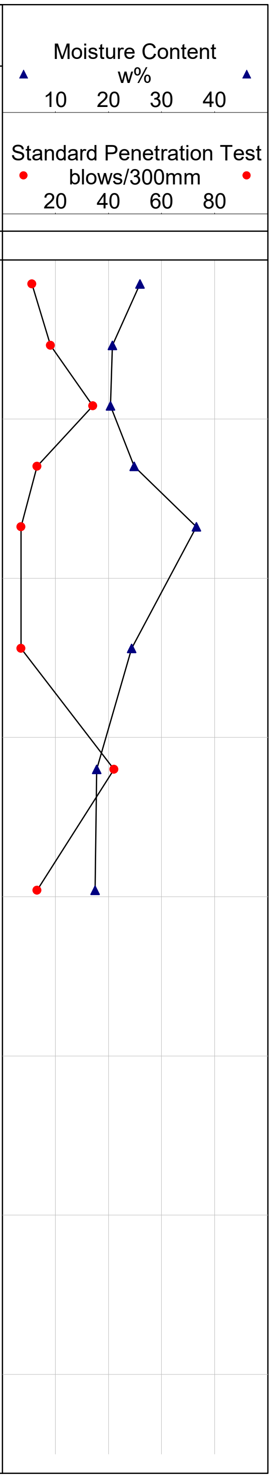
Log of Borehole No. 4

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765208
E: 641522

Depth (ft / m)	Elevation (m)	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	183.54	Ground Surface								
		Topsoil Approximately 200 millimetres of topsoil.		SS	1	4,5,6,8	11	■	>4.5	
		Silty Clay/Clayey Silt Brown, firm to hard.		SS	2	5,7,11,16	18	■	>4.5	
				SS	3	8,15,19,25	34	■	>4.5	
				SS	4	5,6,7,10	13	■	2.0	
	180.65	Transition in colour to grey.		SS	5	3,3,4,5	7	■	<1.0	
				SS	6	2,3,4,4	7	■	<1.0	
	177.30	**Sandy Silt/Silt** Reddish brown, trace clay, compact to dense.		SS	7	5,20,22,28	42	■		
				SS	8	6,6,7,7	13	■		
	175.32	End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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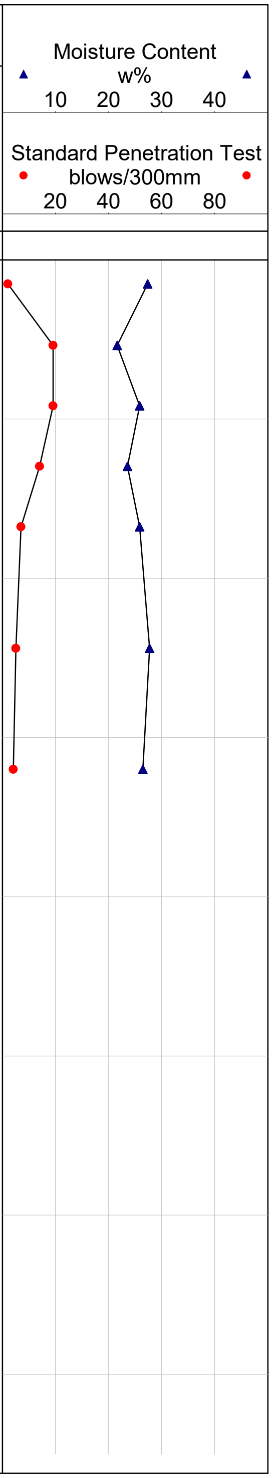
Log of Borehole No. 5

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765091
E: 641718

Depth (ft / m)	Elevation (m)	Description
0 / 0	183.12	Ground Surface
0 – 0.2 m		**Topsoil** Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown to reddish brown, firm to very stiff.
13 ft / 4 m	179.01	Transition in colour to grey.
22 ft / 6.7 m	176.42	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,1,1,4	2	▆	>4.5	
SS	2	6,8,11,17	19	▆	>4.5	
SS	3	5,8,11,17	19	▆	>4.5	
SS	4	5,6,8,10	14	▆	>4.5	
SS	5	3,3,4,4,	7	▆	<1.0	
SS	6	3,2,3,3	5	▆	<1.0	
SS	7	2,2,2,4	4	▆	<1.0	



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 07, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 0.83 metres

Drill Method: Solid Stem Augers
Drill Date: December 07, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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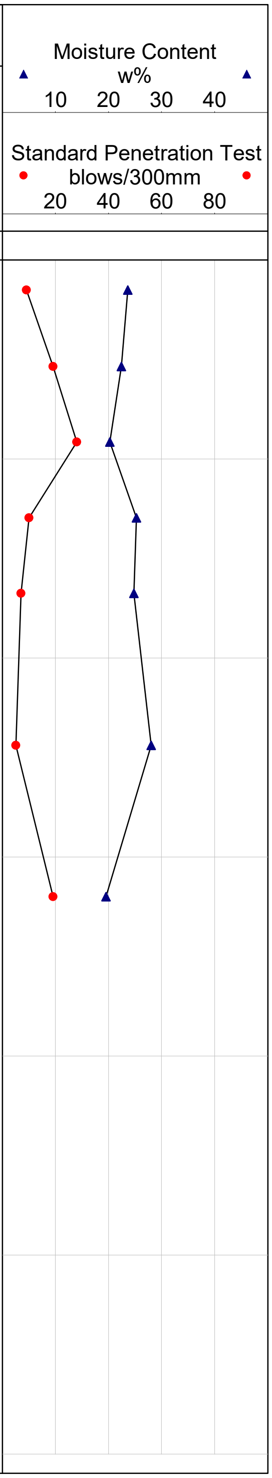
Log of Borehole No. 6

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765198
E: 641374

Depth (ft)	Depth (m)	Elevation (m)	Description
0	0	183.83	Ground Surface
0 – 0.7	0 – 0.2		**Topsoil** Approximately 200 millimetres of topsoil.
0.7 – 9	0.2 – 2.74		**Silty Clay/Clayey Silt** Brown, firm to very stiff.
9 – 20.5	2.74 – 6.24	181.09	Transition in colour to grey.
20.5 – 22	6.24 – 6.7	177.59	**Sandy Silt/Silt** Reddish brown, compact.
22	6.7	177.13	End of Borehole

Sample Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,4,5,7	9	■	>4.5	
SS	2	5,8,11,14	19	■	>4.5	
SS	3	6,9,19,22	28	■	>4.5	
SS	4	4,5,5,6	10	■	1.0	
SS	5	2,3,4,5	7	■	<1.0	
SS	6	2,2,3,5	5	■	<1.0	
SS	7	5,7,12,17	19	■		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.9 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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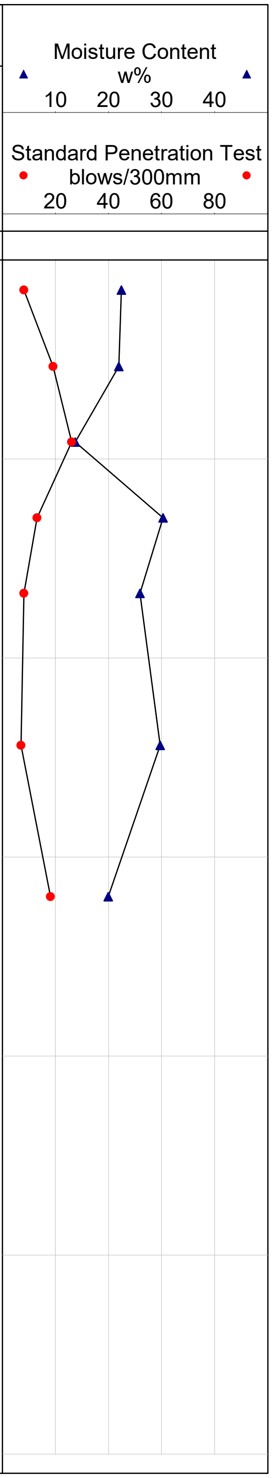
Log of Borehole No. 7

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765042
E: 641421

Elevation (m)	Description
183.52	Ground Surface
183.27	**Topsoil** Approximately 250 millimetres of topsoil.
	Silty Clay/Clayey Silt Brown, firm to very stiff.
179.41	Transition in colour to grey.
177.43	**Sandy Silt/Silt** Reddish brown, compact.
176.82	End of Borehole

Type	Number	Blow Counts	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,3,5,6	8	>4.5	
SS	2	5,7,12,18	19	>4.5	
SS	3	6,12,14,18	26	>4.5	
SS	4	5,6,7,10	13	2.0	
SS	5	3,4,4,7	8	2.0	
SS	6	2,3,4,5	7	<1.0	
SS	7	8,9,9,9	18		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as caved to 5.9 metres and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 1.6 metres

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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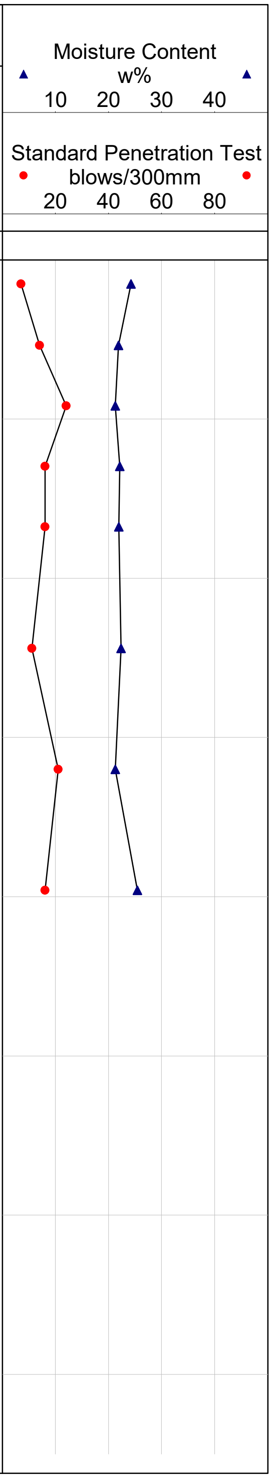
Log of Borehole No. 8

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765199
E: 641192

Elevation (m)	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
184.94	Ground Surface								
	Topsoil Approximately 200 millimetres of topsoil.		SS	1	2,3,4,6	7	▨	2.0	
	Silty Clay/Clayey Silt Brown, occasional gravel, firm to very stiff.		SS	2	4,7,7,12	14	▨	4.0	
			SS	3	5,9,15,20	24	▨	>4.5	
			SS	4	4,6,10,15	16	▨	>4.5	
			SS	5	6,7,9,10	16	▨	4.0	
180.83	Transition in colour to grey.								
			SS	6	4,4,7,11	11	▨	1.5	
179.76	**Sandy Silt/Silt** Reddish brown, compact.								
			SS	7	4,9,12,17	21	▨		
			SS	8	6,7,9,9	16	▨		
176.72	End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 7.3 metres and 'Wet' at a depth of 6.7 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Log of Borehole No. 9

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

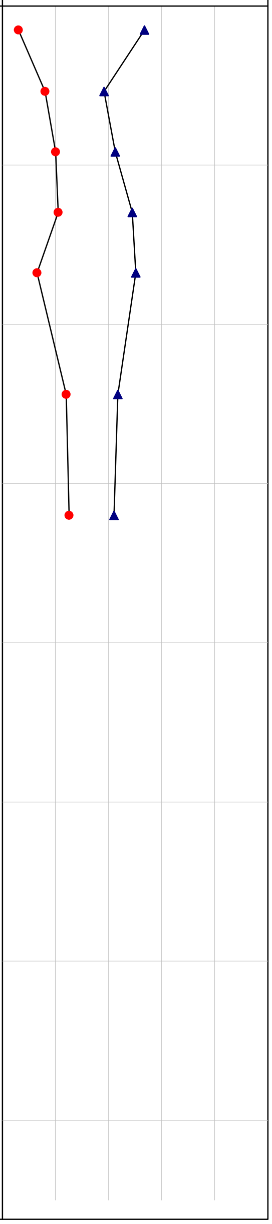
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765253
E: 641229

Depth: ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
m 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
184.05		Ground Surface								
183.75		**Topsoil** Approximately 300 millimetres of topsoil.		SS	1	2,2,4,6	6	■	4.0	
		Silty Clay/Clayey Silt Brown, firm to very stiff.		SS	2	6,7,9,11	16	■	>4.5	
				SS	3	7,9,11,14	20	■	>4.5	
				SS	4	5,9,12,17	21	■	>4.5	
				SS	5	4,6,7,8	13	■	<1.0	
180.40		Transition in colour to grey.								
179.94		**Sandy Silt/Silt** Reddish brown, compact.		SS	6	5,11,13,16	24	■		
				SS	7	7,11,14,21	25	■		
177.35		End of Borehole								

Moisture Content
▲ w% ▲
10 20 30 40

Standard Penetration Test
● blows/300mm ●
20 40 60 80



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as caved to 5.4 metres and 'Wet' at a depth of 5.3 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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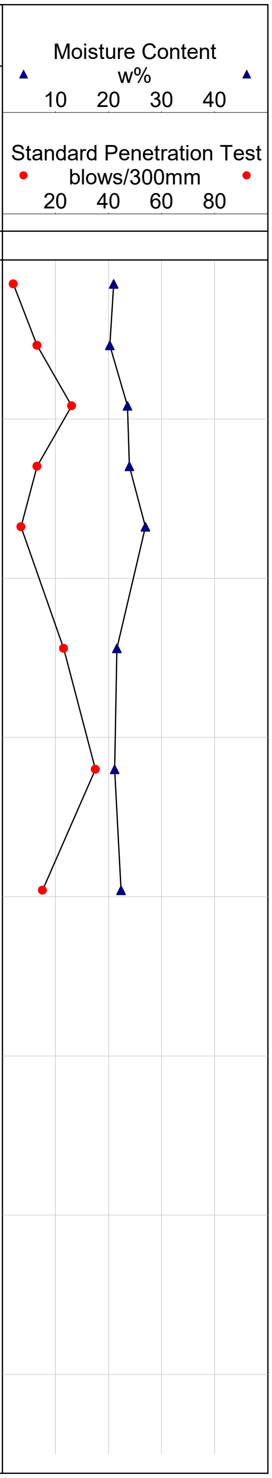
Log of Borehole No. 10

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765588
E: 641174

Depth (ft / m)	Elevation (m)	Description
0 / 0	184.23	Ground Surface
		Topsoil Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown, some organics in upper levels, firm to very stiff.
	180.73	Transition in colour to grey.
	180.12	**Sandy Silt/Silt** Reddish brown, compact to dense.
	176.01	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,1,3,4	4	▨	1.5	
SS	2	4,6,7,11	13	▨	>4.5	
SS	3	5,11,15,18	26	▨	>4.5	
SS	4	5,6,7,9	13	▨	2.5	
SS	5	2,3,4,5	7	▨	1.0	
SS	6	6,11,12,14	23	▨		
SS	7	10,16,19,24	35	▨		
SS	8	6,6,9,10	15	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 6.4 metres and 'Wet' at a depth of 5.7 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Field Logged by: IC
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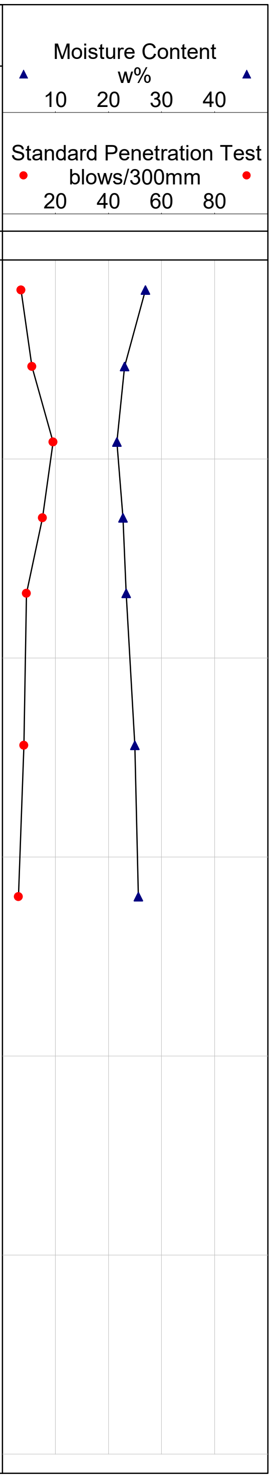
Log of Borehole No. 11

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765518
E: 641270

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft m	183.23		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	2,2,5,5	7	■	2.0	
			Silty Clay/Clayey Silt Brown, some organics in upper levels, firm to very stiff.		SS	2	3,4,7,11	11	■	>4.5	
					SS	3	4,7,12,16	19	■	>4.5	
	180.64		Transition in colour to grey.		SS	4	4,7,8,10	15	■	2.5	
					SS	5	3,4,3,7	9	■	2.0	
					SS	6	3,3,5,7	8	■	1.5	
	176.53				SS	7	2,3,3,4	6	■	<1.0	
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.4 metres upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 0.0 metres

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

Soil-Mat Engineers & Consultants Ltd.
401 Grays Road · Hamilton, Ontario · L8E 2Z3
T: 905.318.7440 · TF: 800.243.1922 · F: 905.318.7455
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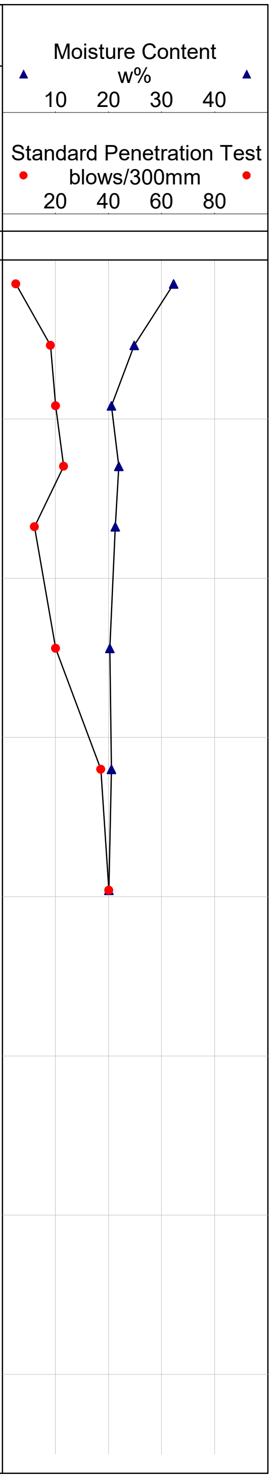
Datum: Geodetic
Field Logged by: IC
Checked by: IS
Sheet: 1 of 1

Log of Borehole No. 12

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765409
E: 641213

Depth (ft / m)	Elevation (m)	Description
0 / 0	184.19	Ground Surface
0 – 0.2 m		**Topsoil** Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown, firm to very stiff.
11 ft / 3.35 m	180.84	Transition in colour to grey.
16 ft / 4.87 m	179.32	**Sandy Silt/Silt** Reddish brown, compact to dense.
27 ft / 8.22 m	175.97	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	0,2,3,5	5	▇	1.5	
SS	2	5,8,10,13	18	▇	>4.5	
SS	3	5,8,12,16	20	▇	>4.5	
SS	4	6,10,13,16	23	▇	>4.5	
SS	5	4,5,7,7	12	▇	1.5	
SS	6	3,5,15,19	20	▇	1.5	
SS	7	12,16,21,25	37	▇		
SS	8	12,14,26,28	40	▇		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Datum: Geodetic
Field Logged by: IC
Checked by: IS
Sheet: 1 of 1

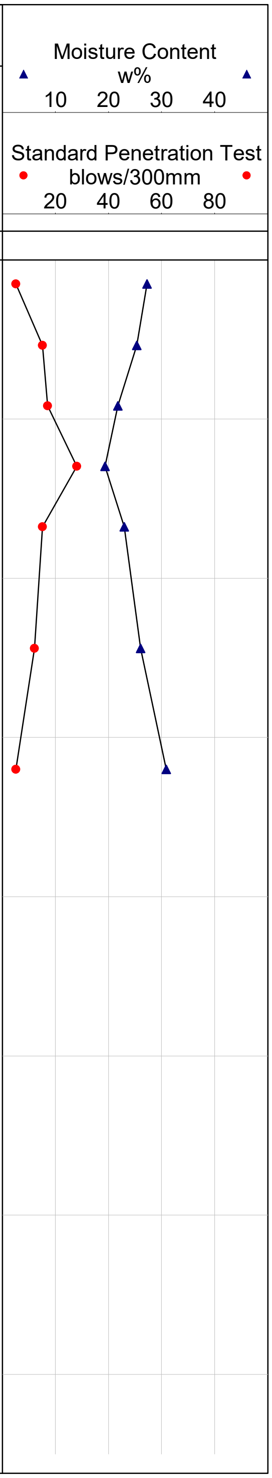
Log of Borehole No. 13

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4764871
E: 641196

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft 0, m 0	183.94		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	0,2,3,6	5	■	1.5	
			Silty Clay/Clayey Silt Brown, firm to very stiff.		SS	2	5,7,8,11	15	■	>4.5	
					SS	3	7,7,10,15	17	■	>4.5	
					SS	4	6,12,16,19	28	■	>4.5	
					SS	5	4,7,8,11	15	■	3.0	
	178.76				SS	6	3,4,8,8	12	■	<1	
			Transition in colour to grey.								
	177.24				SS	7	2,2,3,4	5	■	<1	
			End of Borehole								

ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
m: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.6 metres upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Datum: Geodetic
Field Logged by: IC
Checked by: IS
Sheet: 1 of 1

APPENDIX G

Hydrogeological Study and Wetland Water Balance

TDC Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2 St. Catharines, ON L2M 4W3

June 27, 2024

Primont (Thorold/Welland) Inc.
c/o Ian G. MacPherson, P. Eng.
Vice President, Land Development
9130 Leslie Street, Suite 301
Richmond Hill, Ontario L4B 0B9

Re: Hydrogeologic Study and Wetland Water Balance, 436 Quaker Road, Welland,
and Lot 228/Part Lot 174, Thorold, ON

Dear Mr. MacPherson,

1.0 Introduction and Background Information

Terra-Dynamics Consulting Inc. respectfully submits this DRAFT Hydrogeologic Study and Wetland Water Balance of 436 Quaker Road Welland, and Lot 228/Part Lot 174, Thorold (the Site, Figure 1, see attachments). The rectangular 60.8 hectare Site is located at the northwest corner of Quaker Road and First Avenue, within both the City of Welland (southern part of Site) and south of an unopened Merritt Road allowance within the City of Thorold (northern part of Site) (Figures 1 and 2, see attachments). This report has been completed as part of planning for future residential development of the currently agricultural lands. No tile-drainage is mapped for the Site (OMAFRA, 2023).

The Ministry of Natural Resources and Forestry (MNRF) have mapped at the Site approximately 17 hectares of Provincially Significant Wetland (PSW) associated with the Niagara Street Cataract Road Woodlot Wetland Complex (MNRF, 2009), this includes (Figure 2, see attachments):

1. 5.2 hectares of swamp along Quaker Road and First Avenue in the southeast corner of the Site,
2. 8.2 hectares of swamp in the northern portion of the Site, and
3. 3.6 hectares of marsh in the northeast corner of the Site close to Cataract Road.

A Wetland Water Balance was completed to:

1. Ensure no negative impacts to the natural heritage system; and

2. Inform future stormwater management design at the Site in such a manner that pre-development wetland water balance conditions are maintained.

The wetland water balance assessment evaluated the pre-development hydrologic regime of the Provincially Significant Wetland areas on-site associated with the Niagara Street Cataract Road Woodlot Wetland Complex (MNRF, 2009) as well as additional wetland vegetation mapped by GEI Consultants (2022).

2.0 Methodology

Primary tasks completed as part of the Hydrogeology Study and Wetland Water Balance included:

A. Submission of a Water Balance Terms of Reference (Appendix A) to the Niagara Peninsula Conservation Authority (NPCA) and Niagara Region for review and comment. NPCA indicated they were satisfied (Appendix A) with the submission of an Updated Water Balance Terms of Reference reflecting a response to initial NPCA comments on the proposed Terms of Reference, however, as of the date of this report, no response was received from Niagara Region.

B. Initial characterization of the physical setting was completed using published information from the following government agencies: (i) the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), (ii) the Ministry of Natural Resources and Forestry (MNRF), (iii) the Ministry of the Environment, Conservation and Parks (MECP), (iv) the Niagara Peninsula Conservation Authority (NPCA), and (v) the Ontario Geological Survey (OGS);

C. Field investigations to refine site conditions have included:

    (i) 2021 and 2022 geotechnical borehole investigations including laboratory soil grain-size analyses;

    (ii) Construction of thirteen groundwater monitoring wells between 2021 and 2022;

    (iii) Installation of eighteen wetland staff gauges deployed with water level dataloggers monitoring from July 2022 to November 2023, as well as wetland soil hand-augering;

    (iv) Seasonal manual groundwater level measurements at 13 locations from May 2022 to November 2023, and water level dataloggers deployed at four monitoring wells from May 2022 to November 2023;

    (v) Hydraulic testing of groundwater monitoring wells at 11 selected locations; and

    (vi) Tow Path Drain surface water level monitoring at four locations from August to November 2023.

D. Modelling of pre-development monthly water balance conditions through consideration of: surface water catchments, land cover, soils, climate normals and wetland hydroperiods in order to inform future site design.

3.0 Physical Setting

According to historical aerial photos, most of the Site was cleared for farming in 1934. Aerial photos indicate that areas of the north-central and southeast portions of the Site had gradually become re-vegetated by 2000, similar to the extent of the vegetation in 2016 (Niagara Navigator, 2023).

The Site is flat-lying with ground surface at approximately 185 metres above sea level (m ASL) along the western boundary sloping to both the northeast at 182 m ASL and the southwest at 181 m ASL, (Figure 2, see attachments), with little to no slope, being less than 1% slope on average.

The Site is regionally located on the Haldimand Clay Plain (Chapman and Putnam, 1984) described in the NPCA Port Robinson Subwatershed Study (part of the Site is within that study area, Figure 1, see attachments), as a physical feature that "…*prevents significant infiltration to depth*…" (NPCA, 1999). However, the upgradient Fonthill Kame-Delta Complex also plays a role in the hydrology of the Site as it "*is a thick deposit consisting mainly of permeable sand and gravel which provides a significant groundwater flow system within the surrounding clay plain*" (Blackport et al, 2005). This is discussed in Section 3.5 and visualized in Figure 3.

3.1 Surface Water

3.1.1 Watershed and Catchments

Overall drainage of the Site is split approximately between two subwatersheds (Figure 1, see attachments): (i) Port Robinson West (NPCA, 1999) - northern part of the Site and, (ii) the Tow Path Drain Subwatershed Catchment – southern part of the Site. The drainage divide between these two subwatersheds roughly parallels the municipal boundary between the City of Thorold to the north and the City of Welland to the south (Figure 2, see attachments). The Port Robinson West, and Tow Path Drain Subwatersheds, are 1,409 ha and 503 ha in size, respectively, consequently the Site is 2% of the Port Robinson Subwatershed (~29 ha), and 6% of the Toe Path Drain Subwatershed (~32 ha).

On-site surface water drainage can be further refined into four pre-development catchments (Figure 4): (i) Singer's Drain West; (ii) Singer's Drain East, (iii) Tow Path Drain North; and (iv) Tow Path Drain South.

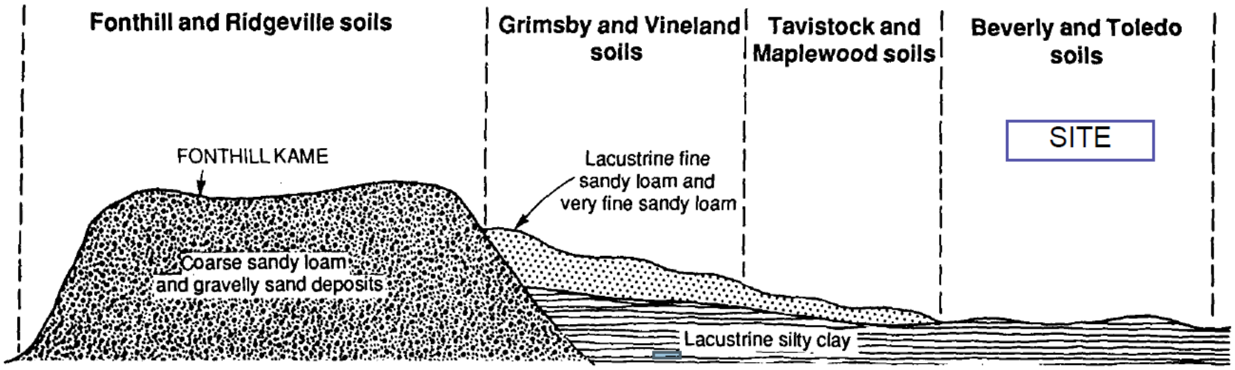


Figure 3 – Schematic landscape cross-section showing the relationship of soils on the Fonthill Kame-Delta Complex and its southern slopes (Kingston and Presant, 1989)

3.1.2 Watercourses

Within the northern part of the Site, i.e. flowing to Singer's Drain, are two watercourses that begin off-site to the west of Rice Road (Figure 2, see attachments), and meet within the Provincially Significant Wetland (PSW) north of the Site, and eventually outlet north of the Site at Cataract Road. NPCA (2017) have previously mapped the northern watercourse as ephemeral and the southern watercourse as intermittent or ephemeral (Figure 2, see attachments). No baseflow was identified for these two watercourses at Rice Road during 2003 surface water monitoring completed as part of the Fonthill Kame-Delta Complex study (Blackport et al, 2005).

Within the southern part of the Site, i.e. flowing to Tow Path Drain, are also two watercourses, that meet within the PSW on-site, and flow roughly west to east from Rice Road and Quaker Road, outletting at First Avenue (Figure 2, see attachments). NPCA (2017) have previously mapped these two watercourses as ephemeral, potentially becoming intermittent close to 1st Avenue. No baseflow was identified at upstream Rice Road during 2003 and 2004 surface water monitoring completed as part of the Fonthill Kame-Delta Complex study (Blackport et al, 2005). Investigations in 2018 by Aquafor Beech (2019) also identified dry conditions upstream of the Site (at the more southern watercourse) and intermittent conditions at 1st Avenue. These results correspond with more recent reporting for this portion of the Tow Path Drain that:

> "*throughout the length of the drain no signs of groundwater inputs were noted and flows in the drain are entirely dependent on precipitation surface water inputs within its catchment…the drain supports ephemeral flows with minimal flows during the spring freshet and ending by May…the drain flows through… a shallow 1-1.5 m wide straight dug channel/ditch with a shallow U shaped channel morphology…does not provide permanent fish habitat*" (Beacon Environmental, 2022).

A series of four surface water staff gauges (SG-101, SG-102, SG-103 and SG-104) were installed on-site along Tow Path Drain in August 2023 (Figure 2, see attachments and Appendix F) and equipped with water level datalogger pressure transducers recording at 15-minutes intervals. The surface water monitoring was completed in addition to the original Terms of Reference (Appendix A). Clayey soils were observed beneath Tow Path Drain during the installation of the gauges via hand-augering completed to between 0.7-0.8 metres below ground surface. During the monitoring period (i.e. mid-August to mid-November 2023) August monthly precipitation was well-above average, while September, October and November monthly precipitation were well-below average (Table 1, see attachments). Water level monitoring of Tow Path Drain indicated surface water is only present intermittently as shown by dry conditions following precipitation events (Appendix F). Nearby groundwater levels were below ground surface during this monitoring period (BH21-13 and BH21-14) further confirming no groundwater discharge to surface water and an intermittent surface water classification consistent with other's investigations. Water levels at the nearby wetlands were observed to rise following precipitation events (Appendix C). After precipitation events, the water levels at nearby wetlands responded one of two ways:

(i) Where generally water depths were 10 cm or less, diurnal evapotranspiration water level fluctuations and dry/intermittent conditions after rain events (SW-2, SW-3, SW-4, SW-5 and SW-9); or

(ii) Where water depths were greater than 10 cm, diurnal transpiration fluctuations overlaid on a gradual decline, similar to predicted evaporation rates (Schroeter & Associates, 2007) (SW-6 and SW-8).

Wetlands near the Tow Path Drain are primarily sustained by precipitation (Sections 3.6.2 and 4.2), not sustained by backflow retained in the Tow Path Drain, as shown in September 2023 when limited standing water was still present at wetland gauges (i.e. SW-3, SW-4, SW-5, SW-6, SW-8 and SW-9, Appendix E) while dry conditions were observed downgradient at SG-102 and SG-103 (Appendix F).

Surface water flows were measured to decrease downstream on August 10, 2023 (Table 2). This indicated a losing reach and this is presumed to be as a result of infiltration of surface water and/or water uptake of adjacent vegetation.

Table 2 - 2023 Tow Path Drain Surface Water Flow Measurements (L/s)

Date/Station	**SG-101**	**SG-102**	**SG-103**	**SG-104**
August 10	No flow	2.3	2.2	1.8
September 6	Dry	Dry	Dry	Dry
October 3	Dry	Dry	Dry	Dry
October 23	Dry	No flow*	Dry	No flow*
November 20	No flow*	No flow*	No flow*	0.6

Note: * - water present but not flowing

Staff gauge SG-102 was removed by wildlife or vandalism in November 2023.

3.2 Soils

The Site soils are mapped as silty clays: (i) Toledo – Loamy Phase, and (ii) Beverly – Loamy Phase, with (iii) a small portion of Berrien soils (Figure 4, see attachments), details include (Kingston and Presant, 1989):

i. Toledo Loamy Phase: silty clay texture (Table 3), (38% of site, 23.1 ha in northern part of Site and 2.26 ha in the southern part of the Site), poorly drained, slowly permeable, water levels stay near the surface much of the year, relatively high water-holding capacity and moderate to high surface runoff (HSG D, Table 4). The Singer's Drain PSW is perched on these low permeability soils.

ii. Beverly Loamy Phase: silty clay texture (Table 3), (50% of site, 30.3 ha in central to southern part of Site), imperfectly drained, moderately to slowly permeable, water occupies the surface horizons for a period of time each year and is prolonged where subsoil has been overcompacted by heavy machinery, water-holding capacity ranges from medium to high, and surface runoff is moderate to high, (HSG C, Table 4).

iii. Berrien: 40 to 100 cm sandy sediments over silty clay (Table 3), (6% of Site, 3.9 ha in southeast corner of Site), imperfectly drained, rapidly permeable but water perches because of underlying clayey soils, and slow surface runoff (HSG C, Table 4). However sandy sediments were not encountered during hand-augering in this area in 2023.

iv. 6% of the Site's soils are not mapped (NM, Figure 4, see attachments) but are likely partially Toledo loamy phase and partially Beverly loamy phase, as silty clay/clayey silt/silt was recorded at boreholes within (i.e. BH21-3 and BH22-01) or immediately adjacent (e.g. BH21-16 and BH22-03) these areas (Section 3.3, Appendix B).

The Tow Path Drain PSW is mostly underlain by Berrien and Beverly loamy phase (soils >90%, i.e. HSG C) with <10% Toledo loamy phase (HSG D).

Table 3 – Horizon C Grain-size Analyses Summary[1]

Soil Name/Location	Sand%	Silt%	Clay%	Texture[2]
Beverly – Loamy Phase	7	49	44	Silty Clay
Toledo – Loamy Red Phase	9	50	41	
Berrien	8	46	46	

Note: [1] - Kingston and Presant, 1989, [2] - Texture as per Fetter (1994)

Table 4 - Hydrologic Soil Groups (USDA, 1986)

HSG Group	Soil description
A	sand, loamy sand or sandy loam
B	silt loam or loam
C	sandy clay loam
D	clay loam, silty clay loam, sandy clay, silty clay or clay

3.3 Surficial Geology

The Ontario Geological Survey (OGS) have mapped the Site as being covered by a layer of low permeability soils (clayey silt to silty clay) (Feenstra, 1984). This general characterization was confirmed by two geotechnical investigations of the Site (DS Consultants, 2022 and Soil-Mat Engineers and Consultants, 2023). These geotechnical investigations involved sixteen boreholes in 2021 and another sixteen boreholes in 2022 (Figure 2, see attachments). The boreholes are summarized on two geologic cross-sections (Figures 5 and 6, see attachments) which show the Site as underlain by silty clay to clayey silt, with some limited seams of fine sand to silt. It is noted that 0.5 m of silty sand was noted at surface at three locations in the northwest part of the Site (BH21-1, BH21-2 and BH21-12) overlying the clayey silt to silty clay aquitard and is shown on the north-south section (Figure 5, see attachments). The at-surface silty clay to clayey silt that covers most of the Site is often underlain by a sandy silt to silt at 5-6 metres below ground surface (m BGS). Most of the geotechnical boreholes were completed to between 7 and 8 m BGS. Four deep boreholes were also completed (i.e. 20 to 36 m BGS) without encountering bedrock but confirming that the underlying soils consist of silty clay, silt/sandy silt and clayey silt till. The thickness of the overburden ranges between 45 to 40 m, across the Site from west to east, respectively (NPSPA, 2013).

3.4 Bedrock

The Site is underlain by two bedrock formations, (i) Lockport Formation dolostone – northwest part of the Site, and (ii) Guelph Formation dolostone – the southeast part of the Site (NPSPA, 2013).

3.5 Hydrogeologic Setting

The Site is located on the Haldimand Clay plain which is a regional aquitard (Gartner Lee Limited, 1987). This aquitard consists of the Upper Whittlesey, Halton, Lower Whittlesey and Wentworth Aquitards (Burt, 2016). An aquitard is "*a low-permeability geologic unit that can store groundwater, but that transmits groundwater slowly*" (Niagara Peninsula Source Protection Authority, 2013). Upgradient of the Site is the Fonthill Kame-Delta Complex (Figure 7, schematic below) which is a regional groundwater recharge area (NPCA and AquaResource Inc., 2010).

The Port Robinson Subwatershed Study (NPCA, 1999) previously described the hydrostratigraphy as follows (the numbered bullets below correspond with the numbers on schematic Figure 7 as modified from NPCA, 1999):

1. *The upper end of the subwatershed consists of permeably (sandy) deposits which often extend to bedrock;*
2. *The eastern part of the subwatershed is relatively flat, and is predominantly underlain by aquitard (clay) materials, with sandy pockets;*
3. *A thin, sand aquifer unit may separate the aquitard (Unit 2) from bedrock. This unit may be hydraulically connected to the sand deposits to the west;*
4. *The subwatershed is underlain by dolostone bedrock;*
5. *Precipitation falling within the western half of the subwatershed, could (a) runoff, (b) recharge radially from the topographic height, to the deeper aquifer units, such as bedrock, or the lower sand, or (c) discharge to surface in the vicinity of the clay contact, providing baseflow to area tributaries; and*
6. *The majority of precipitation falling within the eastern half of the subwatershed, will become runoff, rather than infiltration, however the limited precipitation that does infiltrate is expected to discharge to local tributaries.*

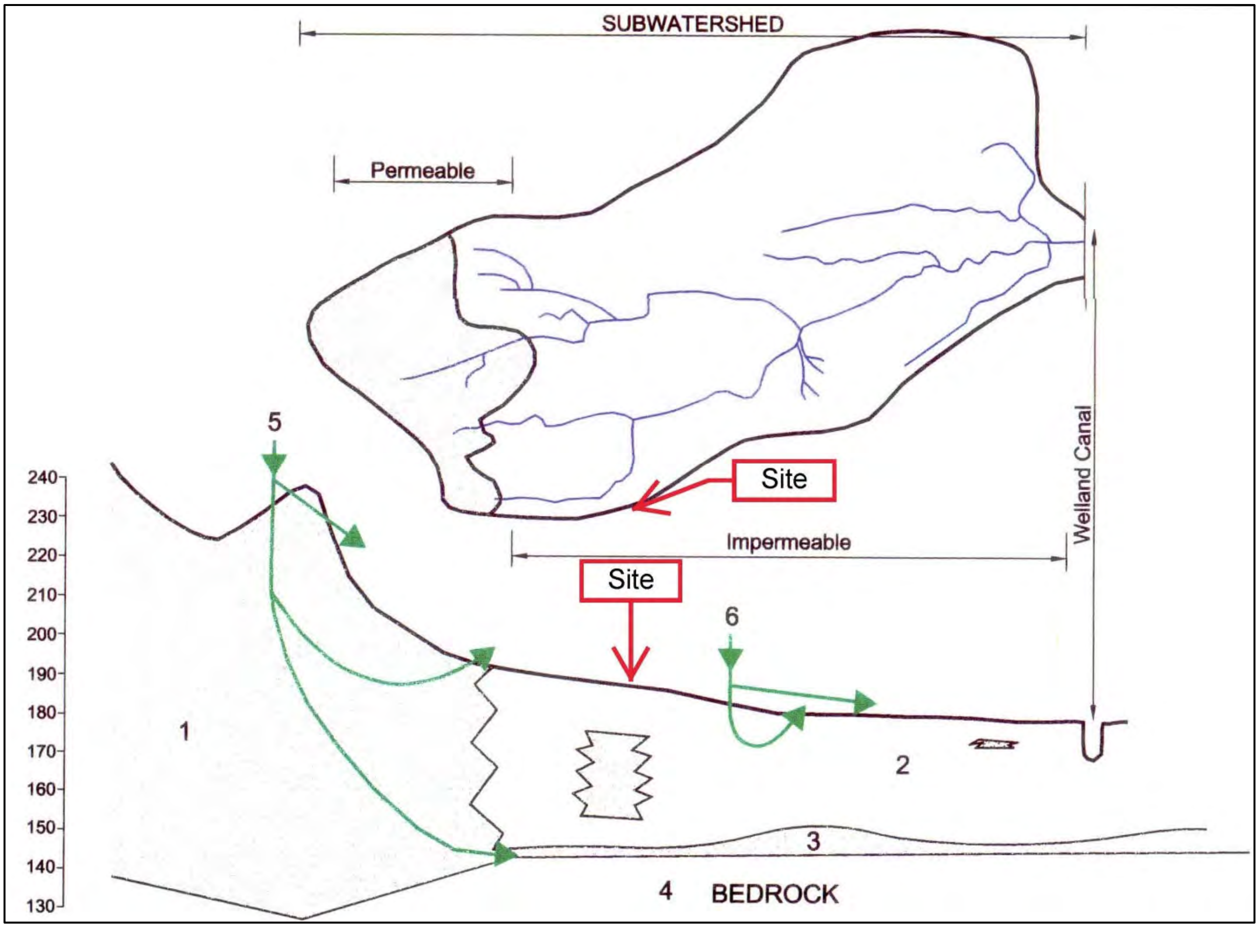


Figure 7 - Conceptual Hydrostratigraphy (modified after NPCA, 1999, section numbers are explained in Section 3.5)

3.5.1 Overburden Aquitard

The hydraulic conductivity of the regional Haldimand Clay Plain overburden aquitard is reported as 7x10^{-7} m/s, or less (GLL, 1987). Hydraulic conductivity testing at the Site generally confirmed similar or lower hydraulic conductivities with an average value of 3x10^{-9} m/s, with two minor exceptions in the northeast portion of the Site (i.e. BH21-1 and BH21-6) that had slightly higher values which is inferred at these locations to be as a result of fine sand or silt seams.

Two methods were used to determine on-site hydraulic conductivities:

(i) Laboratory grain size analyses and the Excel-tool HydrogeoSieveXL (Devlin, 2015); and
(ii) Hydraulic conductivity of select monitoring wells previously constructed on-site as part of the geotechnical investigations (Figure 2, see attachments).

These results are presented in Table 5 (below) and the analyses are provided in Appendix C.

Table 5 – Hydraulic Conductivity Analyses

Geologic Unit(s)	Location	Hydraulic Conductivity (m/s)	Depth (m BGS)	Analysis Method
Poorly sorted clay with fines	BH22-2	1x10^{-9}	5	Devlin (2015)
	BH22-1	4x10^{-8}	5	
	BH22-3	1x10^{-9}	5	
	BH21-2	6x10^{-9}	3	
	BH21-3	1x10^{-9}	3	
	BH21-6	3x10^{-9}	3	
	BH21-8	3x10^{-10}	3	
	BH21-9	5x10^{-10}	3	
	BH21-11	1x10^{-9}	3	
	BH21-13	3x10^{-10}	3	
	BH21-14	5x10^{-10}	3	
	BH21-16	1x10^{-9}	3	
Silty Clay with fine sand seams or Silt with some sand	BH21-1	5x10^{-7}	4.1-6.1	Bouwer and Rice (1989)
	BH21-2	4x10^{-9}	3.1-6.1	
	BH21-6	3x10^{-7}		
Silty Clay	BH21-3	3x10^{-9}	3.1-6.1	
	BH21-11	1x10^{-9}		
	BH21-13	4x10^{-9}		
	BH21-14	1x10^{-8}		
	BH21-16	4x10^{-10}		
	BH22-02	4x10^{-8}		
	BH22-03	2x10^{-9}		
	MW-11	8x10^{-9}		
Geometric Mean		3x10^{-9}		

Note: BGS - Below ground surface

The infiltration rates of the on-site soils are calculated as less than 15 mm/hour according to the relationship between soil hydraulic conductivity (Appendix C) and infiltration rate as provided by Credit Valley Conservation (2012). Consequently, the native soils are considered unsuitable for infiltration trenches, soakaway pits and pervious pipes (MECP, 2003).

3.5.2 Overburden Groundwater Flow

The regional groundwater table was previously modelled as towards the Site from the Fonthill Kame-Delta Complex groundwater recharge area (Blackport & Associates, and Waterloo Hydrogeologic Inc., 2005). Groundwater flow in the water table is generally from northwest to southeast as shown on Figure 8 (see attachments) for November 2022. The horizontal gradient in November 2022 was low at approximately 0.005 to 0.008 m/m.

3.5.3 Overburden Groundwater Levels

Manual groundwater level measurements were collected seasonally at thirteen monitoring wells (Figure 2, see attachments, DS Consultants, 2022). The monitoring wells are generally screened in silty clay between 3.1 to 6.1 m BGS (Appendix B). Manual groundwater level measurements (Table 6, see attachments) were collected in spring, summer and fall of 2022 and 2023. Water level dataloggers were deployed collecting measurements every 15-minutes at four monitoring wells MW21-01, MW21-03, M21-13 and MW21-14.

The ’spring-high’ groundwater levels were measured very close to surface in April, 2023 as generally less than 1 m BGS (Figure 9, see attachments). In August, 2022, the depth to groundwater increased across the Site from west to east from ~1 m BGS to 2.5 m BGS despite ‘*Abnormally dry to moderate*’ drought climate conditions reported by Agriculture Canada (2023) for August 2022.

The greatest seasonal groundwater level variations were noted for the downgradient monitoring locations, while less seasonal variation was noted for the upgradient western locations (Figures 10, 11 and 12, see attachments). Dampened seasonal variation for the upgradient western locations is inferred to be as a result of horizontal groundwater recharge from the Fonthill Kame-Delta Complex Recharge Area to the Site. Observations from the groundwater levels include:

1. Upgradient western groundwater levels showed similar limited seasonal variation between spring season highs and summer season lows of 0.5 to 0.8 m (i.e. MW21-1, MW21-2, MW21-6 and MW21-11).
2. Downgradient eastern groundwater levels showed similar greater seasonal variation between spring season highs and fall season lows of 1.1 to 2.7 m (i.e. MW21-3, MW21-8, MW21-9, MW21-13 and MW21-4).

Observations from the water level dataloggers in the four groundwater monitoring wells include (Appendix D):

i. Monitor MW21-01 (west/upgradient): The groundwater level in the monitoring well was consistently above ground surface, at above 184.3 m ASL except during the summer and early fall seasons, however, there were not ponded conditions at surface. With only about 0.5 m of seasonal change from spring to August 2022, it is believed the fine sand seams noted on the borehole log receive lateral recharge from the Fonthill Kame-Delta Complex as limited drawdown only occurred during the summer growing season.

ii. Monitor MW21-13 (located mid-site): The groundwater level showed a distinct seasonal decline of about 2.5 m from the spring season to October 2022, with groundwater level recovery beginning in the fall season of 2022, with some responsiveness to precipitation noted.

iii. Monitor MW21-03 (located downgradient/east): A seasonal decline of groundwater levels of about 1 m from spring to October 2022, with groundwater level recovery beginning in the season of fall 2022 with limited responsiveness to precipitation events.

iv. Monitor MW21-14 (located in the southwest): A seasonal decline of groundwater levels of about 1.5 m from the spring season to August/October 2022, with groundwater level recovery completed before winter 2023, and was very responsive to precipitation events.

Monitoring wells BH21-16 and BH22-03 were decommissioned by a licensed Ontario water well contractor in May 2023 in order to accommodate activities on-site.

3.5.3 Bedrock Aquifer

The confined dolostone bedrock aquifer underlying the Site is the primary local supply for private wells that may be located west, north or east of the Site as Niagara Region has mapped the Welland portion of the Site and south as part of the municipally serviced area. Regional groundwater flow modelling completed for NPCA of the Fonthill Kame-Delta Complex (Blackport et al, 2005) maps the bedrock potentiometric surface as flowing from the west towards the Site. Additional regional contouring of the potentiometric surface of the bedrock aquifer (and other water wells completed greater than 15 metres below ground surface) map it as west (176 m ASL) to east (175.5 m ASL) across the Site, with a groundwater divide to the north (175 m ASL) and south (174.5 m ASL) similar to the surface water divides (WHI, 2005). This suggests a downwards vertical gradient at the Site between the overburden water table and the bedrock aquifer.

3.6 Wetlands

The Site includes 17 ha of the Provincially Significant Niagara Street Cataract Road Woodlot Wetland Complex (MNRF, 2009), mapped to cover 27% of the Site (Figure 2, see attachments). The MNRF have described that the "*dominant wetland type …* (is) *swamp, situated through a slough forest ecosystem. A slough forest ecosystem is characteristic of the Haldimand and Niagara Clay plain physiographic regions and consists of shallow to deep depressions…*" (MNRF, 2009). It is noted an area of marsh was also mapped by the MNRF in the northeast corner of the Site. General information regarding the Provincially Significant Wetlands mapped by the MNRF at the Site are summarized in Table 7. For example, the wetlands have been mapped as Palustrine wetlands, based upon having intermittent or no inflow, and either permanent or intermittent outflow and may rely on rainfall and some overland flow (MNRF, 2014).

Table 7 – Provincially Significant Wetland Information (MNRF, 2009)

Area	Size (ha)	Type	Dominant Vegetation	Wetland Hydrology	Soils
North Swamp Singers Drain	7.84	Swamp	Red maple	Palustrine	Clay/Loam
North Marsh Singers Drain	3.62	Marsh	Broadleaf cattail	Palustrine	Clay/Loam
South Toe Path Drain	5.21	Swamp	Rice cut grass	Palustrine	Clay/Loam

Additional wetland vegetation at the Site has been mapped by GEI Consultants (2022) and is summarized in Section 3.6.1 with respect to their Ecological Land Classifications and shown on Figure 13 (see attachments). It is our understanding the wetland extents were staked in June 28, 2021 with the Niagara Peninsula Conservation Authority (NPCA) and Niagara Region.

3.6.1 Wetland Ecological Land Classification (ELC) Mapping

The Wetland Ecological Land Classifications (ELCs) from GEI Consultants (2022) are summarized below in Table 8 with the associated wetland monitoring staff gauges listed and shown on Figure 13 (see attachments). However, it is our understanding that the wetlands monitored by staff gauges SW-1, SW-2, SW-13 and SW-14 are not being kept as part of the development plan.

Table 8 – Wetland Ecological Land Classifications (ELCs)

ELC	Description	Hydrologic Sensitivity*	Staff Gauges
MAS2-1	Cattail Mineral Shallow Marsh	Medium	SW-1, SW-13, SW-14, SW-15
SWT2-9	Grey Dogwood Mineral Thicket Swamp	Low**	SW-2, SW-17
SWD3-3/ CUW1/ SWT2-8/ CUT1-1	Swamp Maple Mineral Deciduous Swamp/ Mineral Cultural Woodland/ Silky Dogwood Mineral Thicket Swamp/ Sumac Cultural Thicket	Medium	SW-3, SW-7
SWT2-8/ MAM2-10	Silky Dogwood Mineral Thicket Swamp/ Forb Mineral Meadow Marsh	Medium/ Low	SW-16
SWT2-8/ MAS2-1	Silky Dogwood Mineral Thicket Swamp/ Cattail Mineral Shallow Marsh	Medium	SW-4, SW-5, SW-6, SW-8, SW-9,
MAM2-10/ MAS2-11	Forb Mineral Meadow Marsh/Dry and European Reed Shallow Marsh	Low**	SW-10, SW-11, SW-12
SWD3-2	Silver Maple Mineral Deciduous Swamp	Medium	SW-18

Notes: * - Wetland Sensitivity from TRCA (2017), ** - ELC not listed in TRCA (2017) and assigned based upon previous investigations in the Niagara Peninsula and/or correspondence with GEI

3.6.2 Wetland Water Level/Hydroperiod Monitoring

A hydroperiod is defined as “*the seasonal pattern of the water level of a wetland…It characterizes each type of wetland, and the constancy of its pattern from year to year ensures a reasonable stability for that wetland. It defines the rise and fall of a wetland’s surface and subsurface water by integrating all of the inflows and outflows”* (Mitsch and Gosselink, 2007).

Eighteen wetland water level staff gauges were installed by Terra-Dynamics between May 10 and 24, 2022 to monitor wetland hydroperiods at locations chosen by GEI Ecological Staff (Figure 13, see attachments, Appendix E Location Photos). During installation of the staff gauges, silty clay soils were confirmed to be between 0.4 and 0.5 m BGS by hand-augering at each of the eighteen locations.

Manual water level measurements began at all locations in the spring season of 2022 on May 24, with some locations also monitored earlier on May 10, 2022 (Table 9, see attachments). Water level data loggers were deployed at each staff gauge beginning July 21, 2022 to measure water levels at 15-minute intervals, and the water level plots are located in Appendix E. The staff gauges for wetland water level monitoring were constructed with well-points that allowed measurement of both surface water levels and shallow water levels to 0.1 m below ground surface.

Surface water was present at each monitored wetland staff gauge on May 10, 2022 with three locations becoming dry by May 24, 2022 (SW-2, SW-5 and SW-16) (Table 9, see attachments), following three months of below average precipitation (Table 1, see attachments). The wetland hydrographs from July 2022 to November 2023 using the water level datalogger information are presented in Appendix E. The primary influence of precipitation in supplying water to the wetlands is supported in comparison of the water levels to the monthly wetland water balance modelling (Section 4.2).

The observed wetland hydrographs at the Site were fairly similar in overall patterns over the July 2022 to November 2023 monitoring period (Appendix E). These perched surface water level patterns are summarized below:

a) Summer 2022: Dry during Summer 2022,
b) Fall 2022: Surface water levels recovered in Fall 2022,
c) Winter 2022-2023: Surface water levels maintained
d) Spring 2023: Surface water levels declined to dry
e) Summer 2023: Mostly wet conditions attributed to above-average July/August precipitation (Table 1, see attachments).
f) Fall 2023: Surface water level decline and recovery. It is noted that as of the November 20, 2023 datalogger download, recovery was not yet noted at SW-5, SW-9 or SW-10.

Mitsch and Gosselink (2007) report that the "*hydroperiods of many bottomland hardwood forests and swamps have distinct periods of surface flooding in the winter and early spring due to snow and ice conditions followed by spring floods but otherwise have a water table that can be a meter or more below the surface*" (Figure 14), this characterization appears reasonable for the wetlands at the Site.

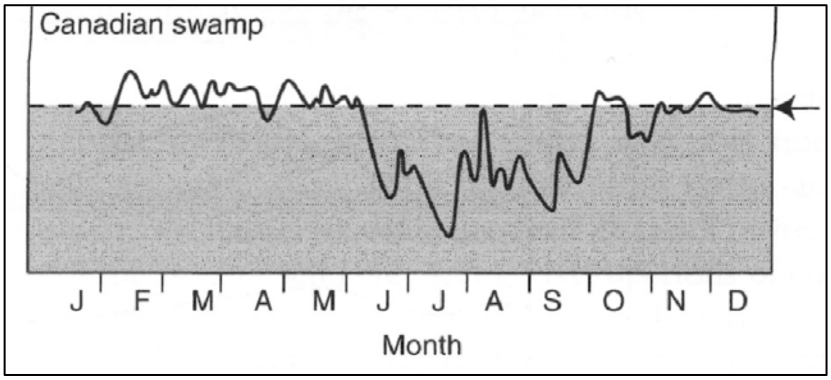


Figure 14 – Canadian Swamp Hydroperiod (Mitsch and Gosselink, 2007)
Note: arrow indicates wetland ground surface

3.6.3 Wetland Characterization

The wetlands are proposed classified as a *surface water depression wetlands* (Figure 15) (Mitsch and Gosselink, 2007).

A surface water depression wetland is summarized as a: "*wetland…dominated by surface runoff and precipitation, with little groundwater outflow due to a layer of low-permeability soils*…". Low permeability silty clay soils have been noted beneath the wetlands as per this description.

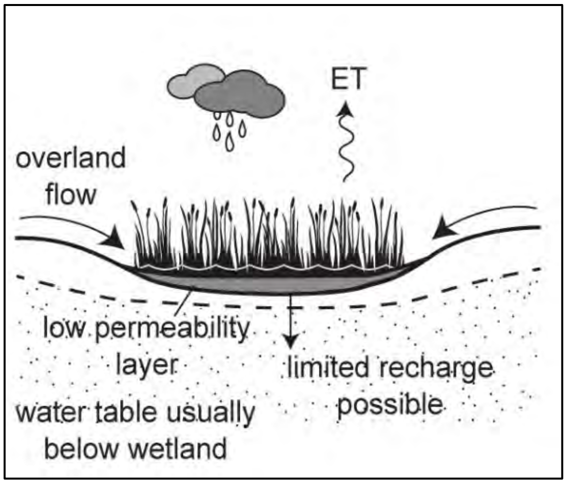


Figure 15 - Surface water depression wetland (Mitsch and Gosselink, 2007)

3.6.3 Soil Water Holding Capacity

The wetlands are primarily underlain by Hydrologic Soil Group (HSG) C soils with the northern wetlands underlain by HSG D or a combination of C/D soils (Section 3.2). The wetlands underlain by HSG C are assigned a soil water holding capacity (SWHC) of 400 mm, where underlain by HSG D 350 mm, and where underlain by HSG C/D 375 mm. These SWHC values are based upon previous swamp wetland values used by NPCA in their water budgeting study (AquaResource Inc. and NPCA, 2009).

3.6.4 Wetland Surface Water Catchments

As described in Section 3.1.1, and shown on Figure 4, the Site can be subdivided into four catchments: (i) Singer's Drain West, (ii) Singer's Drain East, (iii) Tow Path Drain North and (iv) Tow Path Drain South.

Smaller catchments were not modelled as the wetland water level monitoring (Section 3.6.2) and wetland modelling (Section 4.2) support precipitation as the primary source of water sustaining the wetlands.

3.7 Pre-development Subwatershed Water Balance Modelling

NPCA previously completed pre-development water balance modelling for 1991-2005, as part of provincial water budgeting for the source water protection program (AquaResource Inc. and NPCA, 2009). This modelling was completed at 1-hour time steps with a filled-in meteorological dataset including solar radiation and a crop coefficient for improved calculation of evapotranspiration. The modelling used lumped parameter catchments incorporating data such as soils, land cover and slope.

The Site is located within two NPCA modelled catchments: (i) Beaversdam Shriners Creek Welland Canal North W320 (BDSC_WCN_W320) and (ii) Central Welland River Tow Path Drain W100 (CWR_TPD_W100) (Figure 1, see attachments). It was determined that the modelled results for Catchment BDSC_WCN_W320 best suit the Site for application with respect to pre-development water balance conditions (i.e. slope, soils, land cover and evapotranspiration).

Modelled annual and monthly water balance results were obtained for Catchment BDSC_WCN_W320 (Tables 10 and 11, respectively, without decimal places) (AquaResource Inc. and NPCA, 2009). The annual surplus as shown on Table 10 is precipitation minus evapotranspiration, i.e. the water available for runoff and recharge.

Table 10 - Water Balance 15-year (1991-2005) Averages

Catchment	Precipitation	Actual Evapotranspiration	Annual Surplus	Infiltration*	Recharge	Runoff
	(mm/year)					
BDSC_WCN_W310	968	650	318	76	38	242
CWR_TPD_W100	968	469	499	97	49	401

Notes: * - Infiltration is interflow plus recharge

Table 11 - Monthly Runoff and Infiltration (Catchment BDSC_WCN_W310)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Runoff (mm)	38	27	54	45	17	9	3	3	4	3	18	20
Infiltration (mm)	13	12	23	16	5	1	0	0	0	0	3	7

4.0 Wetland Water Balance Assessment

A monthly wetland water balance assessment has been completed for the Site's wetlands, as informed by the Conservation Authority Guidelines for Development Applications (Conservation Ontario, 2013) and TRCA's guidance for water balances (2012).

It is noted that the MECP (2003) water balance approach is typically concerned with the evaluation of post-development to prevent (i) increased runoff, and/or (ii) reduction in groundwater recharge. However, given the current wetland characterization, any on-site water surplus contribution to hydrologic function with respect to the wetlands is via additional surface water flow, not groundwater discharge. Consequently, the purpose of the pre-development on-site water balance assessment modelling is to evaluate if runoff maintains monthly saturated conditions at the wetlands.

4.1 Monthly Water Balance Example

An example of water balance modelling from the University of Waterloo is shown below (Figure 16). Annual groundwater recharge begins in the fall following '*soil water utilization*' and '*deficit*' in the summer. Soil water utilization corresponds with evapotranspiration exceeding the precipitation supply. Annual groundwater recharge occurs during the same time period that groundwater levels rise. However, in this example it is noted that the soil water holding capacity (SWHC) modelled was only 100 mm compared to the higher SWHC 350 to 400 mm for the on-site wetlands (Section 3.6.3) which retain a greater amount of water.

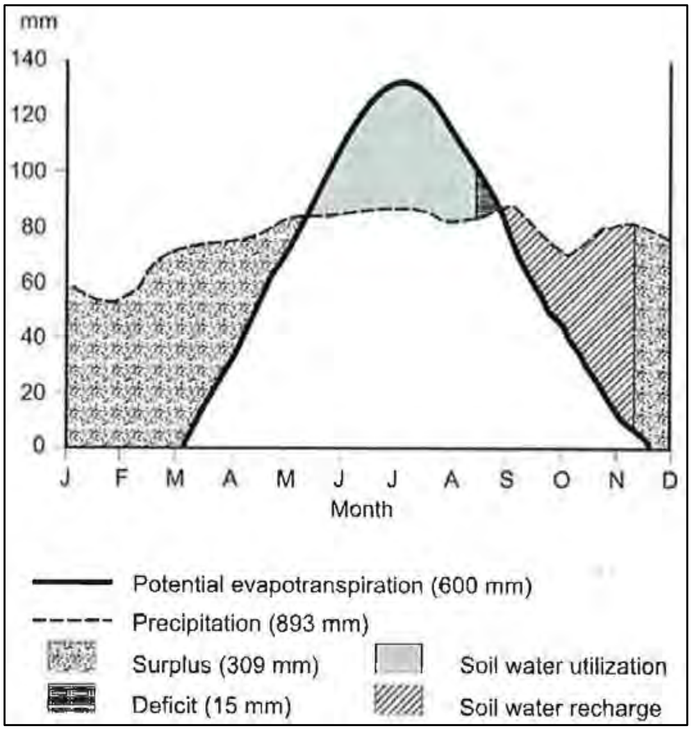


Figure 16 – Brantford Average Water Balance (Sanderson, 2004)

4.2 Wetland Monthly Water Balance

A monthly water balance for the wetlands was completed using the U.S. Geological Survey (USGS) Monthly Water Balance Model (McCabe and Markstrom, 2007), which only considers direct precipitation to the wetland as a water supply. For temperature and precipitation, three time intervals were modelled for the three soil water holding capacities identified (Section 3.6.3) (a) climate normal inputs (1981-2010) from Welland Station ID 6139445 (Environment Canada, 2023a), (b) 2022, and (c) 2023. Monthly wetland water balance modelling results are presented in a series of attached tables for (a) the climate normals (Tables 12a, 12b and 12c), (b) 2022 (Tables 13a, 13b and 13c) and (c) 2023 (Tables 14a, 14b and 14c).

In summary, the average/climate normal results (1981-2010) were:

1. Potential evapotranspiration exceeded precipitation for June, July and August, i.e. soil water utilization occurred on average;
2. Soil water holding capacities were less than saturated for the months of June to October; and
3. Soil water recharge occurred in September and October.

These conditions are presented below in Tables 15a, 15b and 15c:

Table 15a –Average Monthly Wetland Water Balance (mm), HSG C (SWHC 400 mm)

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Precipitation (mm)	78	61	70	75	85	83	86	82	97	89	99	92
Evapotranspiration (mm)	10	12	21	40	72	106	122	97	60	32	17	11
Soil Moisture (mm)	400	400	400	400	400	**373**	**333**	**314**	**346**	**398**	400	400
Soil Water [1] Depletion (mm)	0	0	0	0	0	**27**	**67**	**86**	**54**	**2**	0	0

Notes: [1] Difference between the SWHC and the modelled soil moisture

Table 15b – Average Monthly Wetland Water Balance (mm), HSG D (SWHC 350 mm)

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Precipitation (mm)	78	61	70	75	85	83	86	82	97	89	99	92
Evapotranspiration (mm)	10	12	21	40	72	106	122	97	60	32	17	11
Soil Moisture (mm)	350	350	350	350	350	**323**	**283**	**265**	**297**	**349**	350	350
Soil Water [1] Depletion (mm)	0	0	0	0	0	**27**	**67**	**85**	**53**	**1**	0	0

Notes: [1] Difference between the SWHC and the modelled soil moisture

Table 15c – Average Monthly Wetland Water Balance (mm), HSG C/D (SWHC 375 mm)

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Precipitation (mm)	78	61	70	75	85	83	86	82	97	89	99	92

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration (mm)	10	12	21	40	72	106	122	97	60	32	17	11
Soil Moisture (mm)	375	375	375	375	375	**348**	**308**	**289**	**321**	**374**	375	375
Soil Water [1] Depletion (mm)	0	0	0	0	0	**27**	**67**	**86**	**54**	**1**	0	0

Notes: [1] Difference between the SWHC

The monthly soil water modelling of 2022 and 2023 (Tables 13/14, attached) differed from average conditions as a function of the primary influence of precipitation not being average (Table 1, attached):

1. Potential evapotranspiration exceeded precipitation earlier in May 2022 and 2023 (below average precipitation), and later in September 2023 (below average precipitation) but not in July/August (above average precipitation);
2. Soil water holding capacities were also less than saturated for May 2022 and 2023 (below average precipitation) but not less than saturated for August 2023 (above average precipitation);
3. Soil water recharge occurred earlier in July 2023 (above average precipitation) but not in September 2023 (below average precipitation).

The 2022 and 2023 modelled results reasonably match the observed wetland hydroperiod monitoring water levels (Appendix F), further supporting the primary role of precipitation in sustaining the wetland hydroperiods. It is noted that the hydrographs extend to November 20, 2023 prior to most of the November 2023 precipitation recharging to a “surplus” condition (Tables 14a/14b).

4.3 Wetland Water Balance Assessment

The extensive investigation and monitoring program and water balance modelling support the wetlands at the Site being supported primarily by precipitation. Consequently, development of the Site is not predicted to negatively affect the wetland hydroperiods as long as the proposed Environmental Impact Study buffers are observed.

4.4 Wetland Risk Evaluation

4.4.1 Magnitude of Hydrological Change

TRCA’s wetland risk evaluation (2017) decision tree (Figure 17) includes four key hydrological change criteria:

1) Impervious cover in catchment;
2) Change in catchment size;
3) Dewatering; and
4) Impact to recharge areas.

The magnitude of hydrological change assessment was completed of the proposed southern development within the City of Welland of about 30.2 hectares.

(1) The amount of impervious cover within the areas proposed for development in Tow Path Drain South is calculated to be between 10 and 25% (A.T. McLaren Limited, 2024, WalterFedy, 2024a, Appendix G). Development of Tow Path Drain North as proposed (A.T. McLaren Limited, 2024 and WalterFedy, 2024a, Appendix G) is calculated to be greater than 25%.

(2) The post-development surface water catchments are proposed as follows: (a) Tow Path Drain North: 9% reduction in catchment area and (d) Tow Path Drain South: no reduction in catchment area (WALTERFEDY, 2024b).

(3) Construction dewatering is not expected to affect wetlands due to the low permeability of the soils on-site (Section 3.5.1). The aquitard underlying the Site is generally of sufficiently low permeability that groundwater control pumping methods are likely not feasible (Preene, 2020). However, an exception to this may be the northwest corner of the Site where the most permeable materials were identified at-surface and in the water table. Development in this area may require exclusion methods (e.g. cut-off collars for municipal servicing) to prevent long-term dewatering of adjacent wetlands.

(4) No impacts to wetland recharge areas are predicted as TRCA (2017) defines this as "*replacement of existing soils with significantly less permeable materials*" and the on-site soils are already of low permeability. In addition, there are no locally significant recharge areas to be impacted as these are defined by TRCA (2017) as "*highly porous sedimentary deposits or otherwise having high hydraulic conductivity*".

"*The highest magnitude category with one or more criteria satisfied determines the potential magnitude of change*" with the magnitude thresholds of less than 10% change as low, 10-25% as medium and greater than 25% as high (TRCA, 2017). Hydrologic risk is assigned based upon the magnitude of impervious cover to be introduced in upgradient catchment areas; medium in Tow Path Drain South and high in Tow Path Drain North. However, as discussed in Section 4.3.2, negative hydrologic impacts to the downgradient wetlands are not predicted with the implementation of wetland buffers as recommended by GEI in their future Environmental Impact Study.

4.4.2 Sensitivity of the Wetlands

The risk assignment (Figure 17) is to consider the type of wetlands, and their hydrological sensitivity (TRCA, 2017) which is tabulated in Table 6. None of the wetlands were classified as high hydrologic sensitivity, however, some were classified as medium (i.e. Cattail Mineral Shallow Marsh, Swamp Maple Mineral Deciduous Swamp, Silky Dogwood Mineral Thicket Swamp, Silver Maple Mineral Deciduous Swamp) and others as low (i.e. Grey Dogwood Mineral Thicket Swamp, Forb Mineral Meadow Marsh).

4.4.3 Risk Assignment

As per Figure 17, a medium risk is assigned based upon (i) either a high or medium magnitude of hydrological change, and (ii) a medium wetland sensitivity. The TRCA recommended study, modelling and mitigation requirements are:

(i) Pre-development monitoring as outlined in the Wetland Water Balance Monitoring Protocol (TRCA, 2016).

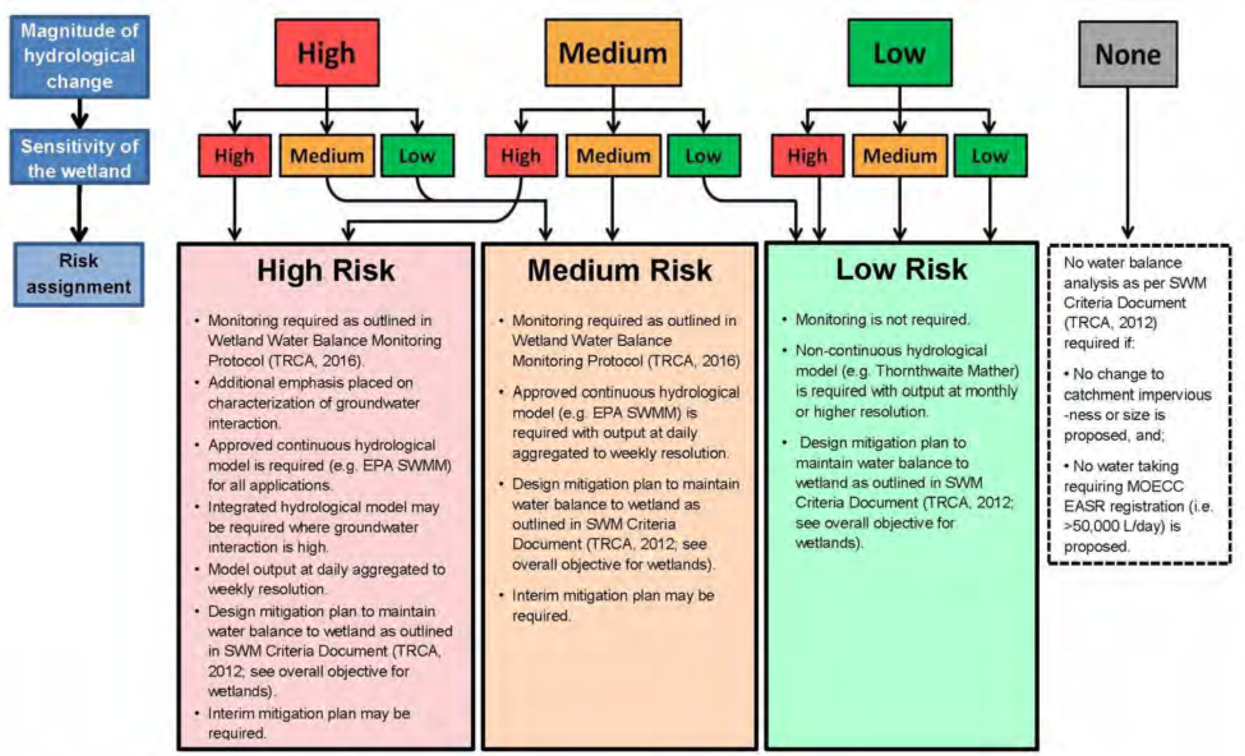
- Pre-development monitoring has occurred and informed the conceptual model and impact assessment for the Site.

(ii) Continuous hydrological modelling at daily aggregated to weekly resolution.

- Existing modelling (completed at 1-hour time steps) completed by NPCA was utilized for this report (AquaResource Inc. and NPCA, 2009) as part of a monthly analysis. Re-visiting this modelling to extract weekly results would not provide discernable benefit.

(iii) Design of a mitigation plan to maintain the wetland water balance, in some cases an interim mitigation plan may also be required.

- Mitigation is not indicated to be required as precipitation is the primary water supply for the wetlands. EIS proposed buffers are predicted to be sufficient to maintain pre-development conditions for the wetlands.



High Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016).
- Additional emphasis placed on characterization of groundwater interaction.
- Approved continuous hydrological model is required (e.g. EPA SWMM) for all applications.
- Integrated hydrological model may be required where groundwater interaction is high.
- Model output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Medium Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016)
- Approved continuous hydrological model (e.g. EPA SWMM) is required with output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Low Risk

- Monitoring is not required.
- Non-continuous hydrological model (e.g. Thornthwaite Mather) is required with output at monthly or higher resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).

No water balance analysis as per SWM Criteria Document (TRCA, 2012) required if:

- No change to catchment imperviousness or size is proposed, and;
- No water taking requiring MOECC EASR registration (i.e. >50,000 L/day) is proposed.

Figure 17 - Wetland Risk Evaluation Decision Tree (TRCA, 2017)

5.0 Key Hydrologic Areas and Features

The Niagara Region Official Plan (2022) lists under Policy 3.1.10.1 that:

> *Development or site alteration shall not be permitted unless it can demonstrated that it will not have negative impacts on:*
>
> *a. the quantity and quality of water in key hydrologic areas, key hydrologic features, sensitive surface water features, and sensitive ground water features;*

> b. *the hydrologic functions of key hydrologic areas, key hydrologic features, sensitive surface water features, and sensitive groundwater features;*
> c. *the interaction and linkage between key hydrologic areas, key hydrologic features, sensitive surface water features, and sensitive groundwater features and other components of the natural environment system;*
> d. *the natural hydrologic characteristics of watercourses such as base flow, form and function, and headwater drainage areas;*
> e. *natural drainage systems and shorelines areas; and*
> f. *flooding or erosion.*

Key hydrologic areas have been defined as "*Significant groundwater recharge areas, highly vulnerable aquifers, and significant surface water contribution areas that are necessary for the ecological and hydrologic integrity of a watershed*"

Key Hydrologic Features have been defined as "*Permanent streams, intermittent streams, inland lakes and their littoral zones, seepage areas and springs and wetlands*" (Niagara Region, 2022).

5.1 Highly Vulnerable Aquifers (HVAs)

There are no Highly Vulnerable Aquifers (HVAs) mapped at the Site. It is noted that potential HVAs are mapped adjacent to the Site, however, these are related to potential historical water wells requiring decommissioning at those lands (NPCA, 2011). The off-site HVA mapping has no bearing on development at the Site. However, it should be noted that as monitoring wells at the Site are no longer required, they must be decommissioned by a licensed water well contractor (MECP, 2023).

5.2 Significant Groundwater Recharge Areas (SGRAs)

Significant Groundwater Recharge Areas (SGRAs) have been mapped at the Site which were mapped based upon prescribed Technical Rules for source water protection studies (MECP, 2009). However, site-level investigations have confirmed the Site as underlain by a low permeability aquitard unsuitable for on-site infiltration activities (i.e. <15 mm/hour infiltration and often high water table conditions). No negative impacts to the ecological and hydrologic integrity of the watershed are predicted and additional groundwater recharge mitigation measures are not required.

The NPCA SGRA mapping was intended as a screening layer to be informed by site-level investigations. NPCA had recommended two levels of SGRA significance (NPCA, 2009) however that is not currently reflected in SGRA mapping. Two levels of significance were recommended as the Source Protection Committee chose an MECP SGRA threshold that is very low and includes clayey silt where infiltration may not be suitable. During development of the Niagara Peninsula Source Protection Plan, no policies were included for SGRAs (NPSPC, 2014).

5.3 Key Hydrologic Features

No negative impacts to the Tow Path Drain are predicted as it has been identified as intermittent and having no baseflow or groundwater inputs.

No negative impacts to the wetlands are predicted as they are primarily sustained by precipitation.

6.0 Conclusions and Recommendations

6.1 Conclusions

The following conclusions are provided:

1. The Site is 60.8 hectares in area. Within the Site the Ministry of Natural Resources & Forestry have mapped Provincial Significant Swamp Wetland associated with the Niagara Street Cataract Road Woodlot Wetland Complex, and GEI Consultants have also mapped additional non-PSW wetlands at the Site. The coverage of wetlands on-site mapped by GEI is currently 27.2 hectares, with 17 hectares being provincially significant (63%).

2. The Site is located on the Haldimand Clay Plain, a regional thick aquitard of silty clay/clayey silt soils and downgradient of the Fonthill Kame-Delta Complex which is considered a regional groundwater recharge area.

3. Native soils are low permeability and not suitable for infiltration trenches, soakaway pits or pervious pipes.

4. Surface water drainage is almost evenly split and roughly along the municipal boundary with flow to the north and Thorold via Singer's Drain, and flow to the south and Welland via Tow Path Drain.

5. Watercourse monitoring at the Site has identified intermittent or ephemeral conditions.

6. Shallow groundwater flow is generally from northwest to southeast across the Site. The high water table in the spring season of 2023 was generally less than 1 m below natural ground surface while during August, 2022 the depth to the water table increased from west to east.

7. Groundwater levels are consistently above ground surface at monitoring well BH21-01 in the northwest corner of the Site. With only about 0.5 m of seasonal change in summer 2022, it is believed fine sand seams receive lateral recharge from the upgradient/off-site Fonthill Kame-Delta Complex.

8. The wetlands are on low permeability silty clay, consisting of surface water depression wetlands.

9. Wetland water levels monitored at eighteen locations, selected by GEI Consultants, since the summer season of 2022 resemble published hydroperiods for Canadian swamps and reasonably match modelled monthly water balance results for being sustained by precipitation alone.

10. A monthly water balance for the wetlands identified, on average, potential evapotranspiration as exceeding precipitation for June, July and August, with soil water holding capacities less than saturated also in September and October.

11. Pre-development monthly water balance modelling reasonably matches wetland water level monitoring supporting the conceptual model of palustrine wetlands (e.g. intermittent or no inflow) supported primarily by precipitation.

12. The Toronto Region Conservation Authority wetland risk screening tool assigned a 'potential' medium risk to the hydrological and ecological integrity of the wetlands, based upon either a high or medium magnitude of hydrological change and medium wetland sensitivity. However, the risk protocol does not include scoping precipitation supplied wetlands.

13. Residential development of the Site should not negatively impact the hydrology of the wetlands because the wetlands are primarily supplied by precipitation and therefore implementation of buffers as prescribed in the Environmental Impact Study should be sufficient.

14. No negative impacts to to the ecological and hydrologic integrity of the watershed are predicted and additional groundwater recharge mitigation measures are not required.

6.2 Recommendations

The following recommendations are provided:

1. Evaluate continuance of the wetland and surface water monitoring programs at the Site following acceptance of this report by NPCA and Niagara Region; and

2. Decommission the on-site monitoring wells once no longer required using a licensed in Ontario water well contractor.

We trust this information is sufficient for your present needs. Please do not hesitate to contact us if you have any questions.

Yours truly,

TERRA-DYNAMICS CONSULTING INC.

Jayme D. Campbell

June 27 2024
J. D. CAMPBELL

Jayme D. Campbell, P. Eng.
Senior Water Resources Engineer

cc. Daniel Stummer, Primont (Thorold/Welland) Inc.
Eric Salembier, WALTERFEDY
Antonette Zimic/Rick Hubbard, GEI

<u>Attachments</u>

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Figure 2 – Site Details
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Appendix A – Terms of Reference
Appendix B – Borehole and Monitoring Well Logs
Appendix C – Hydraulic Conductivity Analyses
Appendix D – Groundwater Datalogger Charts
Appendix E – Wetland Monitoring
Appendix F – Tow Path Drain Surface Water Monitoring
Appendix G – Supporting Information

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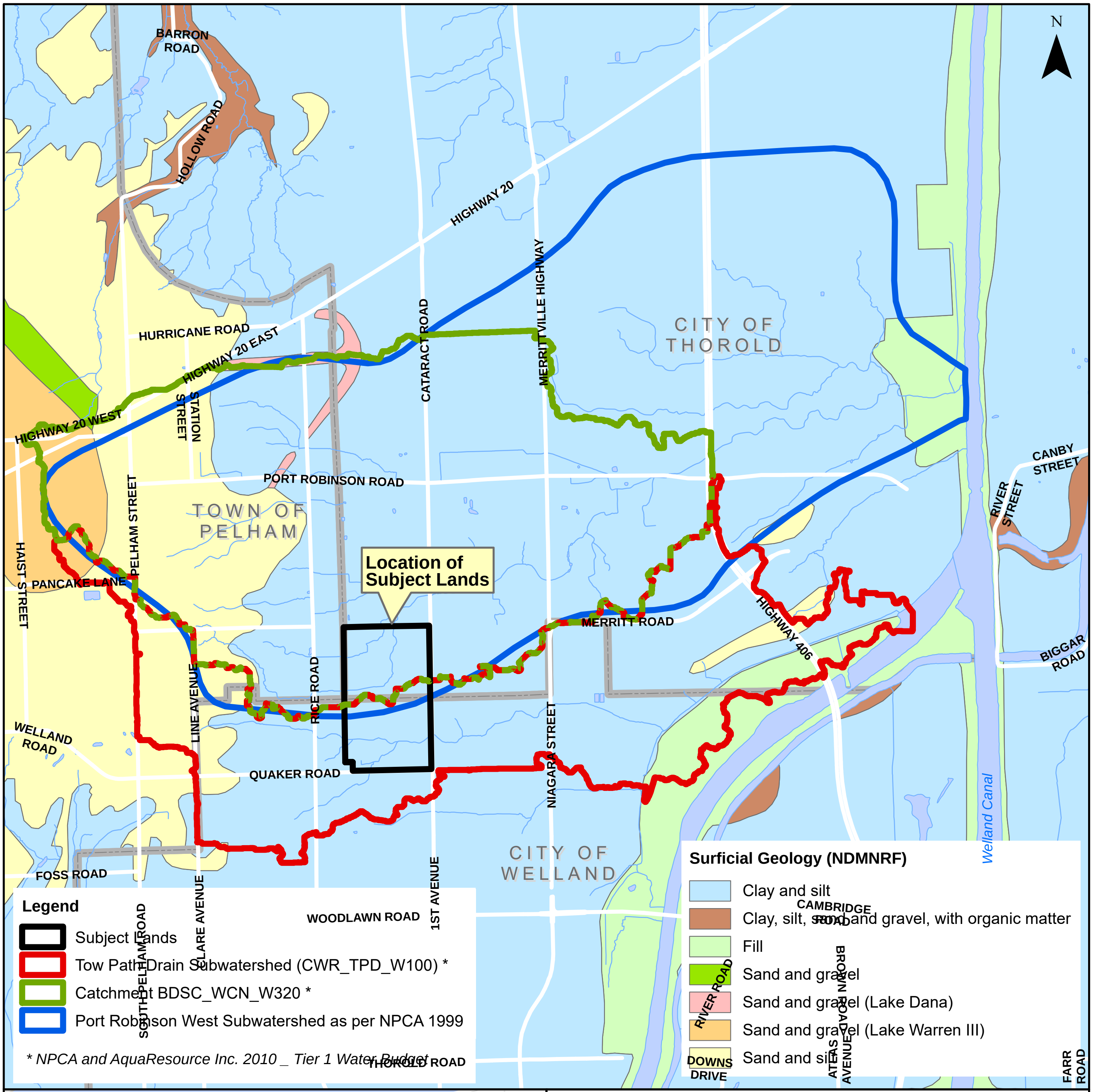

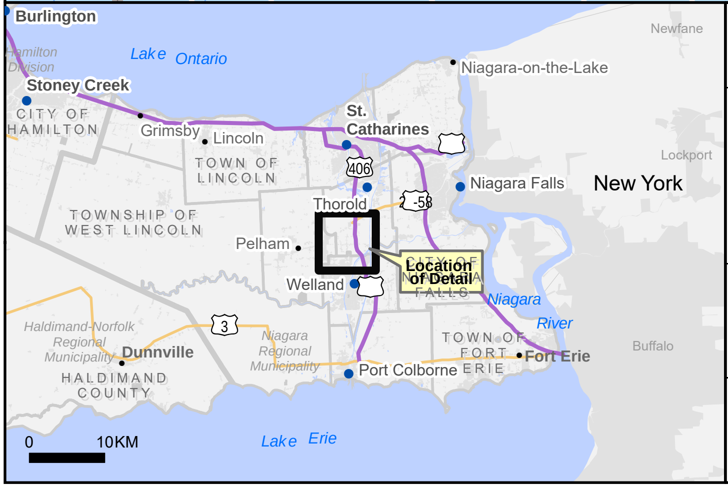

Location of Subject Lands

Hydrogeologic Study and
Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

TDC Terra-Dynamics Consulting Inc.

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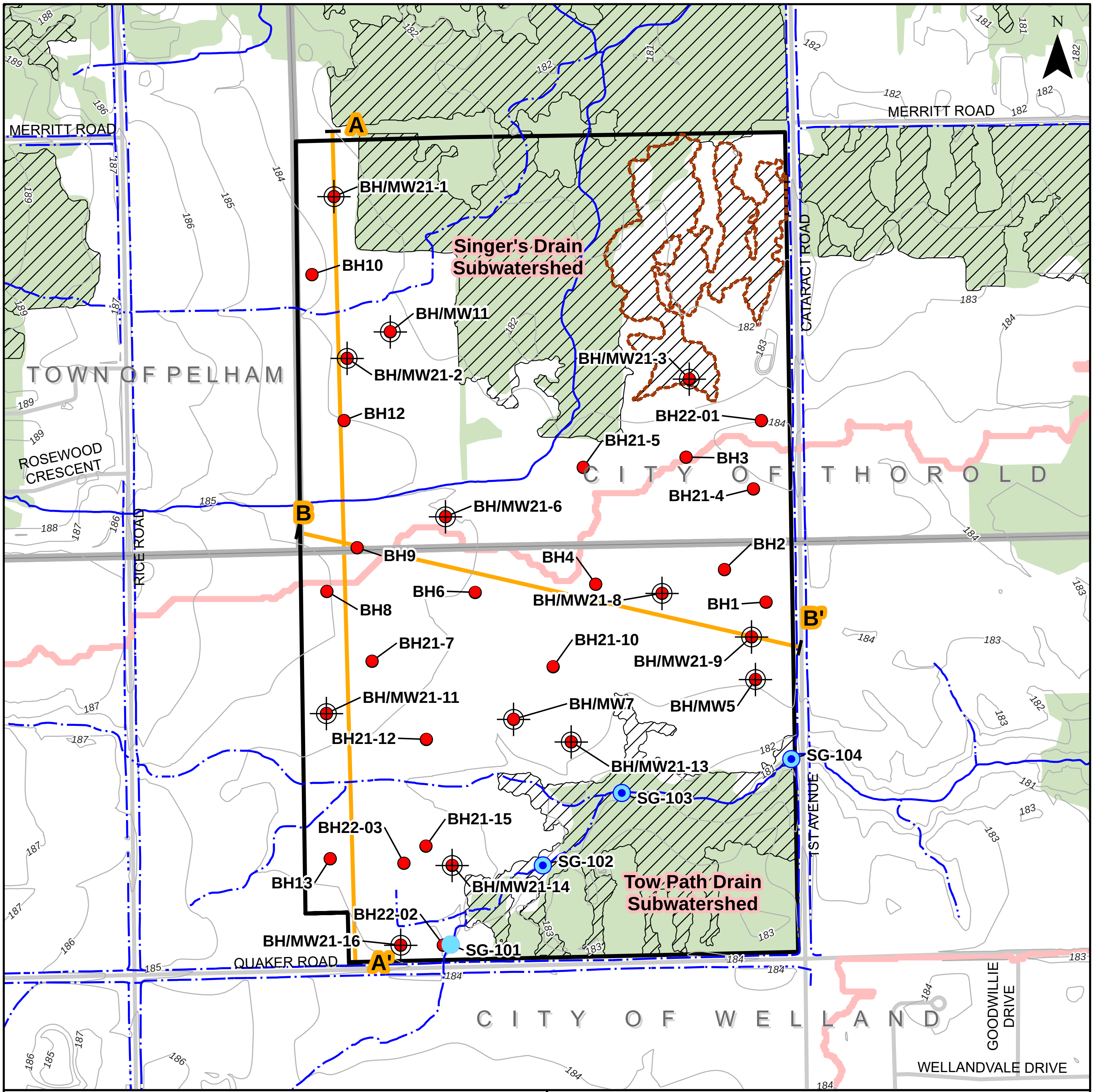
Figure 1

Path: H:\TERRA_DYNAMICS\9647 - TD 436 Quaker Rd\gis\mxd\Figure 1 Location of Subject Lands.mxd Revised: March 11, 2024



- ▭ Subject Lands
- ● Borehole
- ⊕ Monitoring Well
- ◉ Staff Gauge
- ▨ Marsh Area
- ▭ Subwatershed Boundary
- ▨ Niagara Street Cataract Road Woodlot Wetland Complex Provincially Significant Wetlands (MNRF)
- — Ground Surface Contour (NPCA)
- ⊢⊣ Geologic Cross-section

NPCA Watercourse Permanency

- -·- Ephemeral
- — Intermittent or Ephemeral

Site Details

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

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Figure 2

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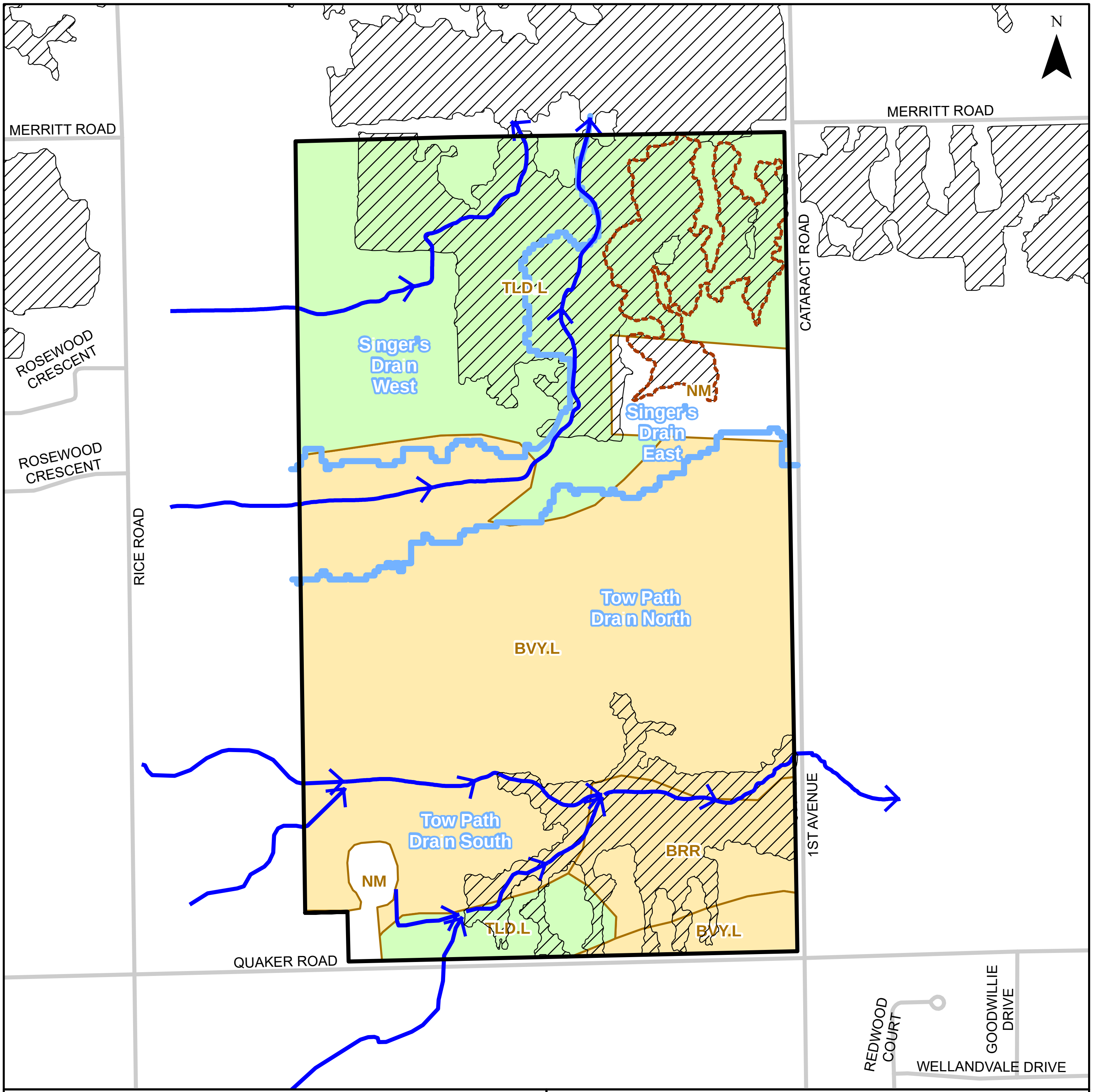

Legend

▭ Subject Lands

→ Surface Water Flow Direction

— Catchment Areas

▨ Niagara Street Cataract Road Woodlot Wetland Complex Provincially Significant Wetlands (MNRF)

---- Marsh Area (MNRF)

Soils (OMAFRA)

BRR	Berrien	TLD.L	Toledo - Loamy Phase
BVY.L	Beverly - Loamy Phase	NM	Not Mapped

Hydrologic Soil Group (OMAFRA)

🟨 C 🟩 D

Soils and Surface Water Catchments

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

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Figure 4

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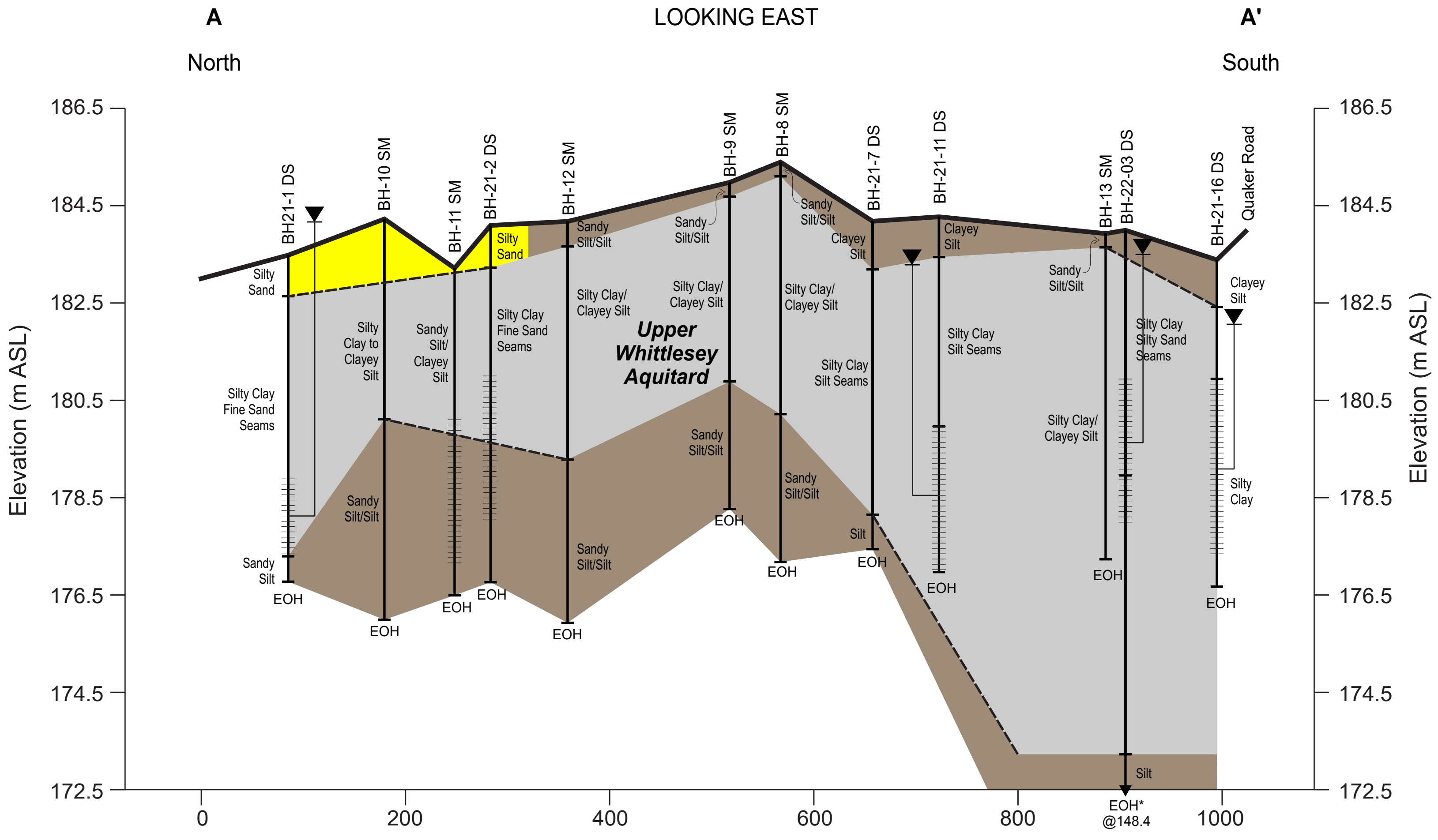


** See borehole log for additional details*

EOH	End of Hole
┼	Well Screen
▼	Groundwater Level (Nov. 9, 2022)
🟫	Silt
⬜	Clay
🟨	Sand

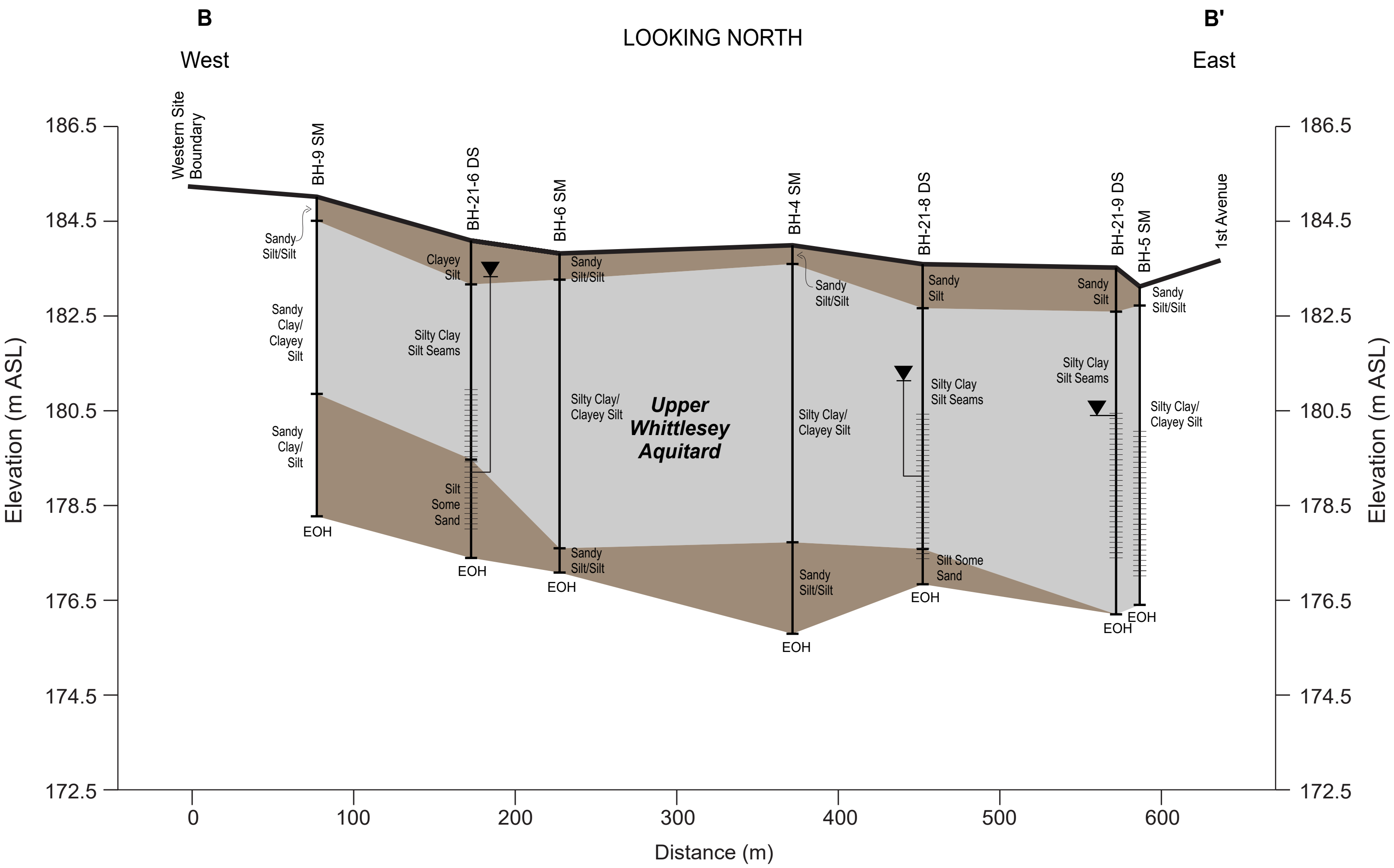
North-South Geologic Cross-section, Looking East

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland
Lot 228/Part Lot 174, Thorold, ON

TDC Terra-Dynamics Consulting Inc.

Figure 5

H:\TERRA_DYNAMICS\9647 - TD 436 Quaker Rd\corel\Figure 5 Hydrogeologic Cross-section north-south.cdr May 8, 2024



EOH	End of Hole
╪	Well Screen
▼	Groundwater Level (Nov. 9, 2022)
🟫	Silt
⬜	Clay

West-East Geologic Cross-section, Looking North

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland
Lot 228/Part Lot 174, Thorold, ON

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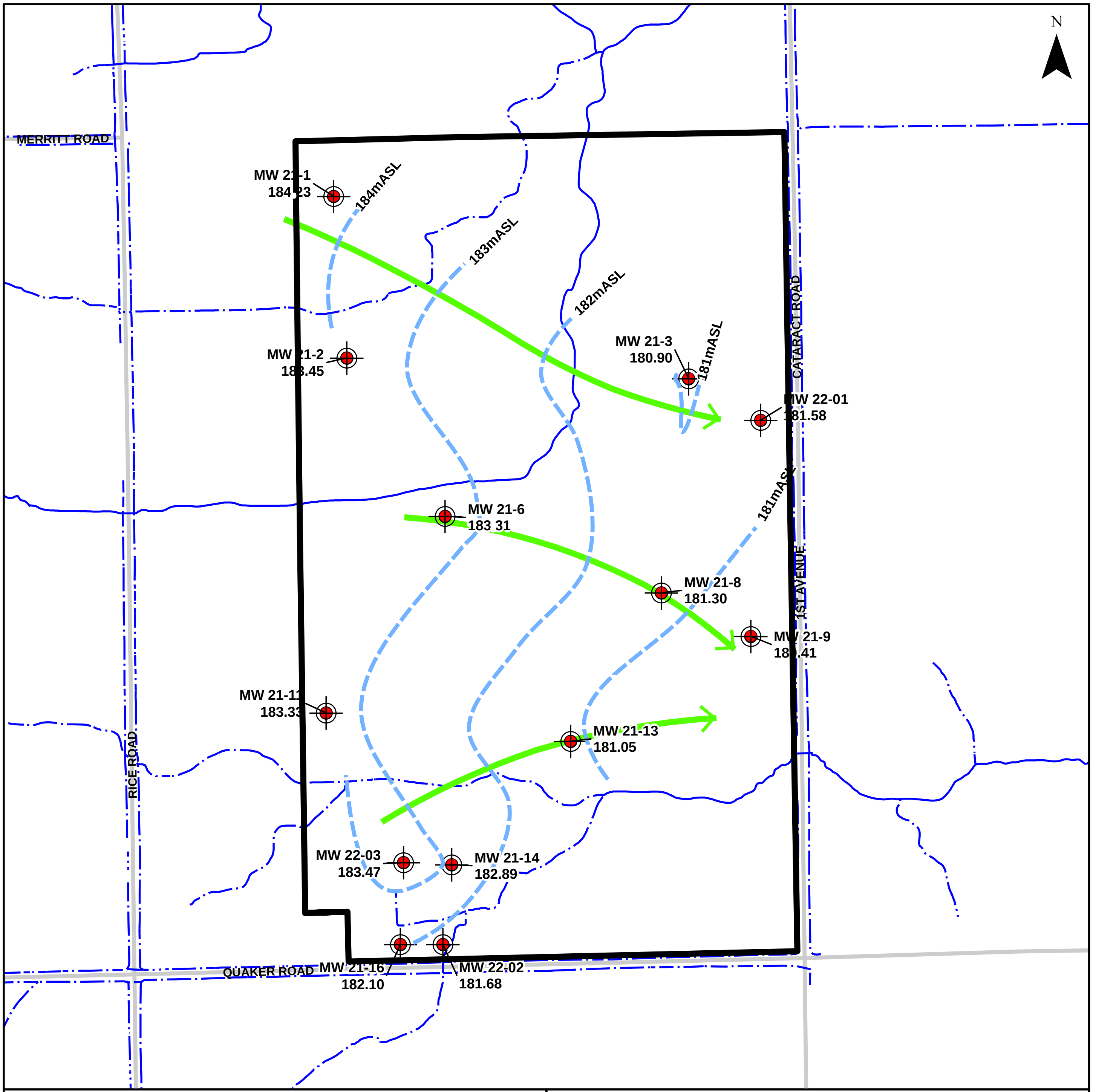
Figure 6

H:\TERRA_DYNAMICS\9647 - TD 436 Quaker Rd\corel\Figure 6 Hydrogeologic Cross-section west-east.cdr May 8, 2024



Legend

▭ Subject Lands

⊕ Monitoring Well Location and Groundwater Elevation (m ASL)

→ Groundwater Flow Direction

- - Water Table Elevation Contours (mASL)

NPCA Watercourse Permanency

-·- Ephemeral

— Intermittent or Ephemeral

Water Table Flow, November 2022

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

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Figure 8

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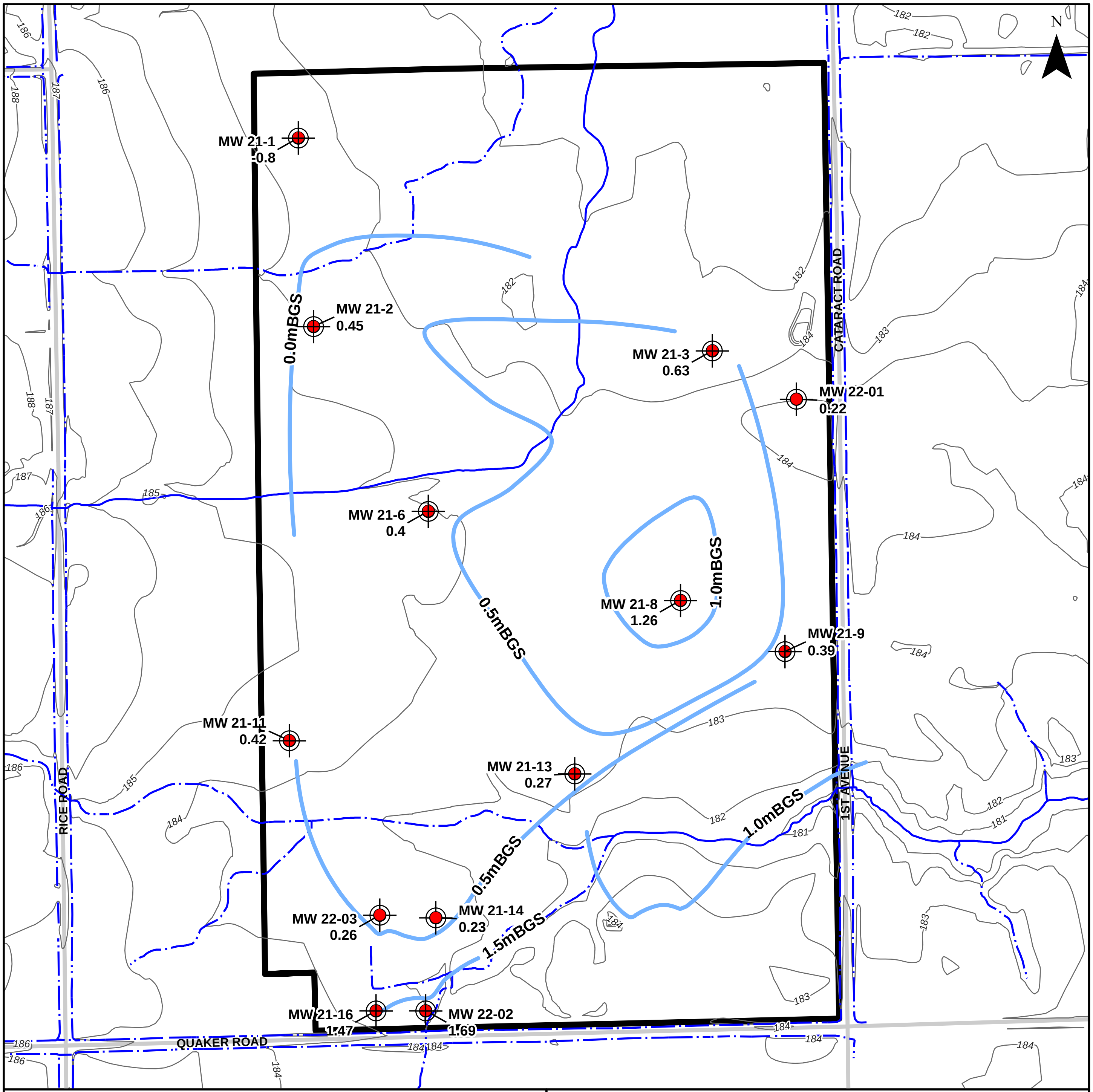

Legend

▭ Subject Lands

⊕ Monitoring Well Location and Depth to Water Table (m)

— Depth to Water Table (mBGS)

— Ground Surface Contour (NPCA)

NPCA Watercourse Permanency

-·- Ephemeral

— Intermittent or Ephemeral

Depth to Water Table, April 2023

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

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Figure 9

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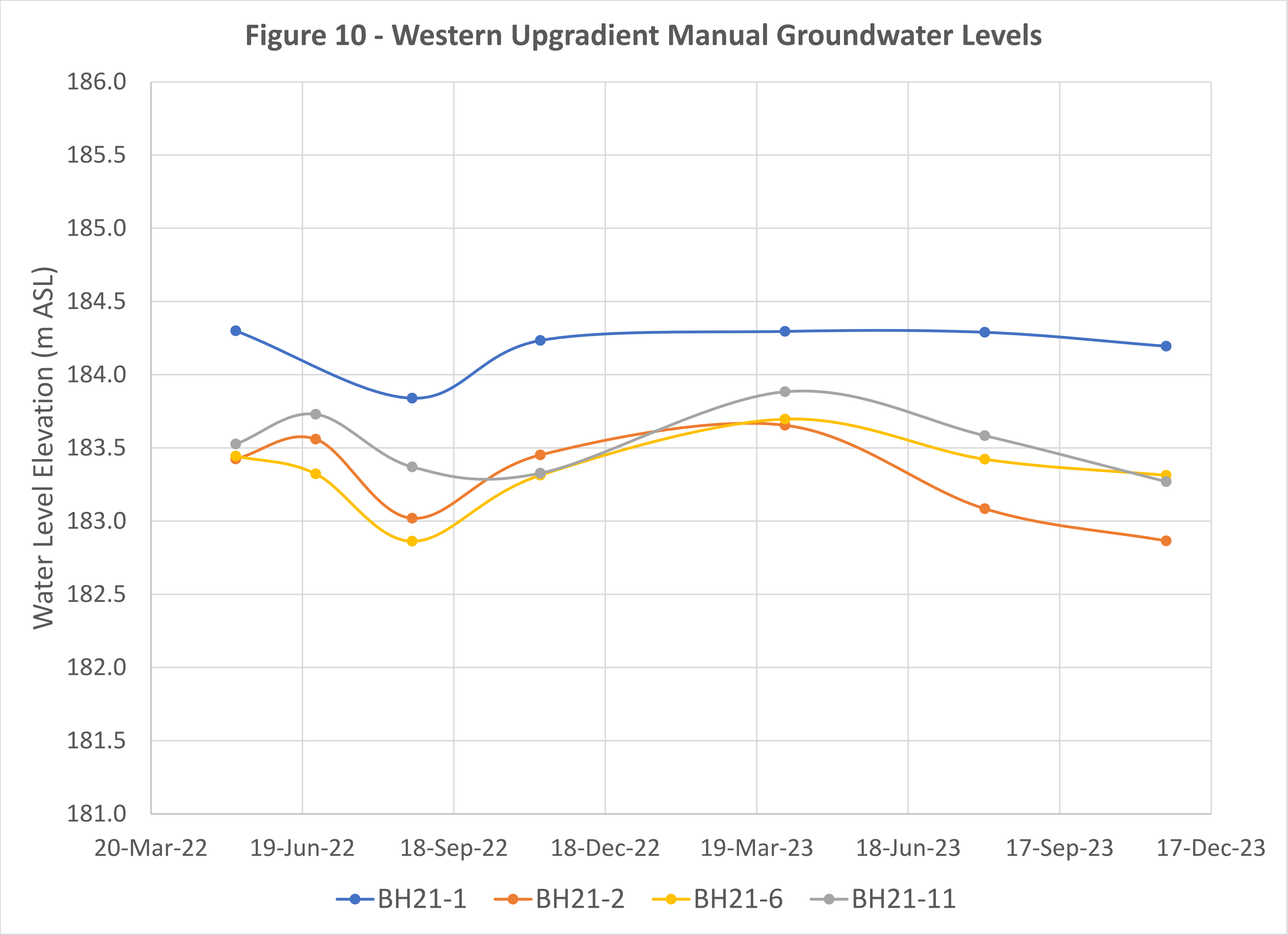


Figure 10 - Western Upgradient Manual Groundwater Levels
Water Level Elevation (m ASL)
186.0
185.5
185.0
184.5
184.0
183.5
183.0
182.5
182.0
181.5
181.0
20-Mar-22
19-Jun-22
18-Sep-22
18-Dec-22
19-Mar-23
18-Jun-23
17-Sep-23
17-Dec-23
BH21-1
BH21-2
BH21-6
BH21-11

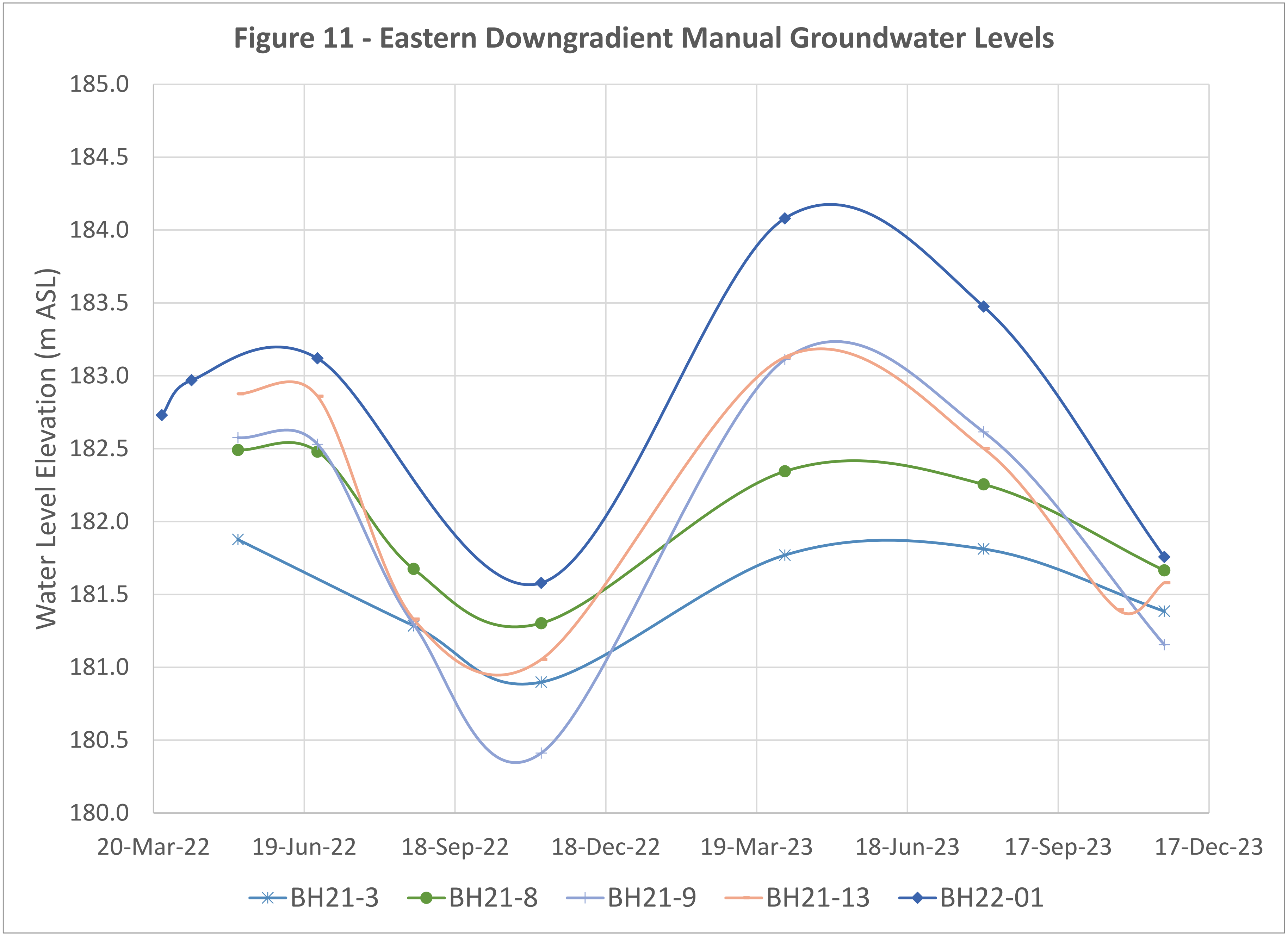


Figure 11 - Eastern Downgradient Manual Groundwater Levels

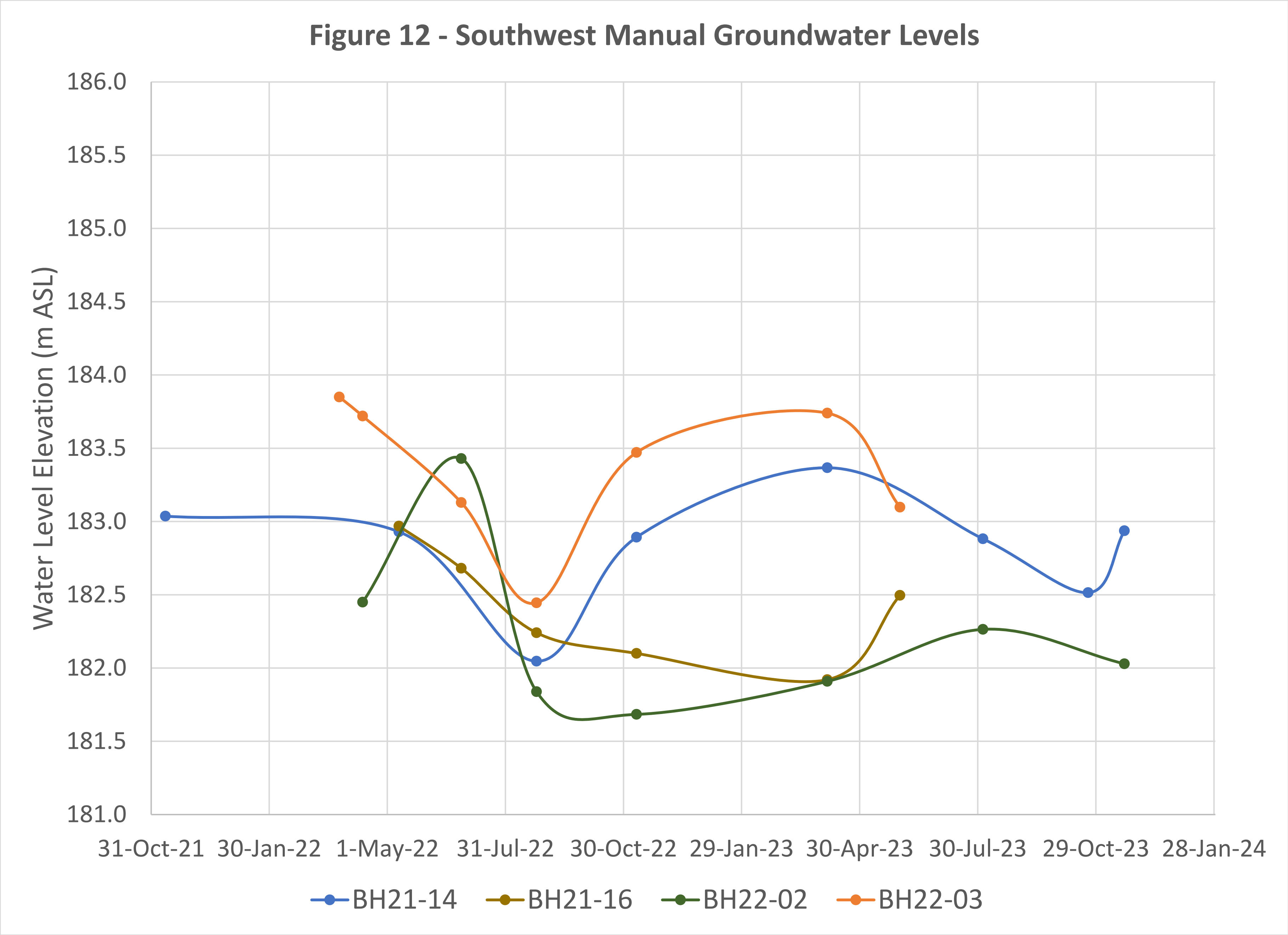
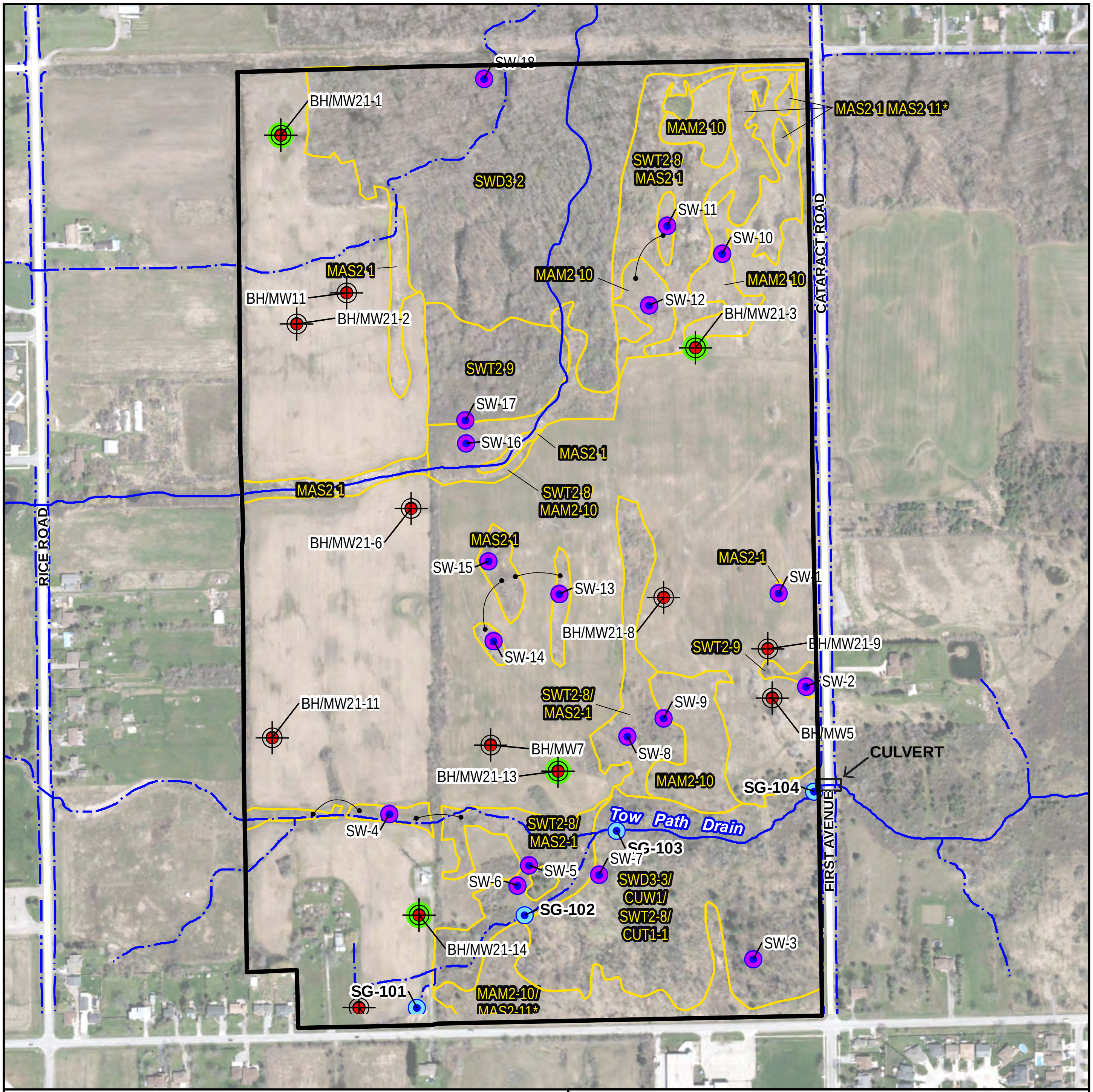


Figure 12 - Southwest Manual Groundwater Levels



Subject Lands

Monitoring Well with Logger

Monitoring Well

ELC Wetland

Wetland Monitoring Location

Staff Gauge

Watercourse (NPCA)

Ephemeral

Intermittent or Ephemeral

Ecological Land Classification (GEI, 2022)

ELC Code	ELC Name
CUT1-1	Sumac Cultural Thicket
CUW1	Mineral Cultural Woodland
MAM2-10	Forb Mineral Meadow Marsh
MAS2-1	Cattail Mineral Shallow Marsh
MAS2-11*	Southern Arrow-wood Mineral Thicket Swamp
SWD3-2	Silver Maple Mineral Deciduous Swamp
SWD3-3	Swamp Maple Mineral Deciduous Swamp
SWT2-8	Silky Dogwood Mineral Thicket Swamp
SWT2-9	Gray Dogwood Mineral Thicket Swamp

Wetland and Surface Water Monitoring

Hydrogeologic Study and Wetland Water Balance
436 Quaker Road, Welland and
Lot 228/Part Lot 174, Thorold, ON
Primont (Thorold/Welland) Inc.

Terra-Dynamics Consulting Inc.

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Figure 13

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Table 1
Welland-Pelham Precipitation Analyses

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Sum
Average* Precipitation (mm)	78.2	61.3	69.7	75.4	85.2	82.9	85.9	82.4	96.8	89.3	98.5	92	998
2021 Welland-Pelham	40.9	47.7	35.2	48.4	39.8	52.2	163.3	63.1	177	124.6	67.1	65.2	925
1-month Average +/-	52%	78%	51%	64%	47%	63%	190%	77%	183%	140%	68%	71%	93%
3-Month Average +/-	67%	67%	59%	64%	54%	58%	101%	111%	152%	136%	130%	92%	
2022 Welland-Pelham	62.1	99.7	59.2	53.4	63.7	72.6	72.5	51.2	86	107.5	104.9	64.4	897
1-month Average +/-	79%	163%	85%	71%	75%	88%	84%	62%	89%	120%	106%	70%	90%
3-Month Average +/-	72%	98%	106%	103%	77%	78%	82%	78%	79%	91%	105%	99%	
2023 Welland-Pelham	86.8	68.6	109.8	98.1	34.6	74.4	163	138.7	30.1	62.9	53.6	110.3	1031
1-month Average +/-	111%	112%	158%	130%	41%	90%	190%	168%	31%	70%	54%	120%	114%
3-Month Average +/-	99%	98%	127%	134%	105%	85%	107%	150%	125%	86%	52%	81%	

Notes: * - Welland Environment Canada (1981-2010, ID 6139445), Grey shading - monthly value between 95-105%, Blue shading >105%, Orange < 95%

Table 6
Monitoring Well Details and Water Levels

Well I.D.	Ground Elevation (m ASL)	Stick-Up (m)	TOC Elevation (m ASL)	Well Depth Below TOC (m)	Well Depth below ground (m)	Date	Water level (m below TOC)	Water Level below ground (m)	Water Level Elevation (m ASL)
BH21-1	183.5	0.82	184.32	6.17	5.35	10-May-22	0.02	-0.80	184.30
						24-Aug-22	0.48	-0.34	183.84
						9-Nov-22	0.09	-0.73	184.23
						5-Apr-23	0.02	-0.80	184.30
						3-Aug-23	0.03	-0.79	184.29
						20-Nov-23	0.13	-0.70	184.20
BH21-2	184.1	0.80	184.90	7.26	6.46	11-Nov-21	1.50	0.70	183.40
						10-May-22	1.48	0.68	183.42
						27-Jun-22	1.34	0.54	183.56
						24-Aug-22	1.88	1.08	183.02
						9-Nov-22	1.45	0.65	183.45
						5-Apr-23	1.25	0.45	183.66
						3-Aug-23	1.82	1.02	183.09
						20-Nov-23	2.04	1.24	182.87
BH21-3	182.4	0.82	183.22	7.12	6.31	10-May-22	1.34	0.52	181.88
						24-Aug-22	1.93	1.12	181.29
						9-Nov-22	2.32	1.50	180.90
						5-Apr-23	1.45	0.63	181.77
						3-Aug-23	1.40	0.59	181.81
						20-Nov-23	1.83	1.02	181.39
BH21-6	184.1	0.82	184.92	5.49	4.67	11-Nov-21	1.36	0.54	183.56
						10-May-22	1.48	0.66	183.44
						27-Jun-22	1.60	0.78	183.32
						24-Aug-22	2.06	1.24	182.86
						9-Nov-22	1.61	0.79	183.31
						5-Apr-23	1.23	0.40	183.70
						3-Aug-23	1.50	0.68	183.42
						20-Nov-23	1.61	0.79	183.31
BH21-8	183.6	0.85	184.45	6.42	5.57	11-Nov-21	2.22	1.37	182.23
						10-May-22	1.95	1.11	182.49
						27-Jun-22	1.97	1.12	182.48
						24-Aug-22	2.77	1.93	181.68
						9-Nov-22	3.14	2.30	181.30
						5-Apr-23	2.10	1.26	182.35
						3-Aug-23	2.19	1.35	182.26
						20-Nov-23	2.78	1.94	181.67
BH21-9	183.5	0.94	184.44	7.24	6.30	11-Nov-21	1.19	0.25	183.25
						10-May-22	1.86	0.92	182.58
						27-Jun-22	1.91	0.97	182.53
						24-Aug-22	3.14	2.21	181.30
						9-Nov-22	4.02	3.09	180.41
						5-Apr-23	1.32	0.39	183.11
						3-Aug-23	1.82	0.89	182.62
						20-Nov-23	3.28	2.35	181.16

Table 6
Monitoring Well Details and Water Levels

Well I.D.	Ground Elevation (m ASL)	Stick-Up (m)	TOC Elevation (m ASL)	Well Depth Below TOC (m)	Well Depth below ground (m)	Date	Water level (m below TOC)	Water Level below ground (m)	Water Level Elevation (m ASL)
BH21-11	184.3	0.68	184.98	6.99	6.31	10-May-22	1.45	0.77	183.53
						27-Jun-22	1.25	0.57	183.73
						24-Aug-22	1.61	0.93	183.37
						9-Nov-22	1.65	0.97	183.33
						5-Apr-23	1.10	0.42	183.88
						3-Aug-23	1.40	0.72	183.58
						20-Nov-23	1.71	1.03	183.27
BH21-13	183.4	0.82	184.22	7.13	6.31	11-Nov-21	1.37	0.55	182.85
						10-May-22	1.34	0.52	182.88
						27-Jun-22	1.36	0.54	182.86
						24-Aug-22	2.89	2.07	181.33
						9-Nov-22	3.17	2.35	181.05
						5-Apr-23	1.09	0.27	183.13
						3-Aug-23	1.72	0.90	182.50
						23-Oct-23	2.83	2.01	181.40
						20-Nov-23	2.64	1.82	181.58
BH21-14	183.6	0.89	184.49	7.15	6.26	11-Nov-21	1.45	0.56	183.04
						10-May-22	1.56	0.67	182.93
						24-Aug-22	2.44	1.55	182.05
						9-Nov-22	1.59	0.71	182.89
						5-Apr-23	1.12	0.23	183.37
						3-Aug-23	1.61	0.72	182.88
						23-Oct-23	1.97	1.09	182.52
						20-Nov-23	1.55	0.66	182.94
BH21-16	183.4	0.93	184.33	7.20	6.27	10-May-22	1.36	0.43	182.97
						27-Jun-22	1.65	0.72	182.68
						24-Aug-22	2.09	1.16	182.24
						9-Nov-22	2.23	1.30	182.10
						5-Apr-23	2.41	1.48	181.92
						31-May-23	1.84	0.90	182.50
BH22-01	184.3	1.14	185.44	7.12	5.99	25-Mar-22	2.71	1.57	182.73
						12-Apr-22	2.47	1.33	182.97
						27-Jun-22	2.32	1.18	183.12
						24-Aug-22	5.38	4.25	180.06
						9-Nov-22	3.86	2.72	181.58
						5-Apr-23	1.36	0.22	184.08
						3-Aug-23	1.96	0.83	183.48
						20-Nov-23	3.68	2.54	181.76
BH22-02	183.6	0.95	184.55	7.10	6.16	12-Apr-22	2.10	1.15	182.45
						27-Jun-22	1.12	0.17	183.43
						24-Aug-22	2.71	1.76	181.84
						9-Nov-22	2.87	1.92	181.68
						5-Apr-23	2.64	1.69	181.91
						3-Aug-23	2.29	1.34	182.26
						20-Nov-23	2.52	1.57	182.03

Table 6
Monitoring Well Details and Water Levels

Well I.D.	Ground Elevation (m ASL)	Stick-Up (m)	TOC Elevation (m ASL)	Well Depth Below TOC (m)	Well Depth below ground (m)	Date	Water level (m below TOC)	Water Level below ground (m)	Water Level Elevation (m ASL)
BH22-03	184.0	1.01	185.01	7.10	6.10	25-Mar-22	1.16	0.15	183.85
						12-Apr-22	1.29	0.28	183.72
						27-Jun-22	1.88	0.87	183.13
						24-Aug-22	2.56	1.56	182.45
						9-Nov-22	1.53	0.53	183.47
						5-Apr-23	1.27	0.26	183.74
						31-May-23	1.91	0.90	183.10
SM MW-5	183.1	1.34	184.46	7.54	6.20	5-Apr-23	1.43	0.09	183.04
SM MW-7	183.5	1.13	184.65	6.82	5.69	5-Apr-23	2.93	1.80	181.72
SM MW-11	183.2	1.17	184.40	7.10	5.93	5-Apr-23	0.69	-0.49	183.72
SG-101		0.55		0.78	0.22	10-Aug-23	0.53	N/A	
						6-Sep-23	0.00	N/A	
						3-Oct-23	0.00	N/A	
						23-Oct-23	0.00	N/A	
						20-Nov-23	0.54	N/A	
SG-102		0.54		0.78	0.24	10-Aug-23	0.43	N/A	
						6-Sep-23	0.00	N/A	
						3-Oct-23	0.00	N/A	
						23-Oct-23	0.50	N/A	
						20-Nov-23	0.43	N/A	
SG-103		0.56		0.79	0.23	10-Aug-23	0.40	N/A	
						6-Sep-23	0.00	N/A	
						3-Oct-23	0.00	N/A	
						23-Oct-23	0.00	N/A	
						20-Nov-23	0.42	N/A	
SG-104		0.54		0.78	0.24	10-Aug-23	0.43	N/A	
						6-Sep-23	0.00	N/A	
						3-Oct-23	0.00	N/A	
						23-Oct-23	0.51	N/A	
						20-Nov-23	0.45	N/A	

Table 9 - Early Manual Wetland Water Level Measurements

Location ID	Soil Type	Depth May 10, 2022 (m)	Depth May 24, 2022 (m)	Depth July 21, 2022 (m)
SW-1	Silty Clay	0.13	0.07	0.00
SW-2	Silty Clay	0.14	0.00	0.00
SW-3	Silty Clay	N/A	0.14	0.06
SW-4	Silty Clay	0.05	0.03	0.00
SW-5	Silty Clay	0.04	0.00	0.00
SW-6	Silty Clay	0.13	0.30	0.02
SW-7	Silty Clay	0.07	0.12	0.00
SW-8	Silty Clay	N/A	0.13	0.00
SW-9	Silty Clay	N/A	0.03	0.00
SW-10	Silty Clay	N/A	0.02	0.00
SW-11	Silty Clay	0.16	0.08	0.00
SW-12	Silty Clay	0.14	0.06	0.03
SW-13	Silty Clay	0.18	0.05	0.00
SW-14	Silty Clay	0.26	0.29	0.00
SW-15	Silty Clay	0.17	0.27	0.00
SW-16	Silty Clay	0.05	0.00	0.00
SW-17	Silty Clay	0.20	0.05	0.00
SW-18	Silty Clay	0.30	0.18	0.01

TABLE 12a
400 mm USGS Wetland Monthly Water Balance (1981-2010)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
========	========	========	========	========	========	========	========	========	========	
January	78.2	9.7	45.6	400	9.7	0	31.3	45.6	50.9	Surplus
February	61.3	11.6	48.1	400	11.6	0	31.3	48.1	50.2	Surplus
March	69.7	21.3	68.1	400	21.3	0	8.8	68.1	61.2	Surplus
April	75.4	39.6	40.8	400	39.6	0	0	40.8	53.4	Surplus
May	85.2	71.6	9.3	400	71.6	0	0	9.3	33.7	Surplus
June	82.9	105.8	-27.1	372.9	105.8	0	0	0	18.9	Soil Water Utilization
July	85.9	124.8	-43.2	332.6	121.9	2.9	0	0	11.7	Soil Water Utilization
August	82.4	100.9	-22.6	313.9	97.1	3.8	0	0	7.8	Soil Water Utilization
September	96.8	60.2	31.7	345.6	60.2	0	0	0	6.7	Soil Water Recharge
October	89.3	32.2	52.6	398.2	32.2	0	0	0	5.4	Soil Water Recharge
November	98.5	17.2	76.4	400	17.2	0	0	74.6	42.7	Surplus
December	92	10.9	67.9	400	10.9	0	10.1	67.9	55.9	Surplus
Sum	997.6				599.1				398.5	

TABLE 12b
350 mm USGS Wetland Monthly Water Balance (1981-2010)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
January	78.2	9.7	45.6	350	9.7	0	31.3	45.6	51	Surplus
February	61.3	11.6	48.1	350	11.6	0	31.3	48.1	50.3	Surplus
March	69.7	21.3	68.1	350	21.3	0	8.8	68.1	61.2	Surplus
April	75.4	39.6	40.8	350	39.6	0	0	40.8	53.4	Surplus
May	85.2	71.6	9.3	350	71.6	0	0	9.3	33.7	Surplus
June	82.9	105.8	-27.1	323	105.8	0	0	0	18.9	Soil Water Utilization
July	85.9	124.8	-43.2	283	121.5	3.3	0	0	11.7	Soil Water Utilization
August	82.4	100.9	-22.6	265	96.5	4.3	0	0	7.8	Soil Water Utilization
September	96.8	60.2	31.7	297	60.2	0	0	0	6.7	Soil Water Recharge
October	89.3	32.2	52.6	349	32.2	0	0	0	5.4	Soil Water Recharge
November	98.5	17.2	76.4	350	17.2	0	0	75.5	43.1	Surplus
December	92	10.9	67.9	350	10.9	0	10.1	67.9	56.2	Surplus
Sum	997.6				598.1				399.4	

TABLE 12c
375 mm USGS Wetland Monthly Water Balance (1981-2010)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
========	========	========	========	========	========	========	========	========	========	
January	78.2	9.7	45.6	375	9.7	0	31.3	45.6	51	Surplus
February	61.3	11.6	48.1	375	11.6	0	31.3	48.1	50.2	Surplus
March	69.7	21.3	68.1	375	21.3	0	8.8	68.1	61.2	Surplus
April	75.4	39.6	40.8	375	39.6	0	0	40.8	53.4	Surplus
May	85.2	71.6	9.3	375	71.6	0	0	9.3	33.7	Surplus
June	82.9	105.8	-27.1	347.9	105.8	0	0	0	18.9	Soil Water Utilization
July	85.9	124.8	-43.2	307.8	121.7	3.1	0	0	11.7	Soil Water Utilization
August	82.4	100.9	-22.6	289.3	96.8	4	0	0	7.8	Soil Water Utilization
September	96.8	60.2	31.7	321	60.2	0	0	0	6.7	Soil Water Recharge
October	89.3	32.2	52.6	373.7	32.2	0	0	0	5.4	Soil Water Recharge
November	98.5	17.2	76.4	375	17.2	0	0	75	42.9	Surplus
December	92	10.9	67.9	375	10.9	0	10.1	67.9	56	Surplus
Sum	997.6				598.6				398.9	

TABLE 13a
400 mm USGS Wetland Monthly Water Balance (2022)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
January	62.1	7.9	11.9	400	7.9	0	41.7	11.9	29.8	Surplus
February	99.7	11.2	75.1	400	11.2	0	52.9	75.1	54.4	Surplus
March	59.2	22.9	80.3	400	22.9	0	6.2	80.3	68.9	Surplus
April	53.4	38.4	18.6	400	38.4	0	0	18.6	45.1	Surplus
May	63.7	80.1	-19.5	380.5	80.1	0	0	0	24.4	Soil Water Utilization
June	72.6	104.5	-35.6	346.6	102.8	1.7	0	0	14.2	Soil Water Utilization
July	72.5	122.5	-53.6	300.2	115.3	7.2	0	0	8.9	Soil Water Utilization
August	51	104.7	-56.2	258	90.6	14	0	0	5.2	Soil Water Utilization
September	86	60.2	21.5	279.4	60.2	0	0	0	5.6	Soil Water Recharge
October	107.5	31.2	70.9	350.3	31.2	0	0	0	6	Soil Water Recharge
November	104.9	18.2	81.5	400	18.2	0	0	31.8	21.5	Surplus
December	64.4	11.9	46.7	400	11.9	0	3.3	46.7	34	Surplus
Sum	897				590.7				318	

TABLE 13b
350 mm USGS Wetland Monthly Water Balance (2022)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
January	62.1	7.9	11.9	350	7.9	0	41.7	11.9	29.9	Surplus
February	99.7	11.2	75.1	350	11.2	0	52.9	75.1	54.4	Surplus
March	59.2	22.9	80.3	350	22.9	0	6.2	80.3	68.9	Surplus
April	53.4	38.4	18.6	350	38.4	0	0	18.6	45.1	Surplus
May	63.7	80.1	-19.5	330.5	80.1	0	0	0	24.4	Soil Water Utilization
June	72.6	104.5	-35.6	296.9	102.5	2	0	0	14.2	Soil Water Utilization
July	72.5	122.5	-53.6	251.4	114.4	8.1	0	0	8.9	Soil Water Utilization
August	51	104.7	-56.2	211	88.8	15.8	0	0	5.2	Soil Water Utilization
September	86	60.2	21.5	232.5	60.2	0	0	0	5.6	Soil Water Recharge
October	107.5	31.2	70.9	303.4	31.2	0	0	0	6	Soil Water Recharge
November	104.9	18.2	81.5	350	18.2	0	0	34.8	23	Surplus
December	64.4	11.9	46.7	350	11.9	0	3.3	46.7	34.7	Surplus
Sum	897				587.7				320.3	

TABLE 13c
375 mm USGS Wetland Monthly Water Balance (2022)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
January	62.1	7.9	11.9	375	7.9	0	41.7	11.9	29.9	Surplus
February	99.7	11.2	75.1	375	11.2	0	52.9	75.1	54.4	Surplus
March	59.2	22.9	80.3	375	22.9	0	6.2	80.3	68.9	Surplus
April	53.4	38.4	18.6	375	38.4	0	0	18.6	45.1	Surplus
May	63.7	80.1	-19.5	355.5	80.1	0	0	0	24.4	Soil Water Utilization
June	72.6	104.5	-35.6	321.7	102.7	1.9	0	0	14.2	Soil Water Utilization
July	72.5	122.5	-53.6	275.7	114.9	7.6	0	0	8.9	Soil Water Utilization
August	51	104.7	-56.2	234.4	89.8	14.9	0	0	5.2	Soil Water Utilization
September	86	60.2	21.5	255.9	60.2	0	0	0	5.6	Soil Water Recharge
October	107.5	31.2	70.9	326.8	31.2	0	0	0	6	Soil Water Recharge
November	104.9	18.2	81.5	375	18.2	0	0	33.2	22.2	Surplus
December	64.4	11.9	46.7	375	11.9	0	3.3	46.7	34.3	Surplus
Sum	897				589.4				319.1	

TABLE 14a
400 mm USGS Wetland Monthly Water Balance (2023)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
========	========	========	========	========	========	========	========	========	========	
January	86.8	12.4	67.2	400	12.4	0	7.2	67.2	52.5	Surplus
February	68.6	13.3	50	400	13.3	0	10.3	50	51.9	Surplus
March	109.8	22.1	89.3	400	22.1	0	4	89.3	74.2	Surplus
April	98.1	42.9	54.3	400	42.9	0	0	54.3	66.8	Surplus
May	34.6	64	-31.2	368.8	64	0	0	0	32.7	Soil Water Utilization
June	74.4	102.6	-31.9	339.4	100.1	2.5	0	0	19.2	Soil Water Utilization
July	163	122.5	32.4	371.7	122.5	0	0	0	15.9	Soil Water Recharge
August	138.7	91.9	39.9	400	91.9	0	0	11.6	16.6	Surplus
September	30.1	63.3	-34.7	365.3	63.3	0	0	0	6.3	Soil Water Utilization
October	62.9	36.5	23.3	388.6	36.5	0	0	0	5.6	Soil Water Recharge
November	53.6	16.5	34.5	400	16.5	0	0	23	15.4	Surplus
December	110.3	14.4	90.3	400	14.4	0	0	90.3	57	Surplus
Sum	1030.9				599.9				414.1	

TABLE 14b
350 mm USGS Wetland Monthly Water Balance (2023)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
========	========	========	========	========	========	========	========	========	========	
January	86.8	12.4	67.2	350	12.4	0	7.2	67.2	52.9	Surplus
February	68.6	13.3	50	350	13.3	0	10.3	50	52.1	Surplus
March	109.8	22.1	89.3	350	22.1	0	4	89.3	74.3	Surplus
April	98.1	42.9	54.3	350	42.9	0	0	54.3	66.9	Surplus
May	34.6	64	-31.2	318.8	64	0	0	0	32.7	Soil Water Utilization
June	74.4	102.6	-31.9	289.7	99.8	2.8	0	0	19.2	Soil Water Utilization
July	163	122.5	32.4	322.1	122.5	0	0	0	15.9	Soil Water Recharge
August	138.7	91.9	39.9	350	91.9	0	0	12	16.8	Surplus
September	30.1	63.3	-34.7	315.3	63.3	0	0	0	6.4	Soil Water Utilization
October	62.9	36.5	23.3	338.6	36.5	0	0	0	5.6	Soil Water Recharge
November	53.6	16.5	34.5	350	16.5	0	0	23	15.4	Surplus
December	110.3	14.4	90.3	350	14.4	0	0	90.3	57.1	Surplus
Sum	1030.9				599.6				415.3	

TABLE 14c
375 mm USGS Wetland Monthly Water Balance (2023)

Date	P	PET	P-PET	Soil Moisture	AET	PET-AET	Snow Storage	Surplus	ROtotal	Comments
========	========	========	========	========	========	========	========	========	========	
January	86.8	12.4	67.2	375	12.4	0	7.2	67.2	52.7	Surplus
February	68.6	13.3	50	375	13.3	0	10.3	50	52	Surplus
March	109.8	22.1	89.3	375	22.1	0	4	89.3	74.2	Surplus
April	98.1	42.9	54.3	375	42.9	0	0	54.3	66.8	Surplus
May	34.6	64	-31.2	343.8	64	0	0	0	32.7	Soil Water Utilization
June	74.4	102.6	-31.9	314.6	100	2.7	0	0	19.2	Soil Water Utilization
July	163	122.5	32.4	346.9	122.5	0	0	0	15.9	Soil Water Recharge
August	138.7	91.9	39.9	375	91.9	0	0	11.8	16.7	Surplus
September	30.1	63.3	-34.7	340.3	63.3	0	0	0	6.4	Soil Water Utilization
October	62.9	36.5	23.3	363.6	36.5	0	0	0	5.6	Soil Water Recharge
November	53.6	16.5	34.5	375	16.5	0	0	23	15.4	Surplus
December	110.3	14.4	90.3	375	14.4	0	0	90.3	57.1	Surplus
Sum	1030.9				599.8				414.7	

Appendix A

Terms of Reference

TDC Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2 St. Catharines, ON L2M 4W3

August 2, 2022

Niagara Peninsula Conservation Authority
250 Thorold Road West, 3rd Floor
Welland, ON L3C 3W2

Re: Updated Water Balance Terms of Reference, Residential Subdivision, 436 Quaker Road, Welland, and Lot 228 /Part Lot 174, Thorold, ON

1.0 Introduction and Background Information

Terra-Dynamics Consulting Inc. respectfully submits this updated Terms of Reference (TofR) responding to comments provided by the Niagara Peninsula Conservation Authority on the TofR submitted April 13, 2022. This TofR is to complete a Site, and wetland feature-based, water balance assessment for the proposed Primont Homes Welland/Thorold Residential Subdivisions. It is our understanding the Site is approximately 64 hectares in size within the City of Welland and the Town of Thorold, and includes 436 Quaker Road in Welland, and Lot 228 and Part Lot 174, Town of Thorold.

The Ministry of Natural Resources and Forestry (MNRF) have mapped approximately 17 hectares of provincially significant wetland at the Site associated with the Niagara Street Cataract Road Woodlot Wetland Complex (MNRF, 2009) including:

1. 5.2 hectares of swamp along Quaker Road and First Avenue in the southeast corner of the Site,
2. 8.2 hectares of swamp in the northern portion of the Site, and
3. 3.6 hectares of marsh in the northeast corner of the Site along Cataract Road.

This scope of work is based upon our experience with the NPCA, and Niagara Region, requiring water balances and our experience studying Niagara's physical environment. Our current understanding of the study requirements are detailed below after a review of information provided by Walter Fedy including a geotechnical investigation report (DS Consultants, 2021), a Conceptual Wetland Restoration Plan (GEI Consultants, 2022) and discussions with GEI Consultants biologists.

2.0 Water Balance Scope of Work

A water balance assessment, both Site and feature-based wetland, will be completed to:

1. Ensure no negative impacts to the natural heritage system;

2. Inform stormwater management design at the Site in such a manner that pre-development water balance conditions are maintained for all wetlands in the Natural Heritage System Designation. A detailed water balance will be required as part of a stormwater management plan submission; and

3. PSW Wetlands be conserved, with the successful matching of pre- and post-development water balances, as best as practical.

Our water balance will address these requirements and be completed following the Conservation Authority Guidelines for Hydrogeological Assessments (see attached Table 1, Conservation Ontario, 2013) and include (i) a description of pre-development conditions, (ii) impact assessment and (iii) recommended mitigation measures for a subdivision on municipal servicing.

The feature-based wetland water balance assessment will evaluate the pre-development hydrologic regime of the Provincially significant wetland areas on-site associated with the Niagara Street Cataract Road Woodlot Wetland Complex (MNRF, 2009).

2.2.1 Field Investigation

Wetland hydroperiod characterization from hydrologic field monitoring includes a year of monitoring at the following locations (Figure 1):

a) eighteen (18) wetland monitoring staff gauges with datalogging pressure transducers (water level loggers);
b) datalogging pressure transducers (water level loggers) installed in four (4) on-site shallow monitoring wells (BH21-1, BH21-3, BH21-13 and BH21-14) constructed by DS Consultants (2021) corresponding with the three primary MNRF wetland polygons; and
c) installation of a barometric pressure data logger to correct for barometric pressure changes on water levels.

Groundwater levels will also be manually measured at the existing on-Site ten (10) monitoring wells in the spring, summer and fall seasons.

Hydraulic conductivity testing will be completed of the four monitoring wells with datalogging pressure transducers installed adjacent the wetlands and compared to hydraulic conductivities calculated from grain-size analyses completed during the geotechnical analyses.

2.2.2 Water Balance/Wetland Modelling

The water balance assessment will use existing long-term water balance modelling by NPCA (AquaResource Inc. and Niagara Peninsula Conservation Authority (NPCA), 2009). This modelling was completed at an hourly interval over a fifteen-year period (1991-2005) providing baseline pre-development water balance values. This approach exceeds the minimum requirements for a “low risk” water balance (Figure 2). Results will be refined using information obtained during the geotechnical investigation and our own field investigations to further refine the hydrogeological characterization.

A water balance model will be completed for the wetland using the United States Geological Survey (USGS) Thornthwaite Monthly Water Balance (McCabe and Markstrom, 2007). The model provides:

i. A number of adjustable parameters for calibration of pre-development conditions to Niagara Peninsula Conservation Authority (NPCA) water balance modelling (AquaResource Inc. and NPCA, 2009); and

ii. A monthly water balance, as this is commonly sufficient detail for assessing wetland hydrologic function during summer months on low permeability soils.

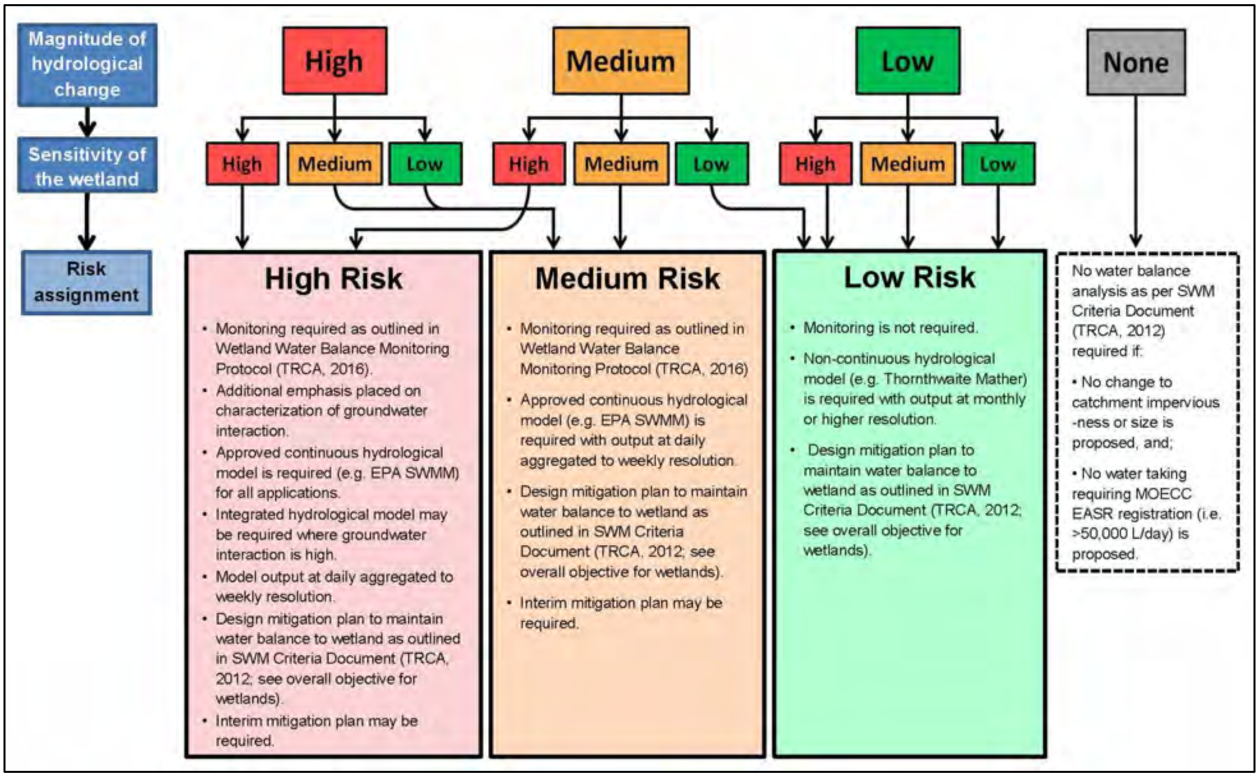
Pre- and post-development wetland catchments will be determined, mapped and used for the wetland water balance analyses.

2.2.4 Wetland Risk Evaluation

Since early 2021, NPCA has been requiring water balances conform to the guidelines (2012), monitoring protocols (2016) and risk evaluations (2017) developed by the Toronto Region Conservation Authority (TRCA). This work program will exceed the requirements for “low risk” evaluation as specified by the TRCA and include a risk evaluation (Figure 2, 2017).

2.2.5 Mitigation

The post-development water balance will consider the proposed storm drainage plan and recommendations provided for the Stormwater Management Plan to improve post-development water management completing the water balance requirement for a “mitigation plan” (Figure 2, TRCA, 2017). It is expected that a mitigation plan can be developed to avoid any requirements for new continuous water balance modelling.



High Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016).
- Additional emphasis placed on characterization of groundwater interaction.
- Approved continuous hydrological model is required (e.g. EPA SWMM) for all applications.
- Integrated hydrological model may be required where groundwater interaction is high.
- Model output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Medium Risk

- Monitoring required as outlined in Wetland Water Balance Monitoring Protocol (TRCA, 2016)
- Approved continuous hydrological model (e.g. EPA SWMM) is required with output at daily aggregated to weekly resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).
- Interim mitigation plan may be required.

Low Risk

- Monitoring is not required.
- Non-continuous hydrological model (e.g. Thornthwaite Mather) is required with output at monthly or higher resolution.
- Design mitigation plan to maintain water balance to wetland as outlined in SWM Criteria Document (TRCA, 2012; see overall objective for wetlands).

No water balance analysis as per SWM Criteria Document (TRCA, 2012) required if:

- No change to catchment imperviousness or size is proposed, and;
- No water taking requiring MOECC EASR registration (i.e. >50,000 L/day) is proposed.

Figure 2 – Wetland Risk Evaluation Decision Tree (TRCA, 2017)

We trust this information is sufficient for your present needs. Thank you for the opportunity to submit this proposed Terms of Reference. Please do not hesitate to contact us if you have any questions.

Yours truly,

TERRA-DYNAMICS CONSULTING INC.

Jayme D. Campbell

Jayme D. Campbell, P. Eng.
Senior Water Resources Engineer

cc. Eric Salembier, WalterFedy

<u>Attachments</u>
Figure 1 – Monitoring Locations
Table 1 – Hydrogeological Assessment Check List intended to Support Development Applications

7.0 References

AquaResource Inc. and Niagara Peninsula Conservation Authority (NPCA), 2009. Water Availability Study for the Central Welland River, Big Forks Creek, and Beaverdams Shriners Creeks Watershed Plan Areas, Niagara Peninsula Source Protection Area.

Conservation Ontario, 2013. Hydrogeological Assessment Submissions, Conservation Authority Guidelines for Development Applications.

DS Consultants Ltd., 2022. Report on Preliminary Geotechnical Investigation, Quaker Road and First Avenue, Welland, Ontario. Prepared for Primont Homes.

GEI Consultants, 2022. Conceptual Wetland Restoration Plan for removal of unevaluated wetlands on lands owned by Primont Homes within the City of Welland and City of Thorold, Ontario. Prepared for Ian MacPherson, Primont Homes.

McCabe, G.J., and Markstrom, S.L., 2007. A monthly water-balance model driven by a graphical user interface. U.S. Geological Survey Open-File report 2007-1008, 6p.

Ministry of Natural Resources and Forestry (MNRF), 2009. Niagara Street – Cataract Road Wetland Complex, Wetland Evaluation Edition 3rd.

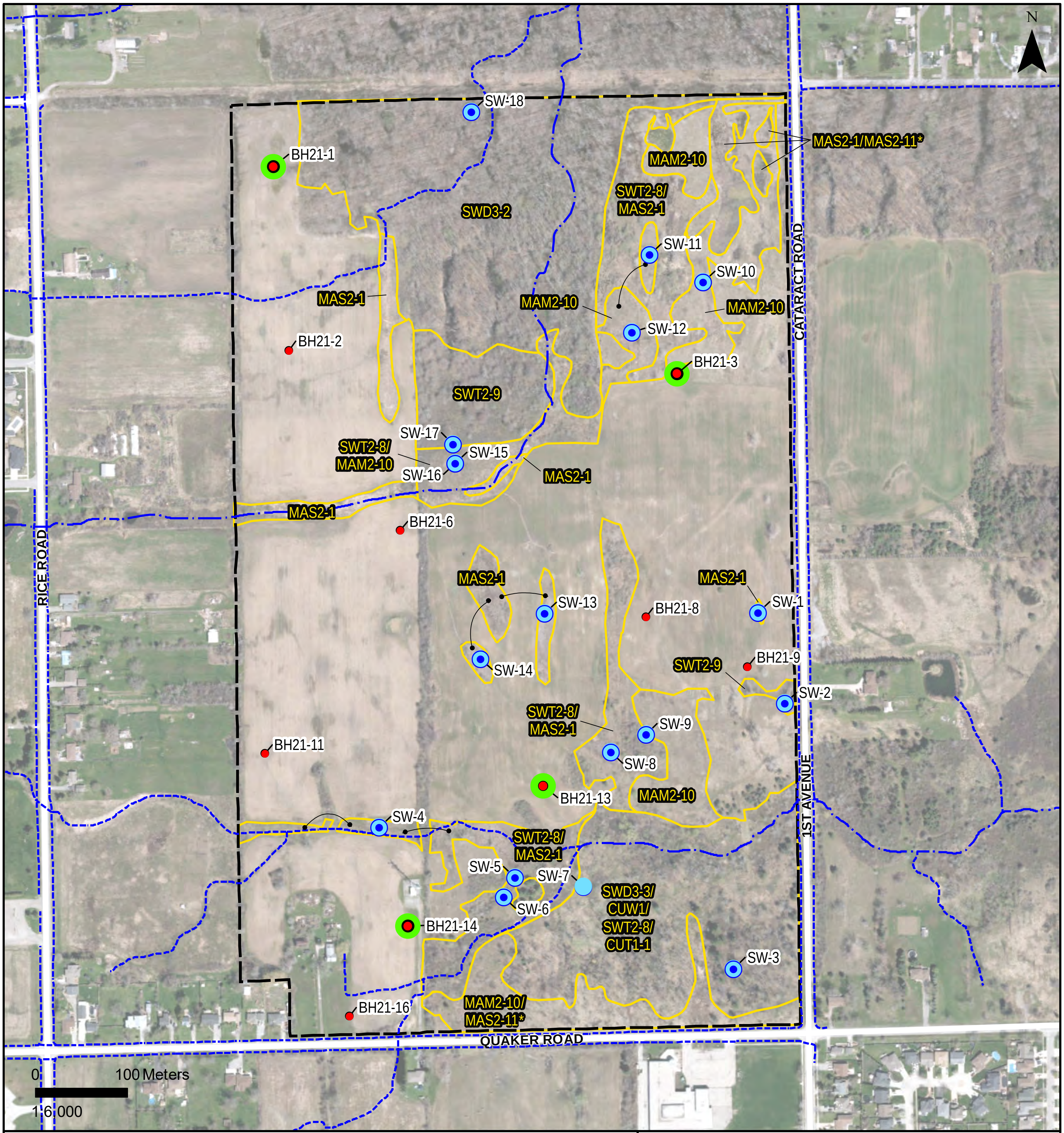
Niagara Peninsula Conservation Authority, 2022. RE: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference. E-mail from Nicholas Godfrey (Watershed Planner) to Jayme Campbell (Senior Water Resource Engineer).

Niagara Peninsula Conservation Authority and AquaResource Inc., 2010. Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment Final Report, Niagara Peninsula Source Protection Area.

Toronto and Region Conservation Authority (TRCA), 2017. Wetland Water Balance Risk Evaluation.

Toronto and Region Conservation Authority (TRCA), 2016. Wetland Water Balance Monitoring Protocol.

Toronto and Region Conservation Authority (TRCA), 2012. Water Balance Guidelines for the Protection of Natural Features.



⌐¬	Subject Lands
●	Monitoring Well
●	Monitoring Well and Datalogger
☐	ELC Wetland
●	Wetland Monitoring Location

Watercourse (NPCA)

---	Ephemeral
-·-	Intermittent or Ephemeral

ELC Code	ELC Name
CUT1-1	Sumac Cultural Thicket
CUW1	Mineral Cultural Woodland
MAM2-10	Forb Mineral Meadow Marsh
MAS2-1	Cattail Mineral Shallow Marsh
MAS2-11*	Southern Arrow-wood Mineral Thicket Swamp
SWD3-2	Silver Maple Mineral Deciduous Swamp
SWD3-3	Swamp Maple Mineral Deciduous Swamp
SWT2-8	Silky Dogwood Mineral Thicket Swamp
SWT2-9	Gray Dogwood Mineral Thicket Swamp

Monitoring Locations

Water Balance, 436 Quaker Rd, Welland
and Lot 228/Lot 174, Thorold, ON
Primont Homes

TDC Terra-Dynamics Consulting Inc.

Figure 1

Path: H:\TERRA_DYNAMICS\9563 - TD Primont\gis\mxd\Figure 1 Monitoring Locations.mxd Revised: August 2, 2022

Table 1: Hydrogeological Assessment Check List intended to Support Development Applications

Groundwater Assessment	Master Environmental Servicing Plan or Equivalent	Environmental Assessment (EA)	Site Plan Commercial, Institutional, or Industrial	Subdivision or Condominium Development		Single lot Residential	Dewatering
				Municipal Servicing	Private Servicing		
1. EXISTING CONDITIONS:							
Introduction and background	☐	☐	☐	☐	☐	☐	☐
Site location and description	☐	☐	☐	☐	☐	☐	☐
Description of: • Topography & Drainage • Physiography • Geology & Soils	☐	☐	☐	☐	☐	☐	☐
Test pits/Boreholes	☐	☐	☐	☐	☐	GNR	☐
Monitoring Wells	☐	☐	☐	☐	☐	GNR	☐
Private Well Survey	☐	☐	☐	☐	☐	GNR	☐
Hydrostratigraphy/Hydrogeology: • Aquifer properties • Groundwater Levels • Groundwater flow direction	☐	☐	☐	☐	☐	☐	☐
Description of surface water features and functions	☐	☐	☐	☐	☐	☐	☐
Water Taking Permit details	GNR	GNR	GNR	GNR	GNR	GNR	☐
Water Quality	☐	☐	☐	☐	☐	GNR	☐
D-5-5 (Water Supply)	GNR	GNR	GNR	GNR	☐	GNR	GNR

Groundwater Assessment	**Master Environmental Servicing Plan or Equivalent**	**Environmental Assessment (EA)**	**Site Plan Commercial, Institutional, or Industrial**	**Subdivision or Condominium Development**		**Single lot Residential**	**Dewatering**
				Municipal Servicing	**Private Servicing**		
2. IMPACT ASSESSMENT:							
Groundwater Levels	☐	☐	☐	☐	☐	GNR	☐
Pumping Tests*	☐	☐	GNR	GNR	☐	GNR	☐
Groundwater Discharge (Baseflow)	☐	☐	☐	☐	☐	GNR	☐
Water Balance	☐	☐	☐	☐	☐	GNR	GNR
Groundwater Quality	☐	☐	☐	☐	☐	GNR	☐
D-5-4 (Onsite Sewage Systems)	GNR	GNR	GNR	GNR	☐	GNR	GNR
3. MITIGATION MEASURES:							
Maintenance of Infiltration/Recharge	☐	☐	☐	☐	☐	GNR	GNR
Maintenance Groundwater Quality	☐	☐	☐	☐	☐	GNR	☐
Monitoring Program	☐	☐	☐	☐	☐	GNR	☐
Contingency Plans**	GNR	GNR	GNR	☐	☐	GNR	☐

NOTES: This table outlines the type of planning application and associated requirements most commonly required by Conservation Authorities in the review of Hydrogeological Assessments. This table is not a complete list of all types of applications dealt with by each Conservation Authority nor is the checklist appropriate for every development situation. Individual Conservation Authorities should be consulted with for specific requirements.

☐ - *Recommended*
GNR – Generally Not Required
** Where development is municipally serviced, these tests will be necessary on a case by case basis (sensitive aquifer/ aquatic considerations).*
***May be scoped, Contingency Plans will not be needed in most cases.*

From:	Taran Lennard <tlennard@npca.ca>
Sent:	August 9, 2022 12:46 PM
To:	jcampbell@terra-dynamics.com
Cc:	'Eric Salembier'
Subject:	RE: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Hi Jayme,

The previous comments have been addressed to the satisfaction of NPCA. Staff do not offer further comment on the ToR for the Water Balance.

Thank you.

Taran Lennard
Watershed Planner
Niagara Peninsula Conservation Authority (NPCA)
250 Thorold Road West, 3rd Floor | Welland, ON L3C 3W2
Tel: 905-788-3135 | extension 277
email: tlennard@npca.ca

NPCA Watershed Explorer

From: jcampbell@terra-dynamics.com <jcampbell@terra-dynamics.com>
Sent: Tuesday, August 2, 2022 3:27 PM
To: Taran Lennard <tlennard@npca.ca>
Cc: Sarah Mastroianni <smastroianni@npca.ca>; 'Eric Salembier' <esalembier@walterfedy.com>
Subject: RE: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Good afternoon Taran,

Please find attached the updated water balance Terms of Reference with the additional information requested by NPCA.

Jayme D. Campbell, P.Eng.

Senior Water Resource Engineer
Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2, St. Catharines, Ontario L2M 4W3
Phone: 289-407-0915
https://terra-dynamics.com/

Common sense solutions to environmental challenges

From: Nicholas Godfrey <ngodfrey@npca.ca>
Sent: May 25, 2022 1:07 PM
To: jcampbell@terra-dynamics.com
Cc: Taran Lennard <tlennard@npca.ca>
Subject: RE: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Good afternoon Jaymee,

Our office has reviewed the Terms of Reference and offers the following comments:

1. The Terms of Reference has identified that 4 wetland monitoring staff gauges and 4 shallow groundwater monitoring wells (BH21-1, BH21-3, BH21-13 and BH21-14) will be established and/or instrumented with datalogging pressure transducers within the study area. Please provide a figure which identifies the proposed monitoring locations.
2. The Terms of Reference has identified that 10 existing monitoring wells will be manually monitored in spring, summer, and fall, please include the location of these wells on a figure.
3. The Terms of Reference does not specify the intended duration of monitoring. Please identify the duration of monitoring.
4. The Terms of Reference does not discuss catchments of the wetlands present within the study area. Pre and post development catchments must be clearly identified and documented in the report and within a figure.

Please let me know if you have any questions.

Best,

Nicholas Godfrey, M.A.
Watershed Planner
Niagara Peninsula Conservation Authority (NPCA)
250 Thorold Road West, 3rd Floor, Welland, ON, L3C 3W2
905-788-3135, ext. 278
ngodfrey@npca.ca
www.npca.ca

> Due to the COVID-19 pandemic, the NPCA has taken measures to protect staff and public while providing continuity of services. The NPCA main office is currently closed with limited staff, please refer to the Staff Directory and reach out to the staff member you wish to speak or meet with directly. Our Conservation Areas are currently open, but may have modified amenities and/or regulations.
>
> Updates regarding NPCA operations and activities can be found at Get Involved NPCA Portal, or on social media at NPCA's Facebook Page & NPCA's Twitter page.

From: jcampbell@terra-dynamics.com <jcampbell@terra-dynamics.com>
Sent: April 19, 2022 10:31 AM

To: 'Eric Salembier' <esalembier@walterfedy.com>
Cc: Sarah Mastroianni <smastroianni@npca.ca>; Nicholas Godfrey <ngodfrey@npca.ca>
Subject: FW: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Good morning Eric,

Would you be able to answer Sarah's question?
Thank you.

Jayme D. Campbell, P.Eng.
Senior Water Resource Engineer
Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2, St. Catharines, Ontario L2M 4W3
Phone: 289-407-0915
https://terra-dynamics.com/

Common sense solutions to environmental challenges

From: Sarah Mastroianni <smastroianni@npca.ca>
Sent: April 19, 2022 10:23 AM
To: Nicholas Godfrey <ngodfrey@npca.ca>
Cc: jcampbell@terra-dynamics.com
Subject: FW: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Hi Nick,

As discussed, please take the lead on this one for the NPCA.

Jayme, I don't actually see a file number internally for this one (and Jessica is no longer here to ask), did this one have a municipal preconsultation meeting that you know of?

Thanks.

Sarah Mastroianni
Manager, Planning and Development
Niagara Peninsula Conservation Authority (NPCA)
250 Thorold Road West, 3rd Floor **|** Welland, ON L3C 3W2
Tel: 905-788-3135 **|** extension 249
smastroianni@npca.ca
www.npca.ca

NPCA Watershed Explorer

Due to the COVID-19 pandemic, the NPCA has taken measures to protect staff and public while providing continuity of services. The NPCA main office is open by appointment only with limited staff, please refer to the Staff Directory and reach out to the staff member you wish to speak or meet with directly.

Updates regarding NPCA operations and activities can be found at Get Involved NPCA Portal, or on social media at facebook.com/NPCAOntario & twitter.com/NPCA_Ontario.

For more information on Permits, Planning and Forestry please go to the Permits & Planning webpage at https://npca.ca/administration/permits.

For mapping on features regulated by the NPCA please go to our GIS webpage at https://gis-npca-camaps.opendata.arcgis.com/ and utilize our Watershed Explorer App or GIS viewer.

To send NPCA staff information regarding a potential violation of Ontario Regulation 155/06 please go to the NPCA Enforcement and Compliance webpage at https://npca.ca/administration/enforcement-compliance.

From: jcampbell@terra-dynamics.com <jcampbell@terra-dynamics.com>
Sent: Wednesday, April 13, 2022 1:23 PM
To: 'Lampman, Cara' <Cara.Lampman@niagararegion.ca>; Adam.Boudens@niagararegion.ca; Sarah Mastroianni <smastroianni@npca.ca>
Cc: 'Eric Salembier' <esalembier@walterfedy.com>
Subject: Primont Homes Welland/Thorold Hydrogeological Water Balance Terms of Reference

Good afternoon Sarah, Cara and Adam,

Please find attached a proposed hydrogeology water balance terms of reference regarding Primont Homes Welland/Thorold Residential Subdivisions for your review and comment.

If you have any questions regarding the attached please feel free to contact me directly.

Jayme D. Campbell, P.Eng.
Senior Water Resource Engineer
Terra-Dynamics Consulting Inc.
432 Niagara Street, Unit 2, St. Catharines, Ontario L2M 4W3
Phone: 289-407-0915
https://terra-dynamics.com/

Common sense solutions to environmental challenges

Appendix B

Borehole and Monitoring Well Logs

LOG OF BOREHOLE BH21-1

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765685 E 641199

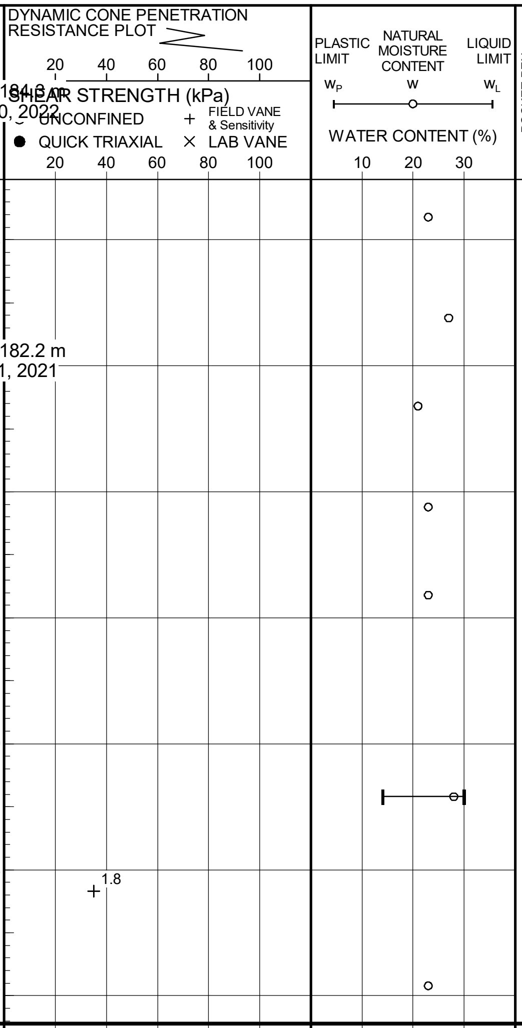
DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-29-2021

REF. NO.: 21-339-300
ENCL NO.: 2

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	ELEVATION	POCKET PEN. (Cu) (kPa)	GR	SA	SI	CL
183.5										
0.0	**TOPSOIL**: 300 mm	1	SS	5						
183.2 0.3	**SILTY SAND**: disturbed/reworked, trace organics, brown, moist, loose				183					
182.7 0.8	**SILTY CLAY**: trace sand, fine sand seams, brown, very moist to moist, very stiff to firm	2	SS	13	182					
		3	SS	20		225				
		4	SS	17	181	175				
	grey below 3m	5	SS	14	180	150				
					179					
	wet, firm below 4.6m	6	SS	6			0	5	56	40
			VANE		178					
177.4 6.1	**SANDY SILT**: trace gravel, trace clay, brown, wet, compact	7	SS	16	177		4	26	63	8
176.8 6.7	**END OF BOREHOLE**									

W. L. 184.3 m
May 10, 2022

W. L. 182.2 m
Nov 11, 2021



Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	1.26
May 10, 2022	-0.8

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ 8=3% Strain at Failure

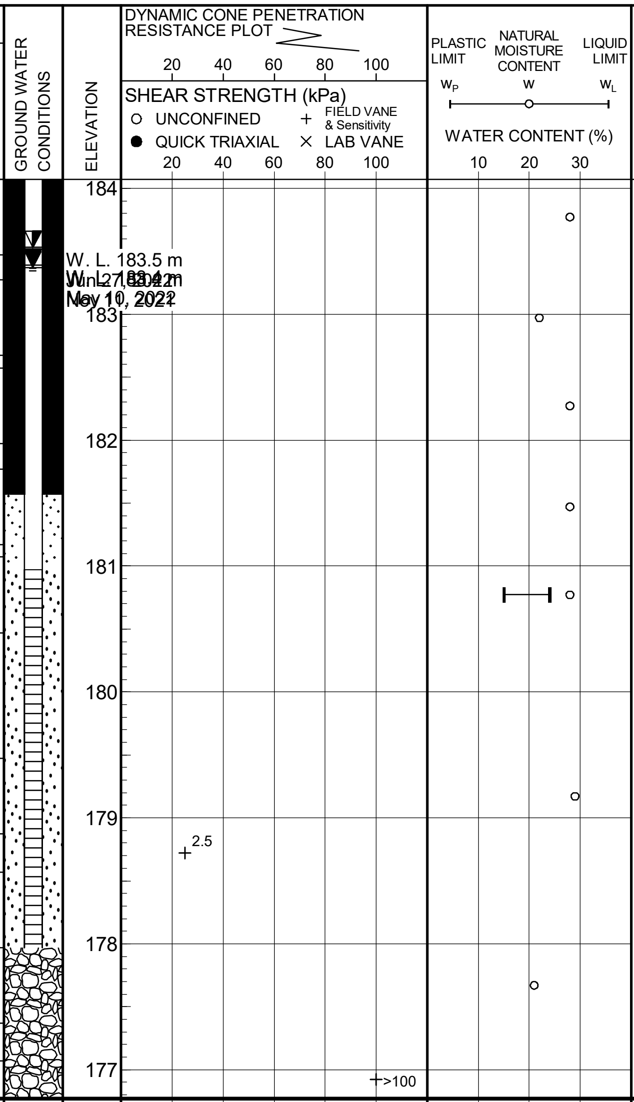
LOG OF BOREHOLE BH21-2

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765487 E 641216

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-29-2021

REF. NO.: 21-339-300
ENCL NO.: 3

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.1							
0.0	**TOPSOIL**: 300 mm	1	SS	4			
183.8 0.3	**SILTY SAND**: disturbed/reworked, trace organics, brown, moist, loose						
183.3 0.8	**SILTY CLAY**: fine sand seams, brown, moist to very moist, very stiff to firm	2	SS	16			
		3	SS	21	225		
	very moist below 2.3m	4	SS	9	150		
	grey below 3m	5	SS	8	100		0 0 67 33
	firm below 4.6m	6	SS	4			
			VANE				
	silt layers, trace gravel	7	SS	6			
176.8			VANE				
7.3	**END OF BOREHOLE**						



Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	0.7
May 10, 2022	0.68
June 27, 2022	0.54

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

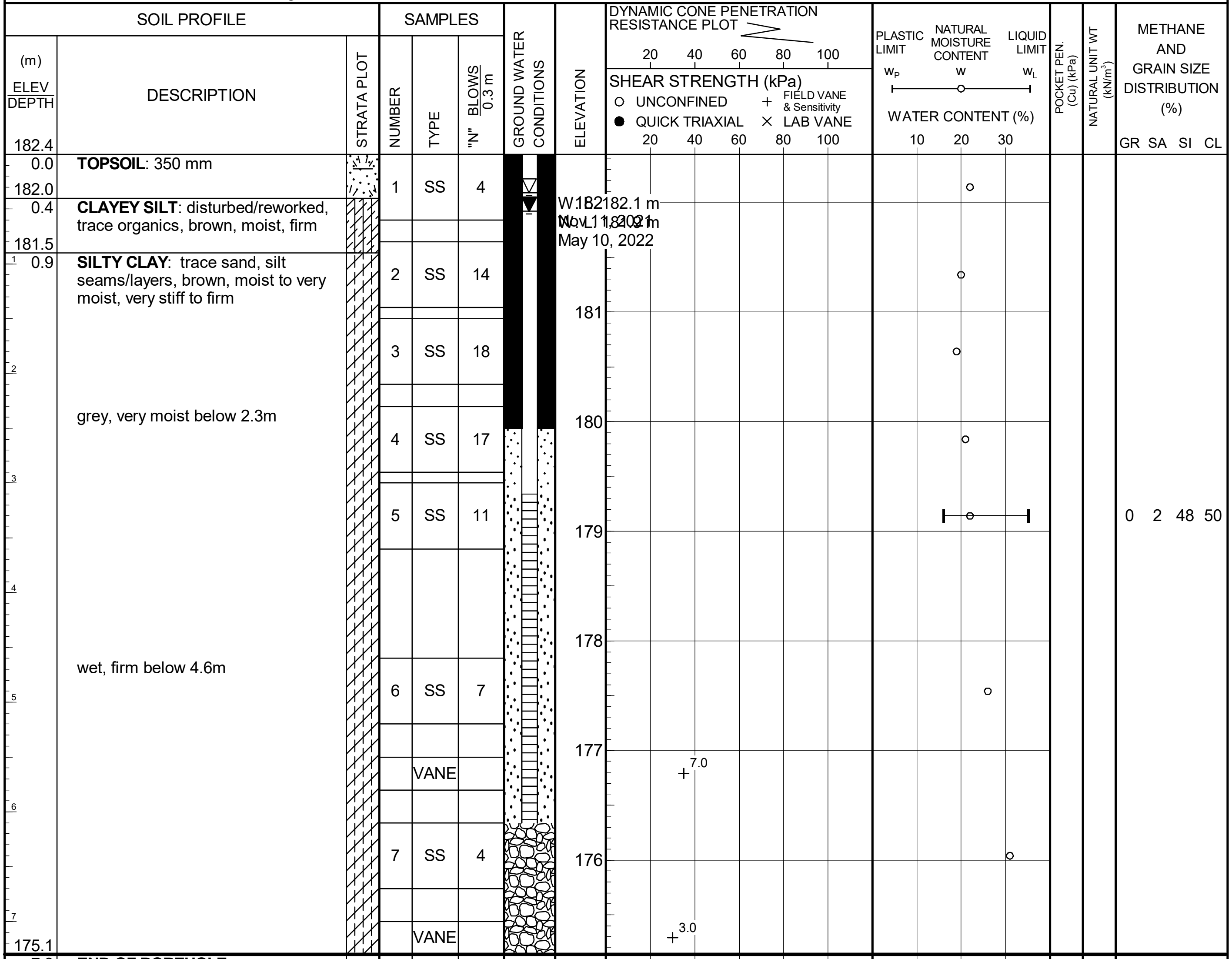
GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH21-3

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765461 E 641631

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 4



(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.4					
0.0	**TOPSOIL**: 350 mm	1	SS	4	
182.0 0.4	**CLAYEY SILT**: disturbed/reworked, trace organics, brown, moist, firm				
181.5 0.9	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist to very moist, very stiff to firm	2	SS	14	
		3	SS	18	
	grey, very moist below 2.3m	4	SS	17	
		5	SS	11	0 2 48 50
	wet, firm below 4.6m	6	SS	7	
			VANE		
		7	SS	4	
			VANE		
175.1 7.3	**END OF BOREHOLE**				

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	0.35
May 10, 2022	0.52

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

DS CONSULTANTS LTD.

LOG OF BOREHOLE BH21-4

1 OF 1

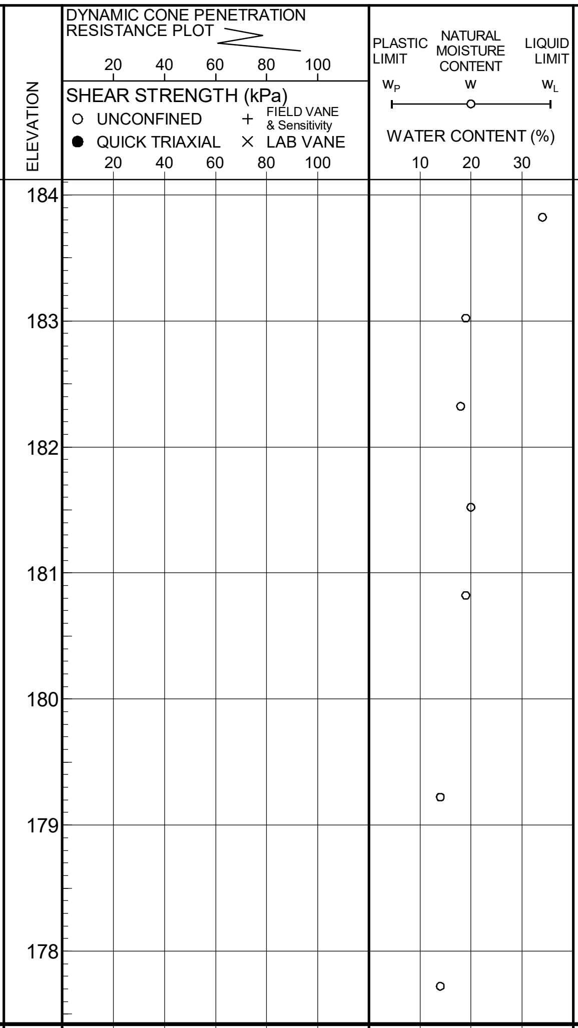
PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765324 E 641710

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 5

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.1								
0.0	**TOPSOIL**: 300 mm	1	SS	2				
183.8 0.3	**CLAYEY SILT**: disturbed/reworked, trace organics, brown, moist, soft							
183.2 0.9	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist, very stiff	2	SS	19		175		
		3	SS	27		225		
		4	SS	27		225		
	grey below 3m	5	SS	19		175		
179.5 4.6	**SILT**: reddish brown, moist, compact to dense	6	SS	20		225		
		7	SS	36				
177.4 6.7	**END OF BOREHOLE**							

Notes:
1. Borehole dry upon completion.



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+³, ×³: Numbers refer to Sensitivity
○ ⁸=3% Strain at Failure

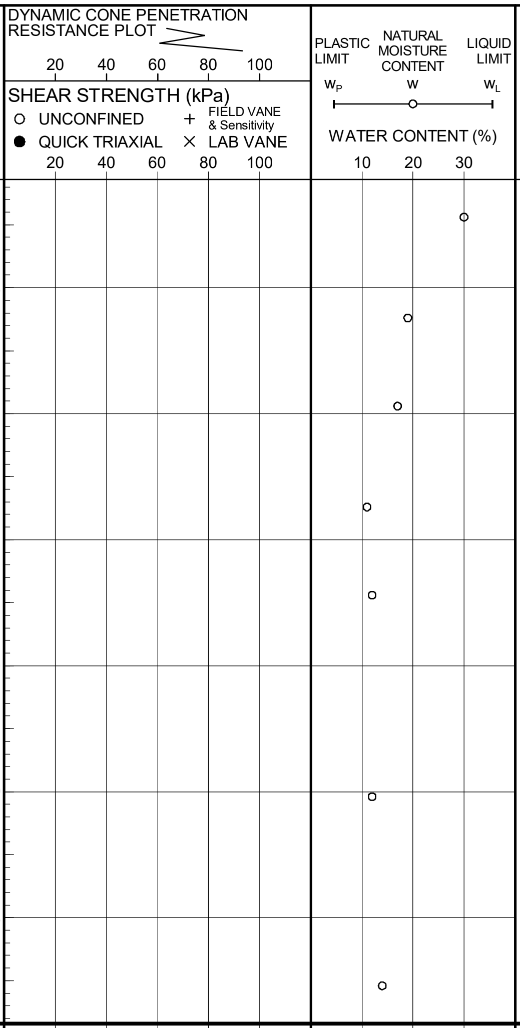
DS CONSULTANTS LTD.

LOG OF BOREHOLE BH21-5

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site	**DRILLING DATA**	
CLIENT: Primont Homes	Method: Solid Stem Augers	
PROJECT LOCATION: Welland, Ontario	Diameter: 150 mm	REF. NO.: 21-339-300
DATUM: Geodetic	Date: Oct-27-2021	ENCL NO.: 6
BOREHOLE LOCATION: See Drawing 1 N 4765353 E 641503		

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m					
183.9									
0.0	**TOPSOIL**: 300 mm	1	SS	5					
183.6 0.3	**CLAYEY SILT**: disturbed/reworked, trace organics, brown, moist, firm								
183.1 0.8	**SILT**: some clay, trace sand, brown, moist, compact	2	SS	19		183			
		3	SS	20		182			
		4	SS	23		181			
	grey below 3m	5	SS	24			225		
						180			
		6	SS	20		179	225		
						178			
	wet	7	SS	18			150		
177.2 6.7	**END OF BOREHOLE**								

Notes:
1. Borehole wet at 6m depth during drilling.



GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

DS CONSULTANTS LTD.

LOG OF BOREHOLE BH21-6

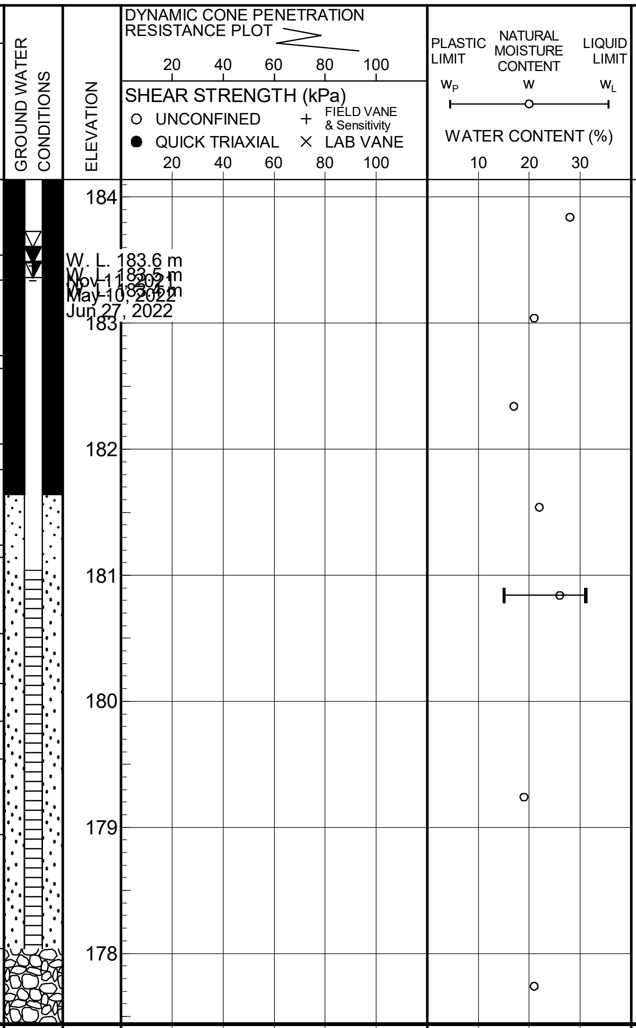
1 OF 1

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765297 E 641336

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 7

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	GR	SA	SI	CL
184.1										
0.0	**TOPSOIL**: 300 mm	1	SS	5						
183.8 0.3	**CLAYEY SILT**: disturbed/reworked, trace organics, brown, moist, firm									
183.2 0.9	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist to very moist, very stiff to firm	2	SS	17						
		3	SS	13						
		4	SS	20	200					
	grey, very moist below 3m	5	SS	7			0	2	56	41
			VANE							
179.5 4.6	**SILT**: some sand, trace clay, grey, wet, compact	6	SS	26			0	14	81	5
		7	SS	28						
177.4 6.7	**END OF BOREHOLE**									



Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date: Water Level(mbgl):
Nov. 11, 2021 0.54
May 10, 2022 0.66
June 27, 2022 0.78

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ $^{\varepsilon}$=3% Strain at Failure

LOG OF BOREHOLE BH21-7

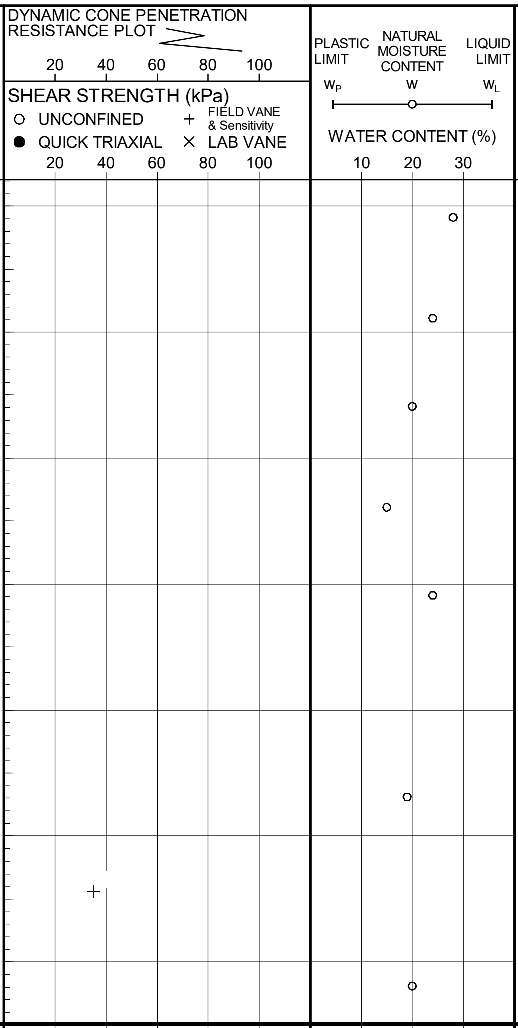
PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765120 E 641247

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 8

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.2										
0.0	**TOPSOIL**: 300 mm		1	SS	3		184			
183.9 0.3	**CLAYEY SILT**: disturbed/reworked, trace organics, brown, moist, soft									
183.3 0.9	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist to very moist, very stiff to firm		2	SS	15		183			
			3	SS	24			225		
			4	SS	16		182	225		
	grey, very moist, stiff below 3m		5	SS	9		181	75		
							180			
	firm below 4.6m		6	SS	7		179			
				VANE						
178.2 6.0	**SILT**: some sand, brown, wet, compact		7	SS	28		178			
177.5 6.7	**END OF BOREHOLE**									

Notes:
1. Borehole wet at 6m depth during drilling.



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: + 3, × 3 : Numbers refer to Sensitivity ○ 8=3% Strain at Failure

LOG OF BOREHOLE BH21-8

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765201 E 641601

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

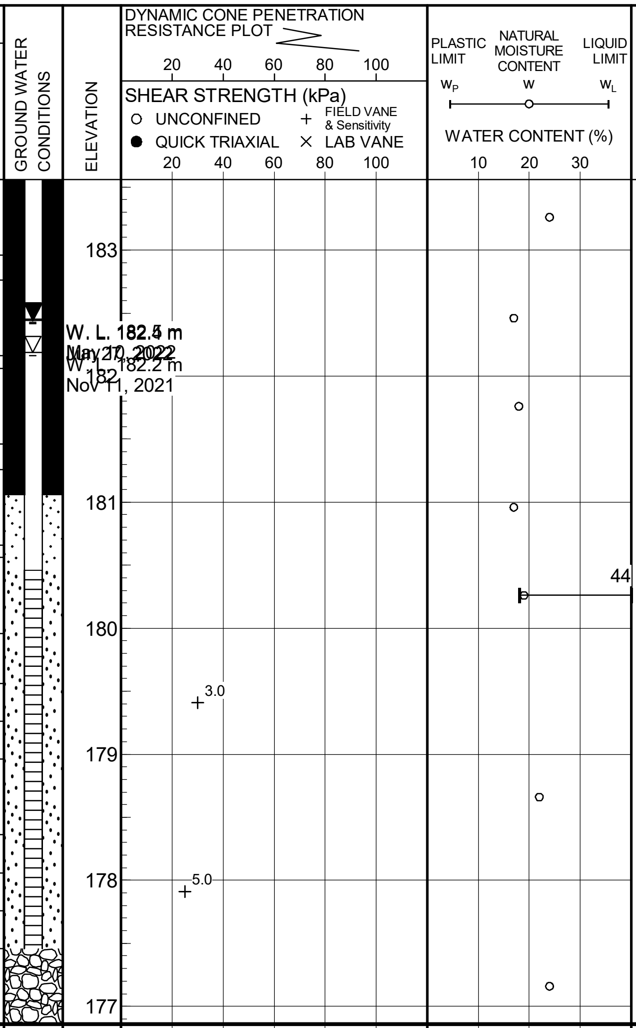
REF. NO.: 21-339-300
ENCL NO.: 9

SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
183.6	
0.0	**TOPSOIL**: 300 mm
183.3 0.3	**SANDY SILT**: disturbed/reworked, trace topsoils, brown, moist, loose
182.7 0.9	**SILTY CLAY**: silt seams/layers, brown, moist, hard to firm grey, very moist, firm below 3m
177.6 6.0	**SILT**: some sand, trace clay, brown, wet, compact
176.9 6.7	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	"N" BLOWS / 0.3 m	GR	SA	SI	CL
1	SS	7				
2	SS	18				
3	SS	32				
4	SS	16				
5	SS	5	0	0	34	66
	VANE					
6	SS	4				
	VANE					
7	SS	10				



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	1.37
May 10, 2022	1.11
June 27, 2022	1.12

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

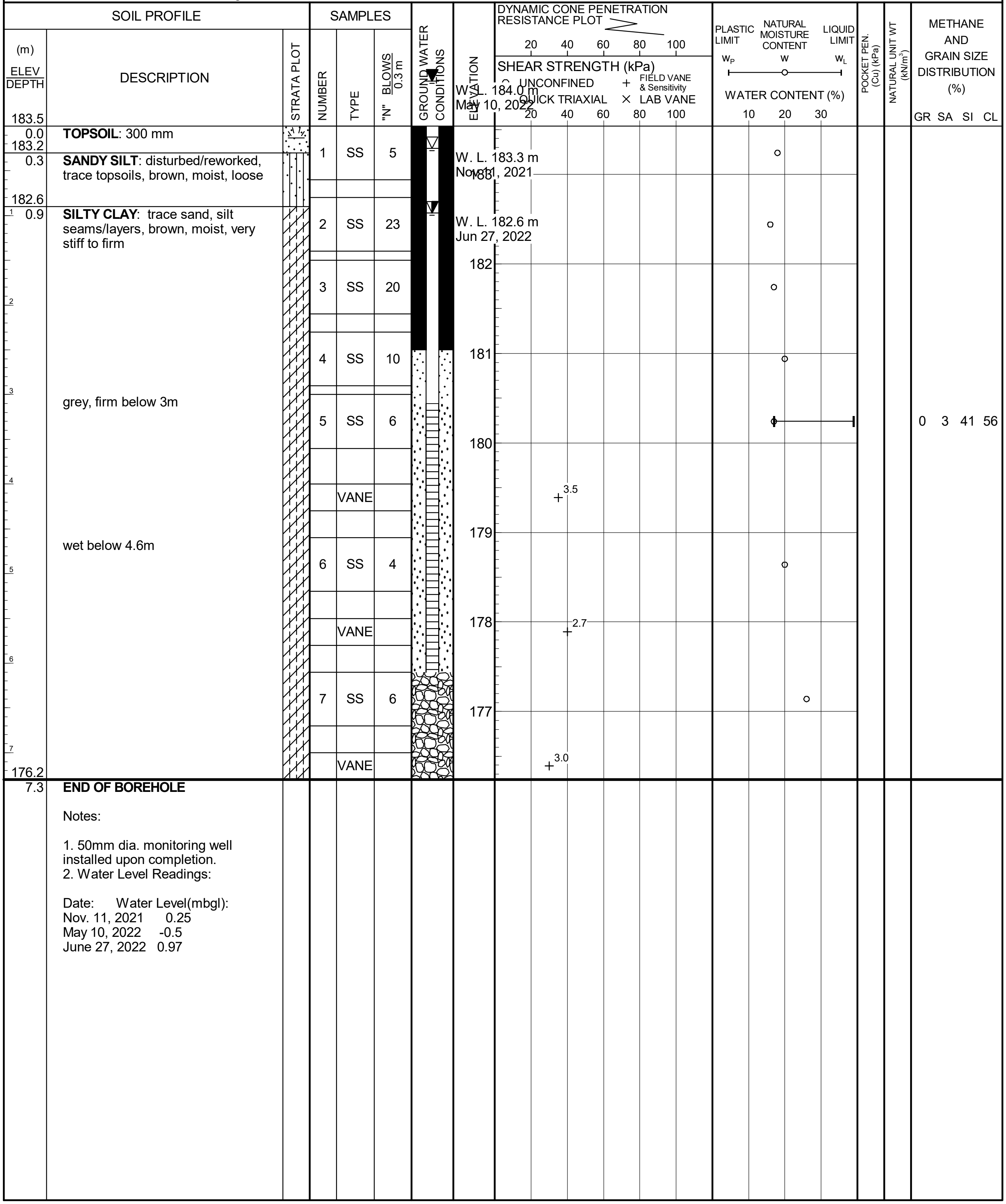
GRAPH NOTES $+^{3}, \times^{3}$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE BH21-9

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765147 E 641707

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 10



SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
183.5	
0.0	**TOPSOIL**: 300 mm
183.2 0.3	**SANDY SILT**: disturbed/reworked, trace topsoils, brown, moist, loose
182.6 0.9	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist, very stiff to firm
	grey, firm below 3m
	wet below 4.6m
176.2 7.3	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	5	
2	SS	23	
3	SS	20	
4	SS	10	
5	SS	6	0 3 41 56
	VANE		
6	SS	4	
	VANE		
7	SS	6	
	VANE		

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	0.25
May 10, 2022	-0.5
June 27, 2022	0.97

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ⁸=3% Strain at Failure

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LOG OF BOREHOLE BH21-10

1 OF 1

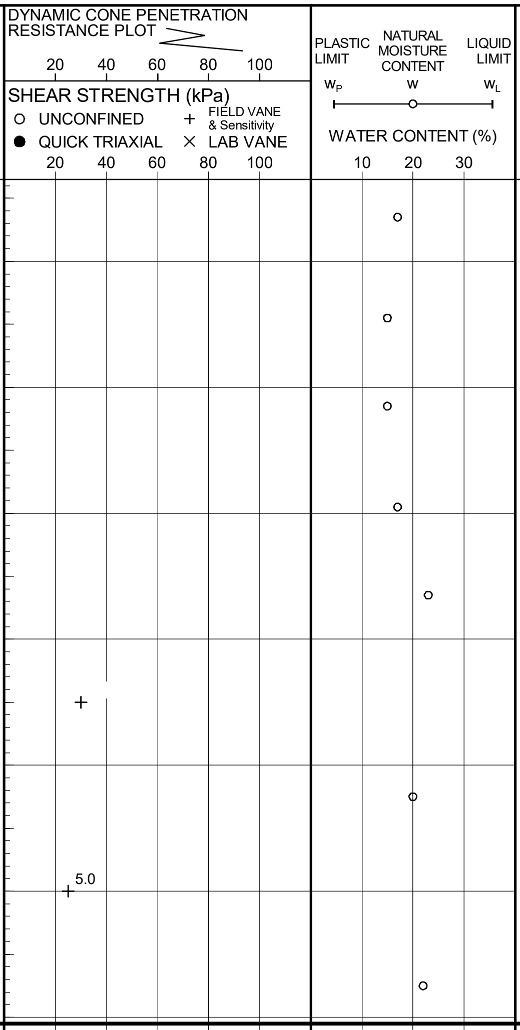
PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765113 E 641466

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 11

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m
183.7				
0.0	**TOPSOIL**: 300 mm	1	SS	6
183.4 0.3	**CLAYEY SILT**: disturbed/reworked, trace topsoils, brown, moist, firm			
182.9 0.8	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist, very stiff to firm	2	SS	21
		3	SS	21
		4	SS	12
	grey, wet, firm below 3m	5	SS	4
			VANE	
		6	SS	5
			VANE	
177.7 6.0	**SANDY SILT**: brown, wet, compact	7	SS	12
177.0 6.7	**END OF BOREHOLE**			

Notes:
1. Borehole wet below 3m depth during drilling.



POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m³) | METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+³, ×³: Numbers refer to Sensitivity
○ ³=3% Strain at Failure

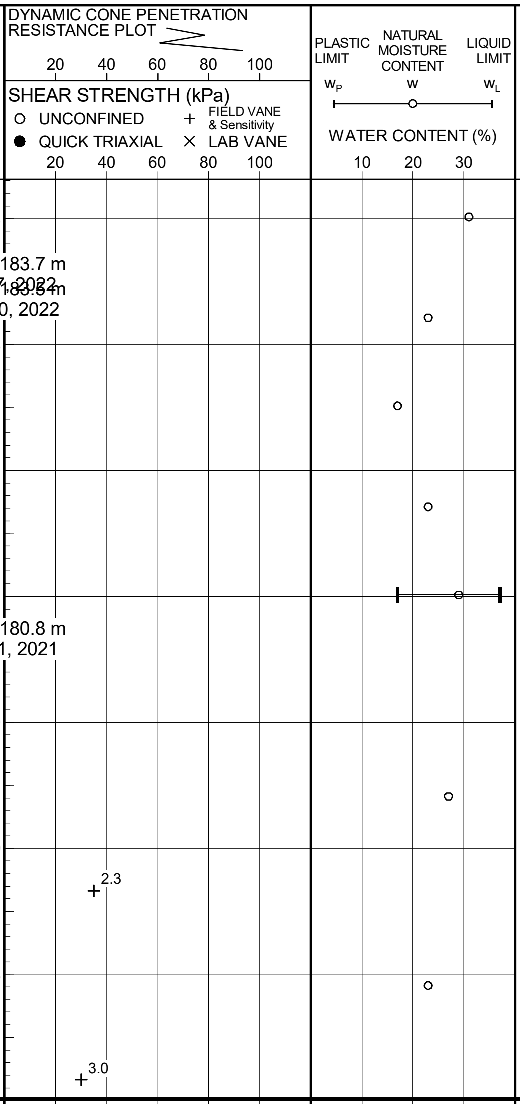
LOG OF BOREHOLE BH21-11

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765056 E 641193

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 12

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	GR	SA	SI	CL
184.3									
0.0	**TOPSOIL**: 450 mm	1	SS	4					
183.8 0.5	**CLAYEY SILT**: disturbed/reworked, trace topsoil, brown, moist, firm				W. L. 183.7 m Jun 27, 2022 W. L. 183.5 m May 10, 2022				
183.5 0.8	**SILTY CLAY**: trace sand, silt seams/layers, brown, moist to very moist, very stiff to firm	2	SS	14					
		3	SS	18					
	very moist, stiff below 2.3m	4	SS	11					
	grey below 3m	5	SS	10	W. L. 180.8 m Nov 11, 2021	0	3	48	50
	wet, firm below 4.6m	6	SS	4					
			VANE						
	silt layers	7	SS	7					
			VANE						
177.0 7.3	**END OF BOREHOLE**								



POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
METHANE AND GRAIN SIZE DISTRIBUTION (%)

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date: Water Level(mbgl):
Nov. 11, 2021 3.47
May 10, 2022 0.77
June 27, 2022 0.57

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity
○ 8=3% Strain at Failure

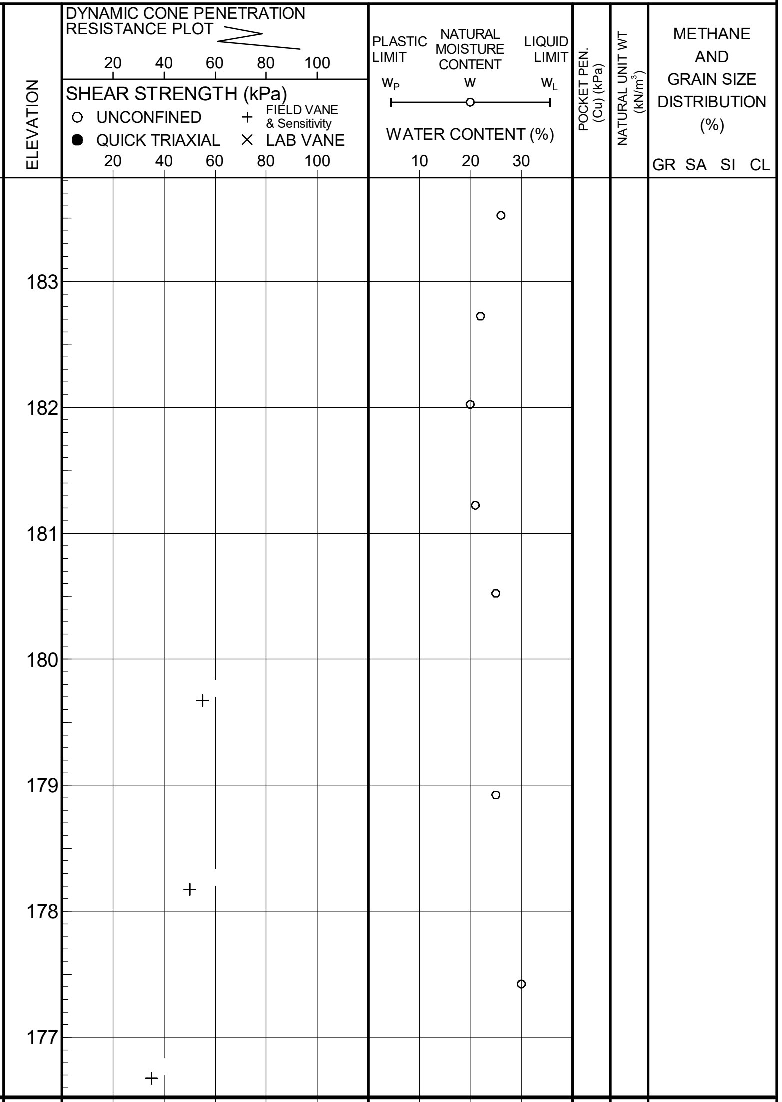
LOG OF BOREHOLE BH21-12

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765024 E 641312

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 13

(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS
183.8						
0.0	**TOPSOIL**: 300 mm					
183.5 0.3	**SILTY SAND**: disturbed/reworked, trace topsoil, brown, moist, loose		1	SS	5	
183.0 0.8	**SILTY CLAY**: trace sand, brown, moist to very moist, very stiff to firm		2	SS	16	
			3	SS	26	
	stiff below 2.3m		4	SS	14	
	grey, wet, firm below 3m		5	SS	6	
				VANE		
			6	SS	6	
				VANE		
			7	SS	7	
176.5				VANE		
7.3	**END OF BOREHOLE** Notes: 1. Borehole wet below 3m depth during drilling.					



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3$, $\times^3$: Numbers refer to Sensitivity
○ ^{8}=3% Strain at Failure

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LOG OF BOREHOLE BH21-13

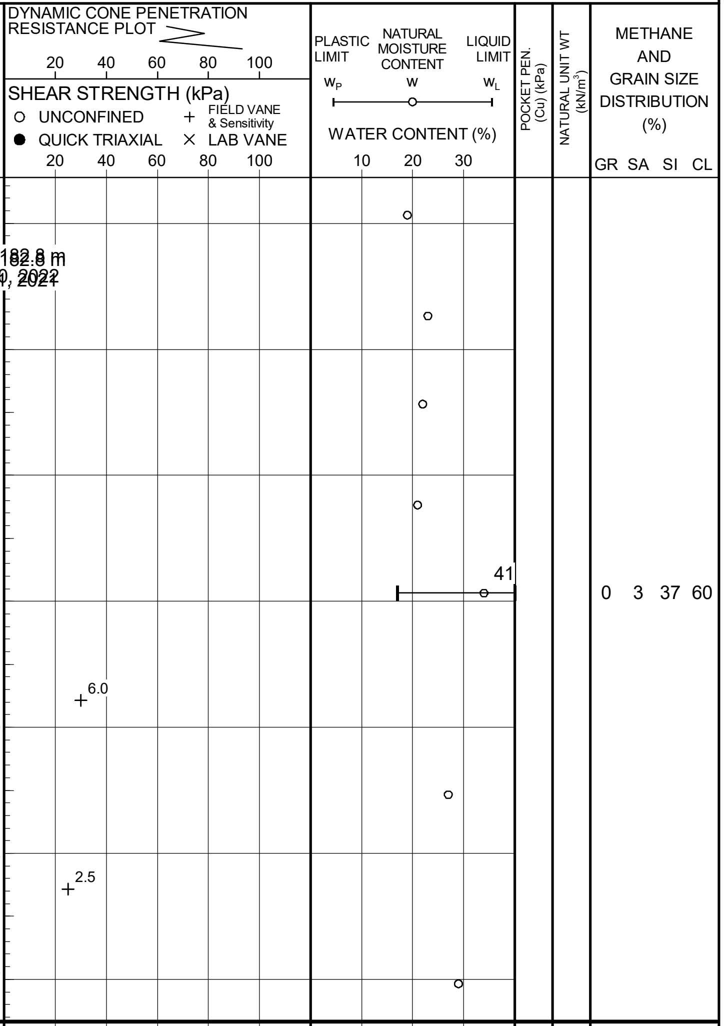
1 OF 1

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4765022 E 641489

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-27-2021

REF. NO.: 21-339-300
ENCL NO.: 14

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	SHEAR STRENGTH (kPa)	WATER CONTENT (%)	GR SA SI CL
183.4									
0.0 183.1	**TOPSOIL**: 300 mm	1	SS	7		183			
0.3 182.6	**CLAYEY SILT**: disturbed/reworked, trace topsoil, brown, moist, firm				W. L. 182.9 m May 10, 2022 W. L. 182.8 m Nov 11, 2021				
0.8	**SILTY CLAY**: trace sand, brown, moist to very moist, very stiff to soft	2	SS	15		182			
		3	SS	20					
	stiff below 2.3m	4	SS	12		181			
	grey, wet, firm below 3m	5	SS	5		180		41	0 3 37 60
			VANE			179	6.0		
		6	SS	6		178			
			VANE				2.5		
176.7	soft	7	SS	3		177			
6.7	**END OF BOREHOLE**								



Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	0.55
May 10, 2022	0.52
June 27, 2022	0.54

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

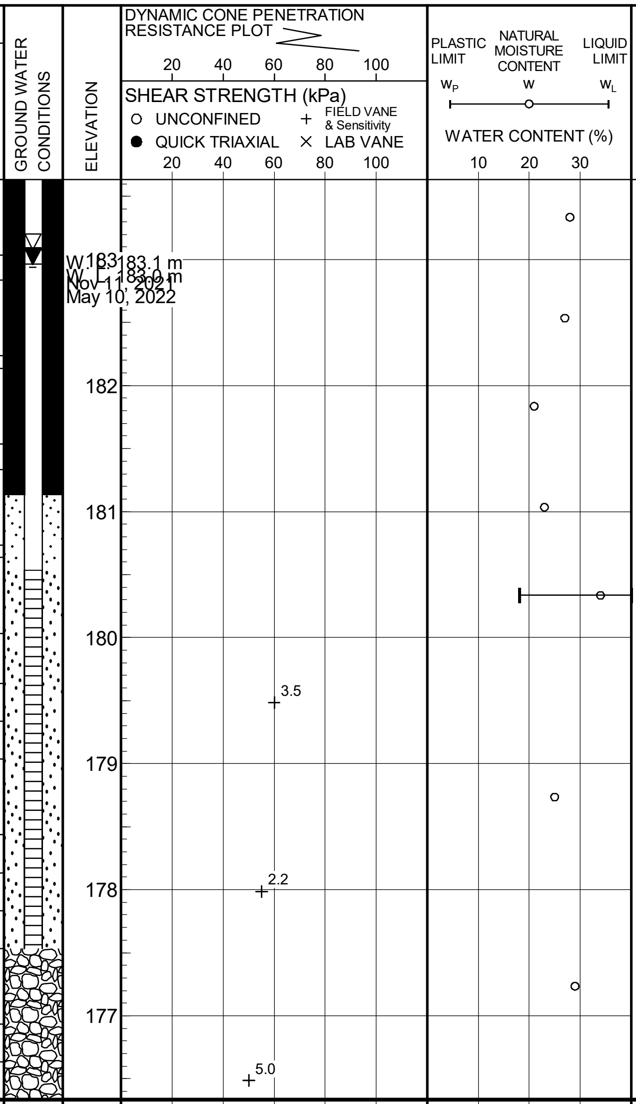
LOG OF BOREHOLE BH21-14

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4764872 E 641346

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 15

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.6					
0.0	**TOPSOIL**: 300 mm	1	SS	4	
183.3 0.3	**CLAYEY SILT**: disturbed/reworked, trace topsoil, brown, wet, firm				
182.8 0.8	**SILTY CLAY**: trace sand, trace gravel, brown, moist to very moist, very stiff to soft	2	SS	13	
		3	SS	18	
	stiff below 2.3m	4	SS	13	
	grey, firm below 3m	5	SS	6	1 6 36 57
			VANE		
	wet below 4.6m	6	SS	3	
			VANE		
	soft	7	SS	3	
176.3			VANE		
7.3	**END OF BOREHOLE**				



POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date: Water Level(mbgl):
Nov. 11, 2021 0.56
May 10, 2022 0.67

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ 8=3% Strain at Failure

LOG OF BOREHOLE BH21-15

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4764896 E 641312

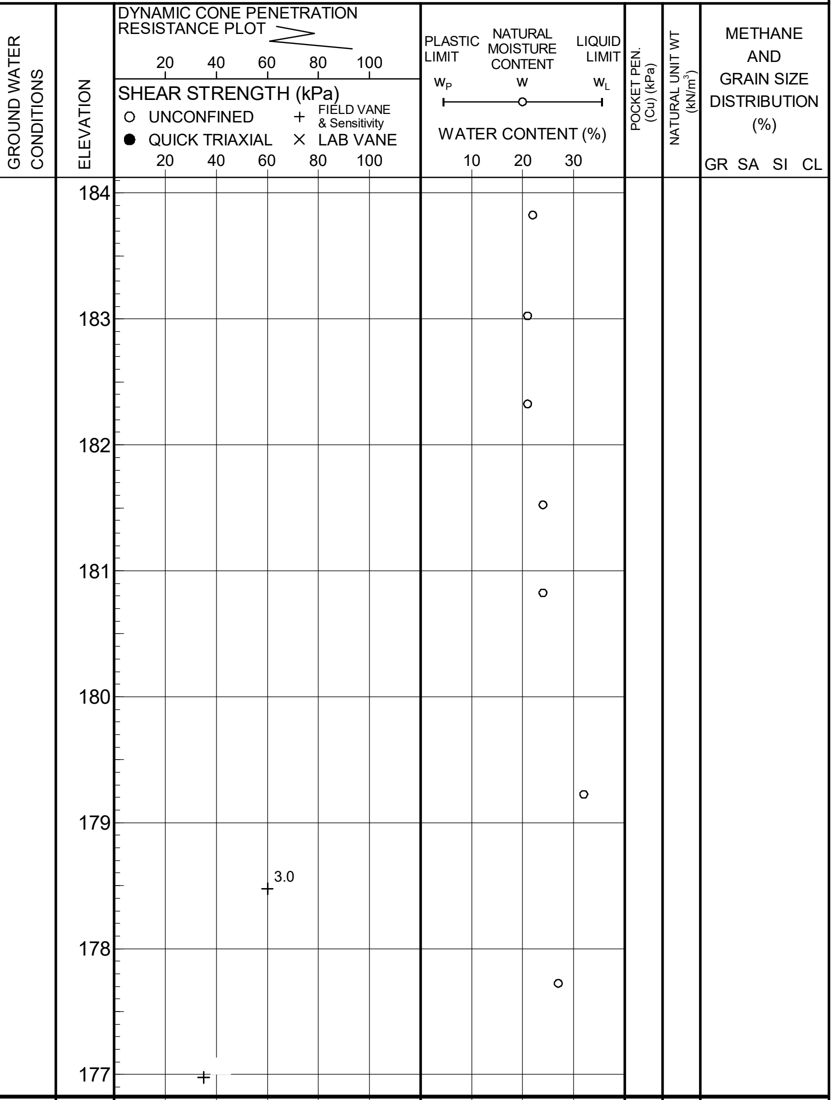
DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 16

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION
184.1	
183.8 0.0	**TOPSOIL**: 300 mm
183.3 0.3	**CLAYEY SILT**: disturbed/reworked, trace topsoil, brown, wet, firm
0.8	**SILTY CLAY**: trace sand, trace gravel, brown, moist to very moist, very stiff to soft
	grey, wet, soft below 4.6m
176.8 7.3	**END OF BOREHOLE**

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m
1	SS	5
2	SS	17
3	SS	23
4	SS	17
5	SS	11
6	SS	3
	VANE	
7	SS	4
	VANE	

Notes:
1. Borehole wet below 4.6m during drilling.



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

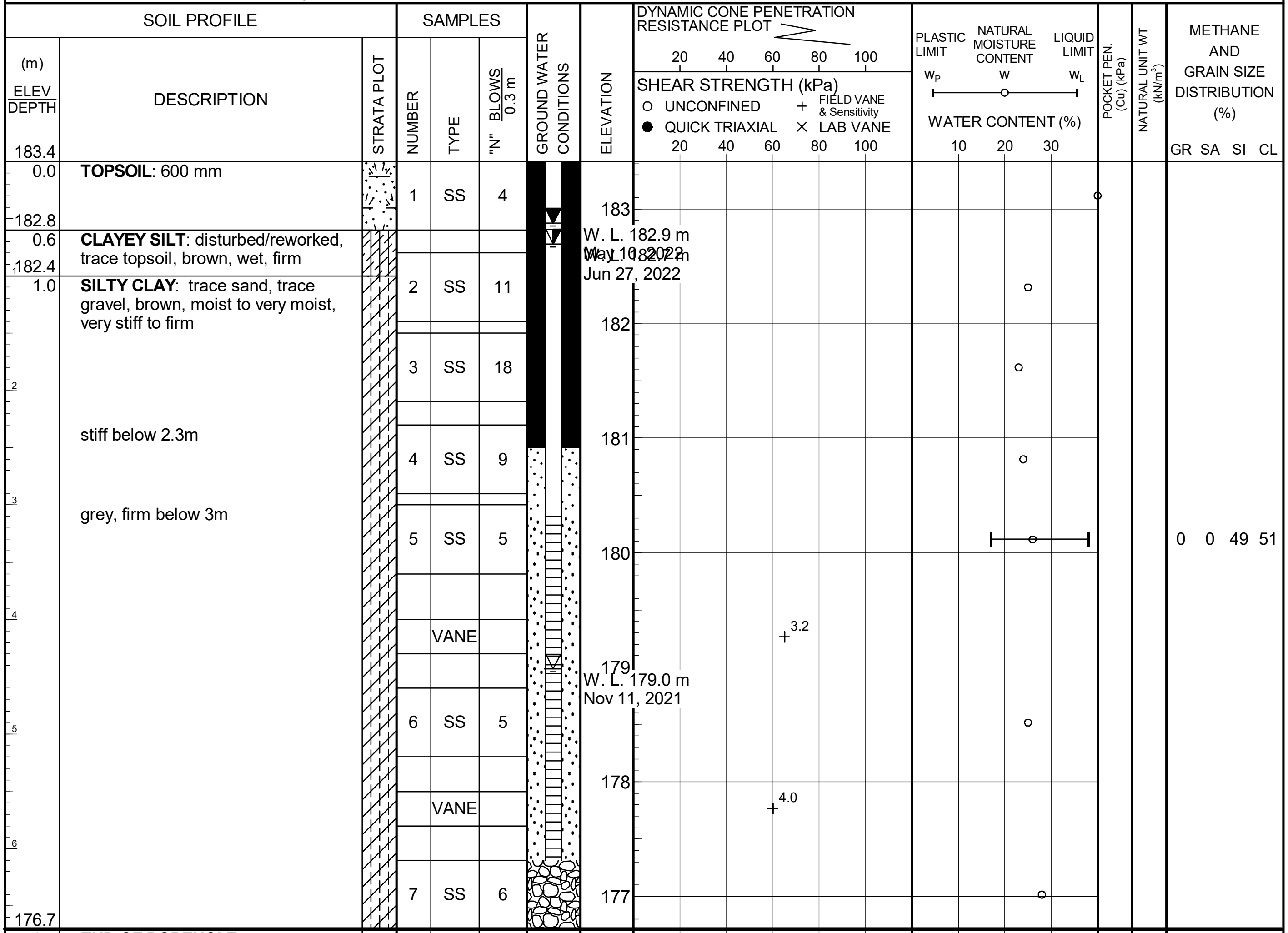
GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE BH21-16

PROJECT: Preliminary Geotechnical Investigation, Welland Thorold Site
CLIENT: Primont Homes
PROJECT LOCATION: Welland, Ontario
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4764776 E 641281

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Oct-28-2021

REF. NO.: 21-339-300
ENCL NO.: 17



(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	GR	SA	SI	CL
183.4								
0.0	**TOPSOIL**: 600 mm	1	SS	4				
182.8 0.6	**CLAYEY SILT**: disturbed/reworked, trace topsoil, brown, wet, firm							
182.4 1.0	**SILTY CLAY**: trace sand, trace gravel, brown, moist to very moist, very stiff to firm	2	SS	11				
		3	SS	18				
	stiff below 2.3m	4	SS	9				
	grey, firm below 3m	5	SS	5	0	0	49	51
			VANE					
		6	SS	5				
			VANE					
176.7		7	SS	6				
6.7	**END OF BOREHOLE**							

Notes:

1. 50mm dia. monitoring well installed upon completion.
2. Water Level Readings:

Date:	Water Level(mbgl):
Nov. 11, 2021	4.43
May 10, 2022	0.54
June 27, 2022	0.72

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ $^{\varepsilon}$=3% Strain at Failure

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LOG OF BOREHOLE BH22-01

1 OF 1

PROJECT: Additional Geotechnical Investigation
CLIENT: Primont Homes
PROJECT LOCATION: Quaker Road and First Avenue, Welland, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Figure 1 N 4765406.469 E 641715.248

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200 mm
Date: Mar-08-2022

REF. NO.: 21-339-302
ENCL NO.: 18

SOIL PROFILE

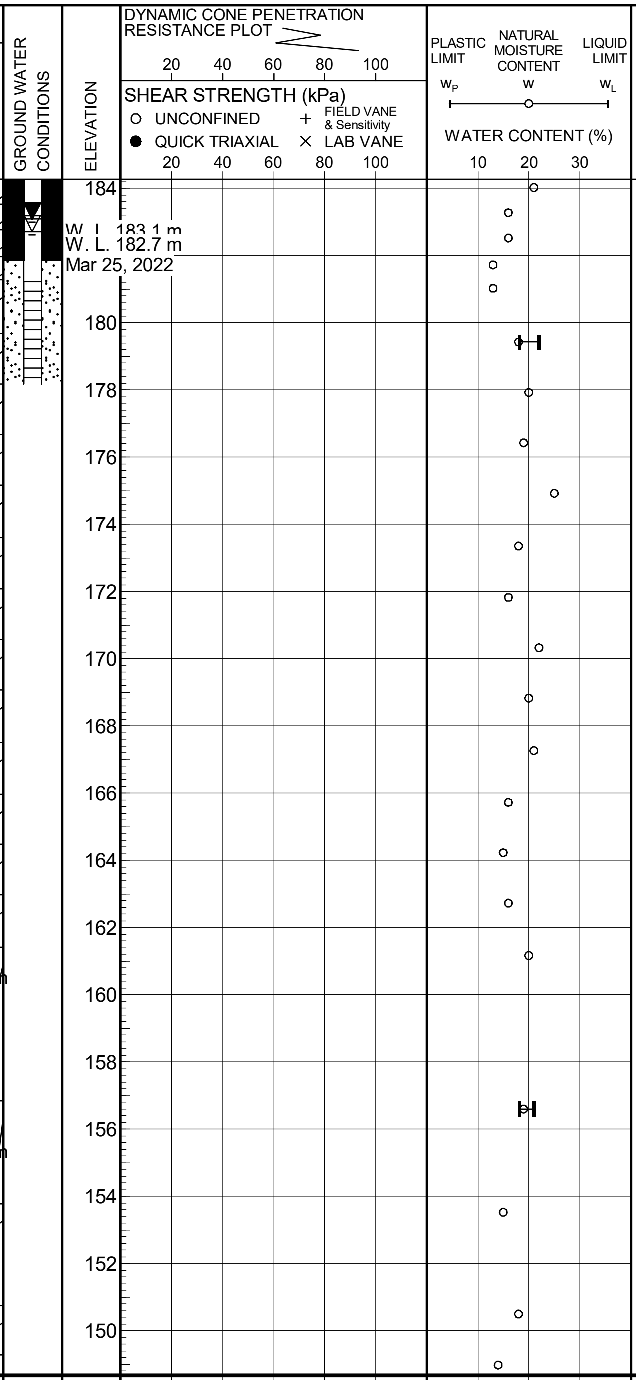
(m) ELEV / DEPTH	DESCRIPTION
184.3 / 0.0	**TOPSOIL**: 350 mm
183.9 / 0.4	**SILT:** some topsoil, disturbed/reworked, trace sand, brown, moist, stiff
183.4 / 0.9	
182.0 / 2.3	**SILT TO SILTY CLAY:** trace gravel, brown, moist, hard
179.7 / 4.6	**SILT:** some sand, brown, moist, dense to very dense
178.3 / 6.0	**CLAYEY SILT**: trace gravel, trace sand, brown, wet, hard
	SILT: trace clay, brown, wet, dense to compact
172.1 / 12.2	**SILTY CLAY:** brown, wet, very stiff
170.6 / 13.7	**SILT:**trace sand, clay seams, grey, wet, compact
166.0 / 18.3	**CLAYEY SILT TILL:** grey, wet, very stiff to hard
159.9 / 24.4	**CLAYEY SILT TO SILT:** brown, wet, hard
153.8 / 30.5	**SILTY CLAY TILL:** brown, moist, hard
148.7 / 35.6	**END OF BOREHOLE**

Notes:
1) 50 mm dia. monitoring well installed upon completion.
2) Water Levels Readings:

Date	Water Level (mbgs)
Mar. 25, 2022	1.57
April 12, 2022	1.33
June 27, 2022	1.18

SAMPLES

NUMBER	TYPE	"N" BLOWS / 0.3 m	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	11				
2	SS	41				
3	SS	33				
4	SS	40				
5	SS	67				
6	SS	39	1	3	82	14
7	SS	31				
8	SS	33	0	0	92	8
9	SS	17				
10	SS	28				
11	SS	20				
12	SS	19				
13	SS	20				
14	SS	25				
15	SS	20				
16	SS	19				
17	SS	40				
18	SS	50/ 125mm				
19	SS	50/ / 125mm	0	0	88	12
20	SS	47				
21	SS	69				
22	SS	69				



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE BH22-02

PROJECT: Additional Geotechnical Investigation
CLIENT: Primont Homes
PROJECT LOCATION: Quaker Road and First Avenue, Welland, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Figure 1 N 4764772.797 E 641331.348

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200 mm
Date: Mar-02-2022

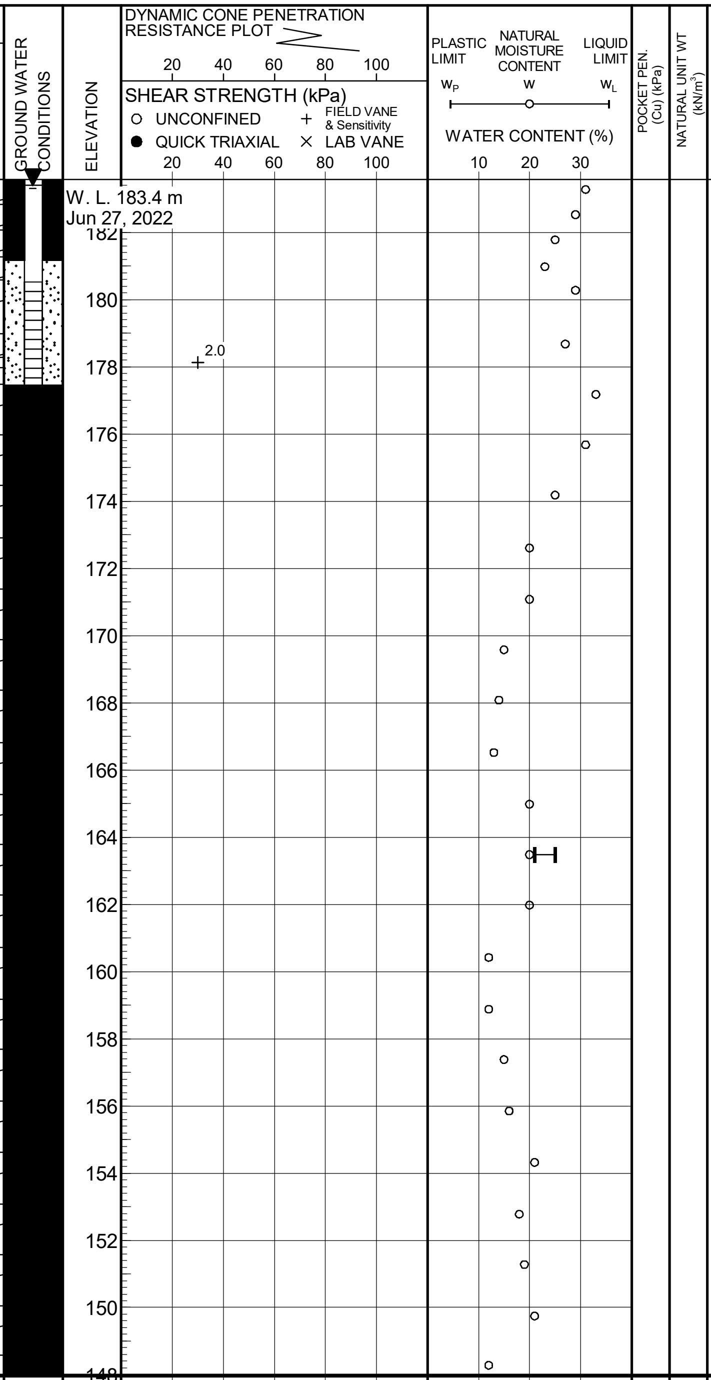
REF. NO.: 21-339-302
ENCL NO.: 19

SOIL PROFILE

(m) ELEV / DEPTH	DESCRIPTION
183.6 0.0	**TOPSOIL**: 400 mm
183.2 0.4	**SILTY CLAY:**disturbed/reworked, brown, moist, soft
182.7 0.9	**SILTY CLAY**: with silt seams, trace gravel, brown, moist to wet, very stiff to firm layer of silt, grey, wet, loose
176.0 7.6	**SILT:** some sand, with clay seams/layers, brown, wet, loose
169.9 13.7	**SILTY CLAY:** trace to some gravel, reddish brown, moist, very stiff to hard
163.8 19.8	**CLAYEY SILT TO SILT:** trace sand, some clay, brown, moist, hard
160.7 22.9	**CLAYEY SILT TILL**: brown, moist, hard to very stiff
148.0 35.6	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	"N" BLOWS / 0.3 m	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	3				
2	SS	17				
3	SS	20				
4	SS	12				
5	SS	9				
6	SS	4	0	0	51	49
	VANE					
7	SS	4				
8	SS	8				
9	SS	4				
10	SS	5				
11	SS	8				
12	SS	15				
13	SS	16				
14	SS	23				
15	SS	31				
16	SS	54	1	3	84	12
17	SS	55				
18	SS	37				
19	SS	43				
20	SS	46				
21	SS	25				
22	SS	18				
23	SS	28				
24	SS	25				
25	SS	39				
26	SS	33				



Notes:
1) 50 mm dia. monitoring well installed at 6.10 mbgs upon completion.
2) Water Levels Readings:

Date	Water Level (mbgs)
Mar. 25, 2022	Not Accessible
April 12, 2022	1.15
June 27, 2022	0.17

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ 8=3% Strain at Failure

DS CONSULTANTS LTD.

LOG OF BOREHOLE BH22-03

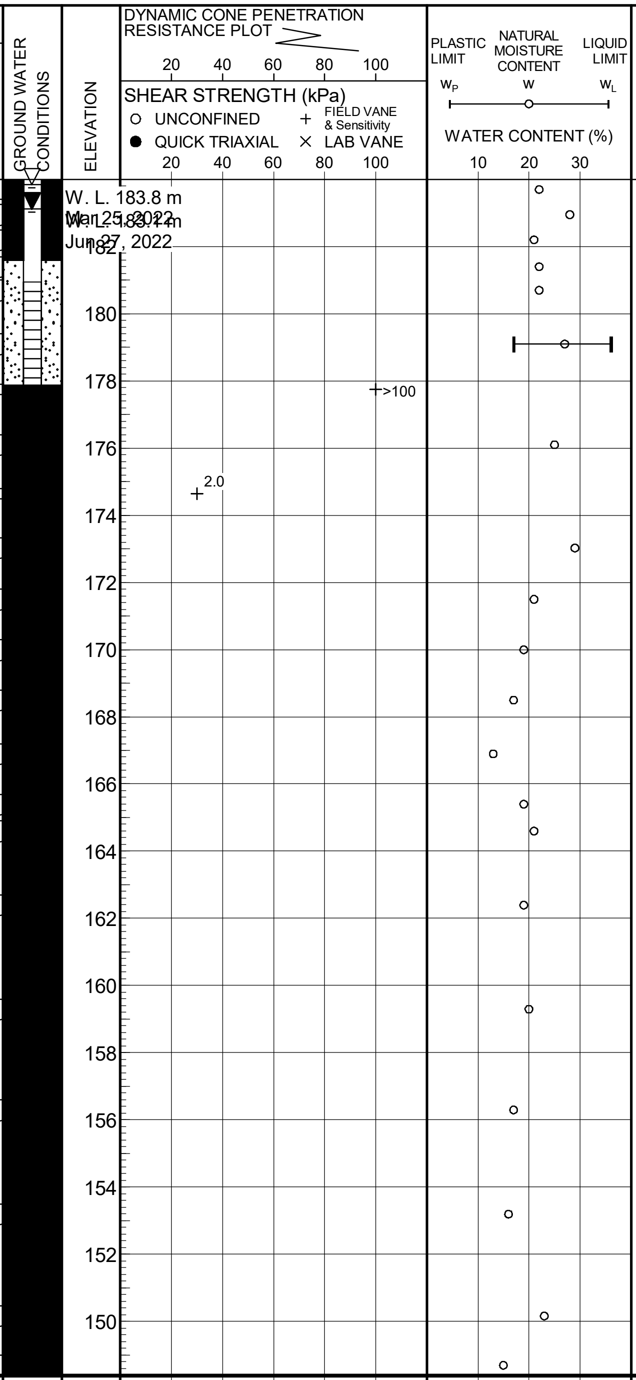
1 OF 1

PROJECT: Additional Geotechnical Investigation
CLIENT: Primont Homes
PROJECT LOCATION: Quaker Road and First Avenue, Welland, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Figure 1 N 4764874.239 E 641283.907

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200 mm
Date: Mar-03-2022

REF. NO.: 21-339-302
ENCL NO.: 20

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" BLOWS / 0.3 m	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.0 0.0	**TOPSOIL** 300 mm, over disturbed/reworked clayey silt to sandy silt	1	SS				
183.1 0.9	**SILTY CLAY:** reddish brown, with silty sand seams/layers, trace gravel, moist to very moist, very stiff to soft with layer of silty sand, grey below 3 m wet, firm below 4.6m	2	SS	10			
		3	SS	22			
		4	SS	21			
		5	SS	11			
		6	SS	7			0 1 54 45
			VANE				
	layer of wet, very loose silty sand at 7.6 m	7	SS	2			
			VANE				
173.3 10.7	**SILT:** with clay seams, brown, wet, loose to compact	8	SS	6			
		9	SS	19			
		10	SS	23			
		11	SS	14			
167.2 16.8	**CLAYEY SILT TILL:** some sand, some gravel, brown, moist, very stiff to hard	12	SS	27			
		13	SS	68			
164.2 19.8	**SANDY SILT:** trace clay, brown, moist to wet, very dense	14	SS	81			
		15	SS	77			0 28 67 5
		16	SS	64			
156.5 27.5	**CLAYEY SILT TILL:** trace gravel, brown, moist, hard to very stiff	17	SS	59			
		18	SS	61			
		25	SS	18			
148.4		26	SS	38			
35.6	**END OF BOREHOLE**						



Notes:
1) 50 mm dia. monitoring well installed at 6.10 mbgs upon completion.
2) Water Levels Readings:

Date	Water Level (mbgs)
Mar. 25, 2022	0.15
April 12, 2022	0.28
June 27, 2022	0.87

GROUNDWATER ELEVATIONS
Measurement 1st ∇ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+³, ×³: Numbers refer to Sensitivity
○ ³=3% Strain at Failure

DS SOIL LOG 22-339-302 QUAKER RD AND FIRST AV - COPY.GPJ DS.GDT 22-7-22

Log of Borehole No. 1

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

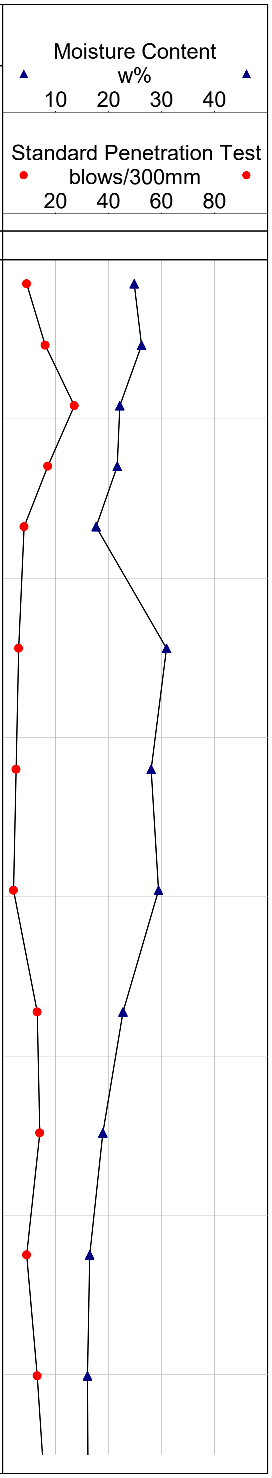
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765186
E: 641731

Depth (ft)	Elevation (m)	Description
0	183.32	Ground Surface
0–0.7		**Topsoil** Approximately 200 millimetres of topsoil.
0.7–11.5		**Silty Clay/Clayey Silt** Brown to reddish brown, some organics in upper levels, firm to very stiff.
11.5	179.82	Transition in colour to grey.
28.5	174.64	**Sandy Silt/Silt** Reddish brown, occasional gravel, loose to very dense.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,3,6,8	9	■	<1.0	
SS	2	7,7,9,13	16	■	>4.5	
SS	3	7,11,16,19	27	■	>4.5	
SS	4	5,7,10,13	17	■	2.5	
SS	5	4,3,5,6	8	■	1.5	
SS	6	3,2,4,5	6	■	<1.0	
SS	7	2,2,3,4	5	■	<1.0	
SS	8	1,2,2,4	4	■	<1.0	
SS	9	6,6,7,8	13	■		
SS	10	6,7,7,6	14	■		
SS	11	3,3,6,7	9	■		
SS	12	4,6,7,10	13	■		

Well Data



Drill Method: Hollow Stem Augers
Drill Date: December 07, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Checked by: IS
Sheet: 1 of 2

Log of Borehole No. 1

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765186
E: 641731

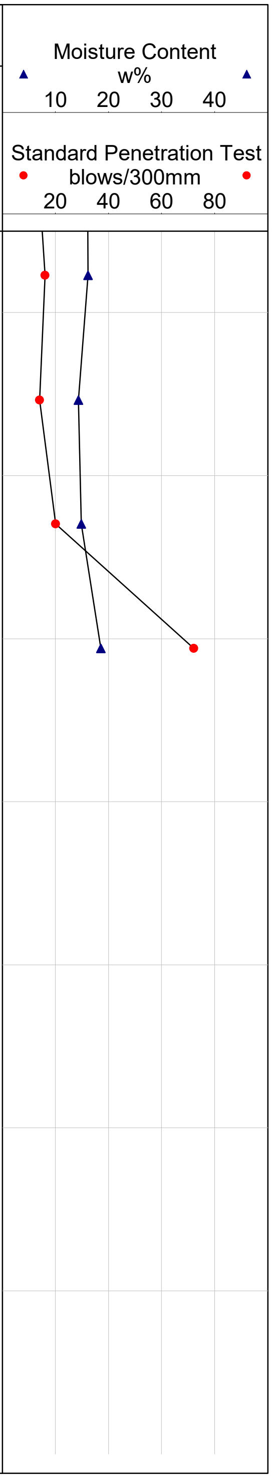
Depth		Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
50												
51						SS	13	4,6,10,12	16	▨		
52	16											
53												
54												
55												
56	17					SS	14	6,6,8,8	14	▨		
57												
58												
59	18											
60												
61						SS	15	5,7,13,16	20	▨		
62	19											
63												
64												
65	20											
66		162.90				SS	16	9,24,48,50/5"	72	▨		
67												
68				End of Borehole								
69	21											
70												
71												
72	22											
73												
74												
75	23											
76												
77												
78												
79	24											
80												
81												
82	25											
83												
84												
85	26											
86												
87												
88												
89	27											
90												
91												
92	28											
93												
94												
95	29											
96												
97												
98												

NOTES:

1. Borehole was advanced using solid stem auger equipment on December 07, 2022 to termination at a depth of 20.4 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.



Drill Method: Hollow Stem Augers
Drill Date: December 07, 2022
Hole Size: 200 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Log of Borehole No. 2

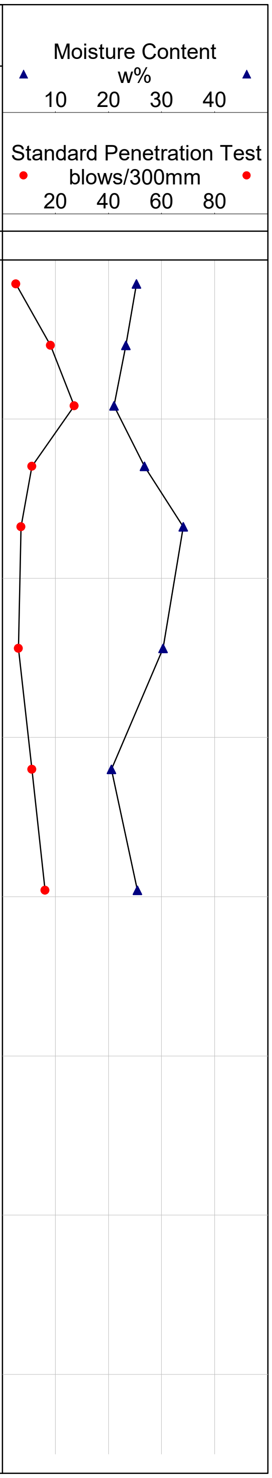
Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765226
E: 641680

Elevation (m)	Description
183.26	Ground Surface
182.96	**Topsoil** Approximately 300 millimetres of topsoil.
180.83	**Silty Clay/Clayey Silt** Brown, occasional gravel, firm to very stiff.
177.93	Transition in colour to grey.
175.04	**Sandy Silt/Silt** Reddish brown, compact.
	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,3,5	5	■	2.0	
SS	2	5,7,11,14	18	■	>4.5	
SS	3	6,11,16,21	27	■	>4.5	
SS	4	4,5,6,7	11	■	1.0	
SS	5	4,3,4,6	7	■	1.5	
SS	6	2,3,3,5	6	■	<1.0	
SS	7	5,5,6,10	11	■		
SS	8	4,7,9,9	16	■		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 6.0 metres and 'Wet' at a depth of 4.8 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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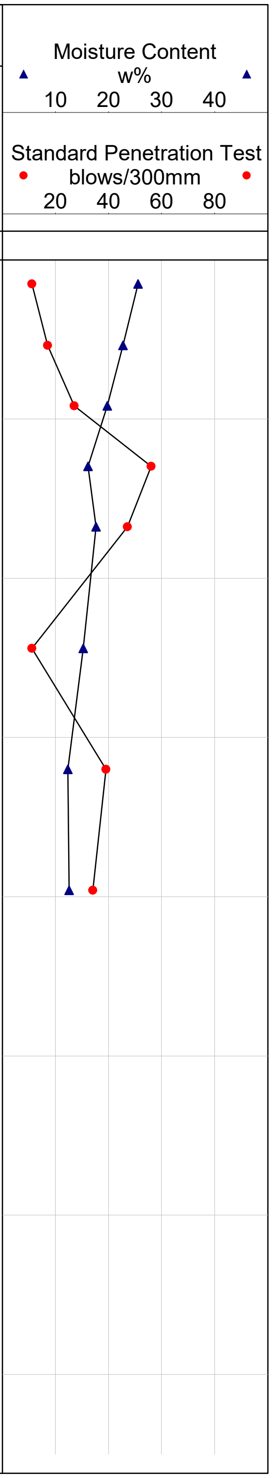
Log of Borehole No. 3

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765364
E: 641633

Depth (m)	Elevation (m)	Description
0	183.80	Ground Surface
		Topsoil Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown, occasional gravel, firm to very stiff.
	181.60	**Sandy Silt/Silt** Reddish brown, more silt content with depth, trace clay, compact to dense.
	175.58	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,4,7,5	11	■	>4.5	
SS	2	5,7,10,12	17	■	>4.5	
SS	3	8,11,16,22	27	■	>4.5	
SS	4	22,26,30,44	56	■		
SS	5	21,23,24,20	47	■		
SS	6	5,6,5,8	11	■		
SS	7	7,17,22,22	39	■		
SS	8	13,16,18,23	34	■		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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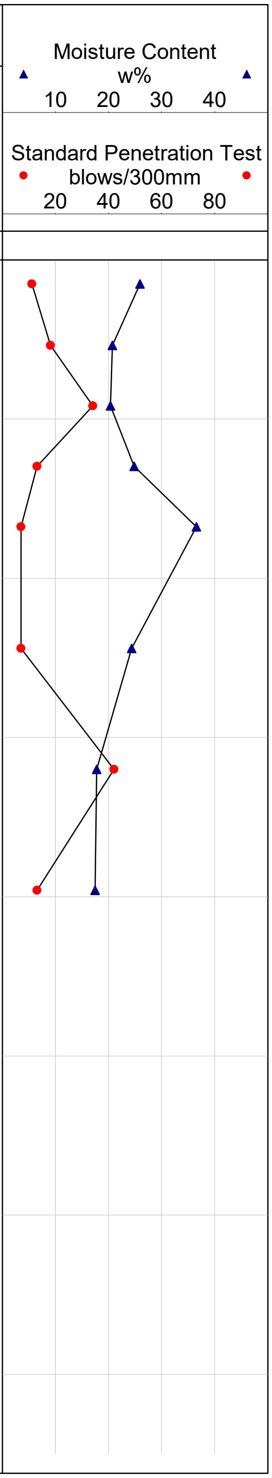
Log of Borehole No. 4

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765208
E: 641522

Depth (ft / m)	Elevation (m)	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	183.54		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	4,5,6,8	11	■	>4.5	
			Silty Clay/Clayey Silt Brown, firm to hard.		SS	2	5,7,11,16	18	■	>4.5	
					SS	3	8,15,19,25	34	■	>4.5	
					SS	4	5,6,7,10	13	■	2.0	
	180.65		Transition in colour to grey.								
					SS	5	3,3,4,5	7	■	<1.0	
					SS	6	2,3,4,4	7	■	<1.0	
	177.30		**Sandy Silt/Silt** Reddish brown, trace clay, compact to dense.		SS	7	5,20,22,28	42	■		
					SS	8	6,6,7,7	13	■		
	175.32		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 06, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 06, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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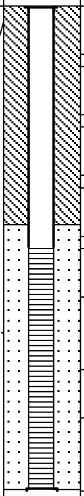
Log of Borehole No. 5

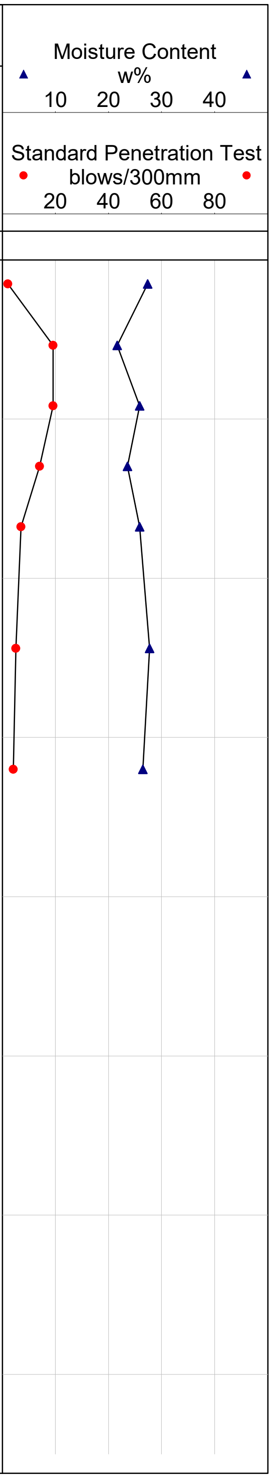
Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765091
E: 641718

Elevation (m)	Description
183.12	Ground Surface
	Topsoil Approximately 200 millimetres of topsoil.
	Silty Clay/Clayey Silt Brown to reddish brown, firm to very stiff.
179.01	Transition in colour to grey.
176.42	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,1,1,4	2	■	>4.5	
SS	2	6,8,11,17	19	■	>4.5	
SS	3	5,8,11,17	19	■	>4.5	
SS	4	5,6,8,10	14	■	>4.5	
SS	5	3,3,4,4,	7	■	<1.0	
SS	6	3,2,3,3	5	■	<1.0	
SS	7	2,2,2,4	4	■	<1.0	





NOTES:

1. Borehole was advanced using solid stem auger equipment on December 07, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 0.83 metres

Drill Method: Solid Stem Augers
Drill Date: December 07, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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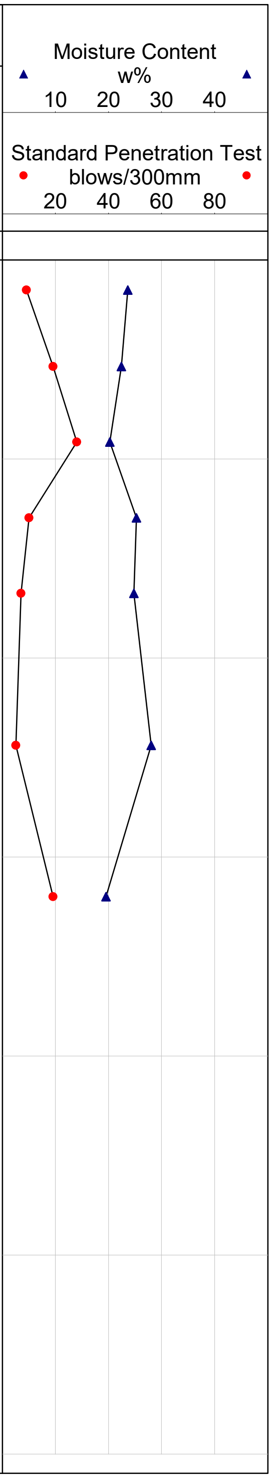
Log of Borehole No. 6

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765198
E: 641374

Depth (m)	Elevation (m)	Description
0	183.83	Ground Surface
		Topsoil Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown, firm to very stiff.
	181.09	Transition in colour to grey.
	177.59	**Sandy Silt/Silt** Reddish brown, compact.
	177.13	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,4,5,7	9	▨	>4.5	
SS	2	5,8,11,14	19	▨	>4.5	
SS	3	6,9,19,22	28	▨	>4.5	
SS	4	4,5,5,6	10	▨	1.0	
SS	5	2,3,4,5	7	▨	<1.0	
SS	6	2,2,3,5	5	▨	<1.0	
SS	7	5,7,12,17	19	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.9 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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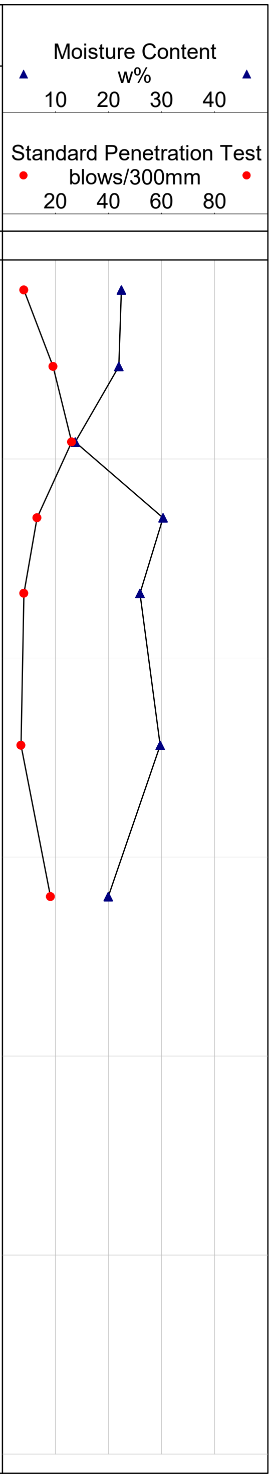
Log of Borehole No. 7

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765042
E: 641421

Elevation (m)	Description
183.52	Ground Surface
183.27	**Topsoil** Approximately 250 millimetres of topsoil.
	Silty Clay/Clayey Silt Brown, firm to very stiff.
179.41	Transition in colour to grey.
177.43	**Sandy Silt/Silt** Reddish brown, compact.
176.82	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,3,5,6	8	▨	>4.5	
SS	2	5,7,12,18	19	▨	>4.5	
SS	3	6,12,14,18	26	▨	>4.5	
SS	4	5,6,7,10	13	▨	2.0	
SS	5	3,4,4,7	8	▨	2.0	
SS	6	2,3,4,5	7	▨	<1.0	
SS	7	8,9,9,9	18	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as caved to 5.9 metres and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 1.6 metres

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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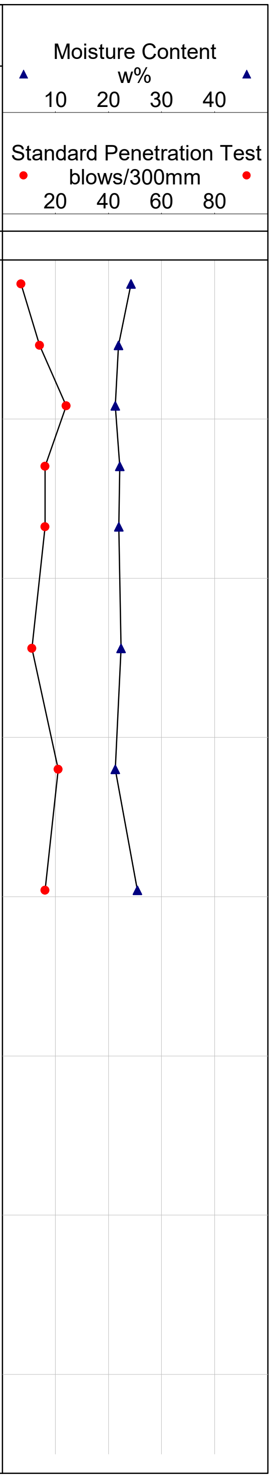
Log of Borehole No. 8

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765199
E: 641192

Depth (m)	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0	184.94		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	2,3,4,6	7	■	2.0	
			Silty Clay/Clayey Silt Brown, occasional gravel, firm to very stiff.		SS	2	4,7,7,12	14	■	4.0	
					SS	3	5,9,15,20	24	■	>4.5	
					SS	4	4,6,10,15	16	■	>4.5	
					SS	5	6,7,9,10	16	■	4.0	
4	180.83		Transition in colour to grey.								
5	179.76				SS	6	4,4,7,11	11	■	1.5	
			Sandy Silt/Silt Reddish brown, compact.		SS	7	4,9,12,17	21	■		
8	176.72				SS	8	6,7,9,9	16	■		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 7.3 metres and 'Wet' at a depth of 6.7 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Datum: Geodetic
Field Logged by: IC
Checked by: IS
Sheet: 1 of 1

Log of Borehole No. 9

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.

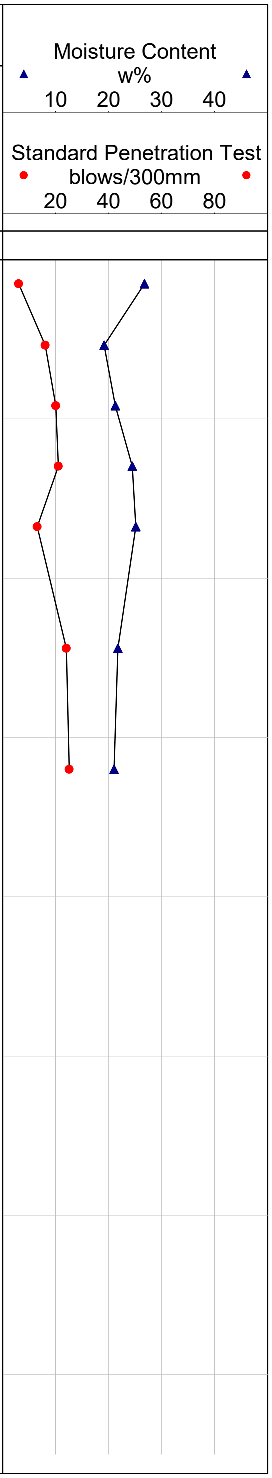
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765253
E: 641229

Depth ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Depth m: 0 1 2 3 4 5 6 7 8 9 1 1 1 1 1

Elevation (m)	Description
184.05	Ground Surface
183.75	**Topsoil** Approximately 300 millimetres of topsoil.
	Silty Clay/Clayey Silt Brown, firm to very stiff.
180.40	Transition in colour to grey.
179.94	**Sandy Silt/Silt** Reddish brown, compact.
177.35	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,4,6	6	▇	4.0	
SS	2	6,7,9,11	16	▇	>4.5	
SS	3	7,9,11,14	20	▇	>4.5	
SS	4	5,9,12,17	21	▇	>4.5	
SS	5	4,6,7,8	13	▇	<1.0	
SS	6	5,11,13,16	24	▇		
SS	7	7,11,14,21	25	▇		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 08, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as caved to 5.4 metres and 'Wet' at a depth of 5.3 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 08, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

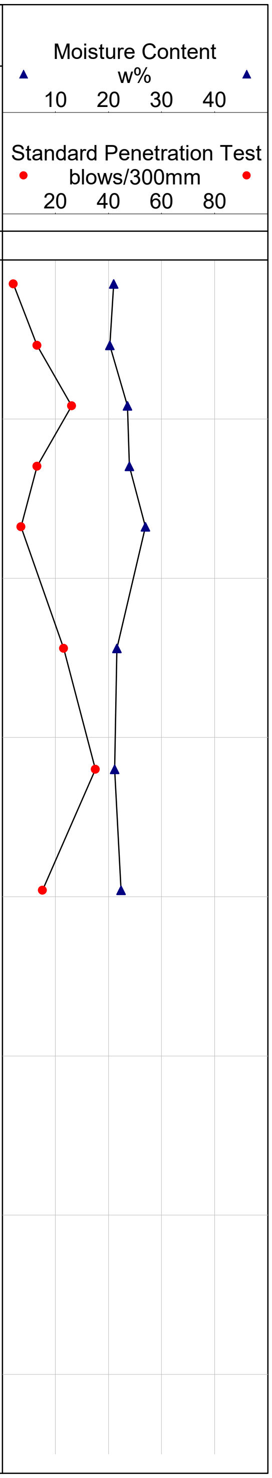
Datum: Geodetic
Field Logged by: IC
Checked by: IS
Sheet: 1 of 1

Log of Borehole No. 10

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765588
E: 641174

Depth (m)	Elevation (m)	Description
0	184.23	Ground Surface
		Topsoil Approximately 200 millimetres of topsoil.
		Silty Clay/Clayey Silt Brown, some organics in upper levels, firm to very stiff.
	180.73	Transition in colour to grey.
	180.12	**Sandy Silt/Silt** Reddish brown, compact to dense.
	176.01	End of Borehole

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,1,3,4	4	▨	1.5	
SS	2	4,6,7,11	13	▨	>4.5	
SS	3	5,11,15,18	26	▨	>4.5	
SS	4	5,6,7,9	13	▨	2.5	
SS	5	2,3,4,5	7	▨	1.0	
SS	6	6,11,12,14	23	▨		
SS	7	10,16,19,24	35	▨		
SS	8	6,6,9,10	15	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as caved to 6.4 metres and 'Wet' at a depth of 5.7 metres below the existing ground surface upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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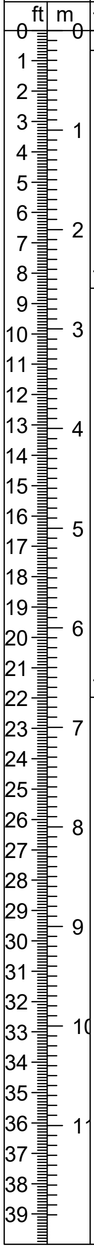
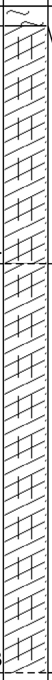
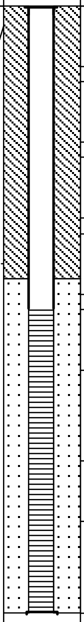
Log of Borehole No. 11

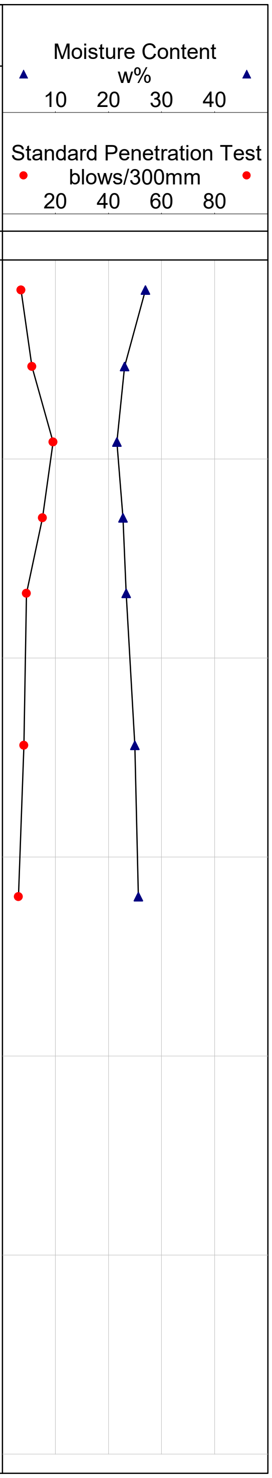
Project No: SM 220530-G
Project Manager: Ian Shaw, P.Eng.
Project: Proposed Residential Development
Borehole Location: See Drawing No. 1
Location: Quaker Road & First Avenue, Welland
UTM Coordinates - N: 4765518
Client: Primont (Thorold/Welland) Inc.
E: 641270



Elevation (m)	Description	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
183.23	Ground Surface							
	Topsoil Approximately 200 millimetres of topsoil.	SS	1	2,2,5,5	7	■	2.0	
	Silty Clay/Clayey Silt Brown, some organics in upper levels, firm to very stiff.	SS	2	3,4,7,11	11	■	>4.5	
		SS	3	4,7,12,16	19	■	>4.5	
180.64	Transition in colour to grey.	SS	4	4,7,8,10	15	■	2.5	
		SS	5	3,4,3,7	9	■	2.0	
		SS	6	3,3,5,7	8	■	1.5	
176.53		SS	7	2,3,3,4	6	■	<1.0	
	End of Borehole							







NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.4 metres upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

4. A monitoring well was installed and the following groundwater level readings have been measured:
January 3 2023 : 0.0 metres

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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Datum: Geodetic
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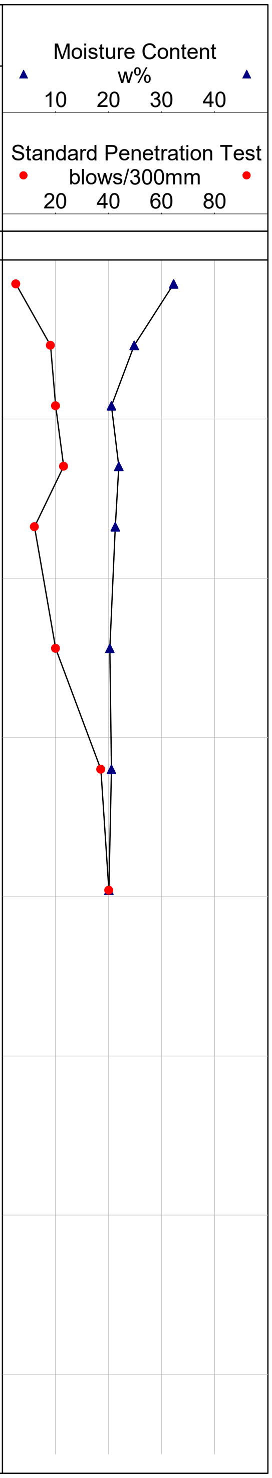
Sheet: 1 of 1

Log of Borehole No. 12

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4765409
E: 641213

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft m 0	184.19		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	0,2,3,5	5	▨	1.5	
			Silty Clay/Clayey Silt Brown, firm to very stiff.		SS	2	5,8,10,13	18	▨	>4.5	
					SS	3	5,8,12,16	20	▨	>4.5	
					SS	4	6,10,13,16	23	▨	>4.5	
	180.84		Transition in colour to grey.		SS	5	4,5,7,7	12	▨	1.5	
	179.32		**Sandy Silt/Silt** Reddish brown, compact to dense.		SS	6	3,5,15,19	20	▨	1.5	
					SS	7	12,16,21,25	37	▨		
	175.97				SS	8	12,14,26,28	40	▨		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 8.2 metres.

2. Borehole was recorded as open and 'Dry' upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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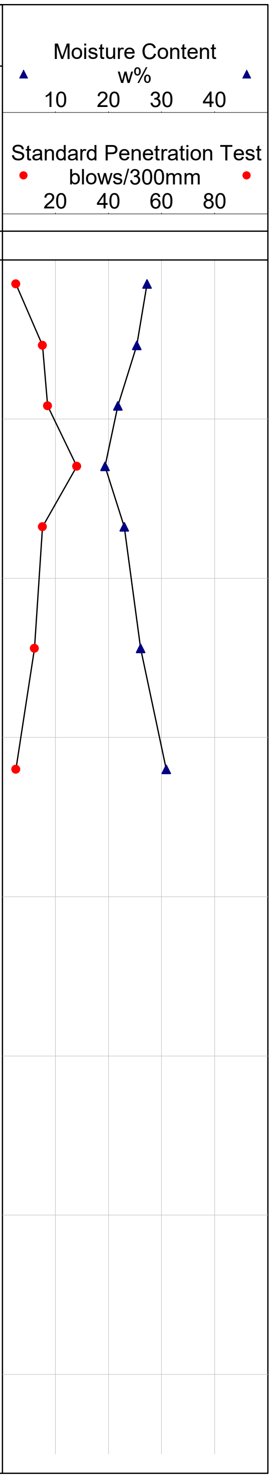
Sheet: 1 of 1

Log of Borehole No. 13

Project No: SM 220530-G
Project: Proposed Residential Development
Location: Quaker Road & First Avenue, Welland
Client: Primont (Thorold/Welland) Inc.
Project Manager: Ian Shaw, P.Eng.
Borehole Location: See Drawing No. 1
UTM Coordinates - N: 4764871
E: 641196

Depth	Elevation (m)	Symbol	Description	Well Data	SAMPLE Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0	183.94		Ground Surface								
			Topsoil Approximately 200 millimetres of topsoil.		SS	1	0,2,3,6	5	▨	1.5	
			Silty Clay/Clayey Silt Brown, firm to very stiff.		SS	2	5,7,8,11	15	▨	>4.5	
					SS	3	7,7,10,15	17	▨	>4.5	
					SS	4	6,12,16,19	28	▨	>4.5	
					SS	5	4,7,8,11	15	▨	3.0	
5	178.76				SS	6	3,4,8,8	12	▨	<1	
			Transition in colour to grey.								
	177.24				SS	7	2,2,3,4	5	▨	<1	
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on December 09, 2022 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'Wet' at a depth of 5.6 metres upon completion and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers
Drill Date: December 09, 2022
Hole Size: 150 Millimetres
Drilling Contractor: Elements Drilling Ltd.

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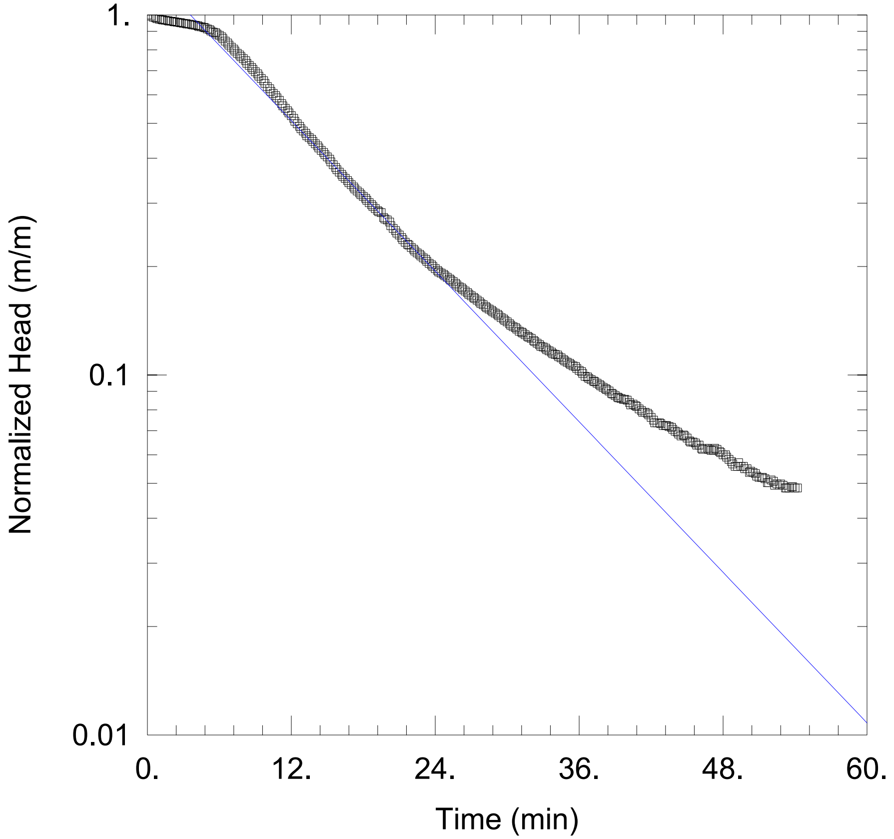
Appendix C

Hydraulic Conductivity Analyses



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_01_new_2023.aqt
Date: 05/16/23 Time: 15:01:11

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-1
Test Date: May 10, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

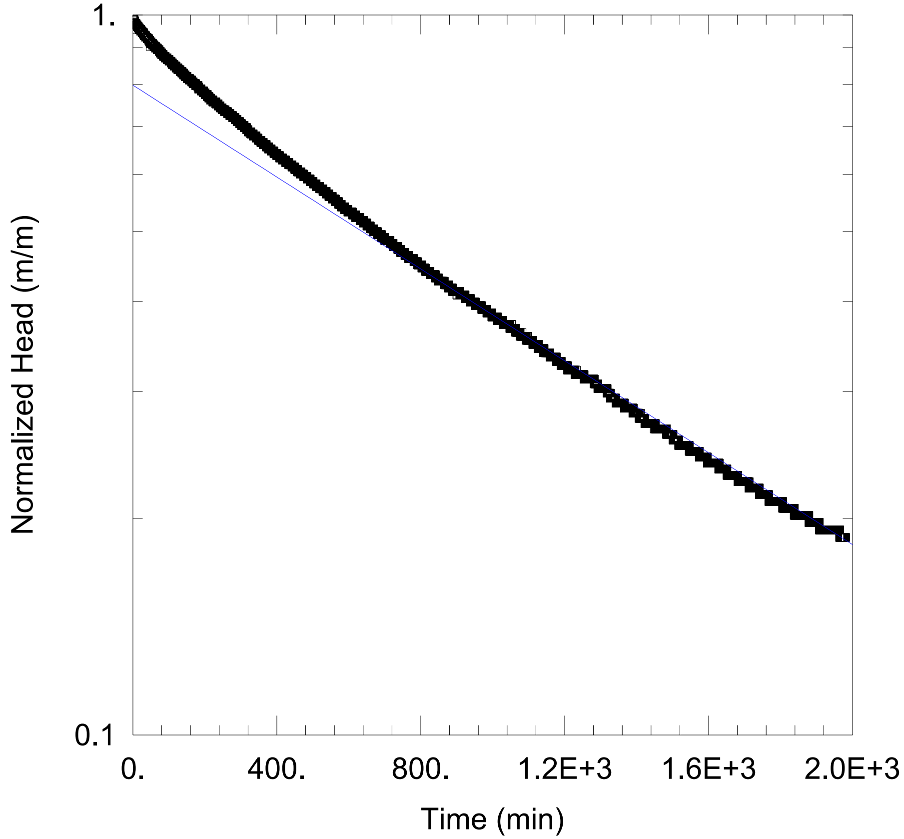
K = 4.831E-7 m/sec
y0 = 3.131 m

AQUIFER DATA

Saturated Thickness: 7.96 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-1)

Initial Displacement: 2.35 m
Total Well Penetration Depth: 7.96 m
Casing Radius: 0.0254 m
Static Water Column Height: 7.96 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_02.aqt
Date: 05/16/23 Time: 16:09:23

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-02
Test Date: May 10, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

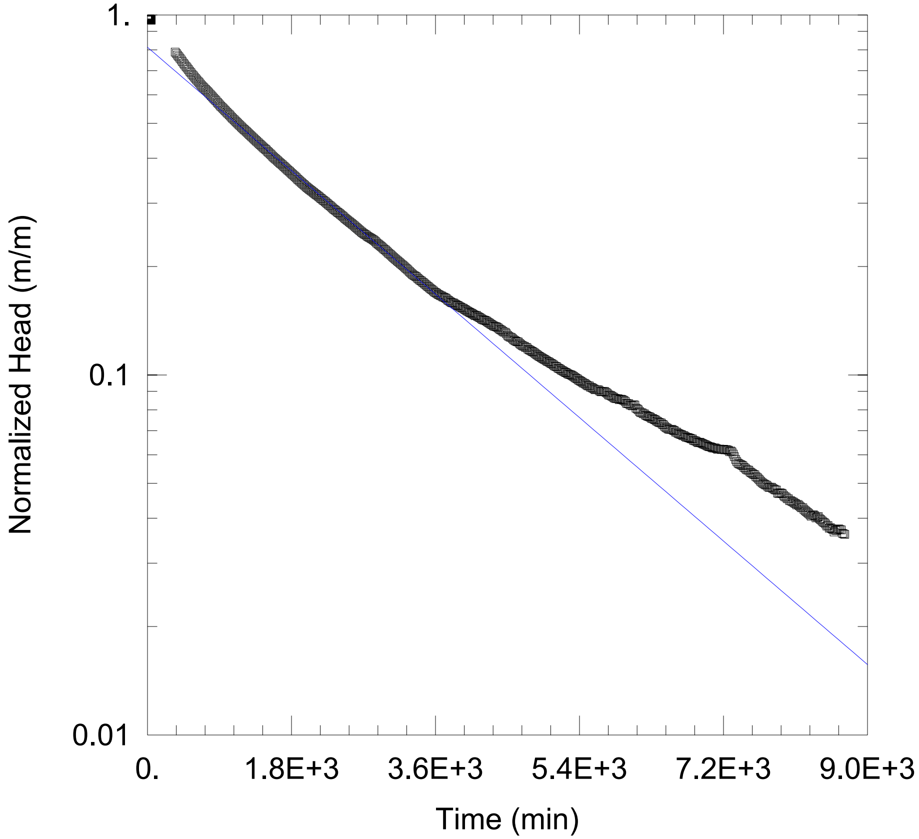
K = 4.131E-9 m/sec
y0 = 1.741 m

AQUIFER DATA

Saturated Thickness: 5.47 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-02)

Initial Displacement: 2.18 m
Total Well Penetration Depth: 5.47 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.47 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_3.aqt
Date: 05/08/23 Time: 10:16:51

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-3
Test Date: November 9, 2022

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

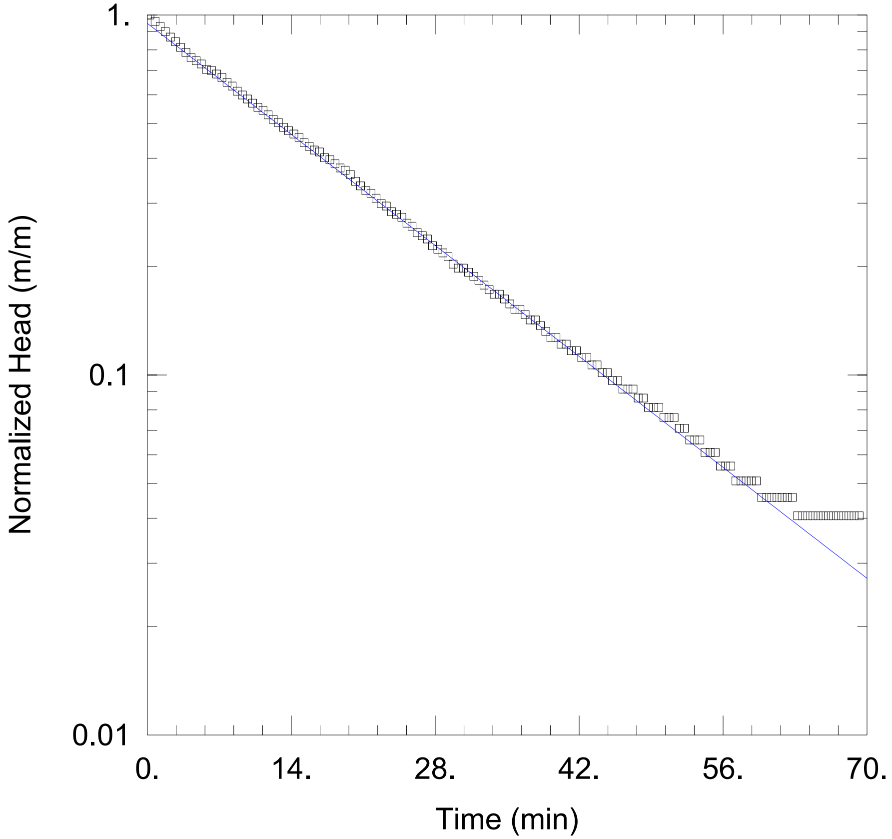
K = 2.611E-9 m/sec
y0 = 1.596 m

AQUIFER DATA

Saturated Thickness: 4.552 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-3)

Initial Displacement: 1.963 m
Total Well Penetration Depth: 4.55 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.552 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_06.aqt
Date: 05/16/23 Time: 15:57:15

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-06
Test Date: May 10, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

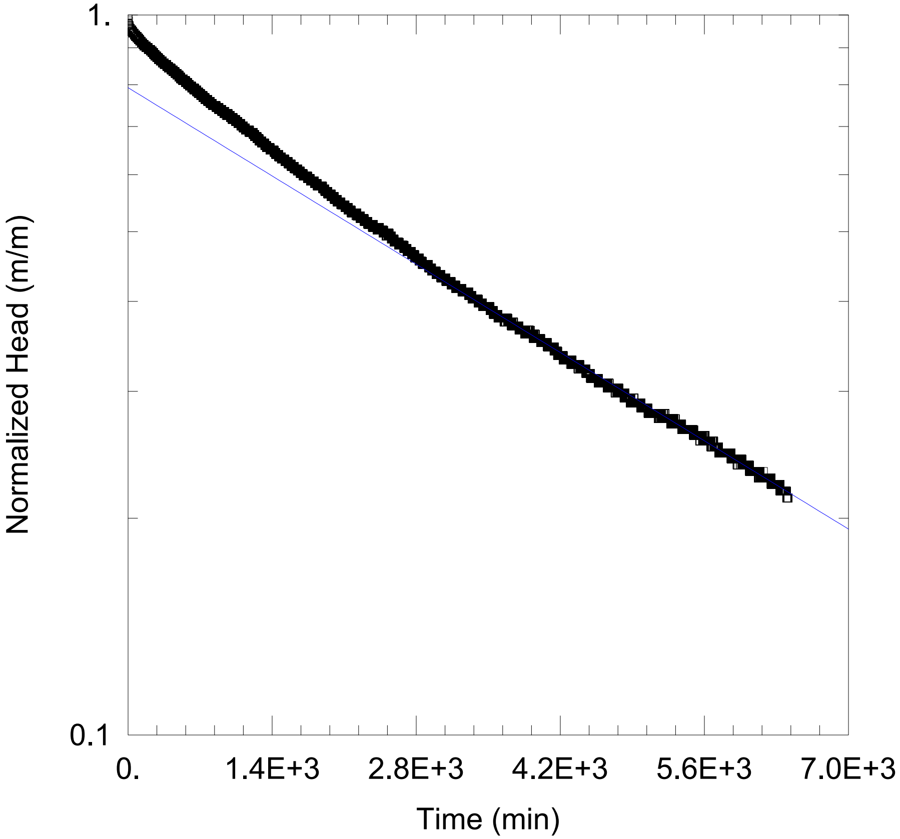
K = 2.858E-7 m/sec
y0 = 1.866 m

AQUIFER DATA

Saturated Thickness: 5.54 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-06)

Initial Displacement: 1.97 m
Total Well Penetration Depth: 5.54 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.54 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_11.aqt
Date: 05/16/23 Time: 15:42:38

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-11
Test Date: May 10, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

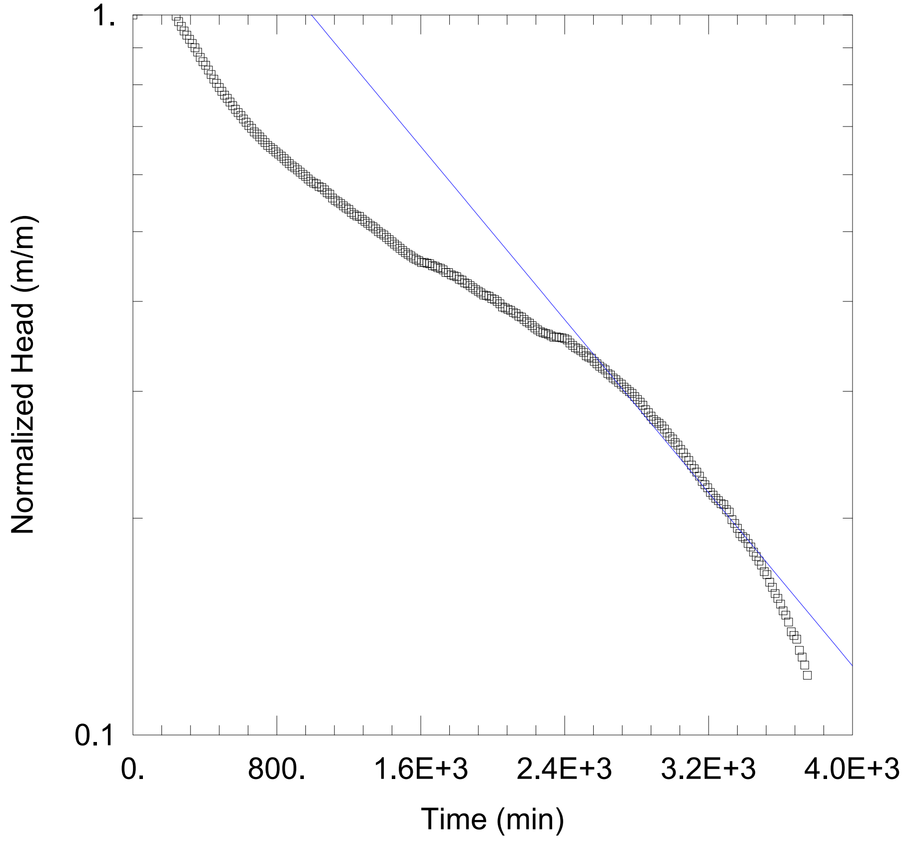
K = 1.179E-9 m/sec
y0 = 1.672 m

AQUIFER DATA

Saturated Thickness: 6.75 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-11)

Initial Displacement: 2.11 m
Total Well Penetration Depth: 6.75 m
Casing Radius: 0.0254 m
Static Water Column Height: 6.75 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_13.aqt
Date: 05/08/23 Time: 10:07:41

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-13
Test Date: November 9, 2022

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

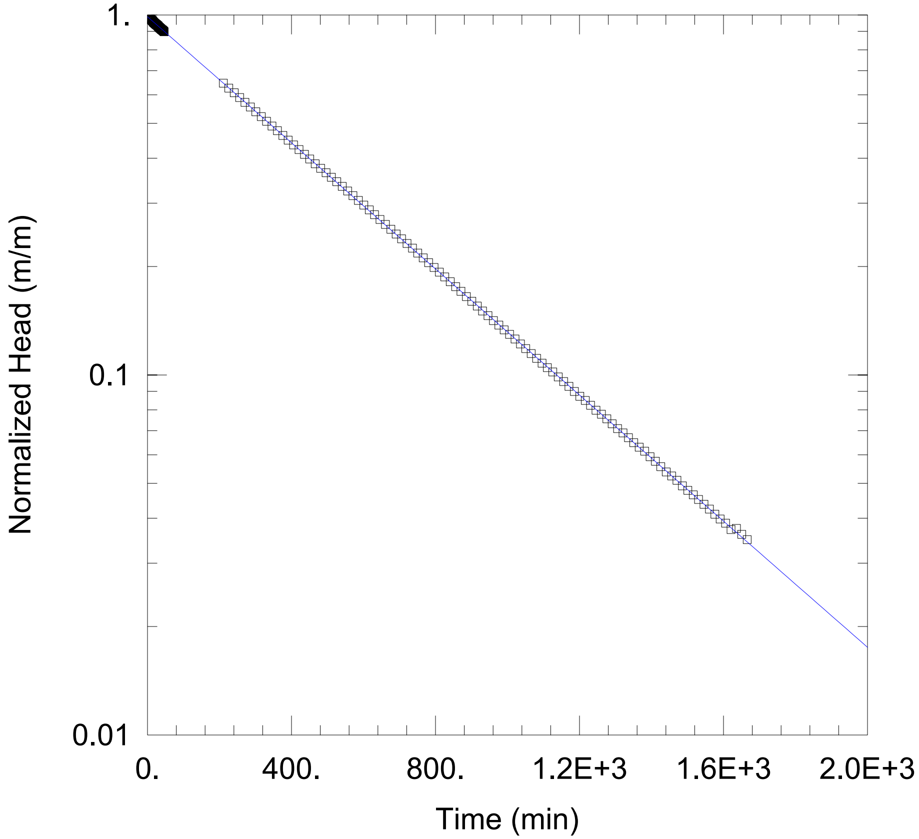
K = 3.617E-9 m/sec
y0 = 0.9899 m

AQUIFER DATA

Saturated Thickness: 3.801 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-13)

Initial Displacement: 0.4983 m
Total Well Penetration Depth: 3.801 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.801 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_14.aqt
Date: 05/08/23 Time: 09:50:10

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-14
Test Date: November 9, 2022

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

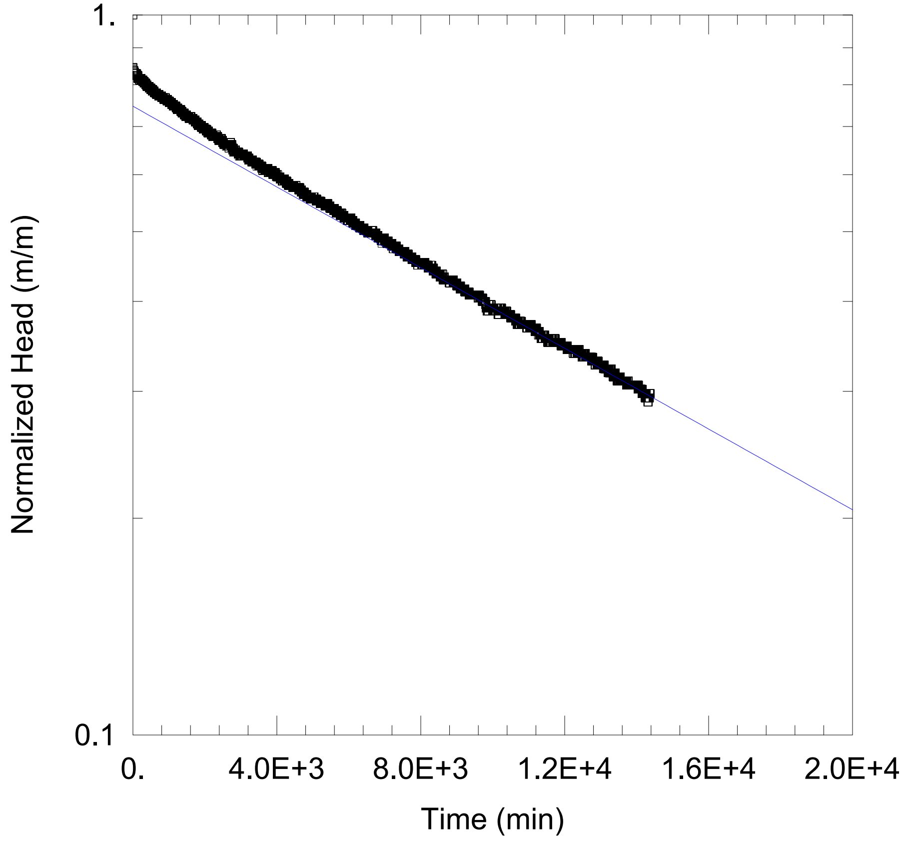
K = 1.132E-8 m/sec
y0 = 2.166 m

AQUIFER DATA

Saturated Thickness: 5.38 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-14)

Initial Displacement: 2.191 m
Total Well Penetration Depth: 5.433 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.38 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH21_16.aqt
Date: 05/17/23 Time: 11:24:15

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH21-16
Test Date: May 5, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

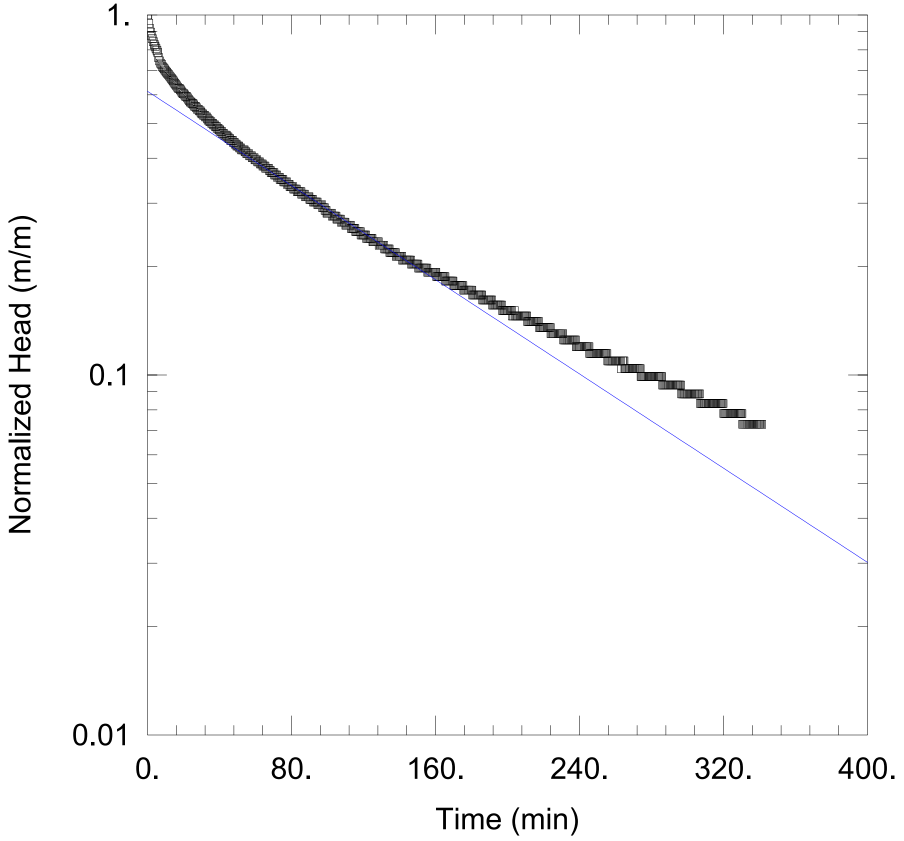
K = 3.583E-10 m/sec
y0 = 1.83 m

AQUIFER DATA

Saturated Thickness: 5.13 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-16)

Initial Displacement: 2.45 m
Total Well Penetration Depth: 5.13 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.13 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH22_02.aqt
Date: 05/17/23 Time: 10:41:00

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH22-02
Test Date: May 5, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

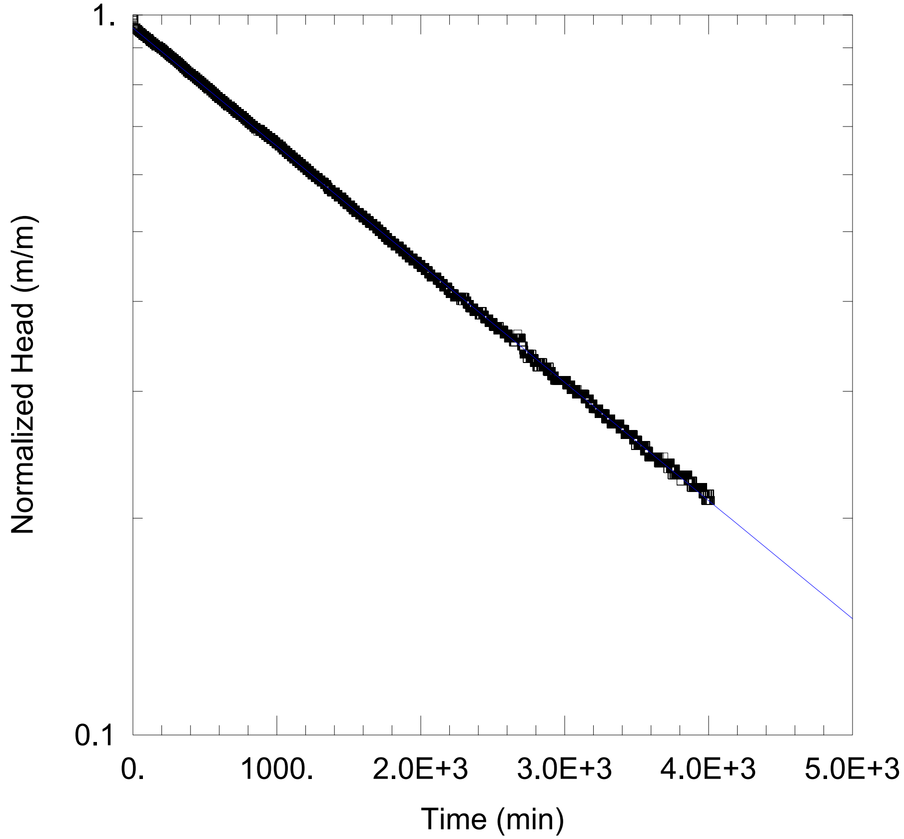
K = 4.158E-8 m/sec
y0 = 1.178 m

AQUIFER DATA

Saturated Thickness: 4.97 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH22-02)

Initial Displacement: 1.92 m
Total Well Penetration Depth: 4.97 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.97 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\BH22_03.aqt
Date: 05/17/23 Time: 10:49:31

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: BH22-03
Test Date: May 5, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

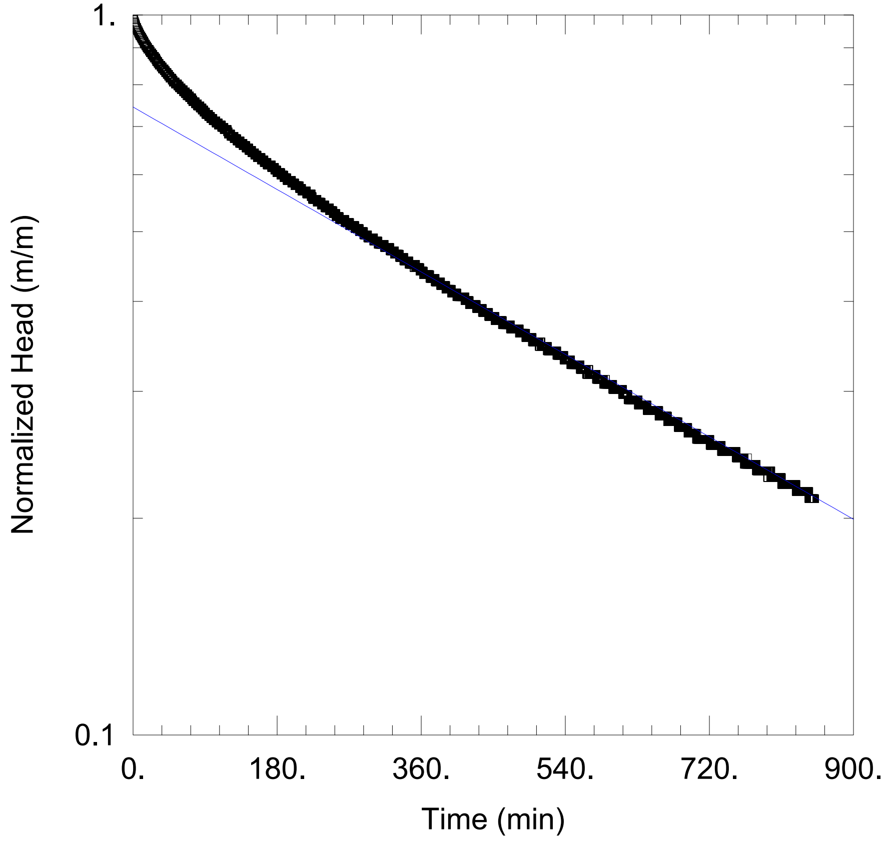
K = 2.151E-9 m/sec
y0 = 2.129 m

AQUIFER DATA

Saturated Thickness: 5.84 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH22-03)

Initial Displacement: 2.22 m
Total Well Penetration Depth: 5.84 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.84 m
Screen Length: 3.05 m
Well Radius: 0.075 m



BAIL-DOWN RECOVERY

Data Set: C:\...\MW11_SM.aqt
Date: 05/17/23 Time: 11:36:55

PROJECT INFORMATION

Company: Terra-Dynamics Consulting Inc.
Client: Primont (Welland/Thorold) Inc.
Location: Welland/Thorold, ON
Test Well: MW-11 SM
Test Date: May 10, 2023

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 8.132E-9 m/sec
y0 = 1.424 m

AQUIFER DATA

Saturated Thickness: 6.31 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11 SM)

Initial Displacement: 2.02 m
Total Well Penetration Depth: 6.31 m
Casing Radius: 0.0254 m
Static Water Column Height: 6.31 m
Screen Length: 3.05 m
Well Radius: 0.075 m

K from Grain Size Analysis Report

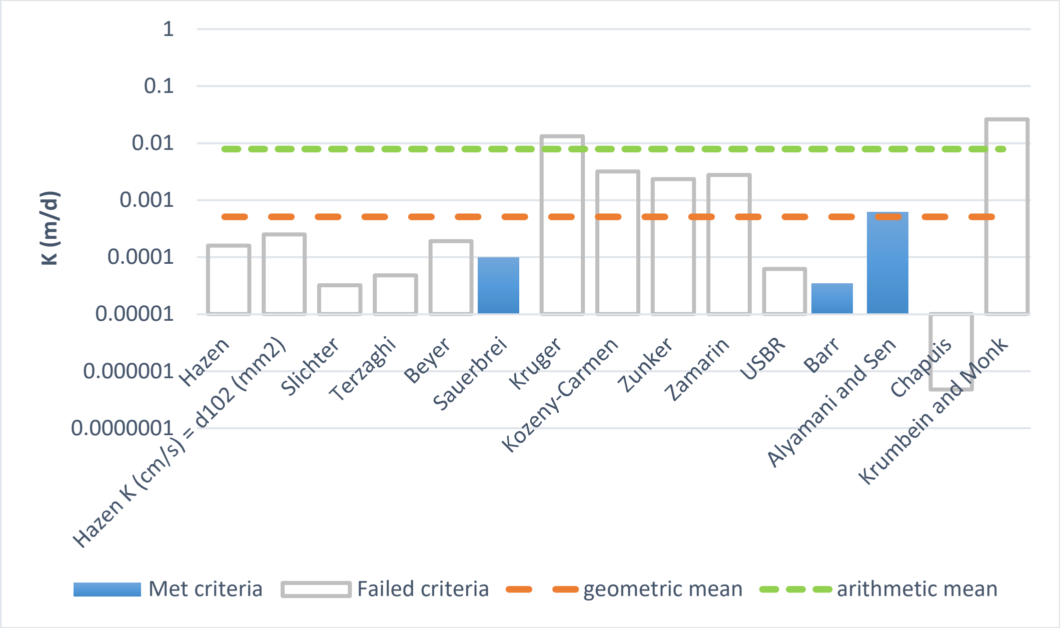
Date: 26-Apr-23

Sample Name: BH21-2 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	2.E-07	2.E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	3.E-07	3.E-09	0.00	
Slichter	4.E-08	4.E-10	0.00	
Terzaghi	6.E-08	6.E-10	0.00	
Beyer	2.E-07	2.E-09	0.00	
Sauerbrei	1.E-07	1.E-09	0.00	
Kruger	2.E-05	2.E-07	0.01	
Kozeny-Carmen	4.E-06	4.E-08	0.00	
Zunker	3.E-06	3.E-08	0.00	
Zamarin	3.E-06	3.E-08	0.00	
USBR	7.E-08	7.E-10	0.00	
Barr	4.E-08	4.E-10	0.00	
Alyamani and Sen	7.E-07	7.E-09	0.00	
Chapuis	6.E-10	6.E-12	0.00	
Krumbein and Monk	3.E-05	3.E-07	0.03	
Shepherd	4.E-05	4.E-07	0.03	
geometric mean	6.E-07	6.E-09	0.00	
arithmetic mean	9.E-06	9.E-08	0.01	

K from Grain Size Analysis Report

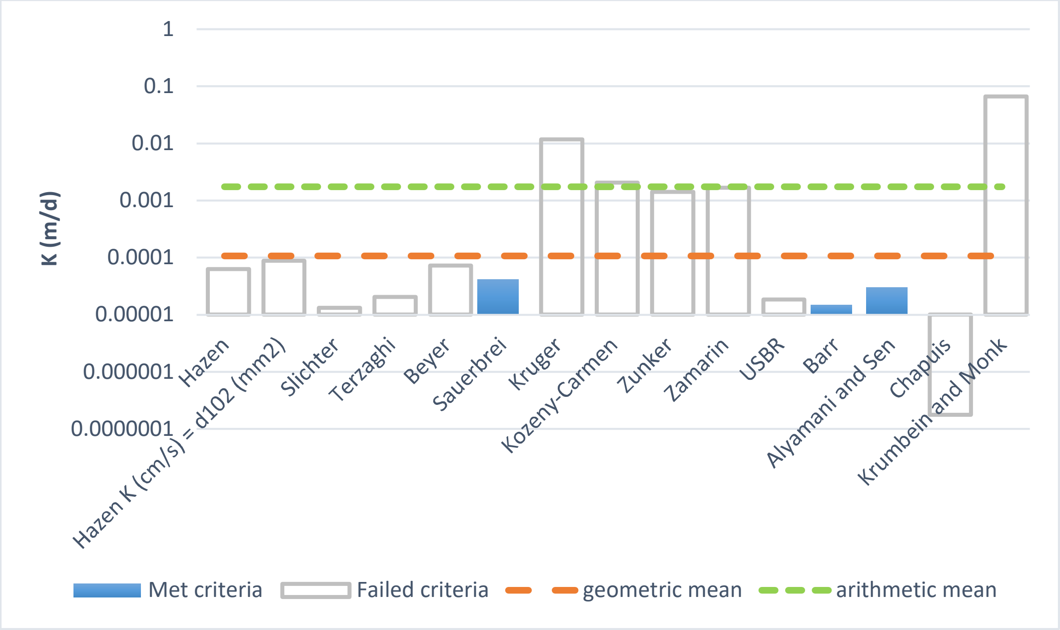
Date: 26-Apr-23

Sample Name: BH21-3 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



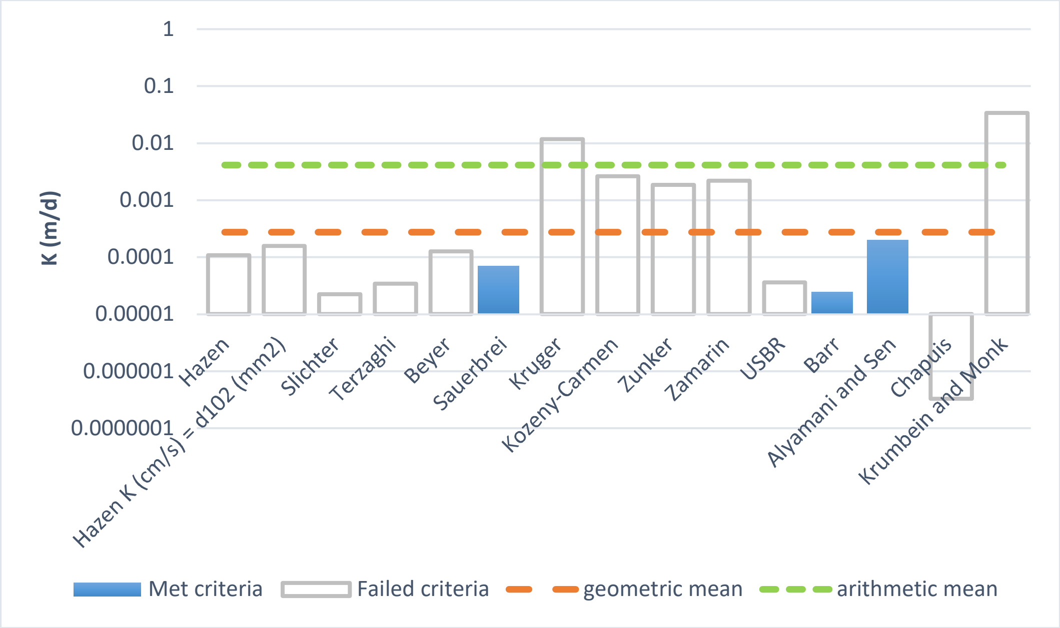
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	7.E-08	7.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	1.E-07	1.E-09	0.00	
Slichter	2.E-08	2.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	8.E-08	8.E-10	0.00	
Sauerbrei	5.E-08	5.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	2.E-08	2.E-10	0.00	
Barr	2.E-08	2.E-10	0.00	
Alyamani and Sen	4.E-08	4.E-10	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	8.E-05	8.E-07	0.07	
Shepherd	8.E-06	8.E-08	0.01	
geometric mean	1.E-07	1.E-09	0.00	
arithmetic mean	2.E-06	2.E-08	0.00	

K from Grain Size Analysis Report Date: 26-Apr-23

Sample Name: BH21-6 SS5 Primont Homes, Welland

Mass Sample (g): 100 T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	1.E-07	1.E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	2.E-07	2.E-09	0.00	
Slichter	3.E-08	3.E-10	0.00	
Terzaghi	4.E-08	4.E-10	0.00	
Beyer	1.E-07	1.E-09	0.00	
Sauerbrei	8.E-08	8.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	3.E-06	3.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	3.E-06	3.E-08	0.00	
USBR	4.E-08	4.E-10	0.00	
Barr	3.E-08	3.E-10	0.00	
Alyamani and Sen	2.E-07	2.E-09	0.00	
Chapuis	4.E-10	4.E-12	0.00	
Krumbein and Monk	4.E-05	4.E-07	0.03	
Shepherd	2.E-05	2.E-07	0.02	
geometric mean	3.E-07	3.E-09	0.00	
arithmetic mean	5.E-06	5.E-08	0.00	

K from Grain Size Analysis Report

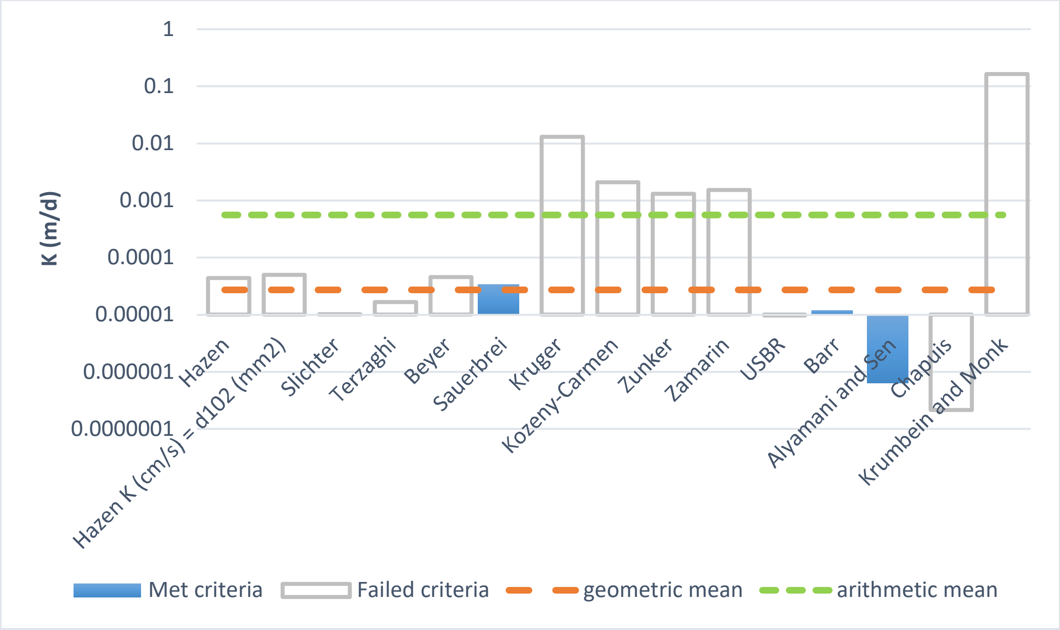
Date: 26-Apr-23

Sample Name: BH21-8 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.E-08	5.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	6.E-08	6.E-10	0.00	
Slichter	1.E-08	1.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	5.E-08	5.E-10	0.00	
Sauerbrei	4.E-08	4.E-10	0.00	
Kruger	2.E-05	2.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	1.E-08	1.E-10	0.00	
Barr	1.E-08	1.E-10	0.00	
Alyamani and Sen	7.E-10	7.E-12	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	2.E-04	2.E-06	0.16	
Shepherd	3.E-06	3.E-08	0.00	
geometric mean	3.E-08	3.E-10	0.00	
arithmetic mean	6.E-07	6.E-09	0.00	

K from Grain Size Analysis Report

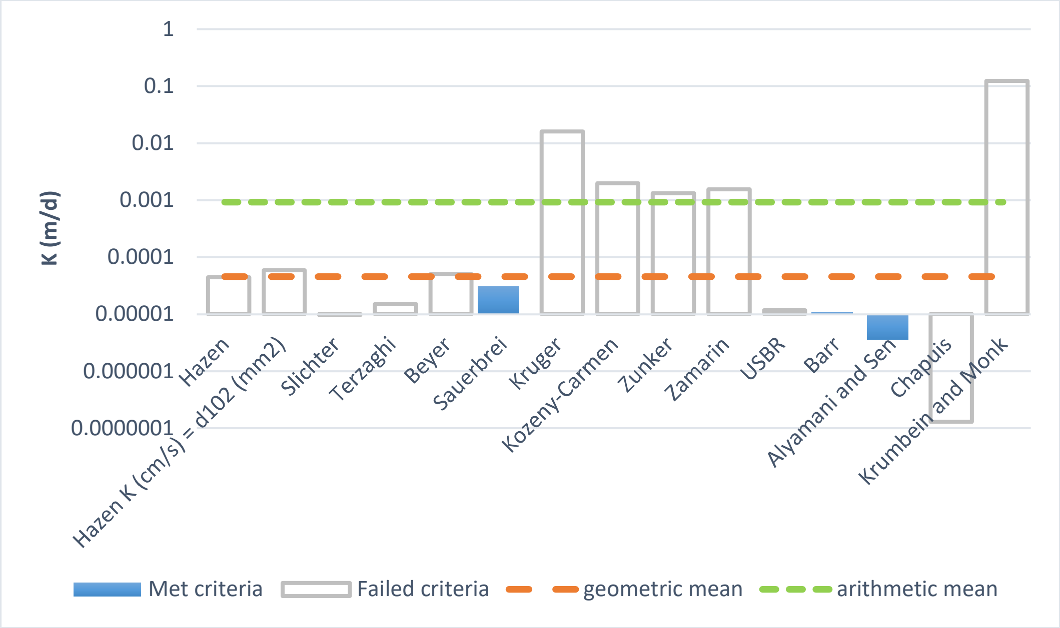
Date: 26-Apr-23

Sample Name: BH21-9 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.E-08	5.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	7.E-08	7.E-10	0.00	
Slichter	1.E-08	1.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	6.E-08	6.E-10	0.00	
Sauerbrei	4.E-08	4.E-10	0.00	
Kruger	2.E-05	2.E-07	0.02	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	1.E-08	1.E-10	0.00	
Barr	1.E-08	1.E-10	0.00	
Alyamani and Sen	4.E-09	4.E-11	0.00	
Chapuis	1.E-10	1.E-12	0.00	
Krumbein and Monk	1.E-04	1.E-06	0.12	
Shepherd	4.E-06	4.E-08	0.00	
geometric mean	5.E-08	5.E-10	0.00	
arithmetic mean	1.E-06	1.E-08	0.00	

K from Grain Size Analysis Report

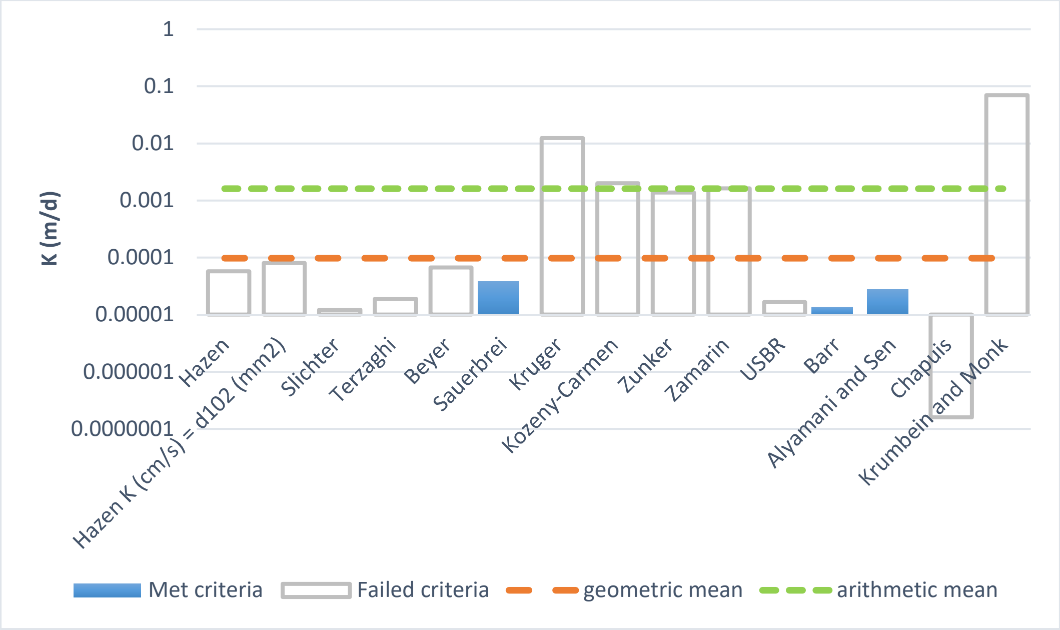
Date: 26-Apr-23

Sample Name: BH21-11 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	7.E-08	7.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	9.E-08	9.E-10	0.00	
Slichter	1.E-08	1.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	8.E-08	8.E-10	0.00	
Sauerbrei	4.E-08	4.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	2.E-08	2.E-10	0.00	
Barr	2.E-08	2.E-10	0.00	
Alyamani and Sen	3.E-08	3.E-10	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	8.E-05	8.E-07	0.07	
Shepherd	7.E-06	7.E-08	0.01	
geometric mean	1.E-07	1.E-09	0.00	
arithmetic mean	2.E-06	2.E-08	0.00	

K from Grain Size Analysis Report

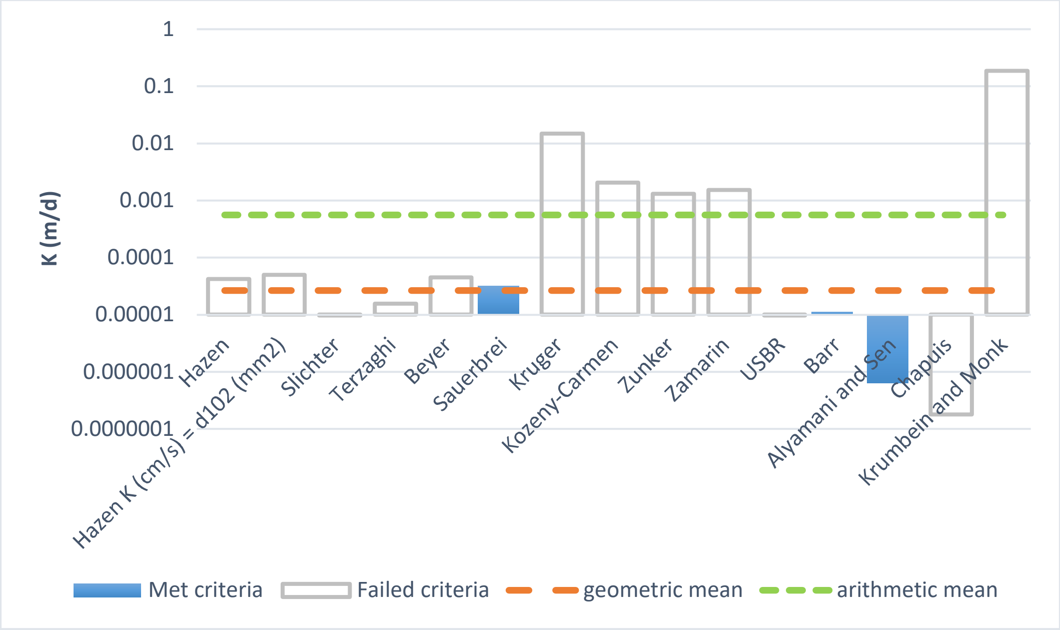
Date: 26-Apr-23

Sample Name: BH21-13 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.E-08	5.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	6.E-08	6.E-10	0.00	
Slichter	1.E-08	1.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	5.E-08	5.E-10	0.00	
Sauerbrei	4.E-08	4.E-10	0.00	
Kruger	2.E-05	2.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	1.E-08	1.E-10	0.00	
Barr	1.E-08	1.E-10	0.00	
Alyamani and Sen	7.E-10	7.E-12	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	2.E-04	2.E-06	0.19	
Shepherd	3.E-06	3.E-08	0.00	
geometric mean	3.E-08	3.E-10	0.00	
arithmetic mean	6.E-07	6.E-09	0.00	

K from Grain Size Analysis Report

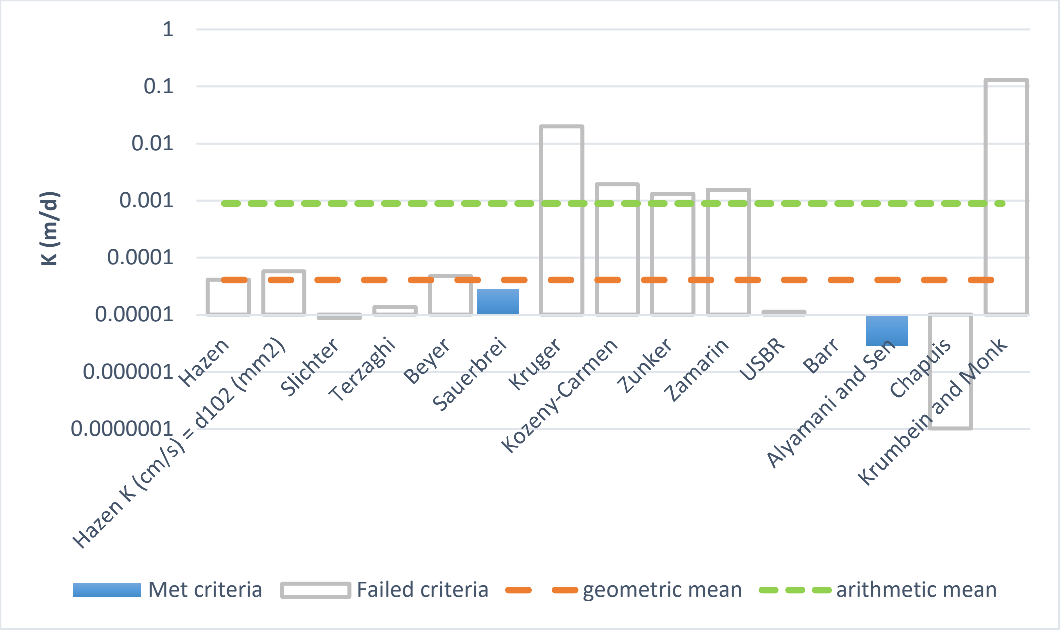
Date: 26-Apr-23

Sample Name: BH21-14 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	5.E-08	5.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	7.E-08	7.E-10	0.00	
Slichter	1.E-08	1.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	5.E-08	5.E-10	0.00	
Sauerbrei	3.E-08	3.E-10	0.00	
Kruger	2.E-05	2.E-07	0.02	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	1.E-08	1.E-10	0.00	
Barr	1.E-08	1.E-10	0.00	
Alyamani and Sen	3.E-09	3.E-11	0.00	
Chapuis	1.E-10	1.E-12	0.00	
Krumbein and Monk	2.E-04	2.E-06	0.13	
Shepherd	4.E-06	4.E-08	0.00	
geometric mean	5.E-08	5.E-10	0.00	
arithmetic mean	1.E-06	1.E-08	0.00	

K from Grain Size Analysis Report

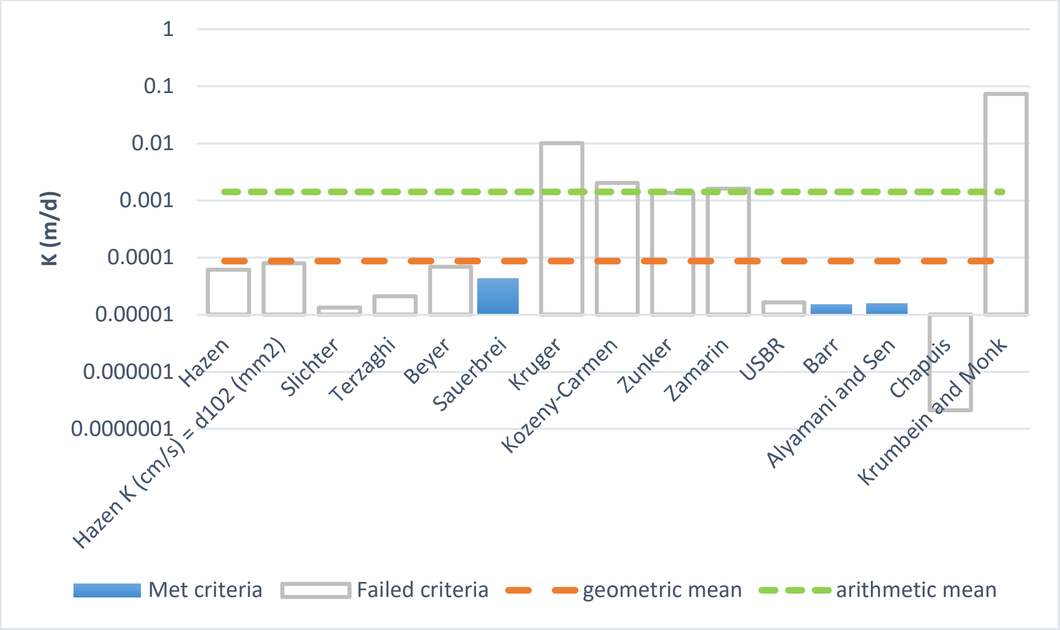
Date: 26-Apr-23

Sample Name: BH21-16 SS5 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



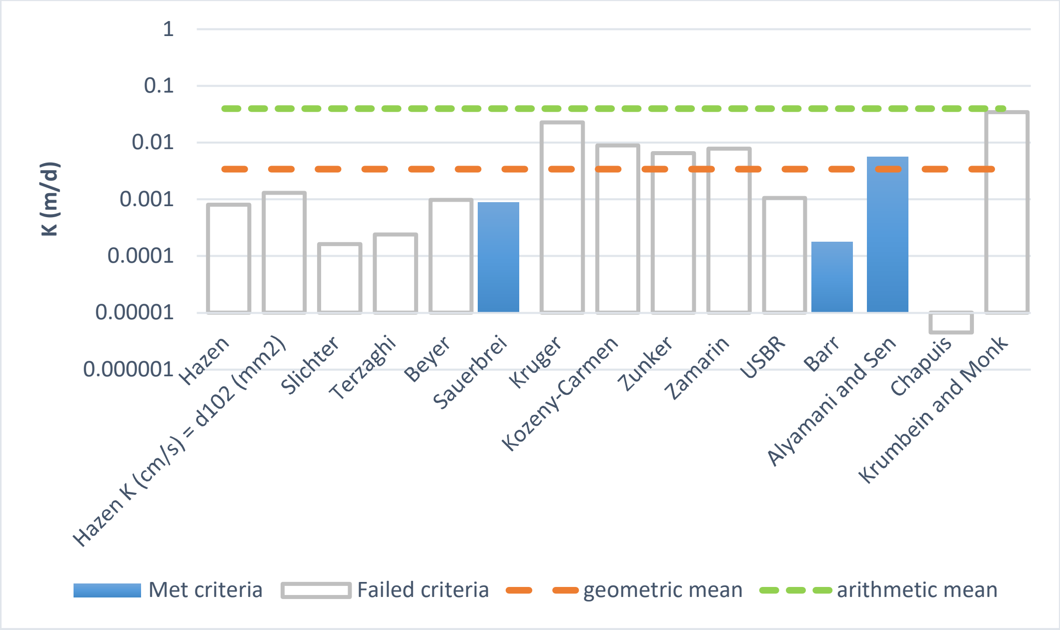
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	7.E-08	7.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	9.E-08	9.E-10	0.00	
Slichter	2.E-08	2.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	8.E-08	8.E-10	0.00	
Sauerbrei	5.E-08	5.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	2.E-08	2.E-10	0.00	
Barr	2.E-08	2.E-10	0.00	
Alyamani and Sen	2.E-08	2.E-10	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	8.E-05	8.E-07	0.07	
Shepherd	7.E-06	7.E-08	0.01	
geometric mean	1.E-07	1.E-09	0.00	
arithmetic mean	2.E-06	2.E-08	0.00	

K from Grain Size Analysis Report | Date: 26-Apr-23

Sample Name: BH22-1 SS6 Primont Homes, Welland

Mass Sample (g): 100 | T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	9.E-07	9.E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	1.E-06	1.E-08	0.00	
Slichter	2.E-07	2.E-09	0.00	
Terzaghi	3.E-07	3.E-09	0.00	
Beyer	1.E-06	1.E-08	0.00	
Sauerbrei	1.E-06	1.E-08	0.00	
Kruger	3.E-05	3.E-07	0.02	
Kozeny-Carmen	1.E-05	1.E-07	0.01	
Zunker	8.E-06	8.E-08	0.01	
Zamarin	9.E-06	9.E-08	0.01	
USBR	1.E-06	1.E-08	0.00	
Barr	2.E-07	2.E-09	0.00	
Alyamani and Sen	6.E-06	6.E-08	0.01	
Chapuis	5.E-09	5.E-11	0.00	
Krumbein and Monk	4.E-05	4.E-07	0.03	
Shepherd	2.E-04	2.E-06	0.15	
geometric mean	4.E-06	4.E-08	0.00	
arithmetic mean	5.E-05	5.E-07	0.04	

K from Grain Size Analysis Report

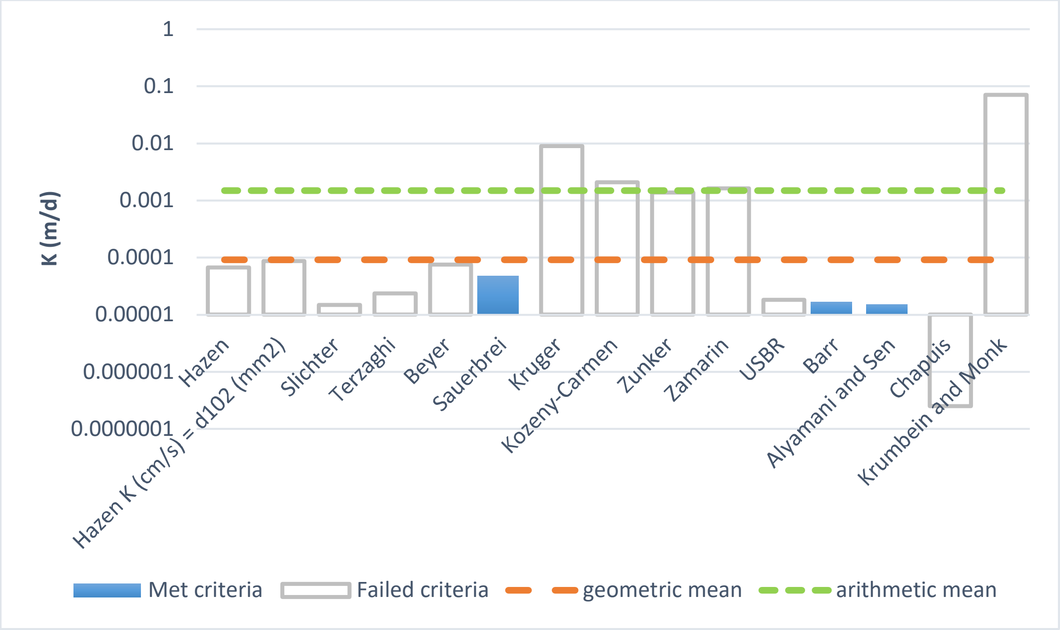
Date: 26-Apr-23

Sample Name: BH22-2 SS6 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	8.E-08	8.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	1.E-07	1.E-09	0.00	
Slichter	2.E-08	2.E-10	0.00	
Terzaghi	3.E-08	3.E-10	0.00	
Beyer	9.E-08	9.E-10	0.00	
Sauerbrei	6.E-08	6.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	2.E-08	2.E-10	0.00	
Barr	2.E-08	2.E-10	0.00	
Alyamani and Sen	2.E-08	2.E-10	0.00	
Chapuis	3.E-10	3.E-12	0.00	
Krumbein and Monk	8.E-05	8.E-07	0.07	
Shepherd	7.E-06	7.E-08	0.01	
geometric mean	1.E-07	1.E-09	0.00	
arithmetic mean	2.E-06	2.E-08	0.00	

K from Grain Size Analysis Report

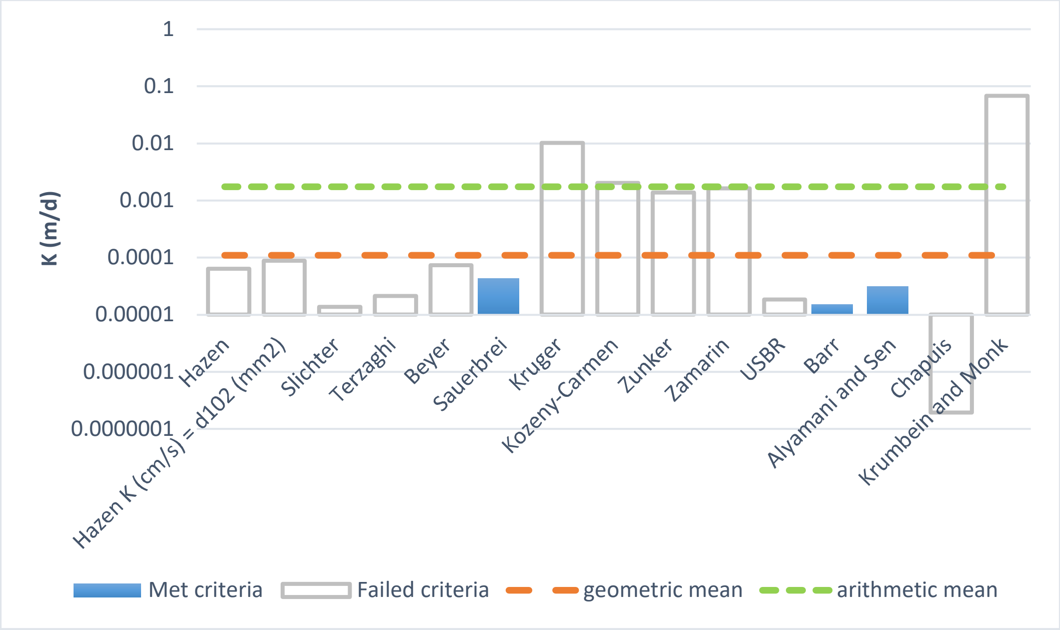
Date: 26-Apr-23

Sample Name: BH22-3 SS6 Primont Homes, Welland

Mass Sample (g): 100

T (oC) 20

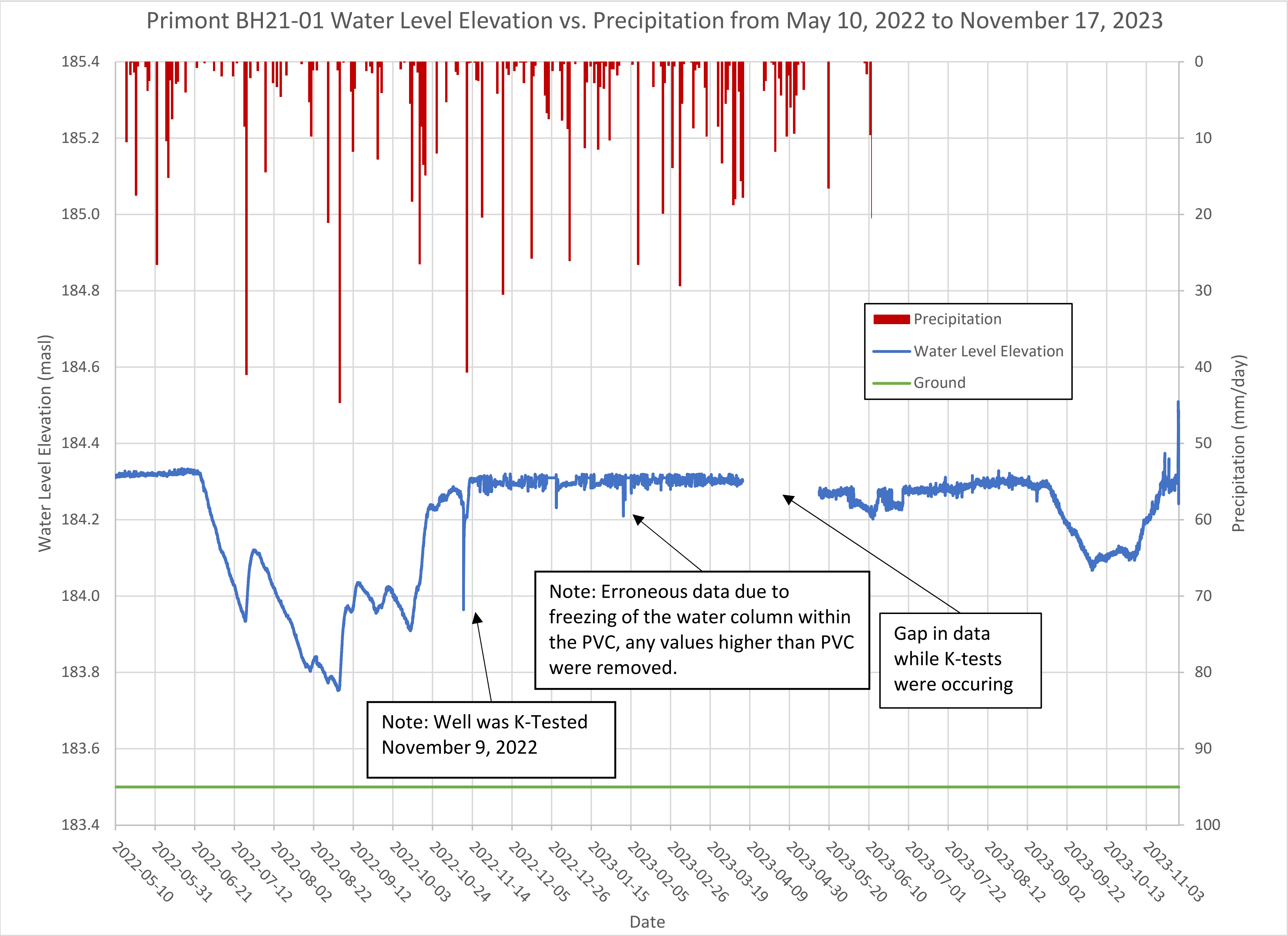
Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	7.E-08	7.E-10	0.00	
Hazen K (cm/s) = d_{10} (mm)	1.E-07	1.E-09	0.00	
Slichter	2.E-08	2.E-10	0.00	
Terzaghi	2.E-08	2.E-10	0.00	
Beyer	8.E-08	8.E-10	0.00	
Sauerbrei	5.E-08	5.E-10	0.00	
Kruger	1.E-05	1.E-07	0.01	
Kozeny-Carmen	2.E-06	2.E-08	0.00	
Zunker	2.E-06	2.E-08	0.00	
Zamarin	2.E-06	2.E-08	0.00	
USBR	2.E-08	2.E-10	0.00	
Barr	2.E-08	2.E-10	0.00	
Alyamani and Sen	4.E-08	4.E-10	0.00	
Chapuis	2.E-10	2.E-12	0.00	
Krumbein and Monk	8.E-05	8.E-07	0.07	
Shepherd	8.E-06	8.E-08	0.01	
geometric mean	1.E-07	1.E-09	0.00	
arithmetic mean	2.E-06	2.E-08	0.00	

Appendix D

Groundwater Datalogger Charts

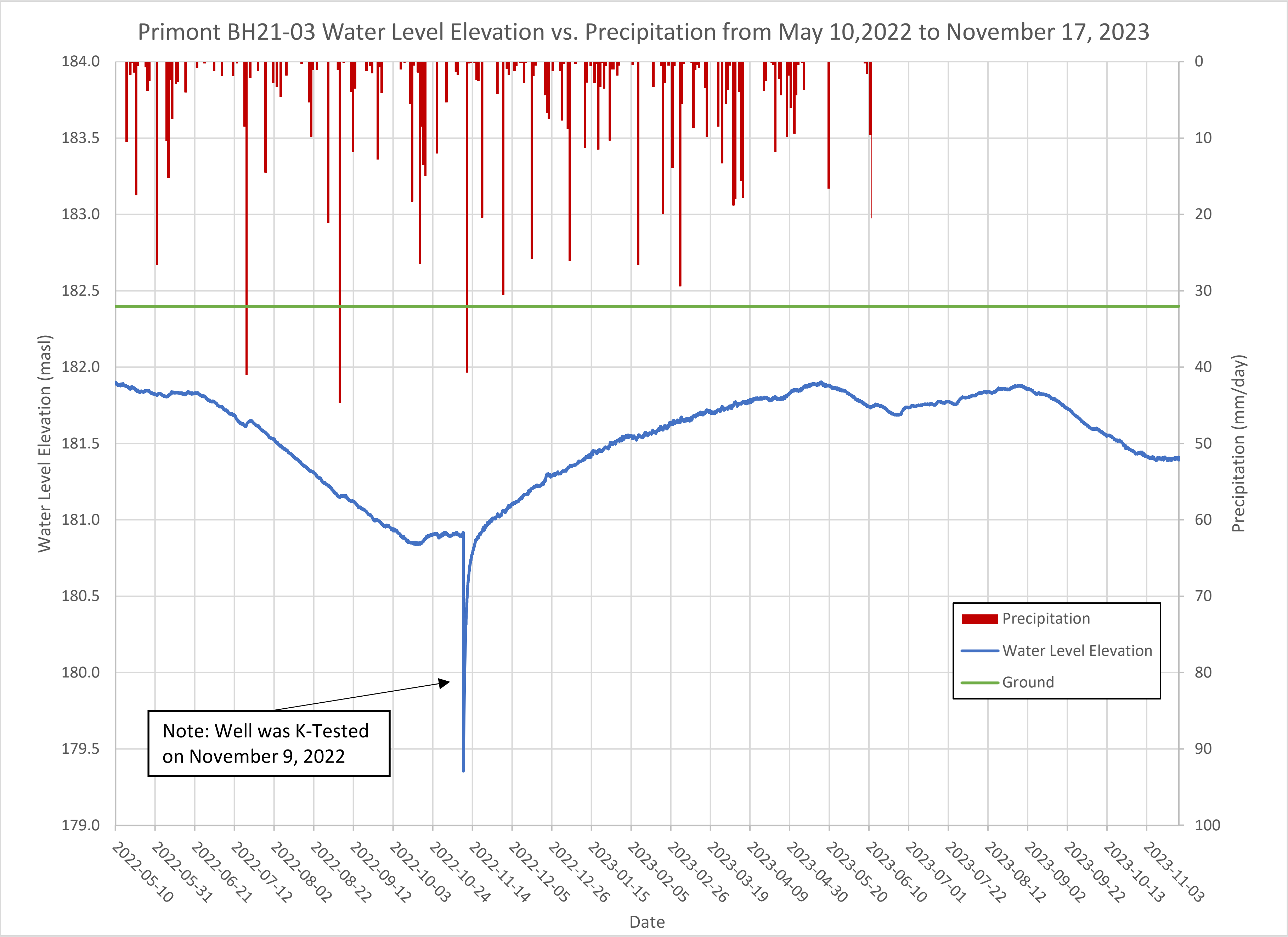


Primont BH21-01 Water Level Elevation vs. Precipitation from May 10, 2022 to November 17, 2023

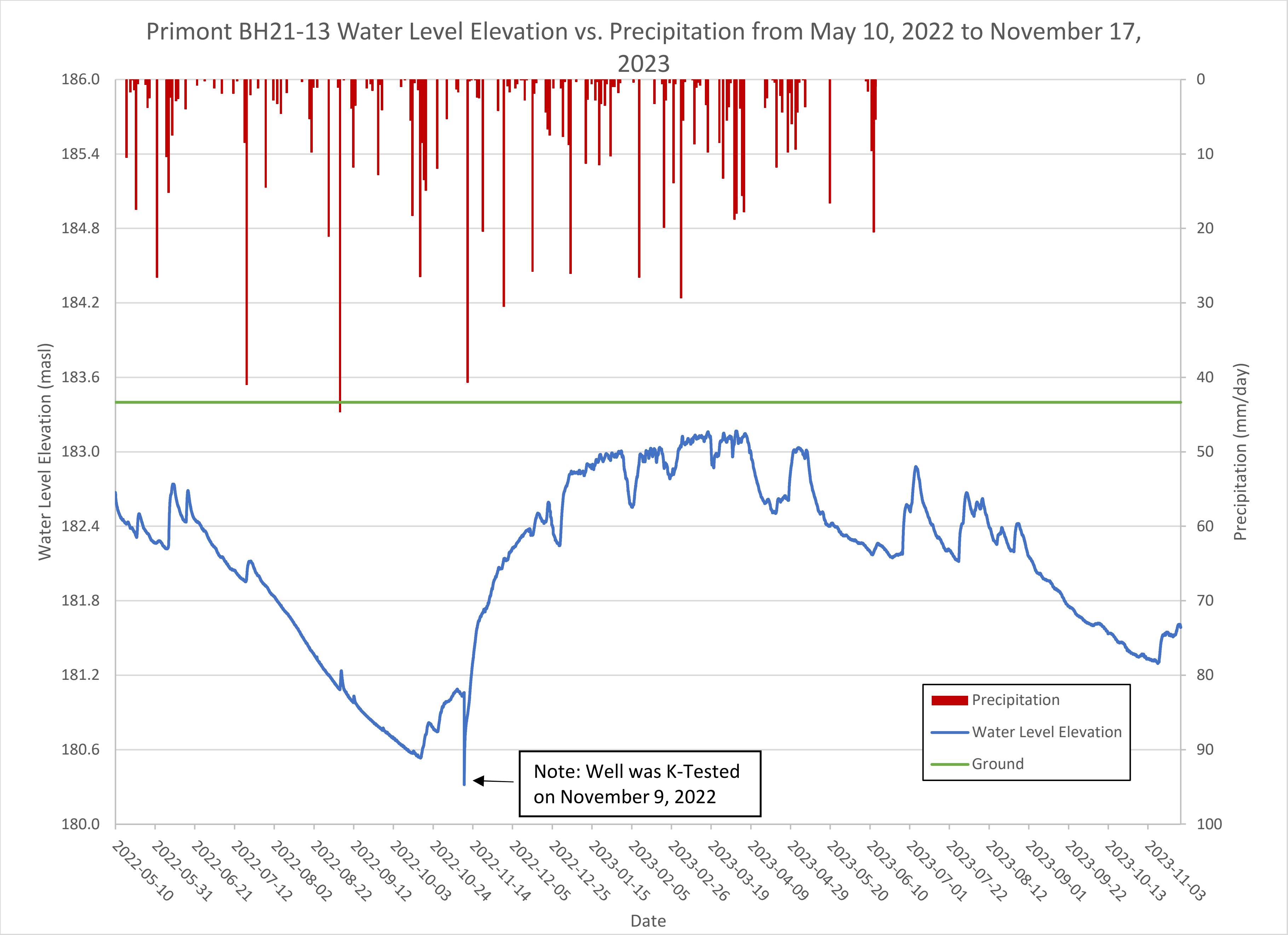
Note: Well was K-Tested November 9, 2022

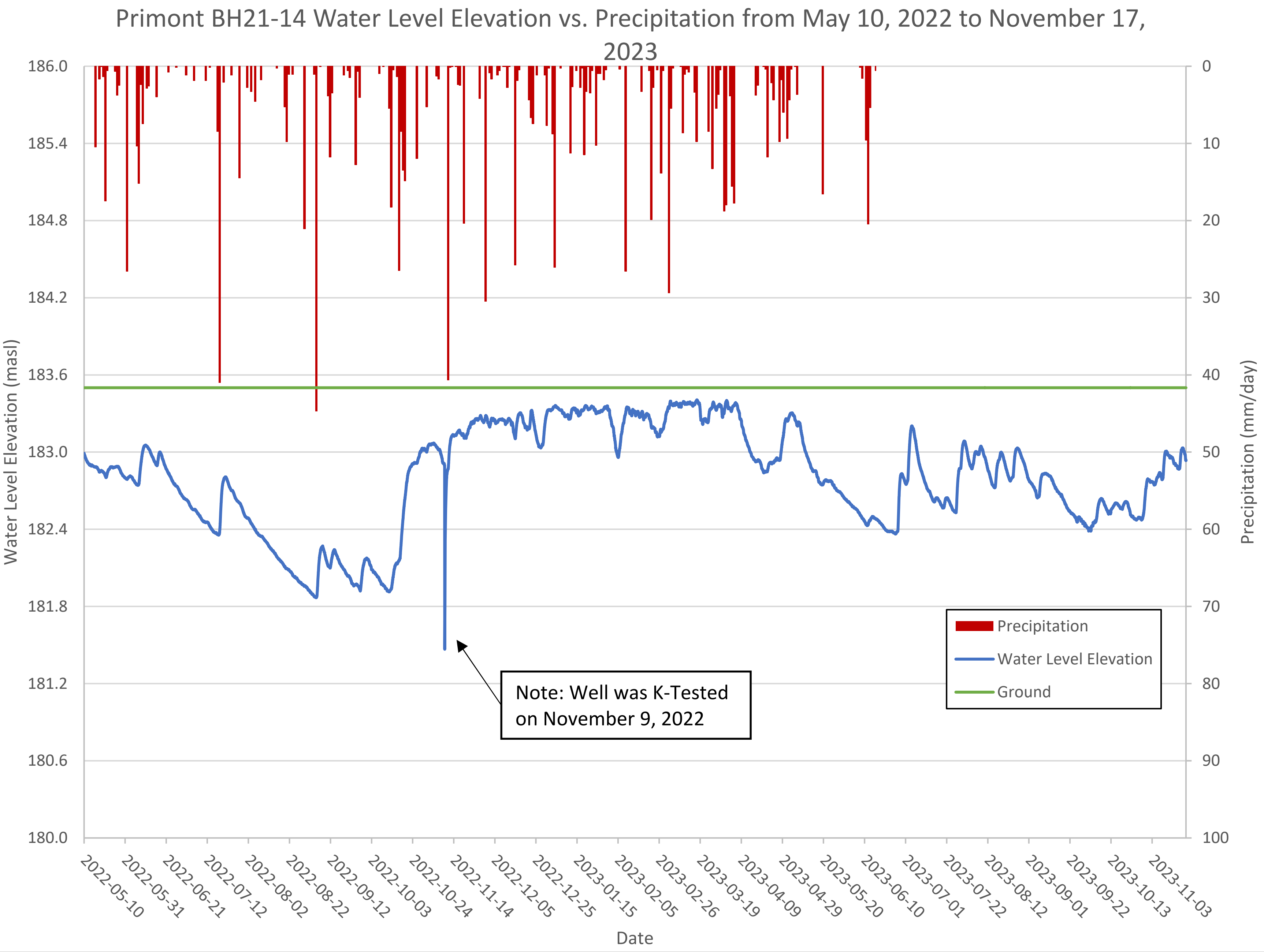
Note: Erroneous data due to freezing of the water column within the PVC, any values higher than PVC were removed.

Gap in data while K-tests were occuring



Note: Well was K-Tested on November 9, 2022


Primont BH21-13 Water Level Elevation vs. Precipitation from May 10, 2022 to November 17, 2023
Water Level Elevation (masl)
186.0
185.4
184.8
184.2
183.6
183.0
182.4
181.8
181.2
180.6
180.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Note: Well was K-Tested on November 9, 2022
Precipitation
Water Level Elevation
Ground
2022-05-10
2022-05-31
2022-06-21
2022-07-12
2022-08-02
2022-08-22
2022-09-12
2022-10-03
2022-10-24
2022-11-14
2022-12-05
2022-12-25
2023-01-15
2023-02-05
2023-02-26
2023-03-19
2023-04-09
2023-04-29
2023-05-20
2023-06-10
2023-07-01
2023-07-22
2023-08-12
2023-09-01
2023-09-22
2023-10-13
2023-11-03
Date


Primont BH21-14 Water Level Elevation vs. Precipitation from May 10, 2022 to November 17, 2023
Water Level Elevation (masl)
186.0
185.4
184.8
184.2
183.6
183.0
182.4
181.8
181.2
180.6
180.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-05-10
2022-05-31
2022-06-21
2022-07-12
2022-08-02
2022-08-22
2022-09-12
2022-10-03
2022-10-24
2022-11-14
2022-12-05
2022-12-25
2023-01-15
2023-02-05
2023-02-26
2023-03-19
2023-04-09
2023-04-29
2023-05-20
2023-06-10
2023-07-01
2023-07-22
2023-08-12
2023-09-01
2023-09-22
2023-10-13
2023-11-03
Precipitation
Water Level Elevation
Ground
Note: Well was K-Tested on November 9, 2022

Appendix E

Wetland Monitoring

Primont Site Visit April 5, 2023

SW-1

- Top Dp-> Water=32.5cm
- Depth at DP=28.5cm
- Temp=8.6 Cond=208

SW-2

- Top Dp-> Water=60.3cm
- Depth at DP=4cm (small pool)
- Temp=11.25 Cond=455us

SW-3

- Top Dp-> Water=49.5cm
- Depth at DP=18.5cm
- Temp=10.5 Cond=305us

SW-4

- Top Dp-> Water=59.5cm
- Depth at DP=5.5cm
- Temp=9.5 Cond=98us

SW-5

- Top Dp-> Water=60.2cm
- Depth at DP=8.5cm
- Temp=11.9 Cond=64us

SW-6

- Top Dp-> Water=30.5m
- Depth at DP=31.5cm
- Temp=9.5 Cond=58us

SW-7

- Top Dp-> Water=52.4cm
- Depth at DP=16cm
- Temp=10.2 Cond=310us

SW-8

- Top Dp-> Water=37cm
- Depth at DP=19.5cm
- Temp=7.3 Cond=120us

SW-9

- Top Dp-> Water=54.4cm
- Depth at DP=8cm
- Temp=10.3 Cond=132us

SW-10

- Top Dp-> Water=53.2cm
- Depth at DP= 7.9cm
- Temp=7.7 Cond=125

SW-11

- Top Dp-> Water= 48.8cm
- Depth at DP=10.5cm
- Temp=7.8 Cond=264us

SW-12

- Top Dp-> Water=50.3cm
- Depth at DP=10.4cm
- Temp=7.5 Cond=154us

SW-13

- Top Dp-> Water=53.5m
- Depth at DP=8.5cm
- Temp=7.5 Cond=82us0

SW-14

- Top Dp-> Water=39.5cm
- Depth at DP=27.2cm
- Temp= 8.6 Cond=80us

SW-15

- Top Dp-> Water=36.5cm
- Depth at DP=25cm
- Temp=9.3 Cond=77us

SW-16

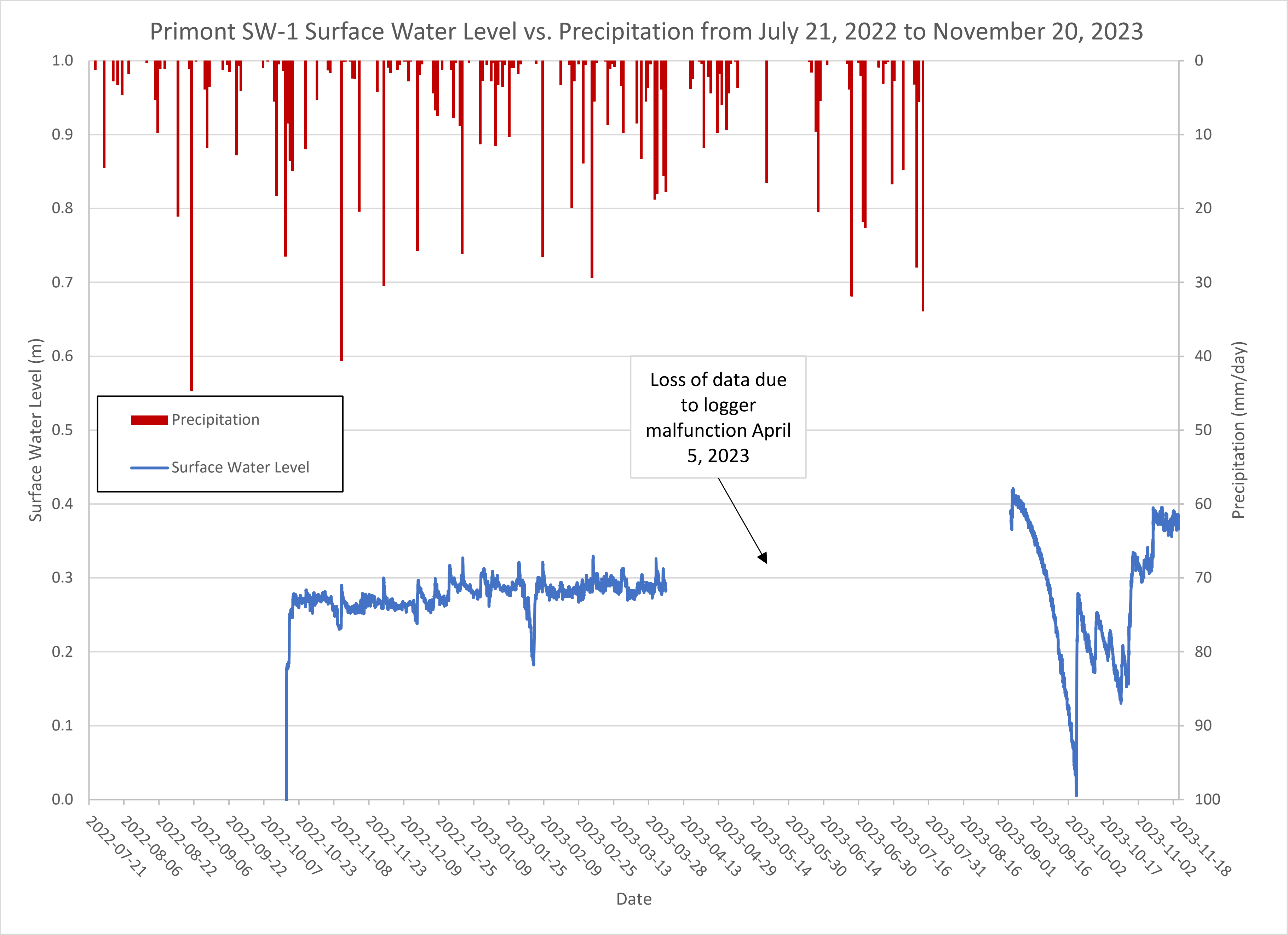
- Top Dp-> Water=62cm
- Depth at DP=7cm
- Temp= 8.5 Cond=153us

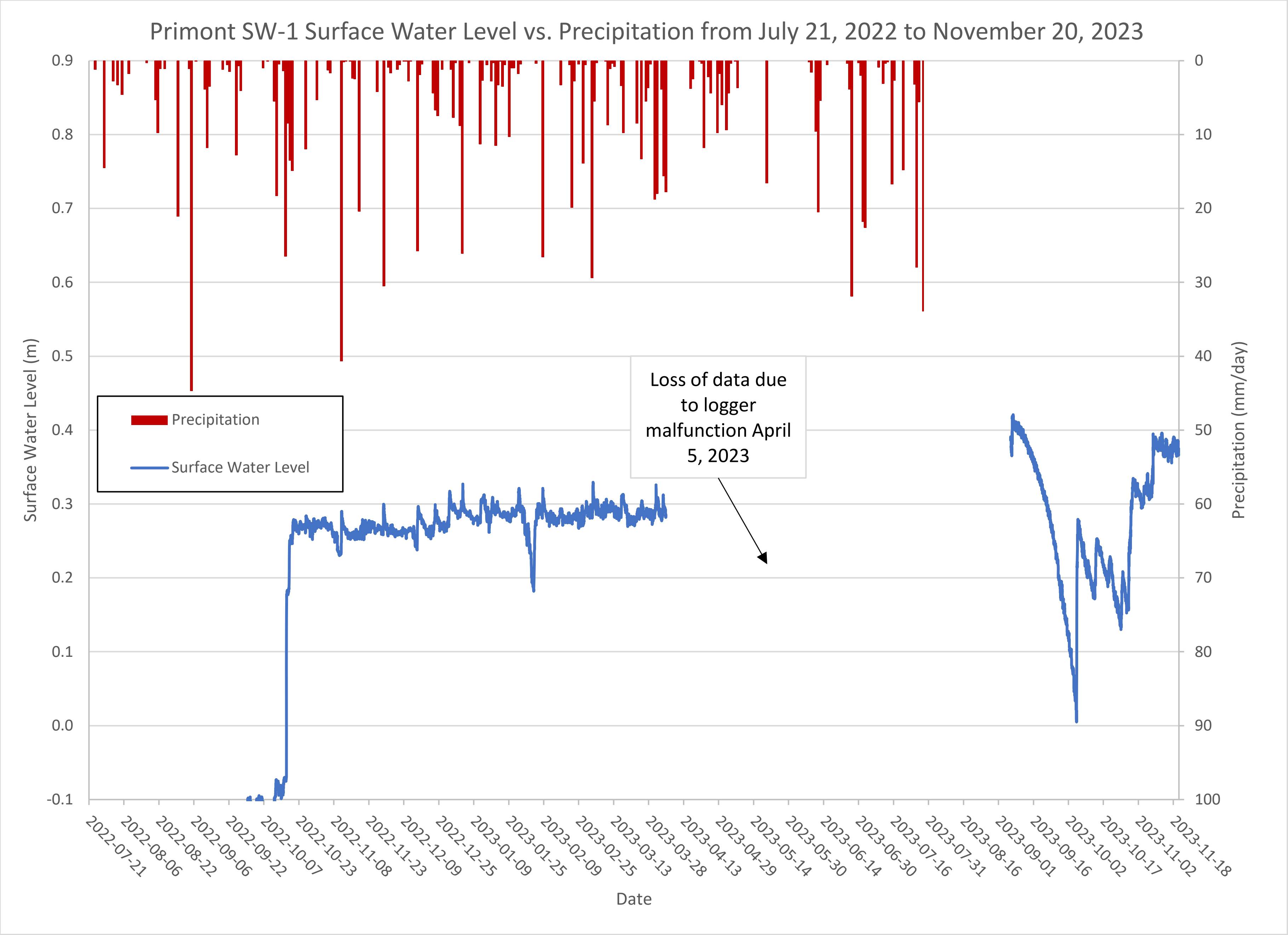
SW-17

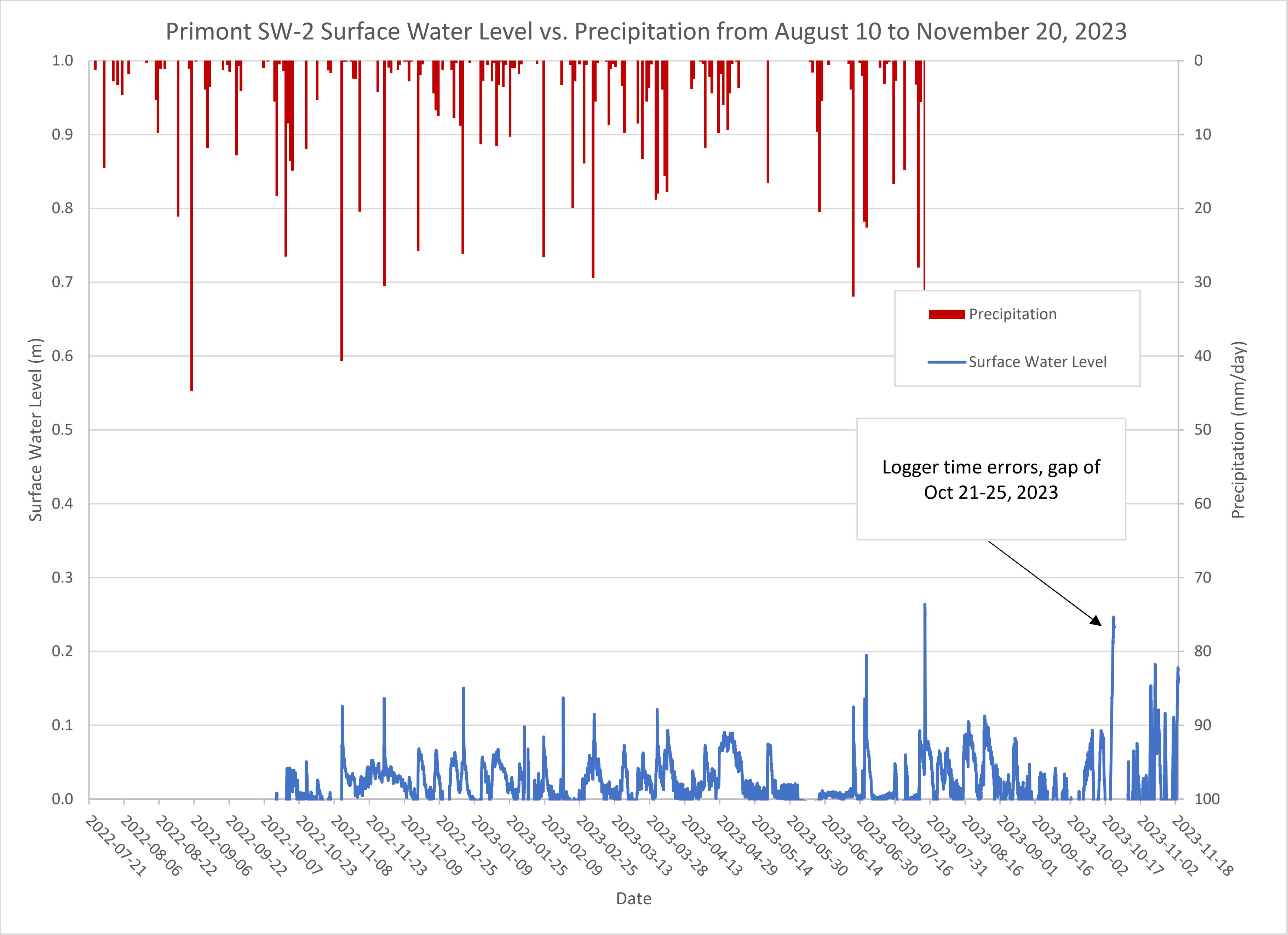
- Top Dp-> Water=58cm
- Depth at DP=7.5cm
- Temp= 7.8 Cond=6us

SW-18

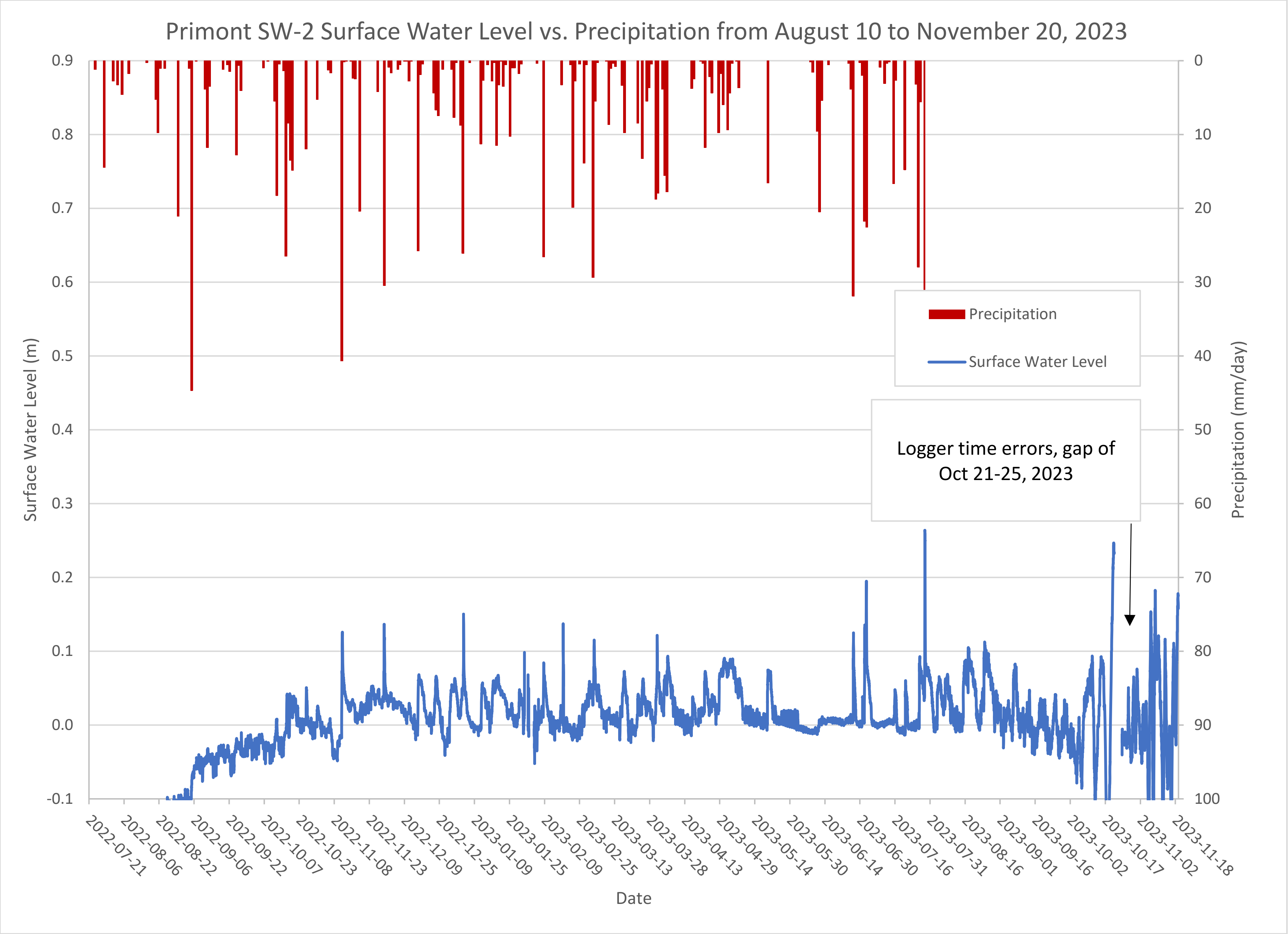
- Top Dp-> Water=36.3cm
- Depth at DP=21.6cm
- Temp= 7.3 Cond=46us

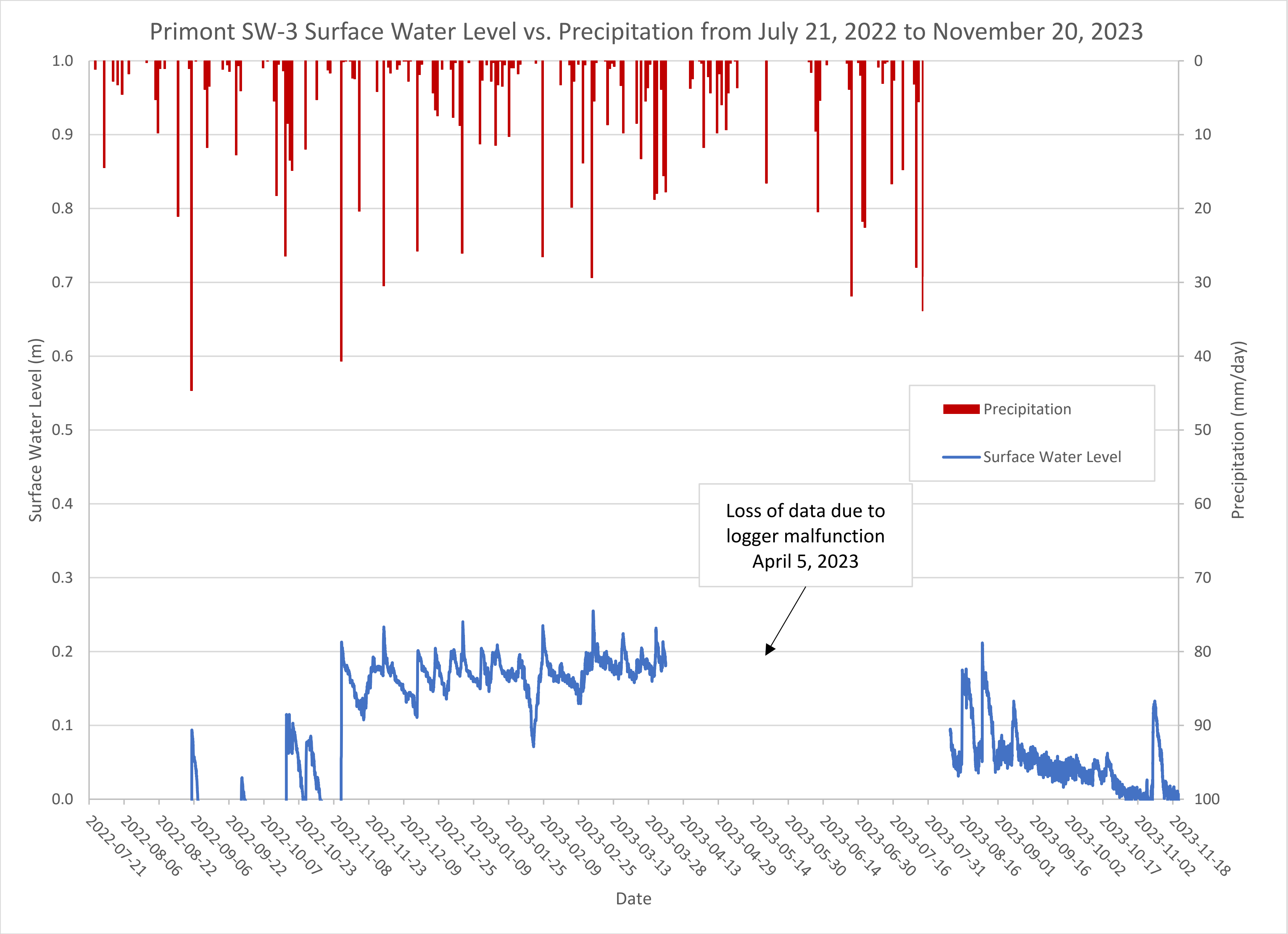

Primont SW-1 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

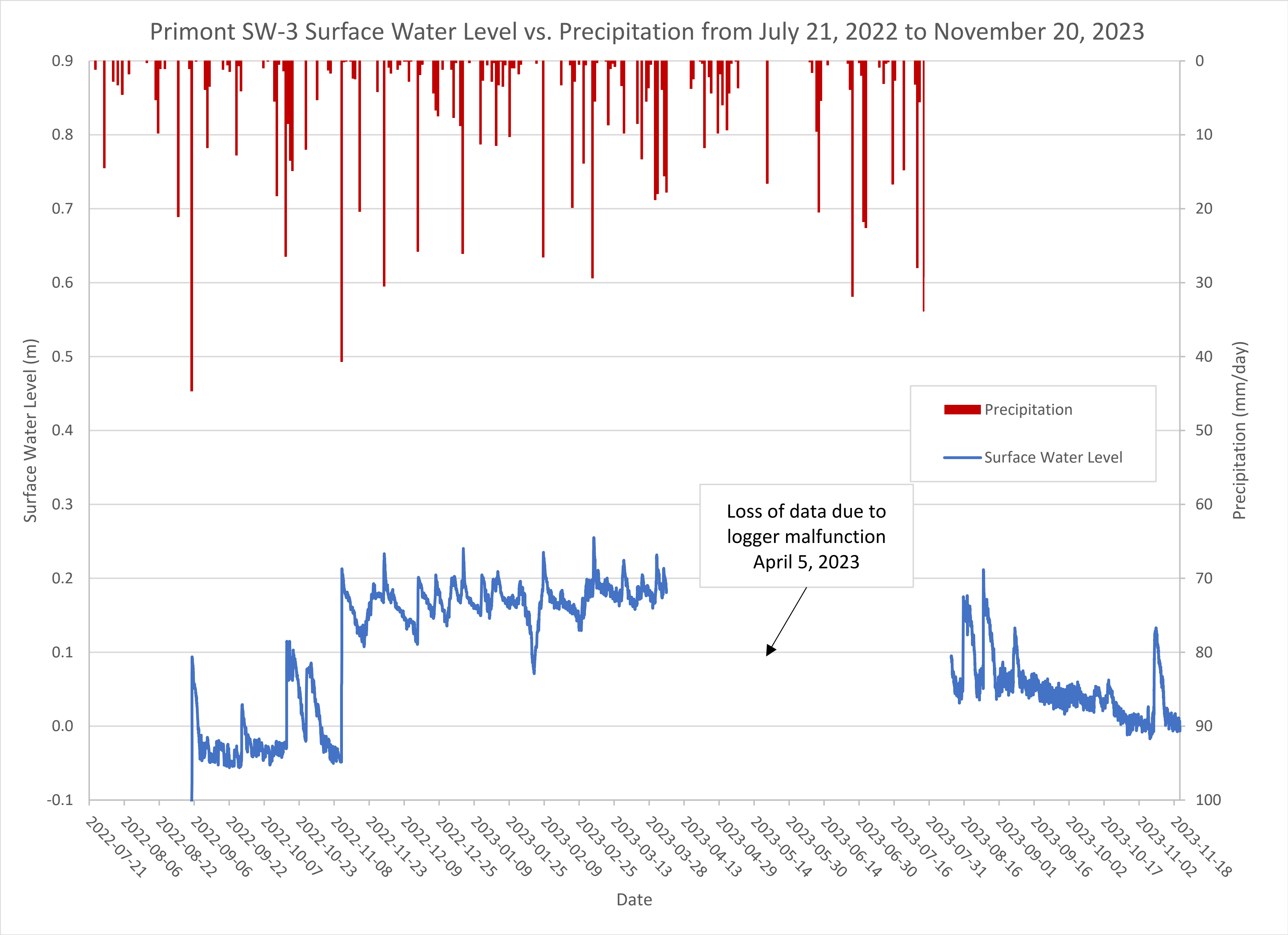

Primont SW-1 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
Precipitation (mm/day)
Date
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

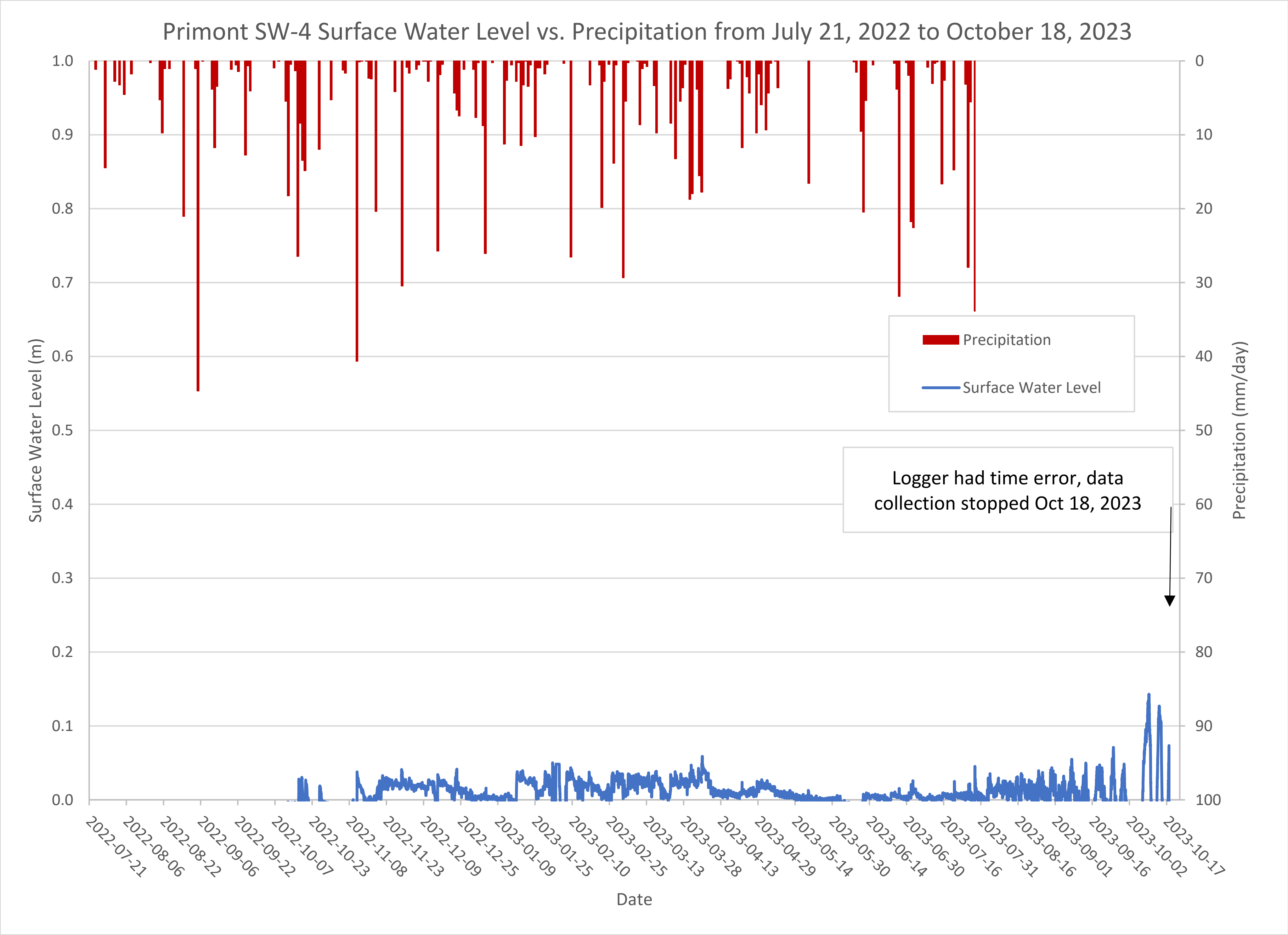


Logger time errors, gap of Oct 21-25, 2023

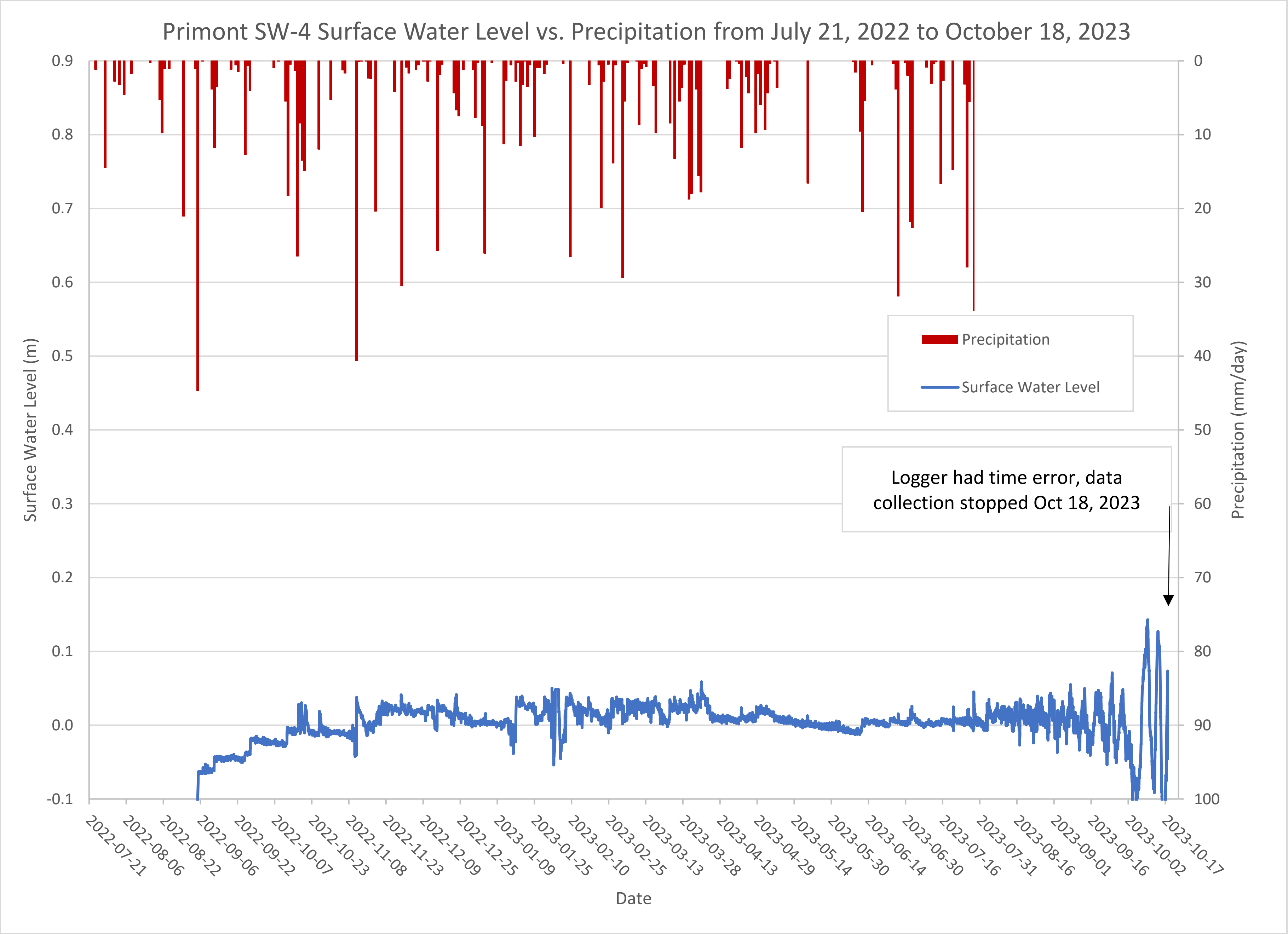
Primont SW-2 Surface Water Level vs. Precipitation from August 10 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger time errors, gap of Oct 21-25, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date

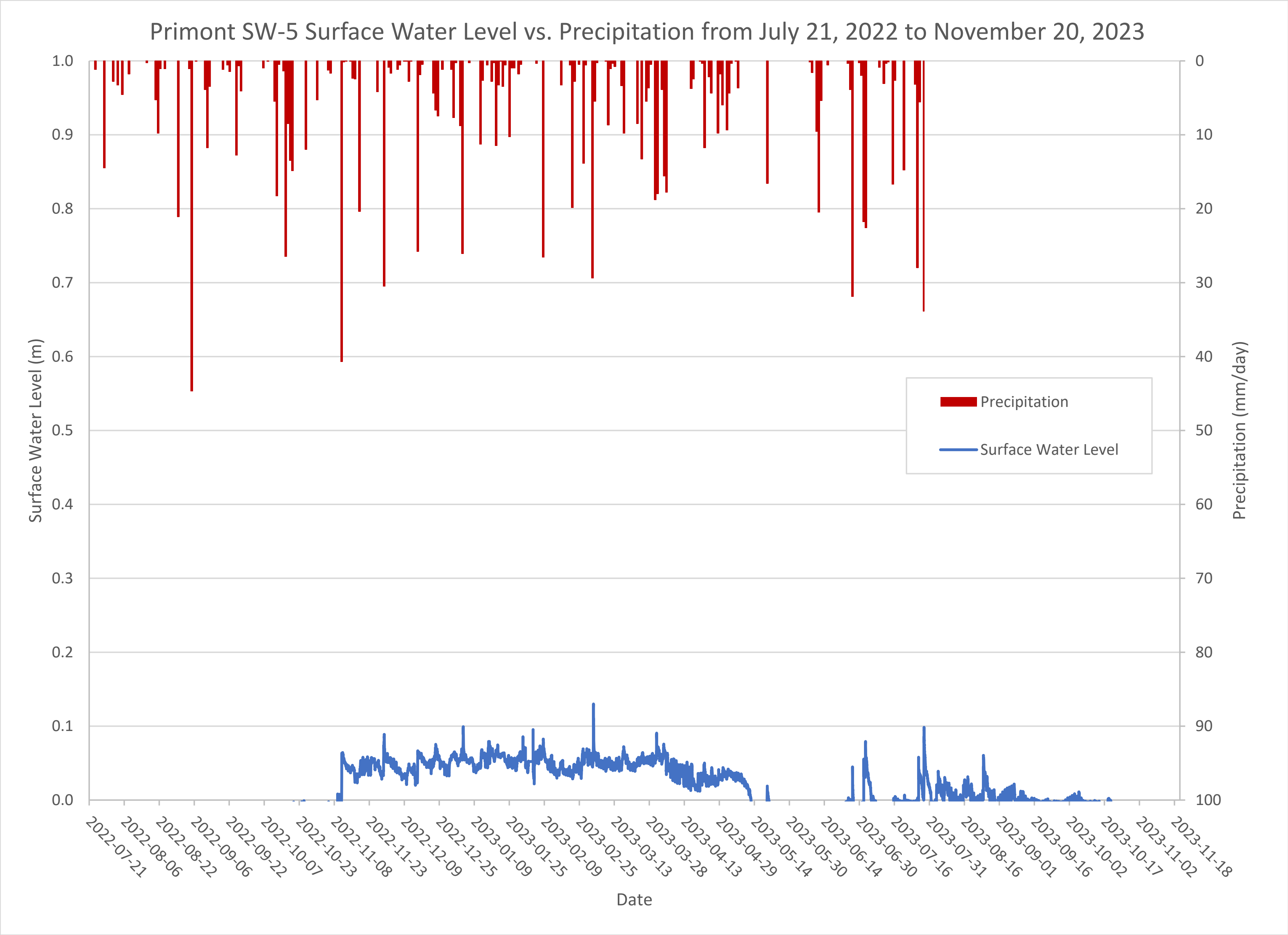

Primont SW-3 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
Precipitation (mm/day)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

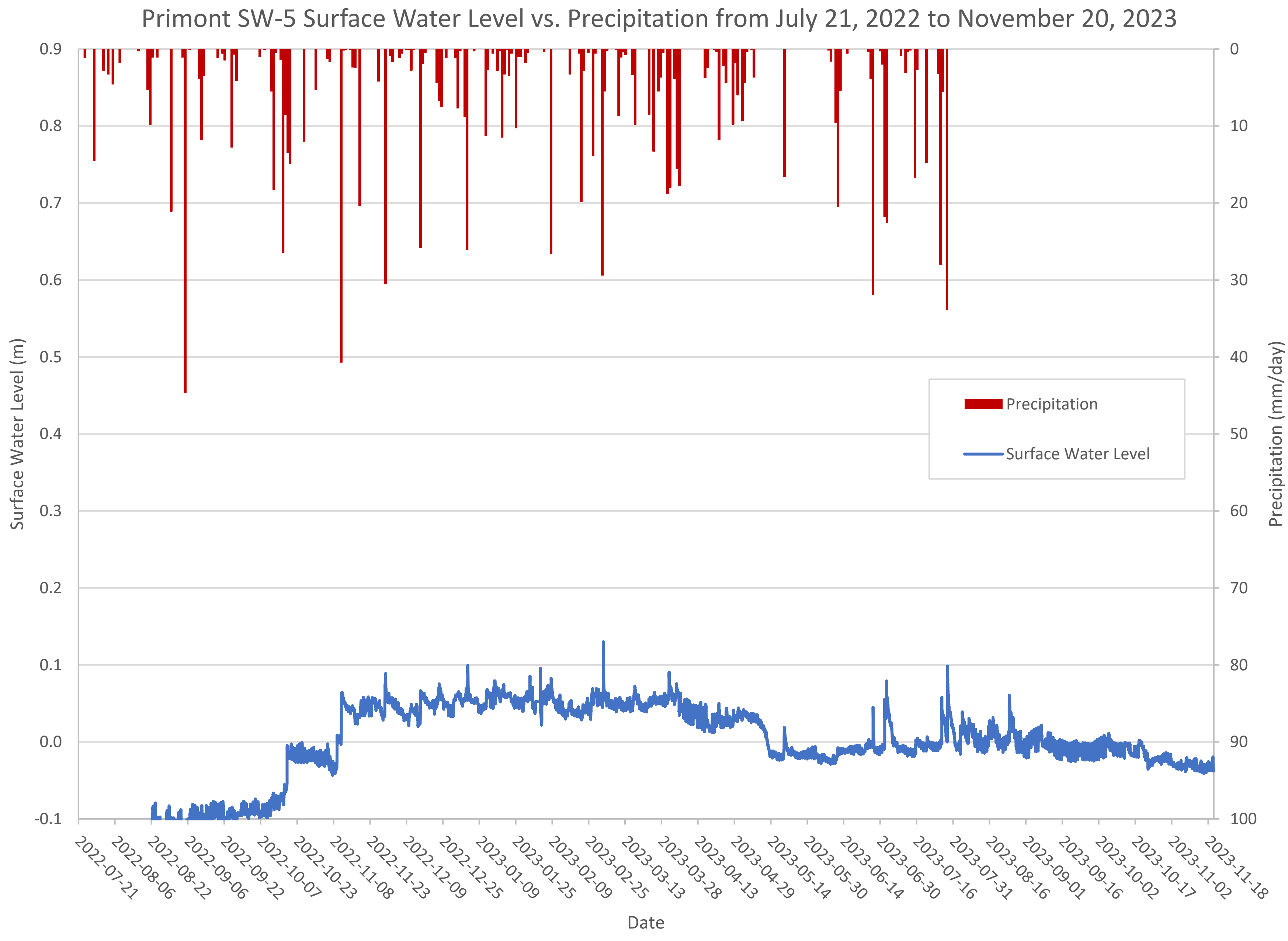

Primont SW-3 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

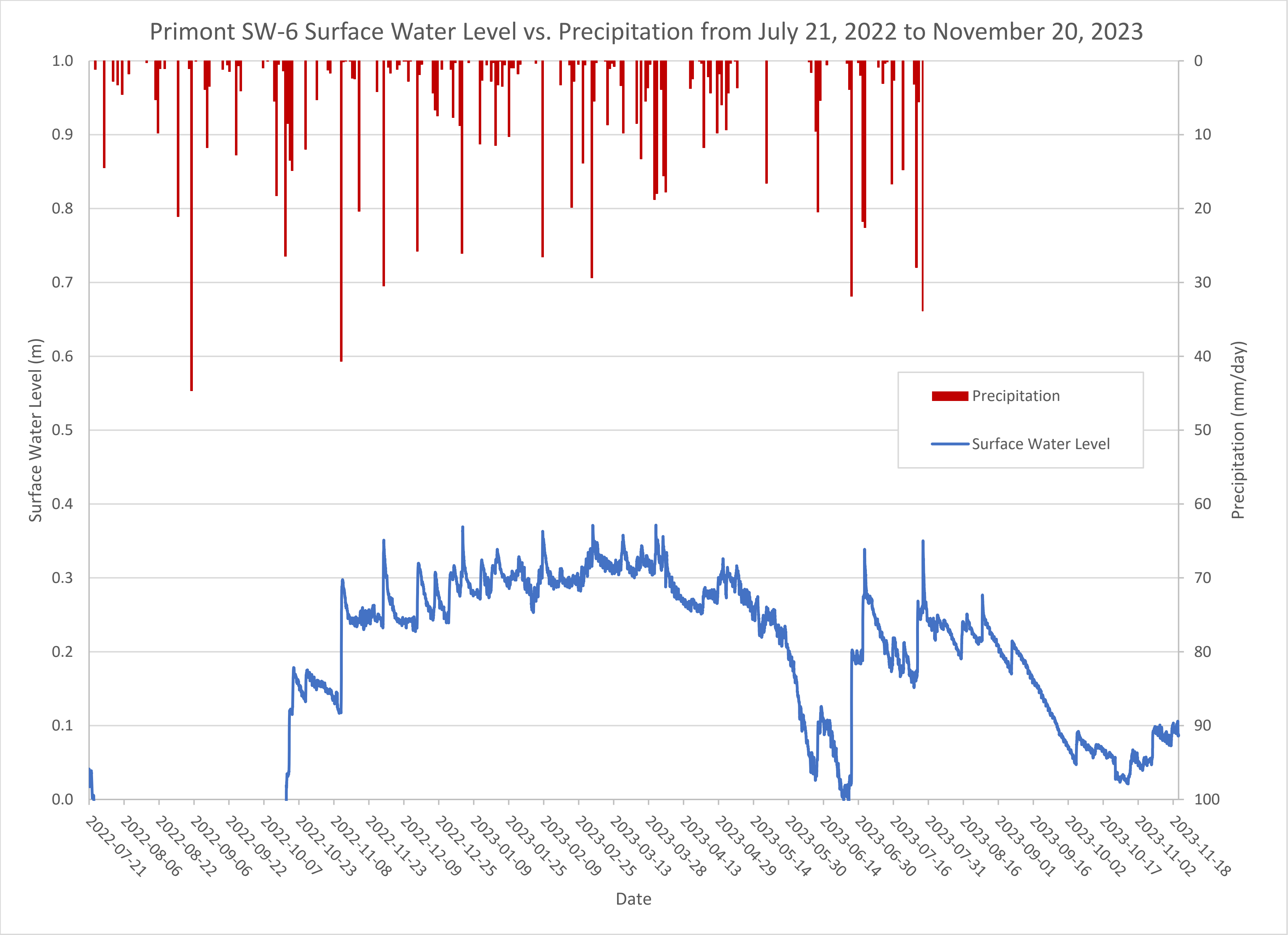


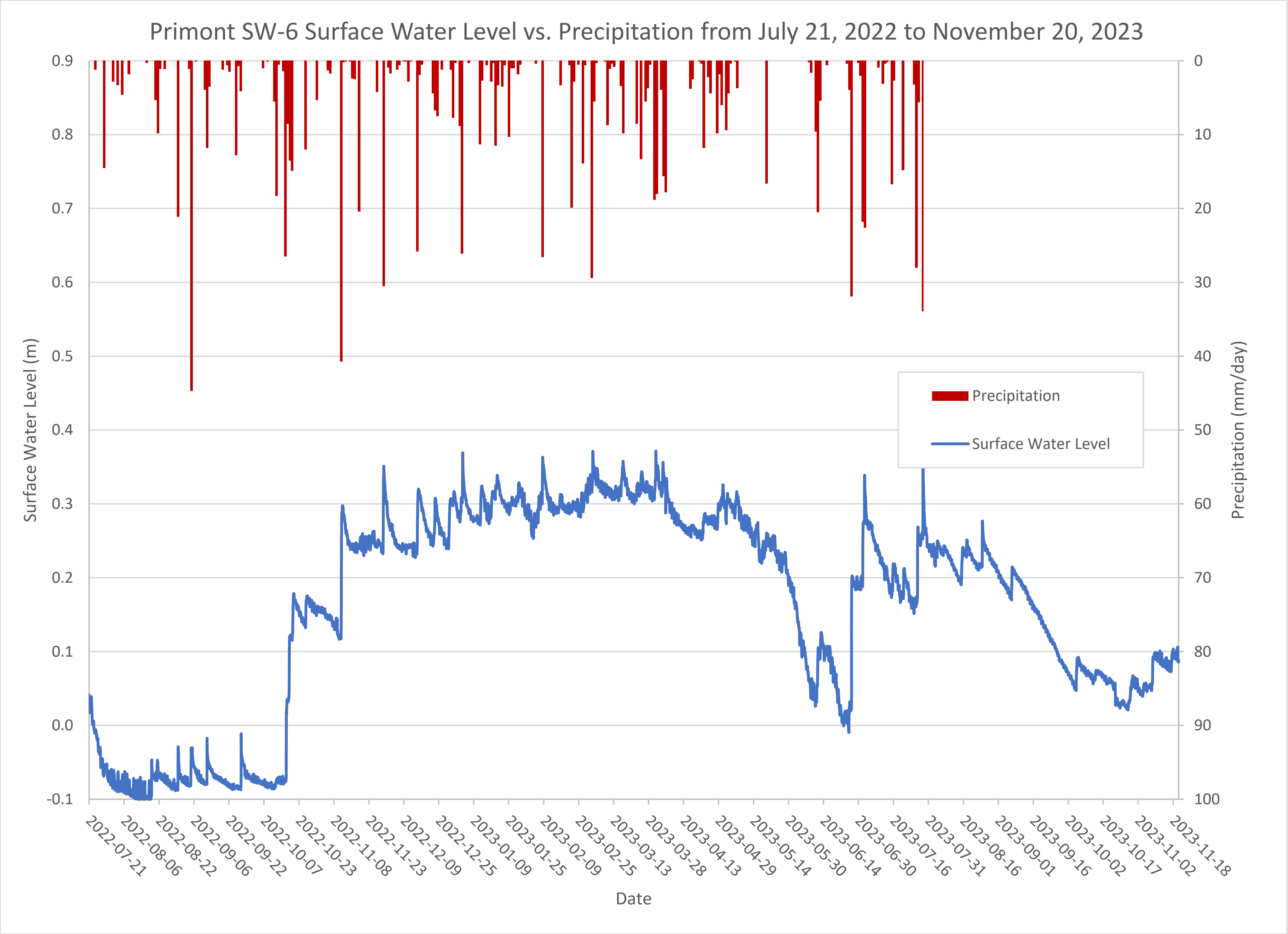
Logger had time error, data collection stopped Oct 18, 2023

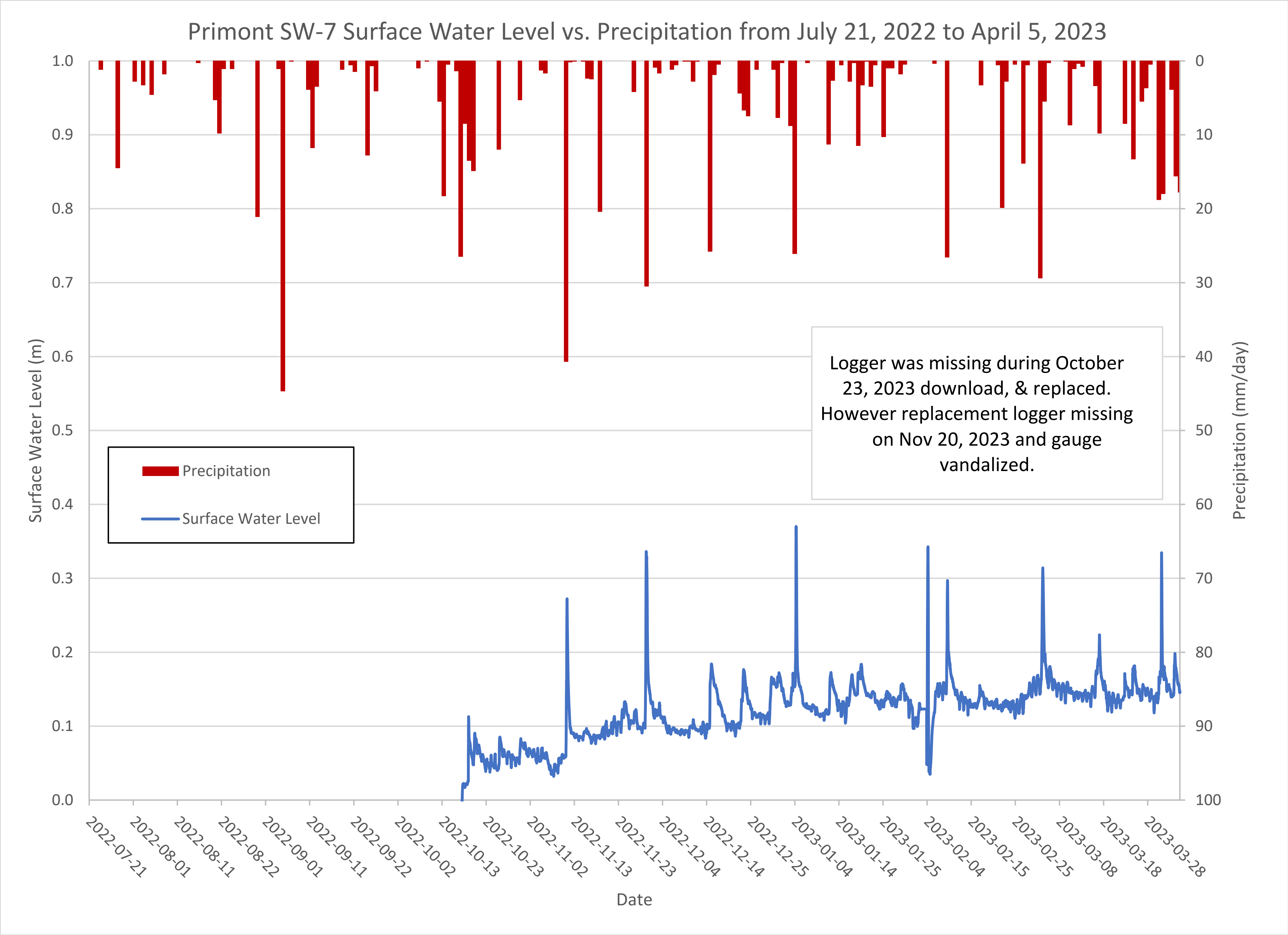

Primont SW-4 Surface Water Level vs. Precipitation from July 21, 2022 to October 18, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger had time error, data collection stopped Oct 18, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
Date


Primont SW-5 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

Primont SW-5 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18

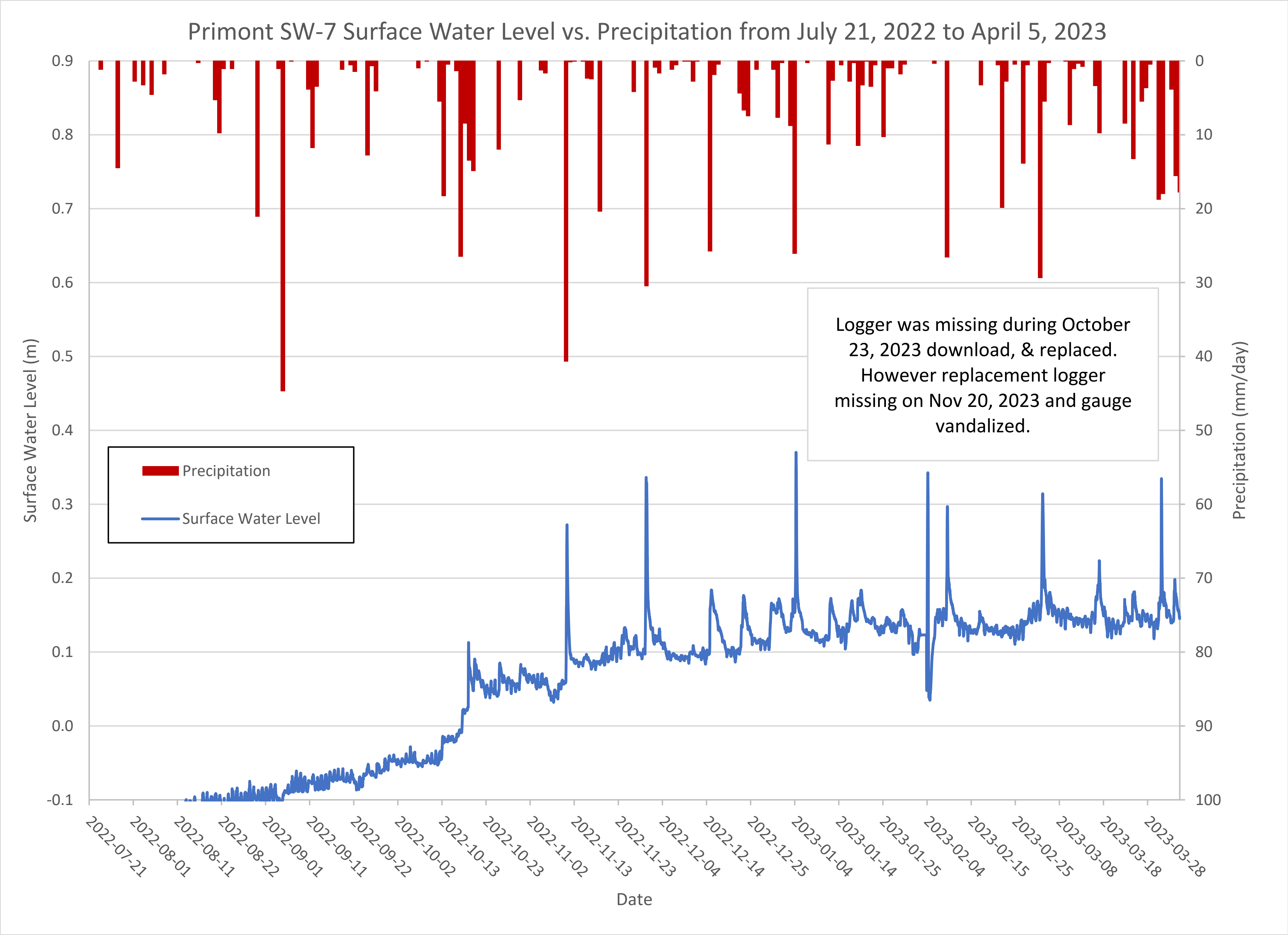

Primont SW-6 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18


Primont SW-6 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date

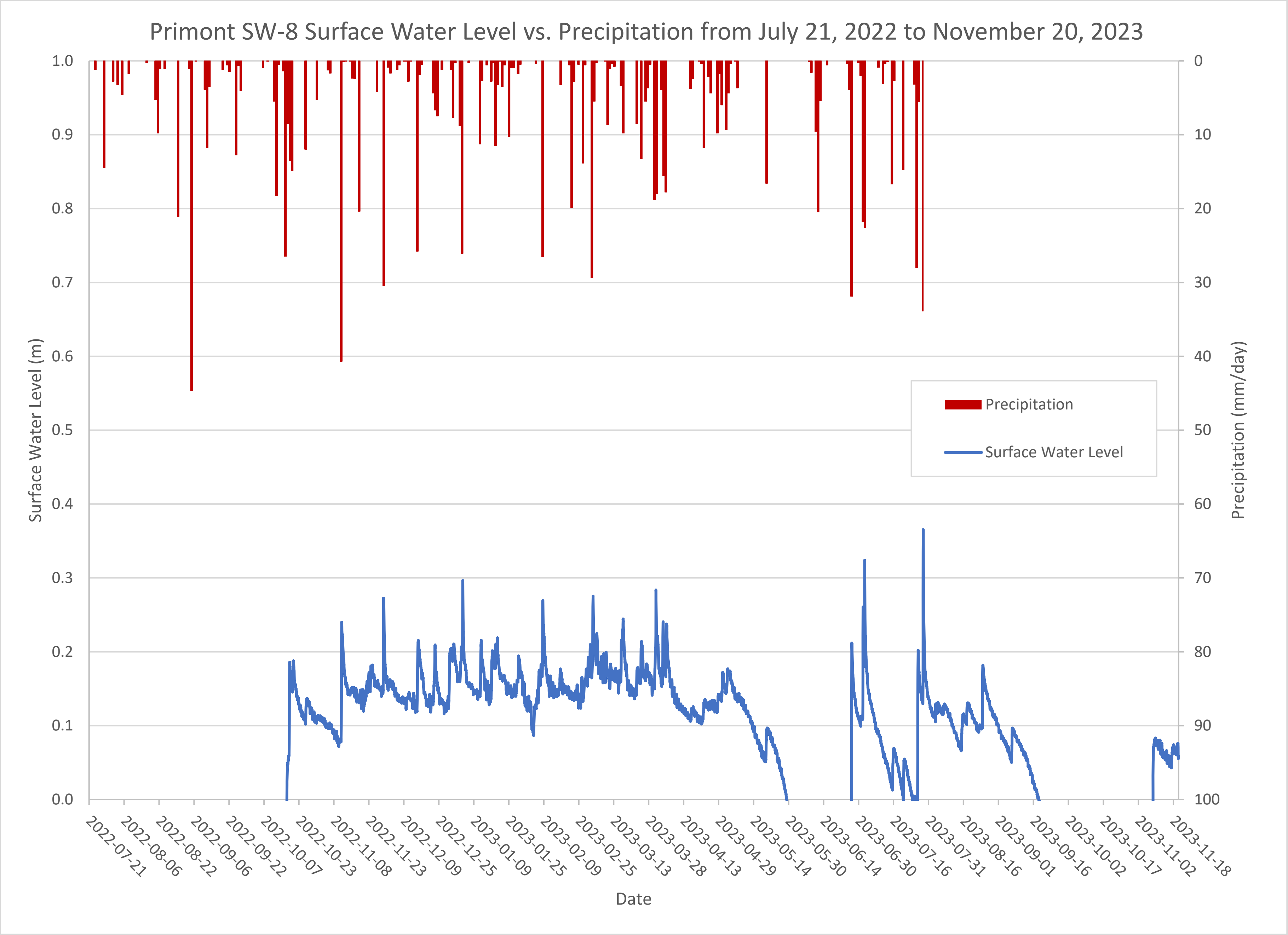


Primont SW-7 Surface Water Level vs. Precipitation from July 21, 2022 to April 5, 2023

Logger was missing during October 23, 2023 download, & replaced. However replacement logger missing on Nov 20, 2023 and gauge vandalized.



Primont SW-7 Surface Water Level vs. Precipitation from July 21, 2022 to April 5, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger was missing during October 23, 2023 download, & replaced. However replacement logger missing on Nov 20, 2023 and gauge vandalized.
2022-07-21
2022-08-01
2022-08-11
2022-08-22
2022-09-01
2022-09-11
2022-09-22
2022-10-02
2022-10-13
2022-10-23
2022-11-02
2022-11-13
2022-11-23
2022-12-04
2022-12-14
2022-12-25
2023-01-04
2023-01-14
2023-01-25
2023-02-04
2023-02-15
2023-02-25
2023-03-08
2023-03-18
2023-03-28
Date



Primont SW-8 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
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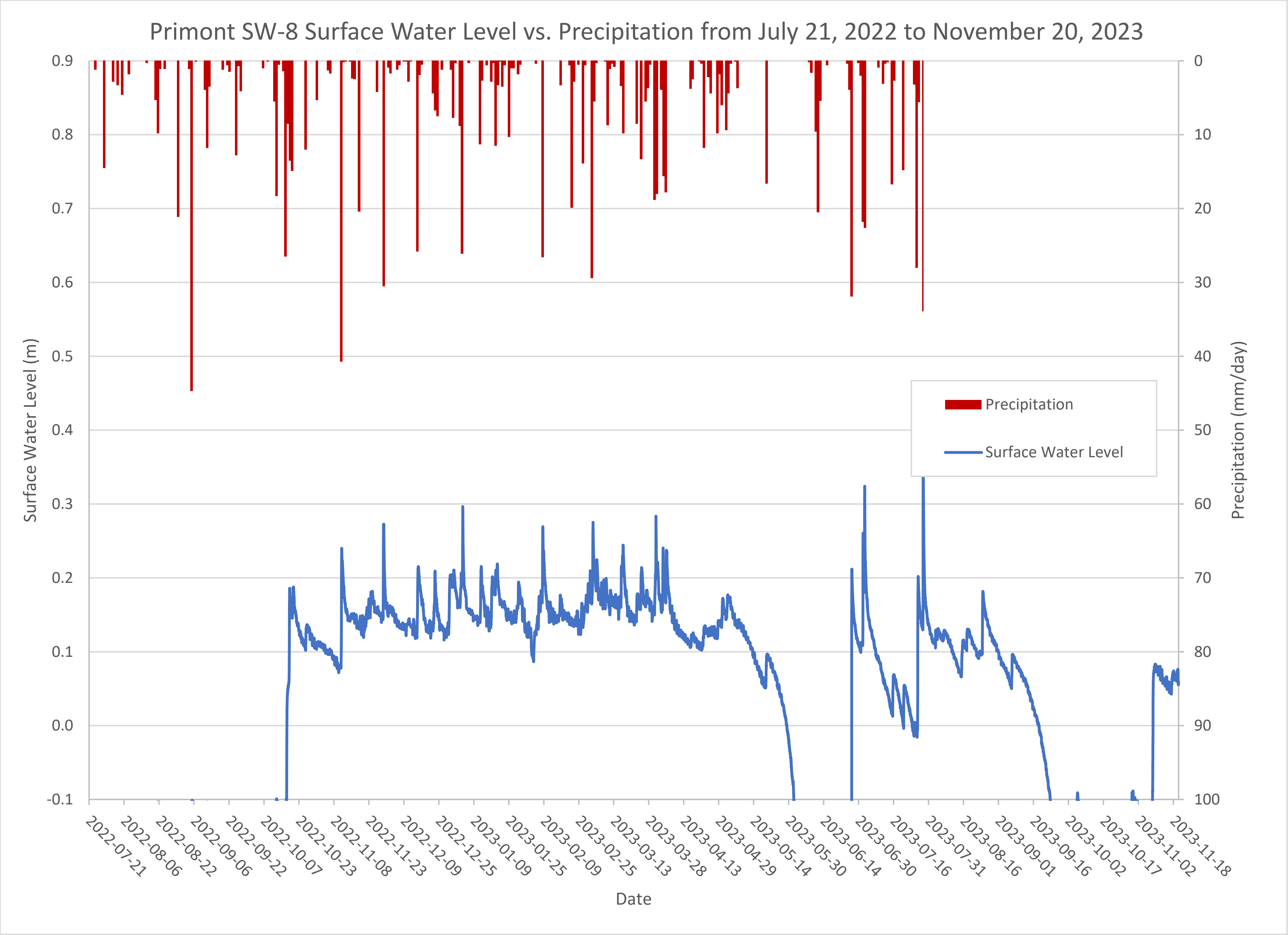
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date


Primont SW-8 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
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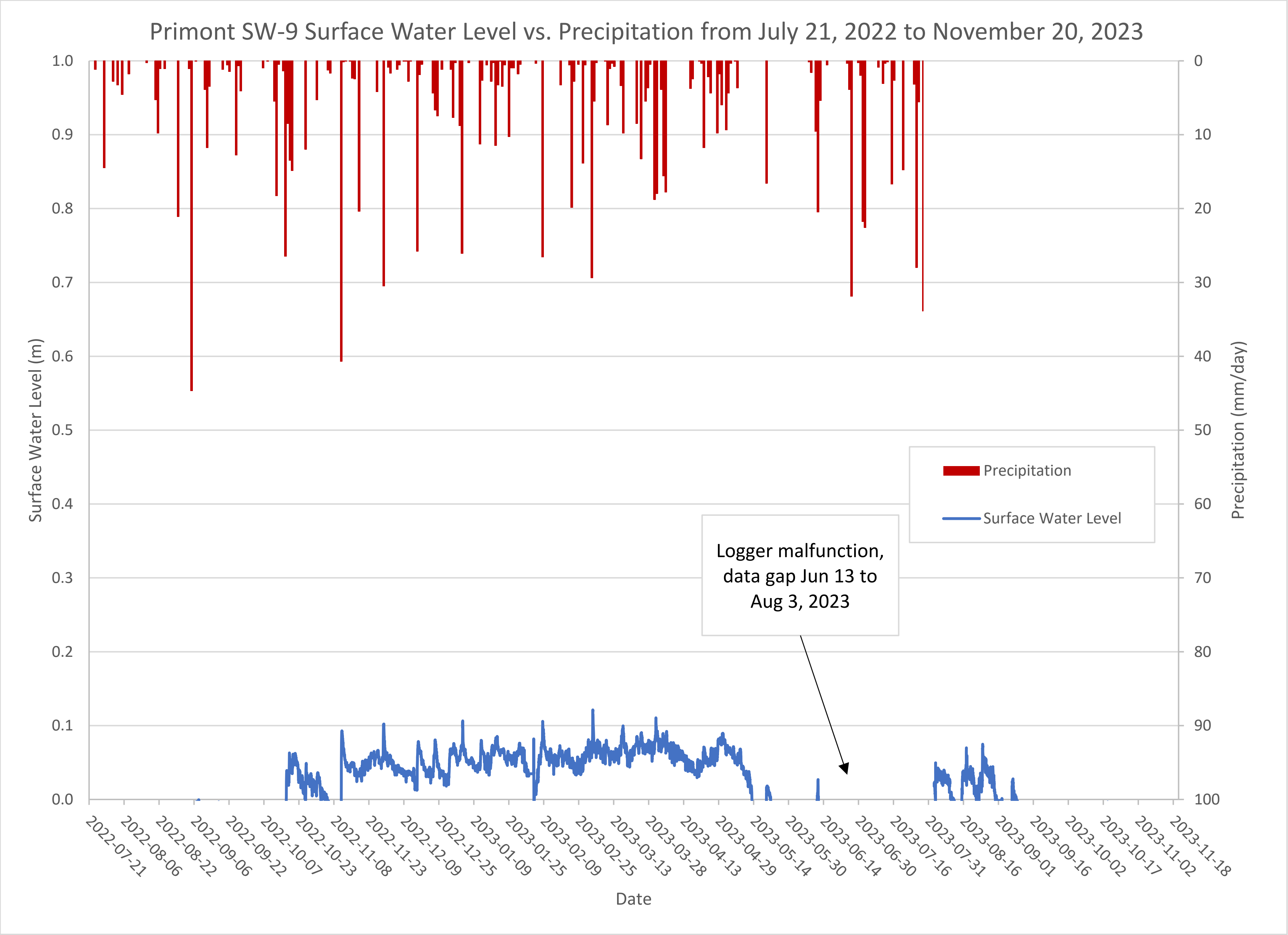
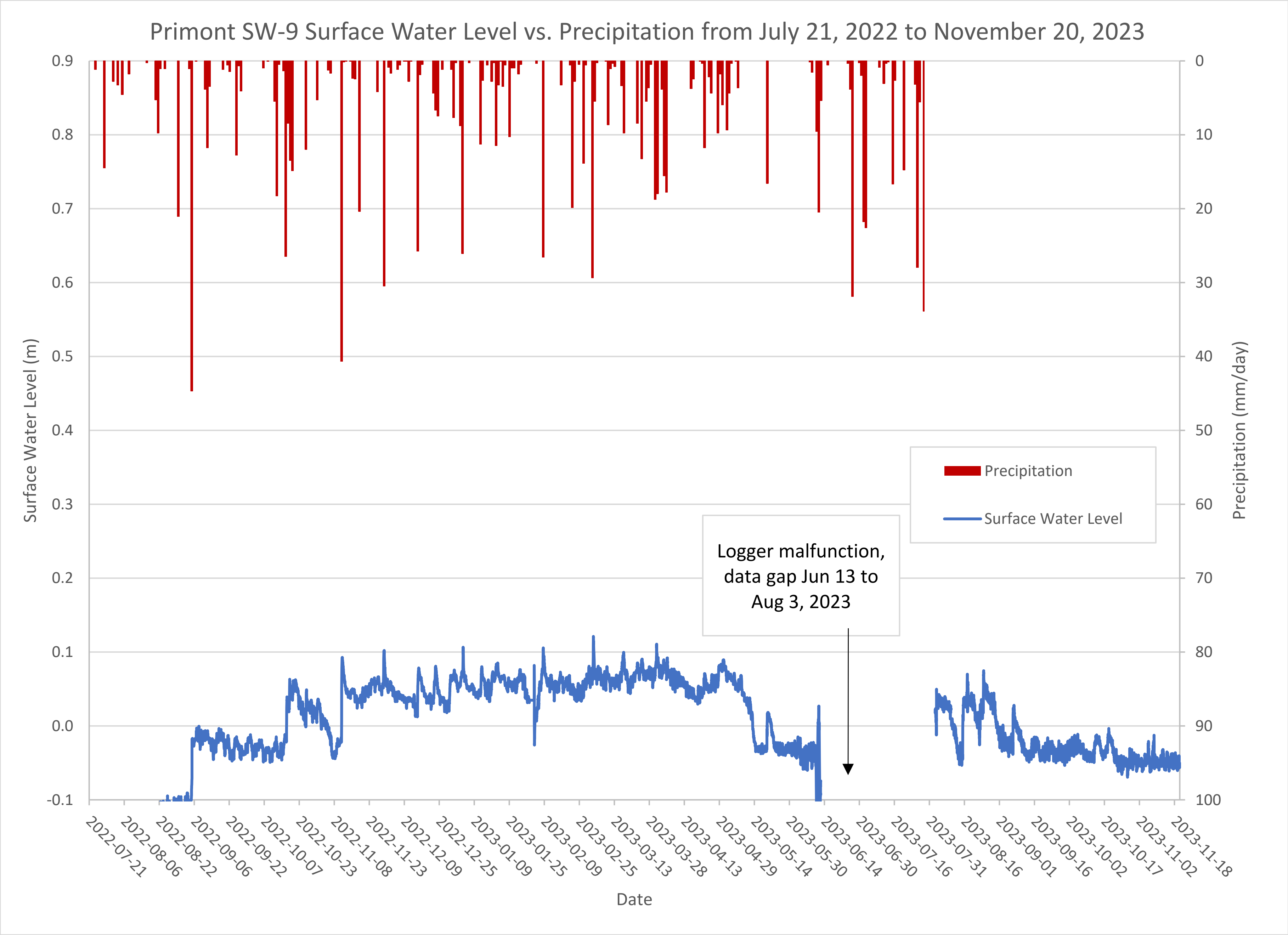
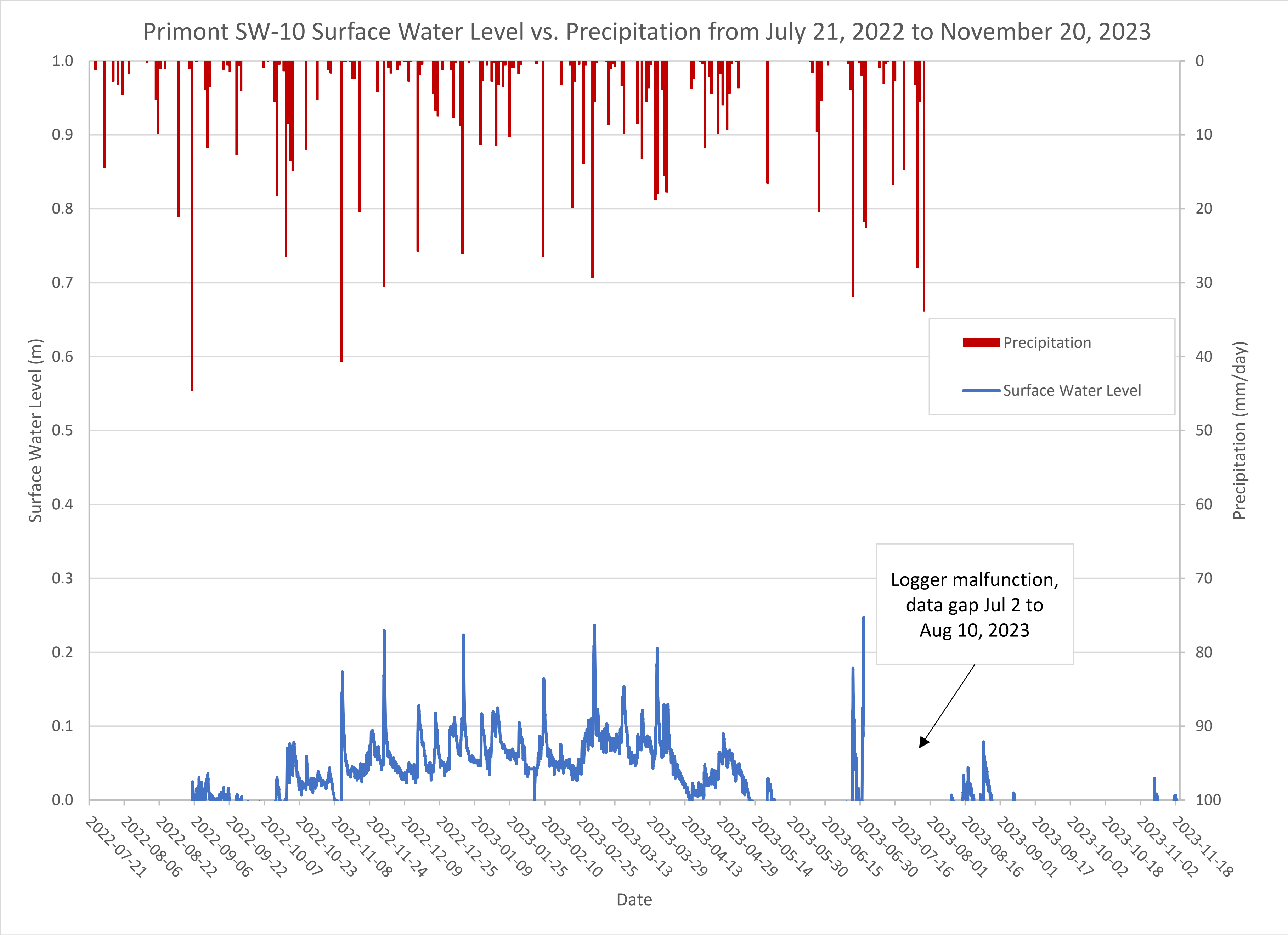
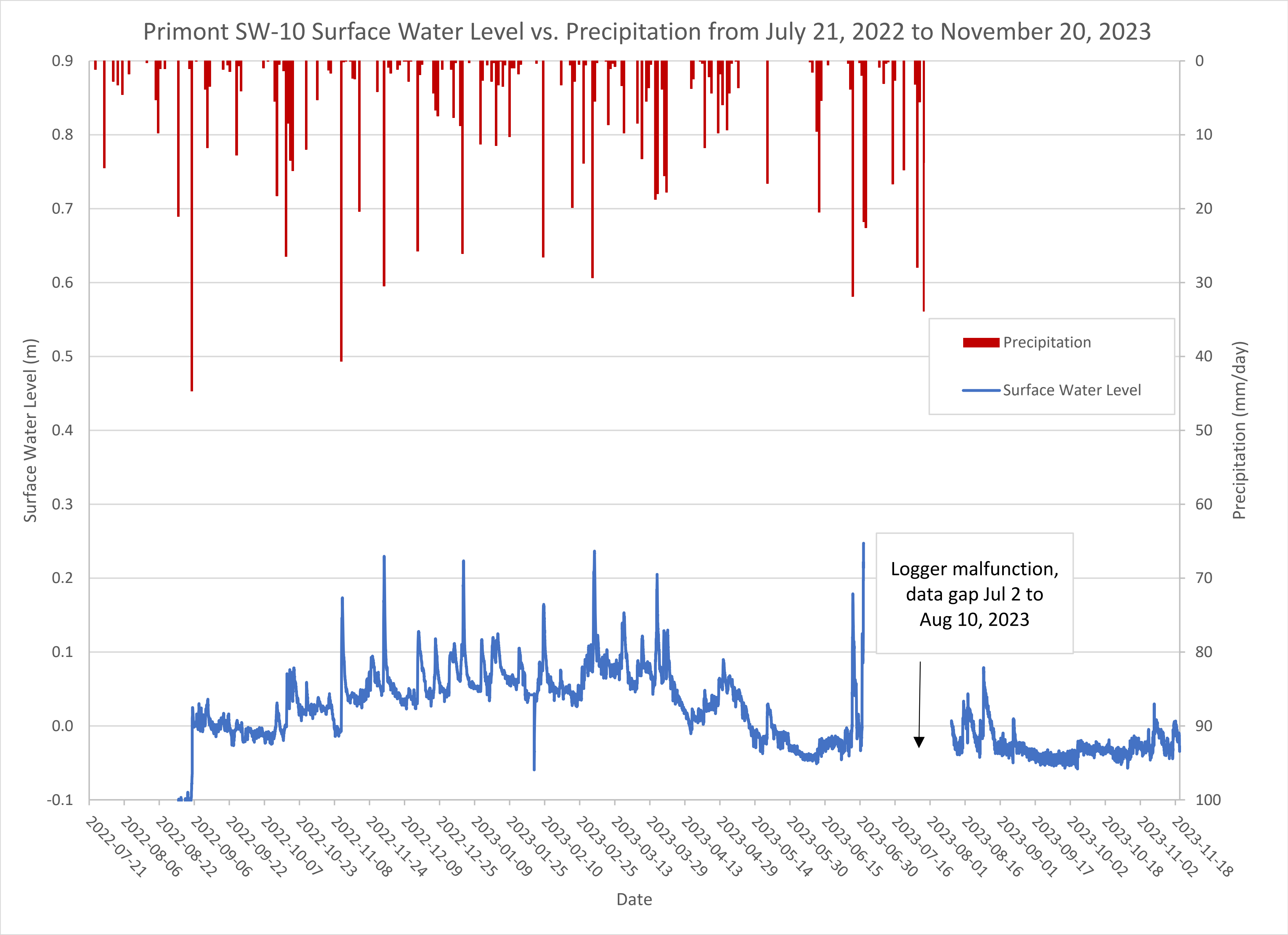
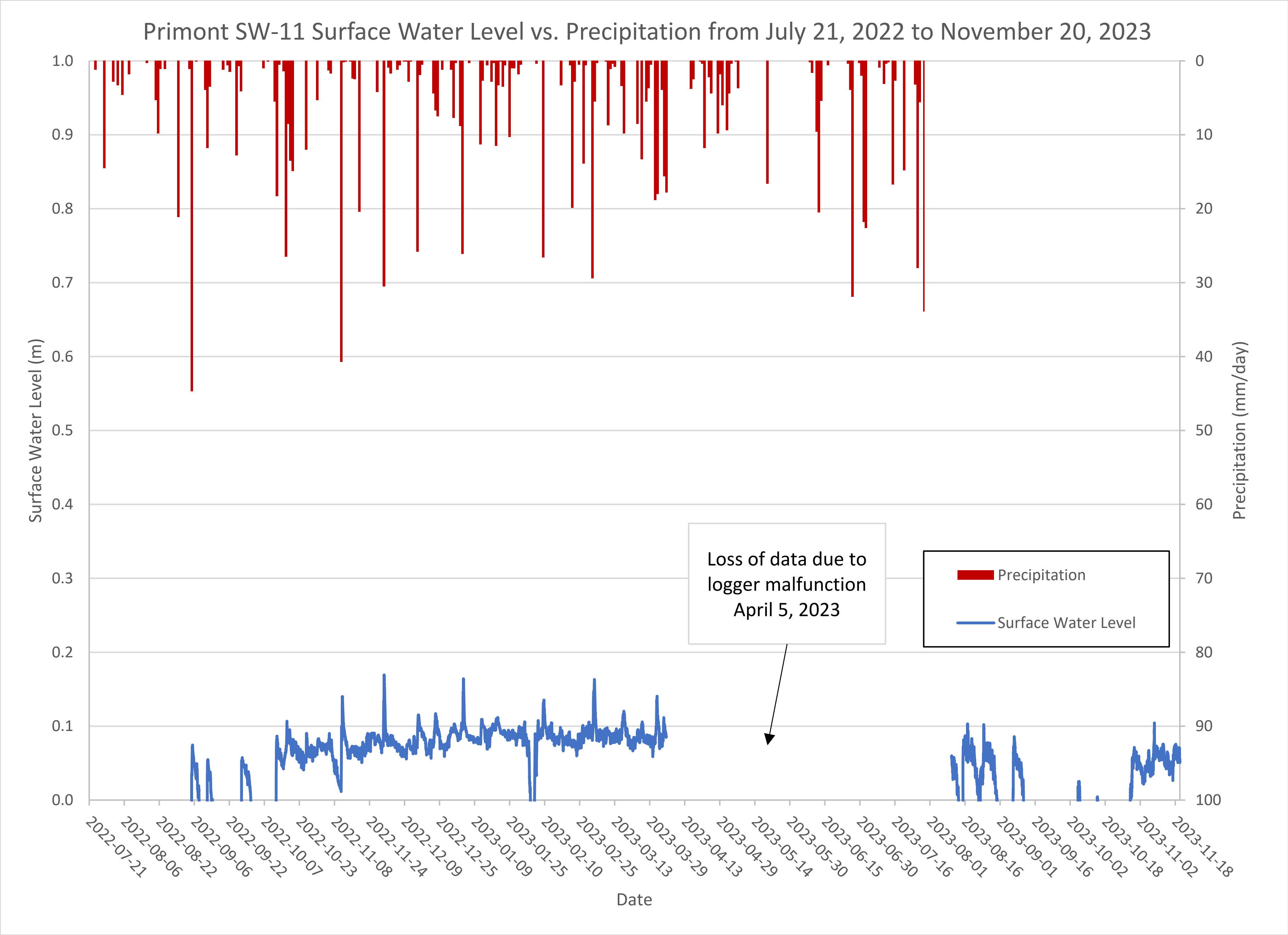
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date


Primont SW-9 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger malfunction, data gap Jun 13 to Aug 3, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date


Primont SW-9 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger malfunction, data gap Jun 13 to Aug 3, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-14
2023-06-30
2023-07-16
2023-07-31
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-17
2023-11-02
2023-11-18
Date

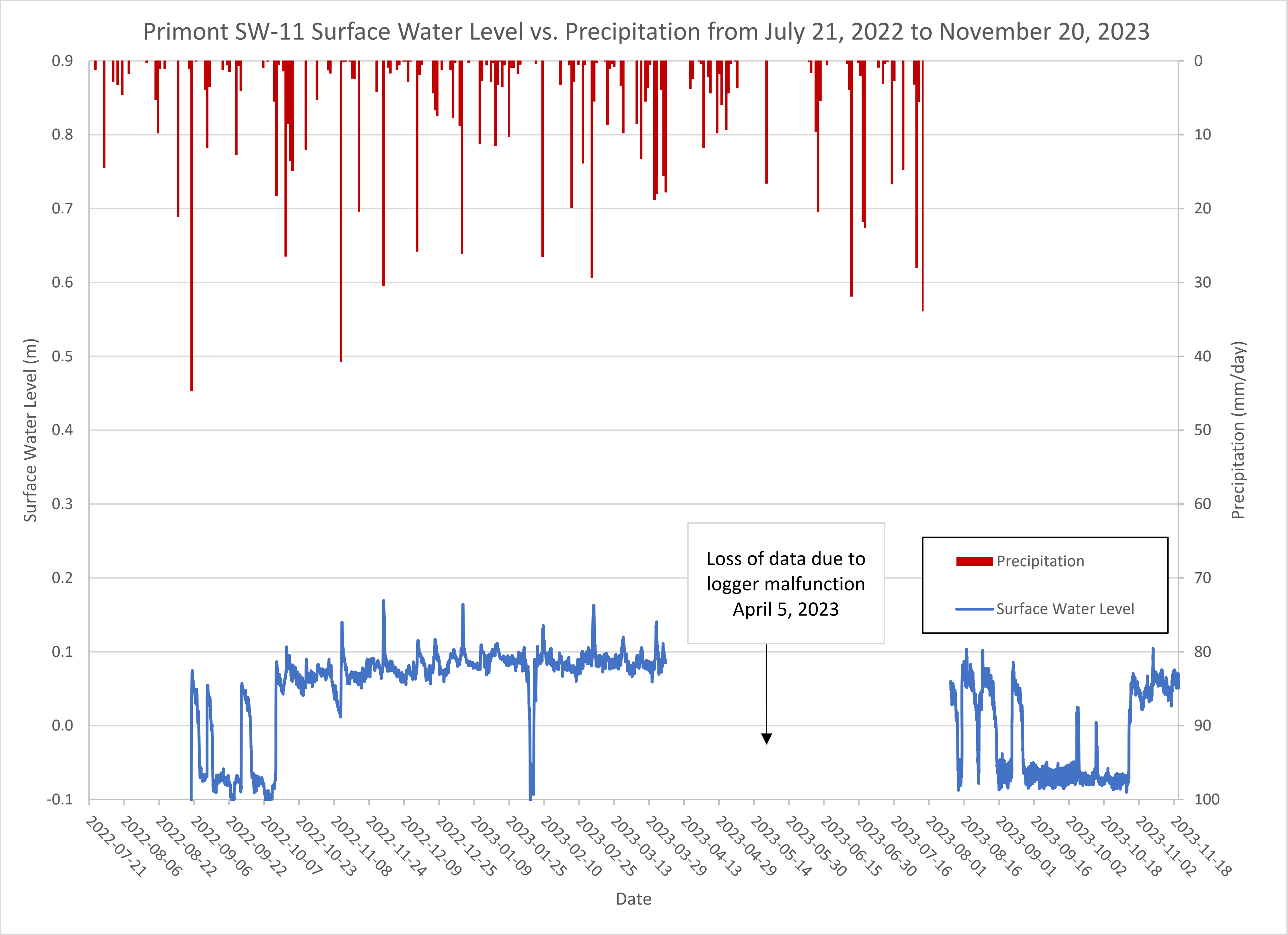

Primont SW-10 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger malfunction, data gap Jul 2 to Aug 10, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-02
2023-11-18

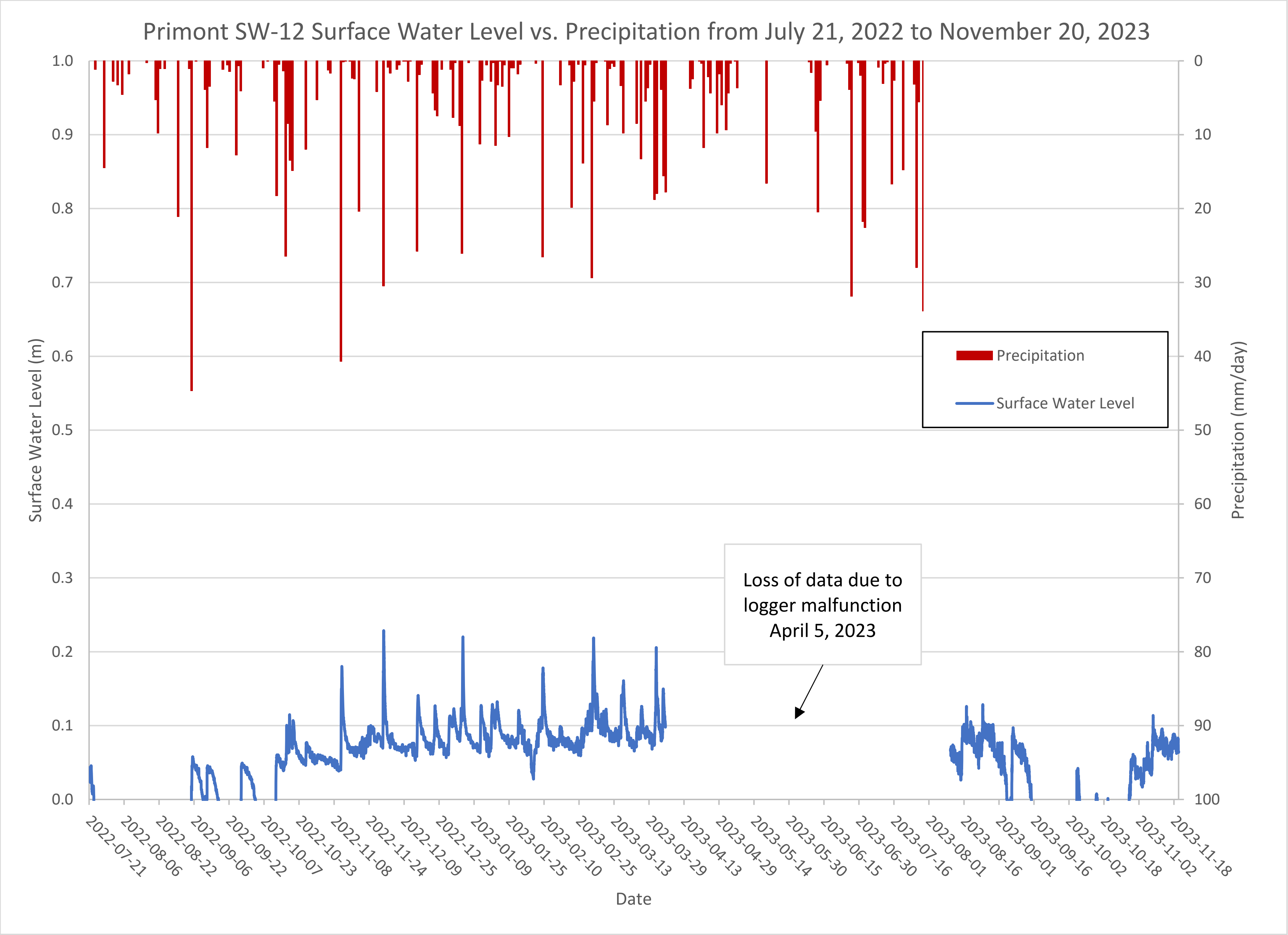

Primont SW-10 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger malfunction, data gap Jul 2 to Aug 10, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-02
2023-11-18

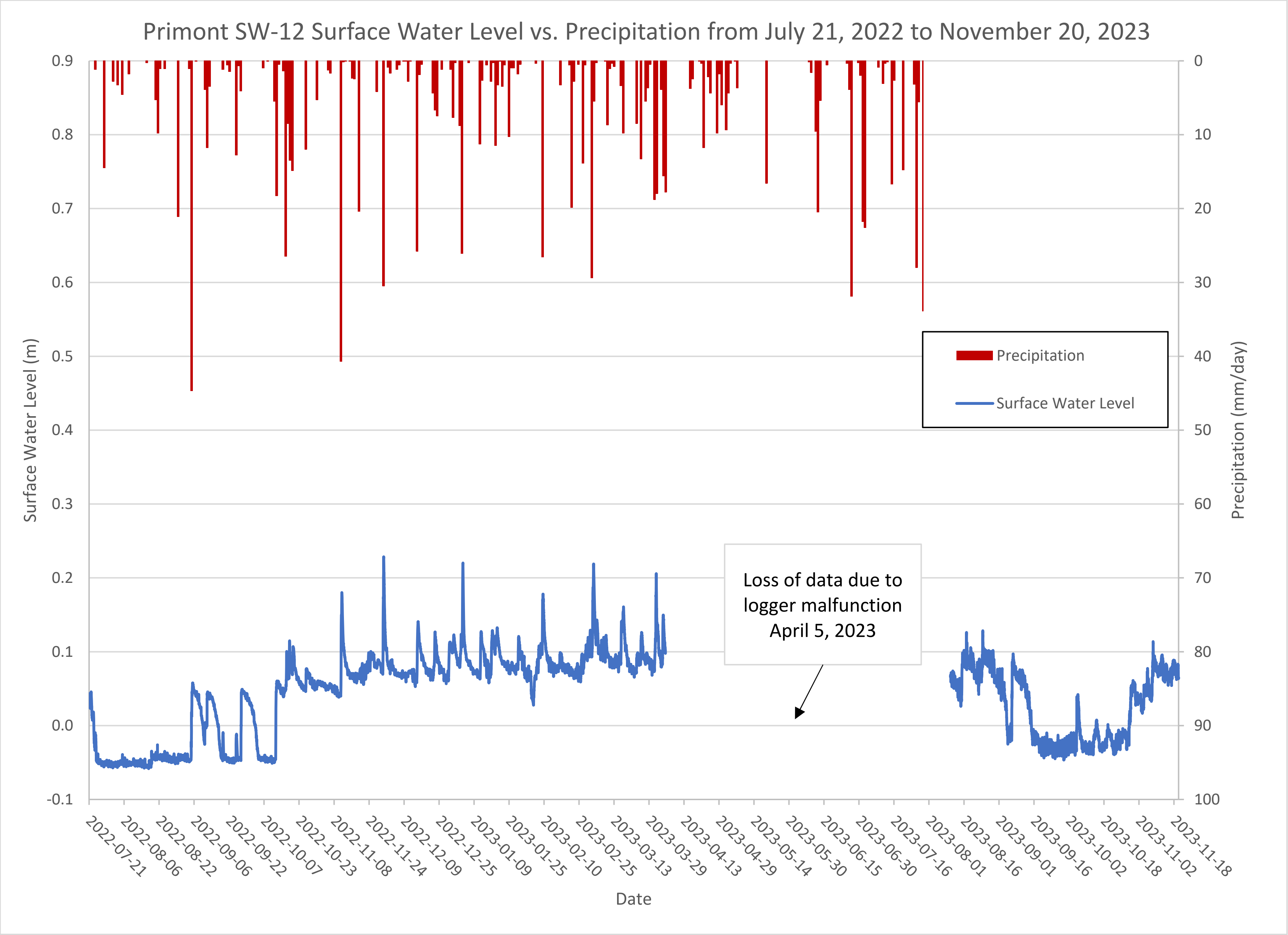


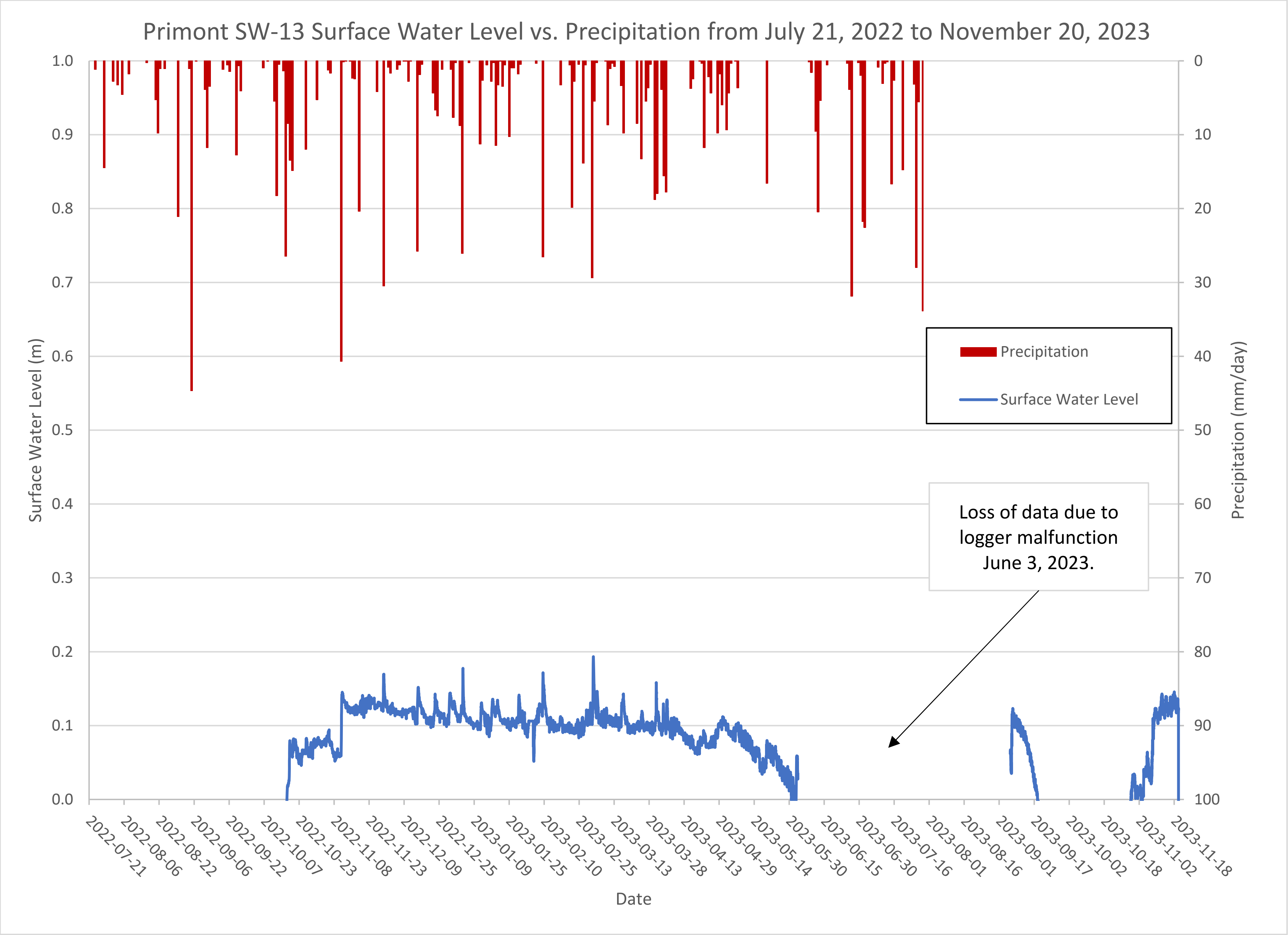
Primont SW-11 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023

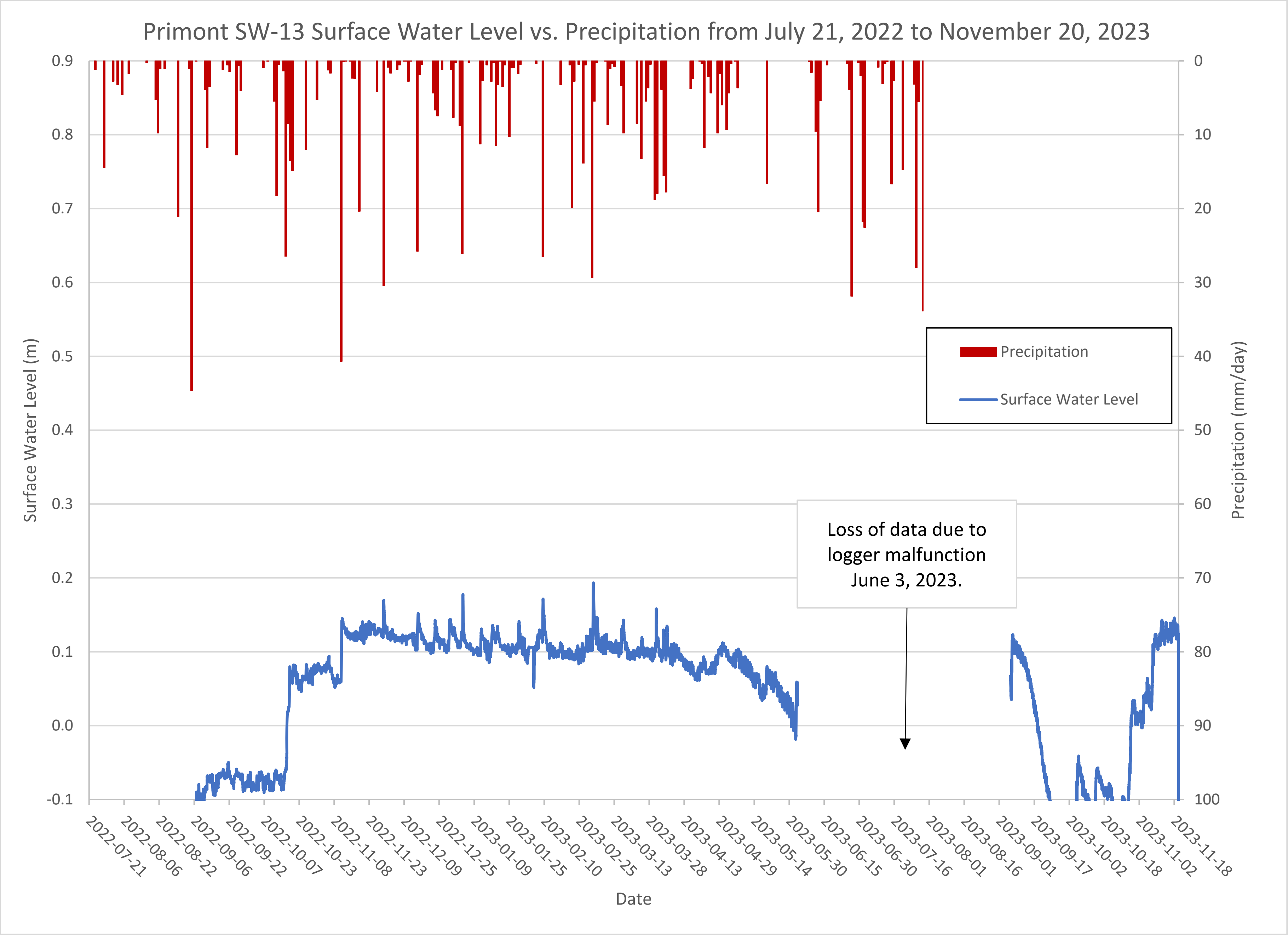
Loss of data due to logger malfunction April 5, 2023

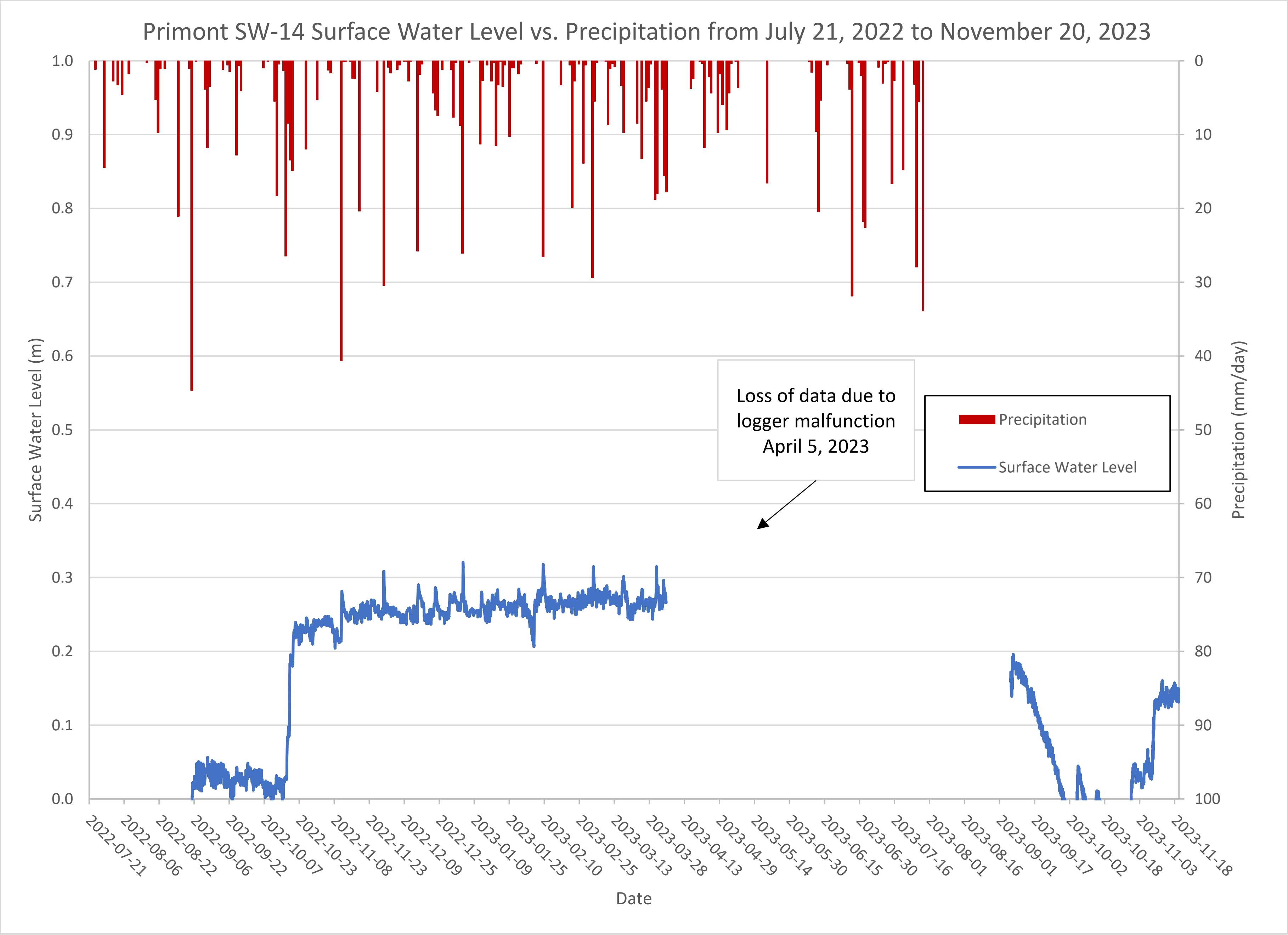

Primont SW-11 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-18
2023-11-02
2023-11-18
Loss of data due to logger malfunction April 5, 2023
Precipitation
Surface Water Level


Primont SW-12 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-18
2023-11-02
2023-11-18
Date

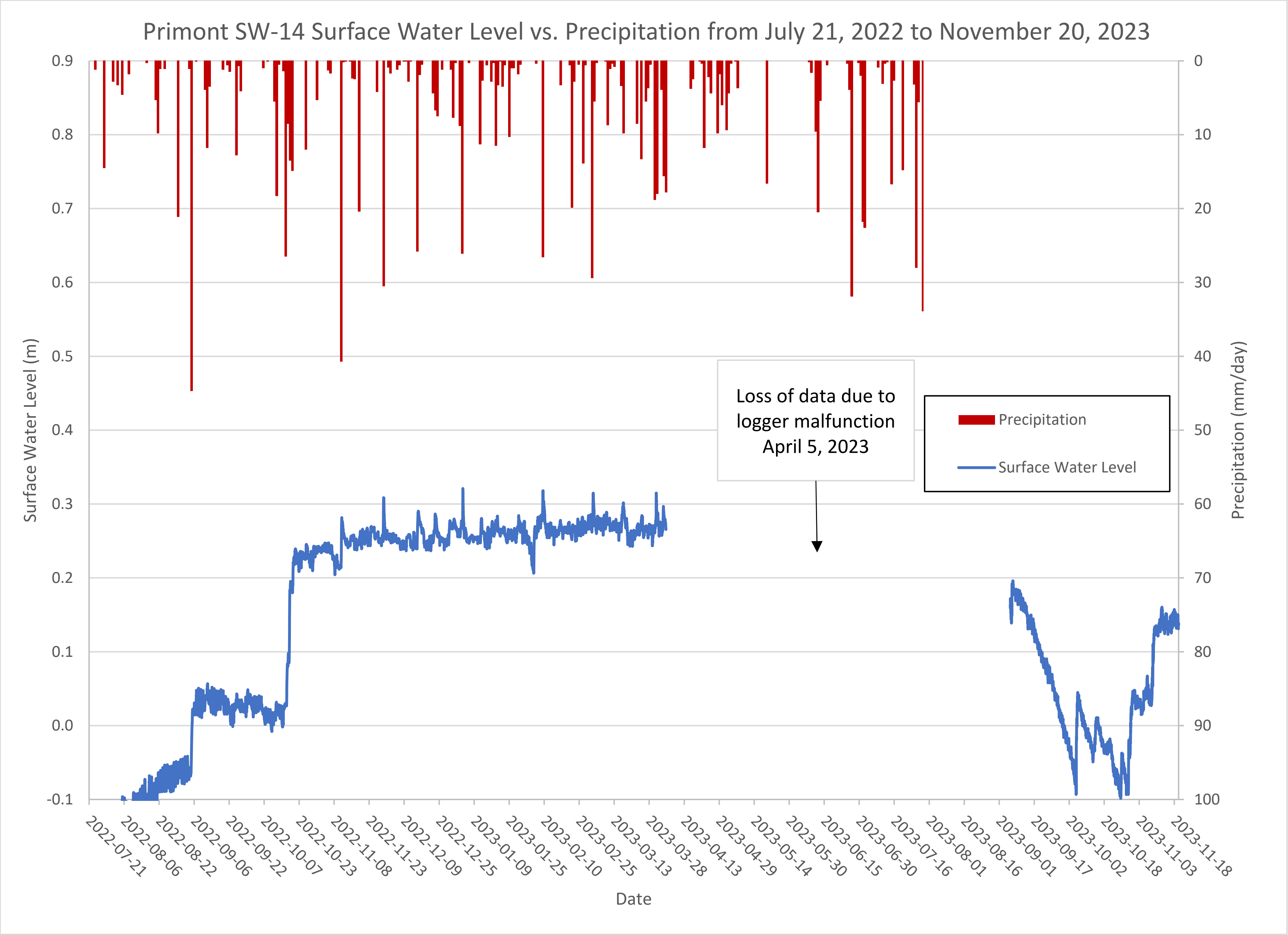

Primont SW-12 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-18
2023-11-02
2023-11-18

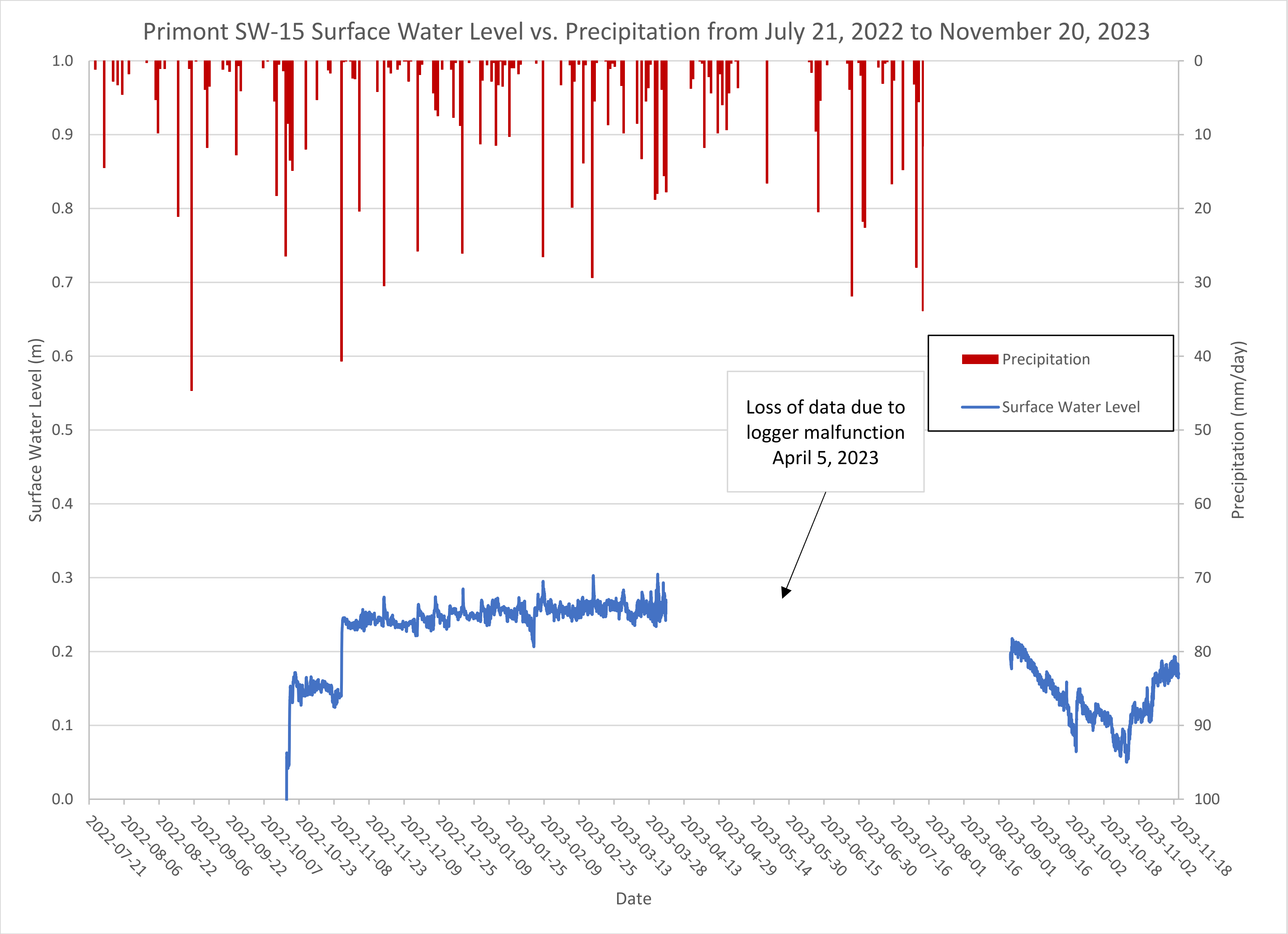

Primont SW-13 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction June 3, 2023.
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-02
2023-11-18

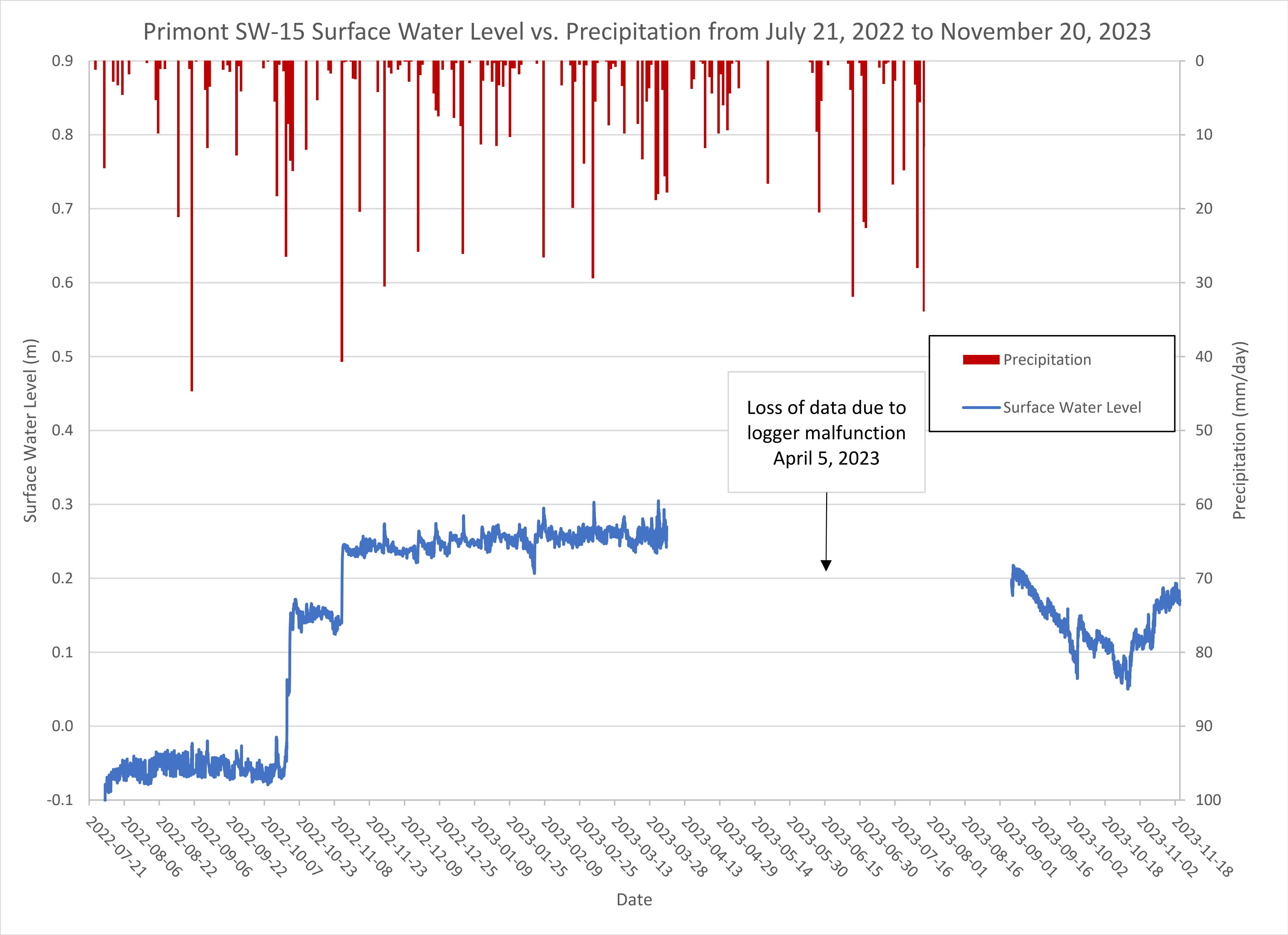

Primont SW-13 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction June 3, 2023.
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-02
2023-11-18

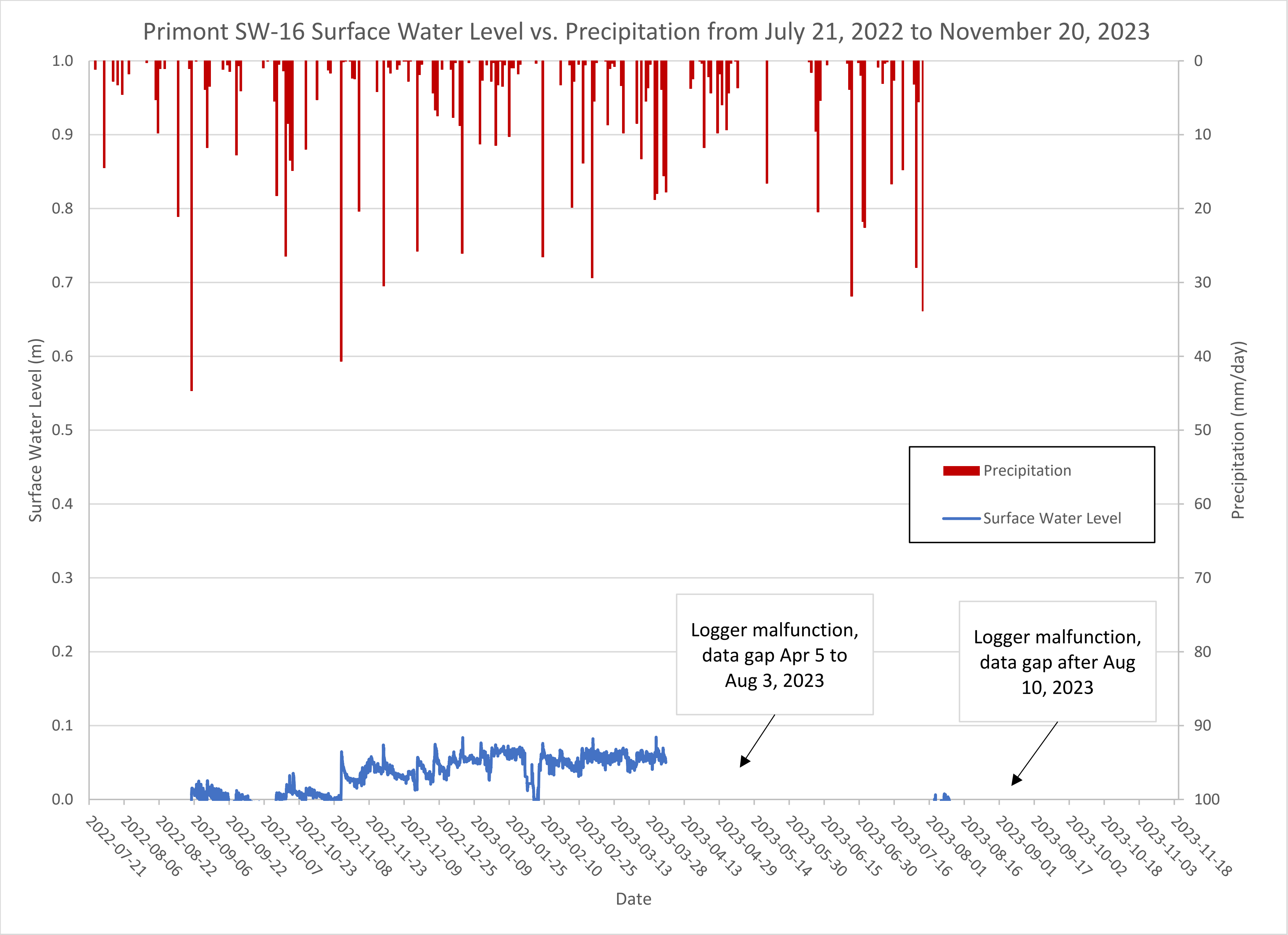


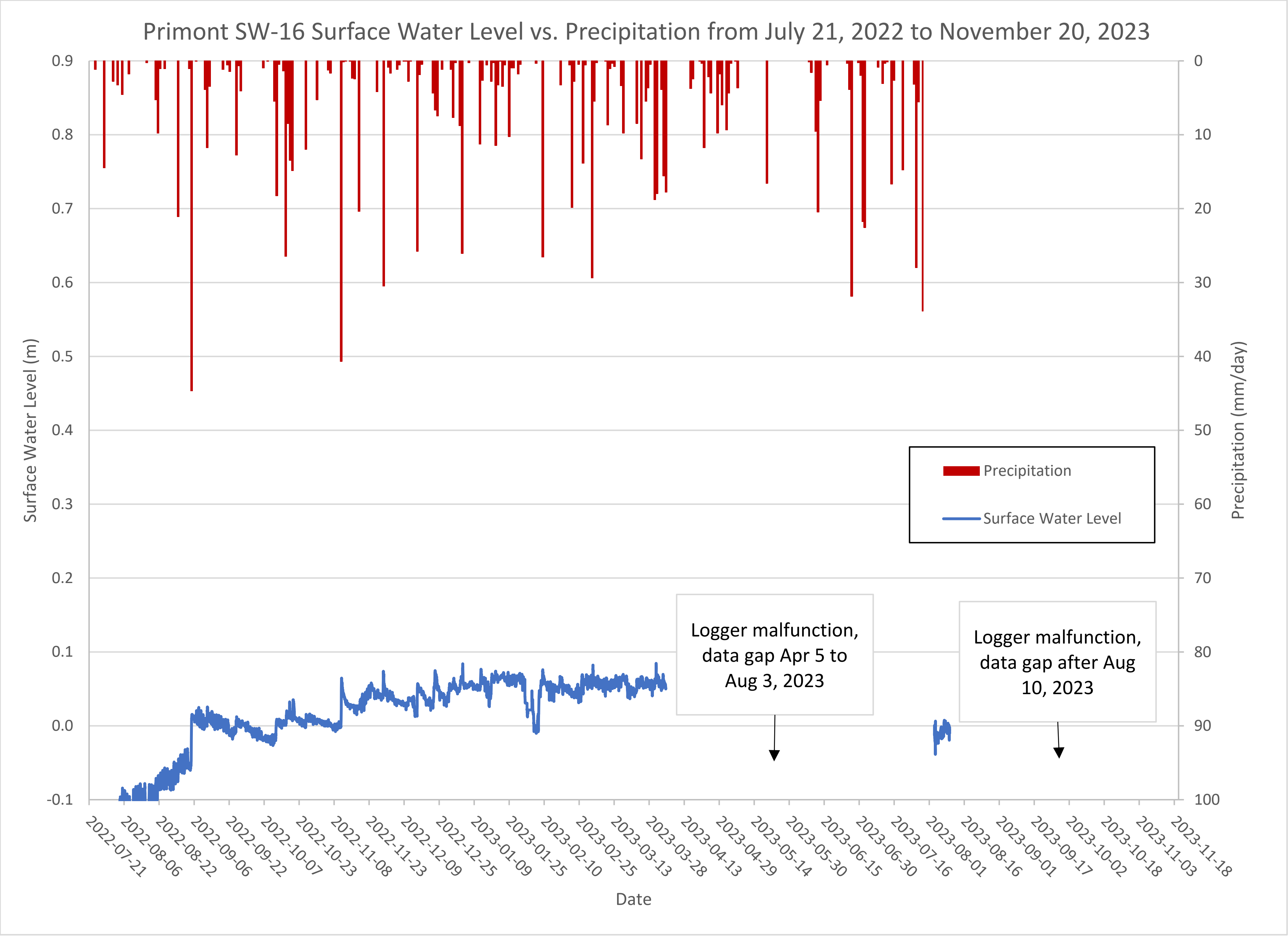
Loss of data due to logger malfunction April 5, 2023

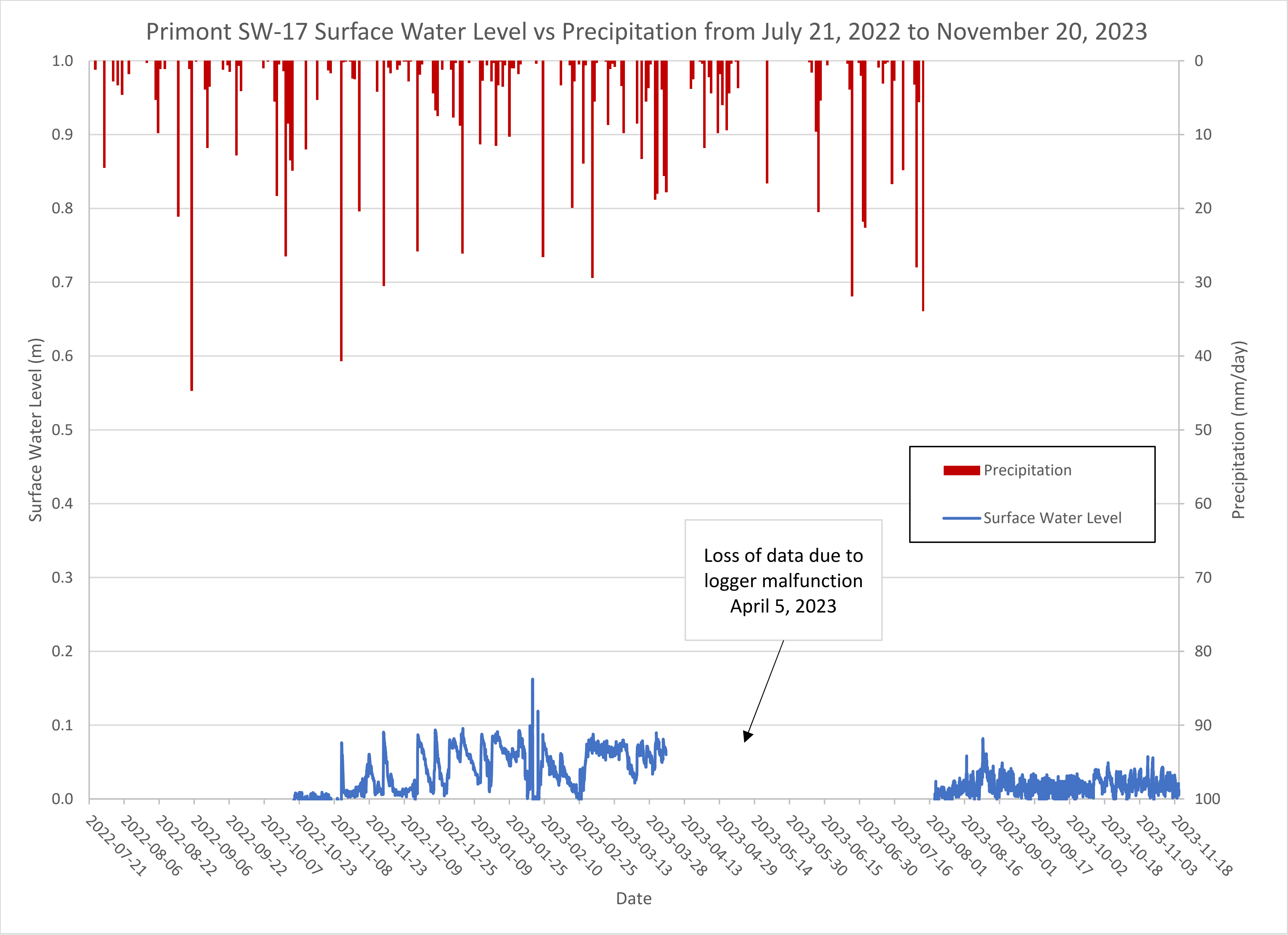

Primont SW-14 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Loss of data due to logger malfunction April 5, 2023
Precipitation
Surface Water Level
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18
Date

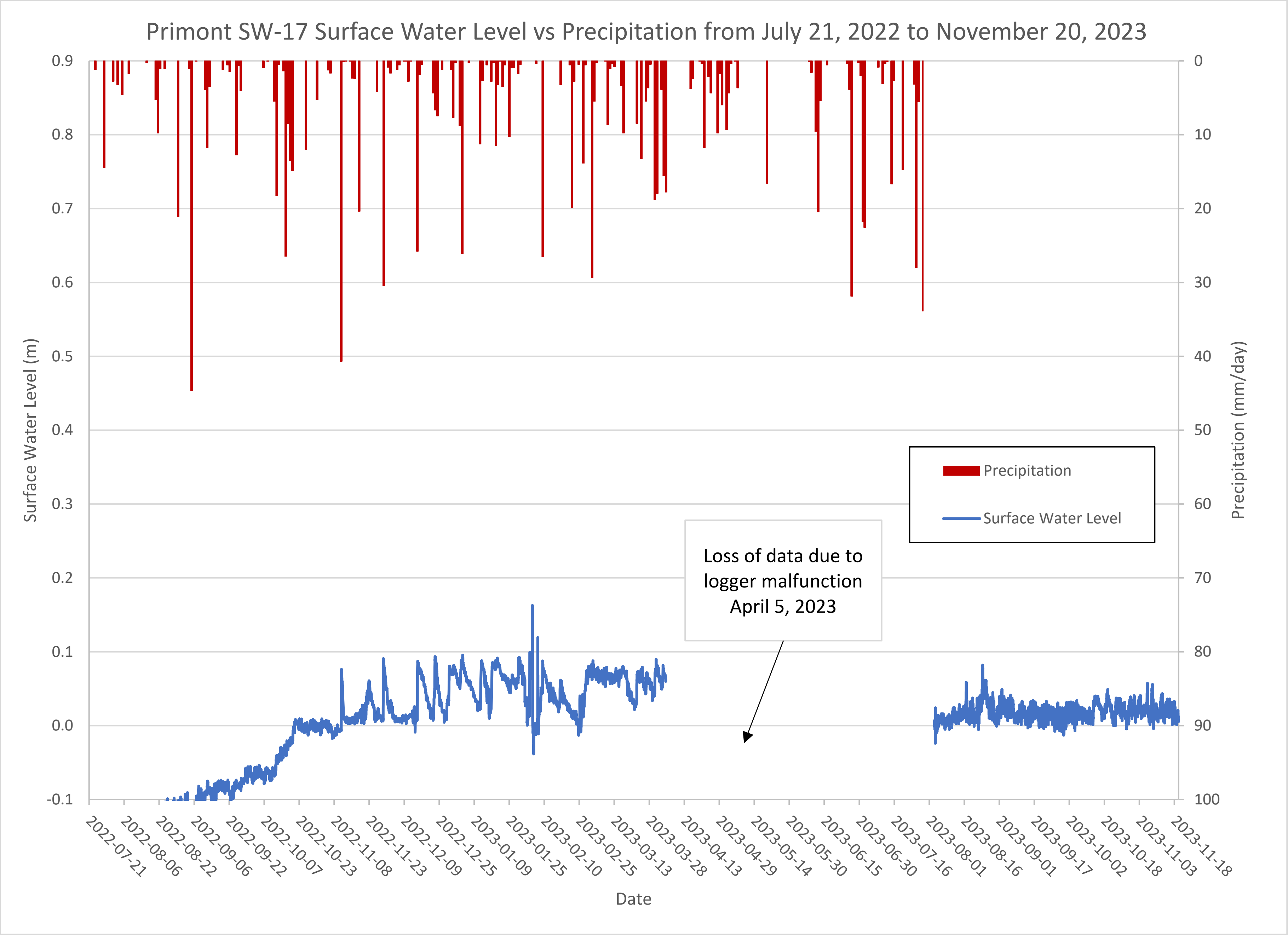

Primont SW-15 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-18
2023-11-02
2023-11-18
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023

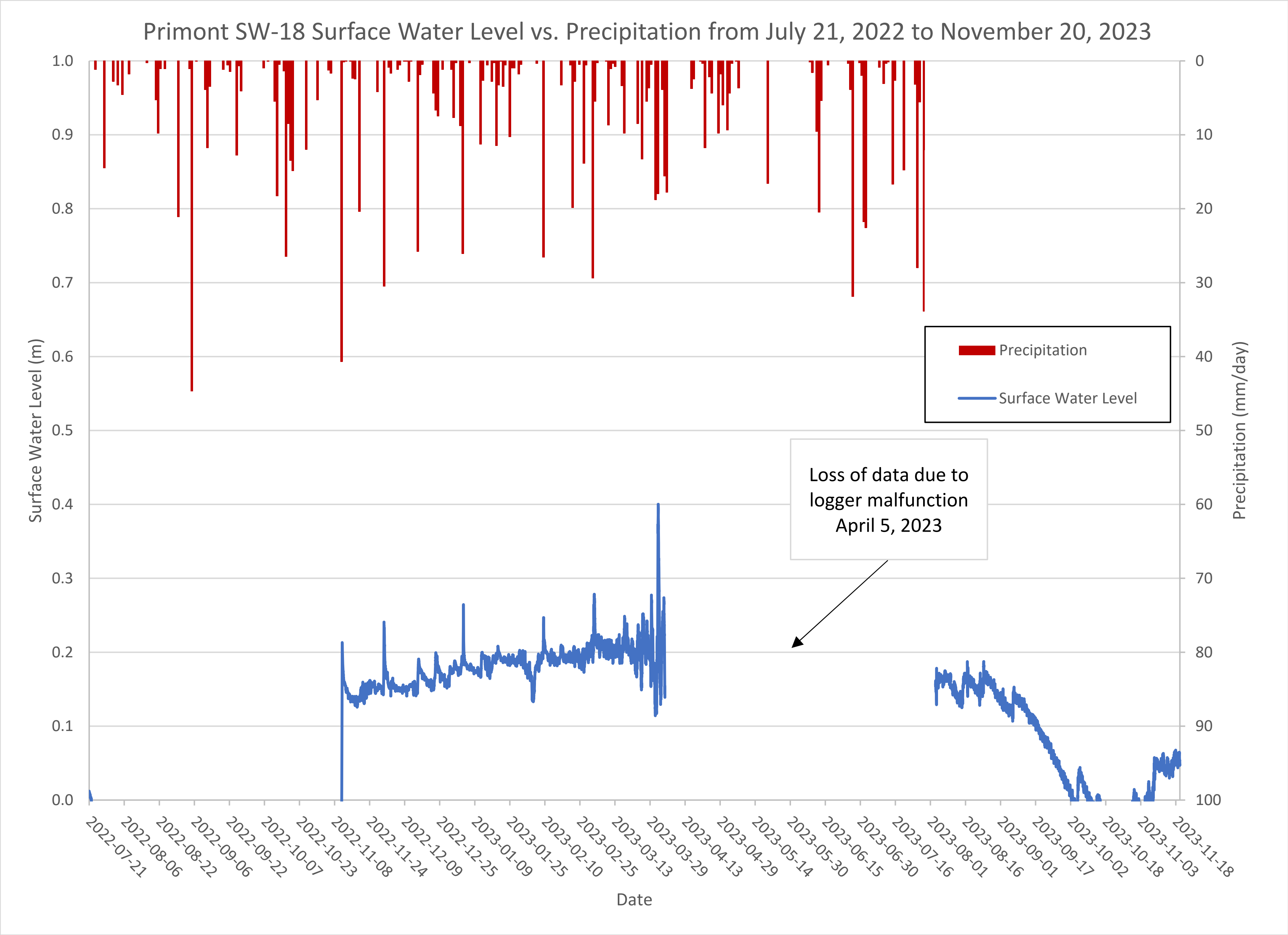

Primont SW-15 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-09
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-16
2023-10-02
2023-10-18
2023-11-02
2023-11-18
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023

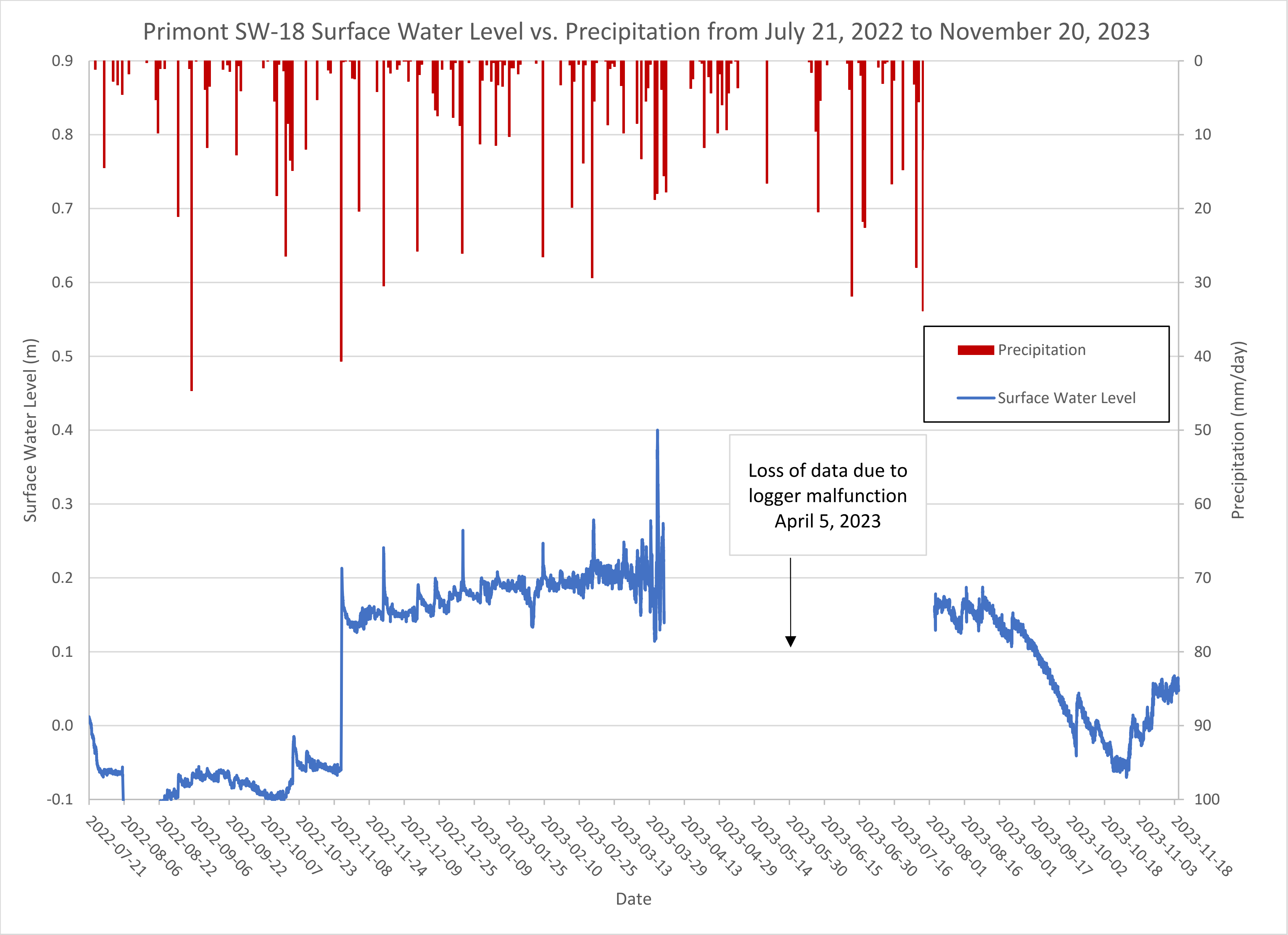

Primont SW-16 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Logger malfunction, data gap Apr 5 to Aug 3, 2023
Logger malfunction, data gap after Aug 10, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18


Primont SW-16 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
Precipitation (mm/day)
Date
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0
10
20
30
40
50
60
70
80
90
100
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18
Precipitation
Surface Water Level
Logger malfunction, data gap Apr 5 to Aug 3, 2023
Logger malfunction, data gap after Aug 10, 2023


Primont SW-17 Surface Water Level vs Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023


Primont SW-17 Surface Water Level vs Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-23
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-28
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023


Primont SW-18 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18


Primont SW-18 Surface Water Level vs. Precipitation from July 21, 2022 to November 20, 2023
Surface Water Level (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
Precipitation (mm/day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
Loss of data due to logger malfunction April 5, 2023
Date
2022-07-21
2022-08-06
2022-08-22
2022-09-06
2022-09-22
2022-10-07
2022-10-23
2022-11-08
2022-11-24
2022-12-09
2022-12-25
2023-01-09
2023-01-25
2023-02-10
2023-02-25
2023-03-13
2023-03-29
2023-04-13
2023-04-29
2023-05-14
2023-05-30
2023-06-15
2023-06-30
2023-07-16
2023-08-01
2023-08-16
2023-09-01
2023-09-17
2023-10-02
2023-10-18
2023-11-03
2023-11-18

Appendix F

Tow Path Drain Surface Water Monitoring

Tow Path Drain Staff Gauges, Welland, Ontario

SG-101 (October 23, 2023)

Photo taken at 12:00 facing to the North.

SG-102 (October 23, 2023)

Photo taken at 10:20 facing the West.

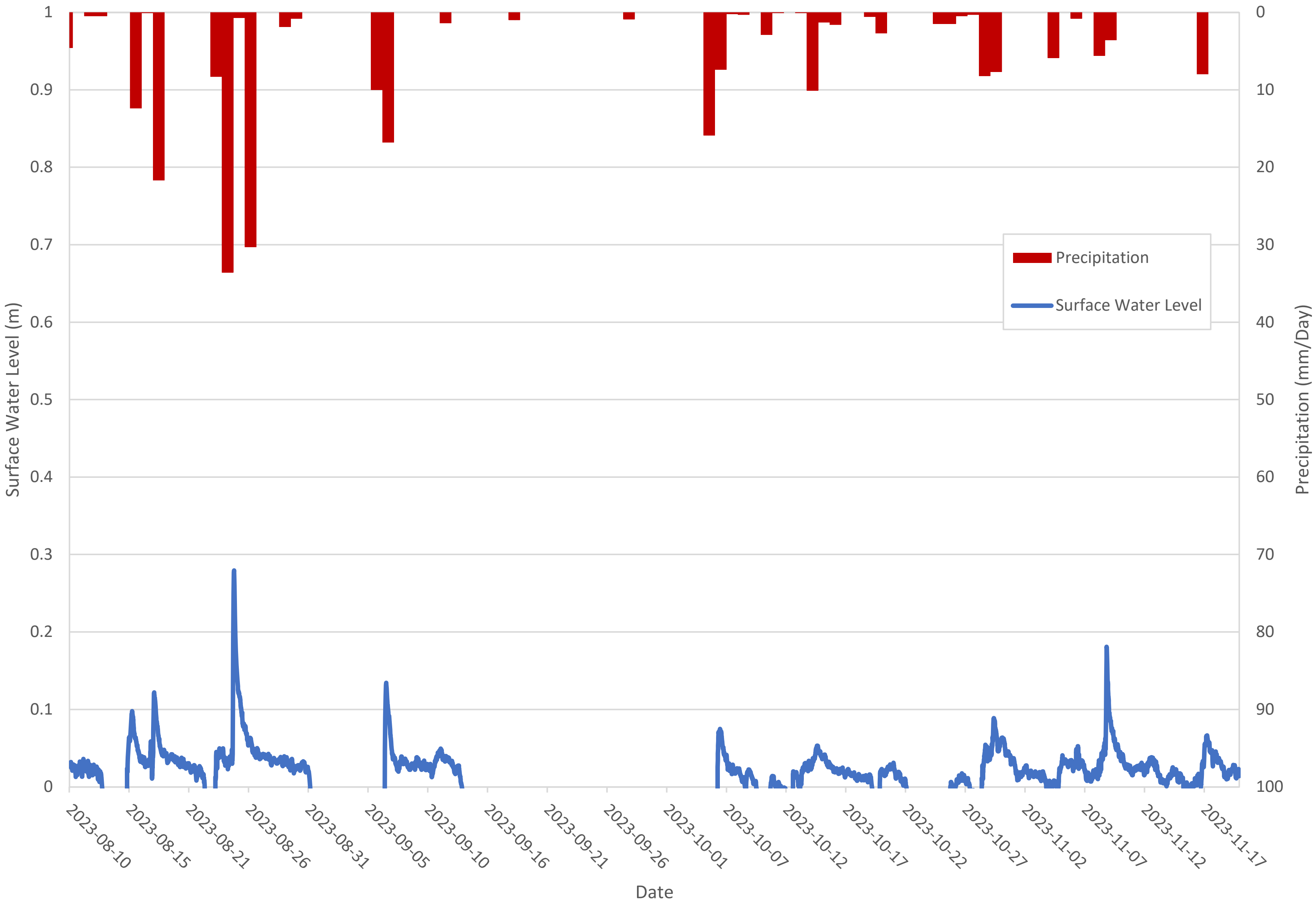
SG-103 (October 23, 2023)

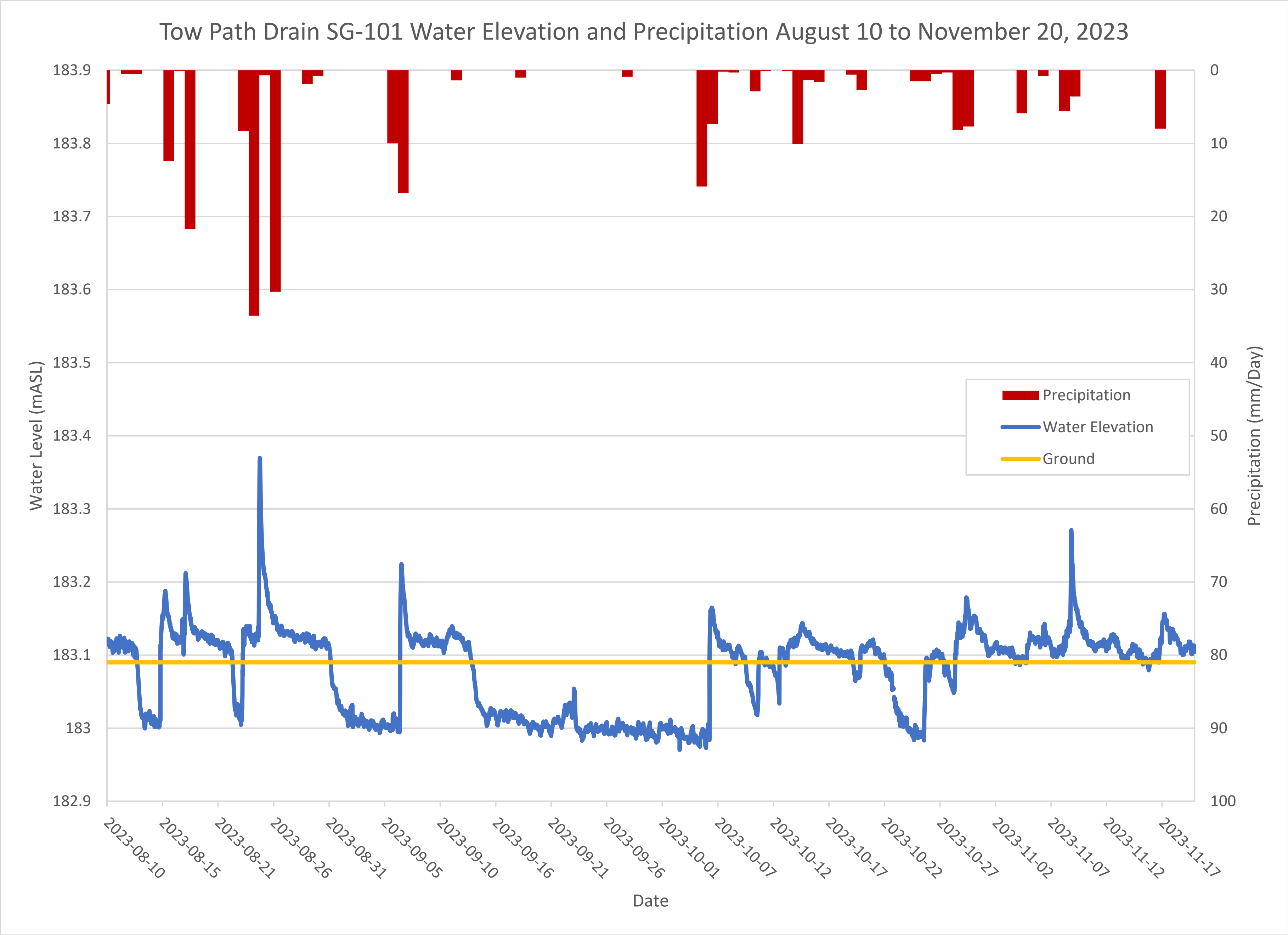
Photo taken at 10:50 facing the West.

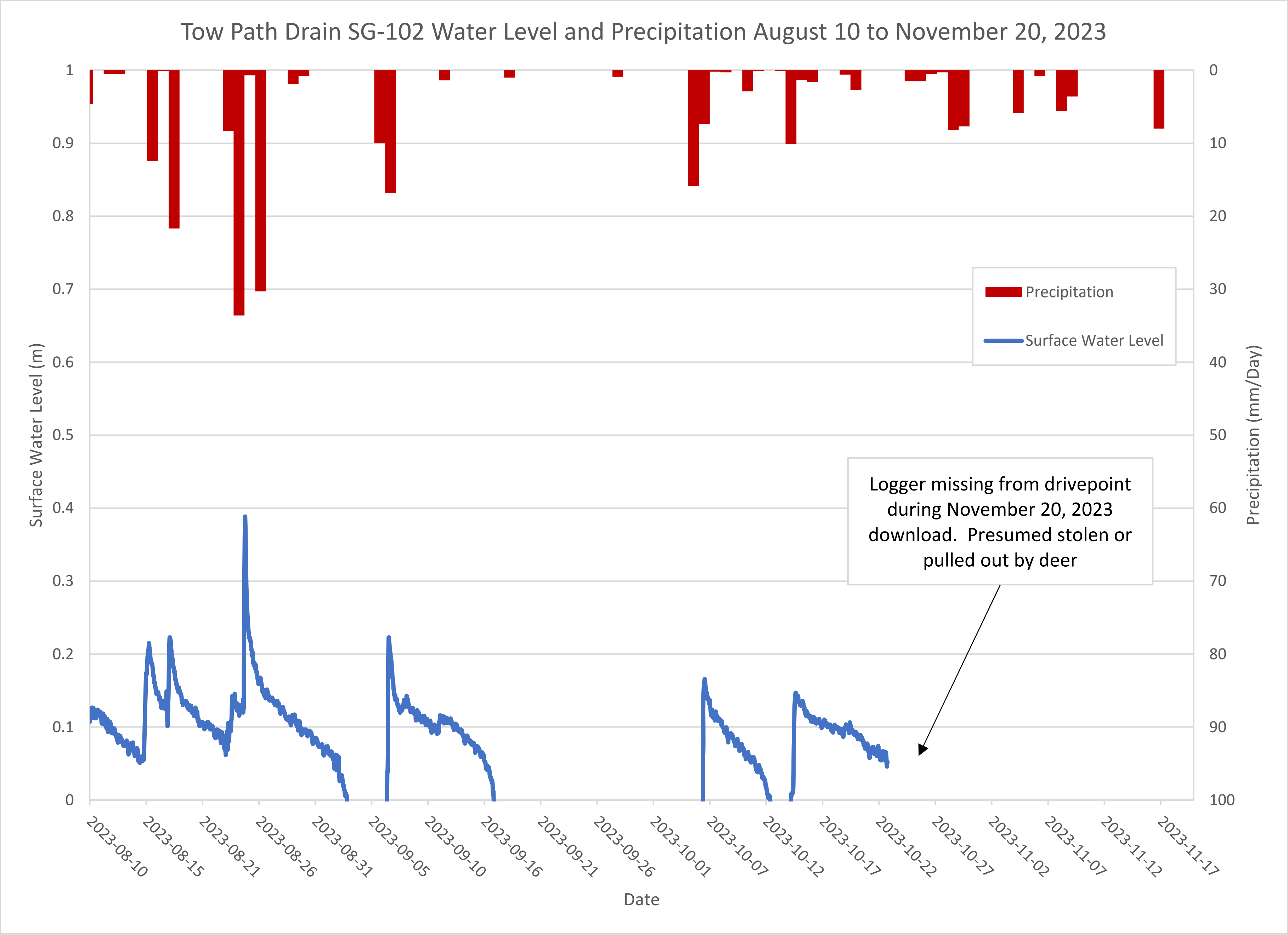
SG-104 (October 23, 2023)

Photo taken at 11:40 facing the South.

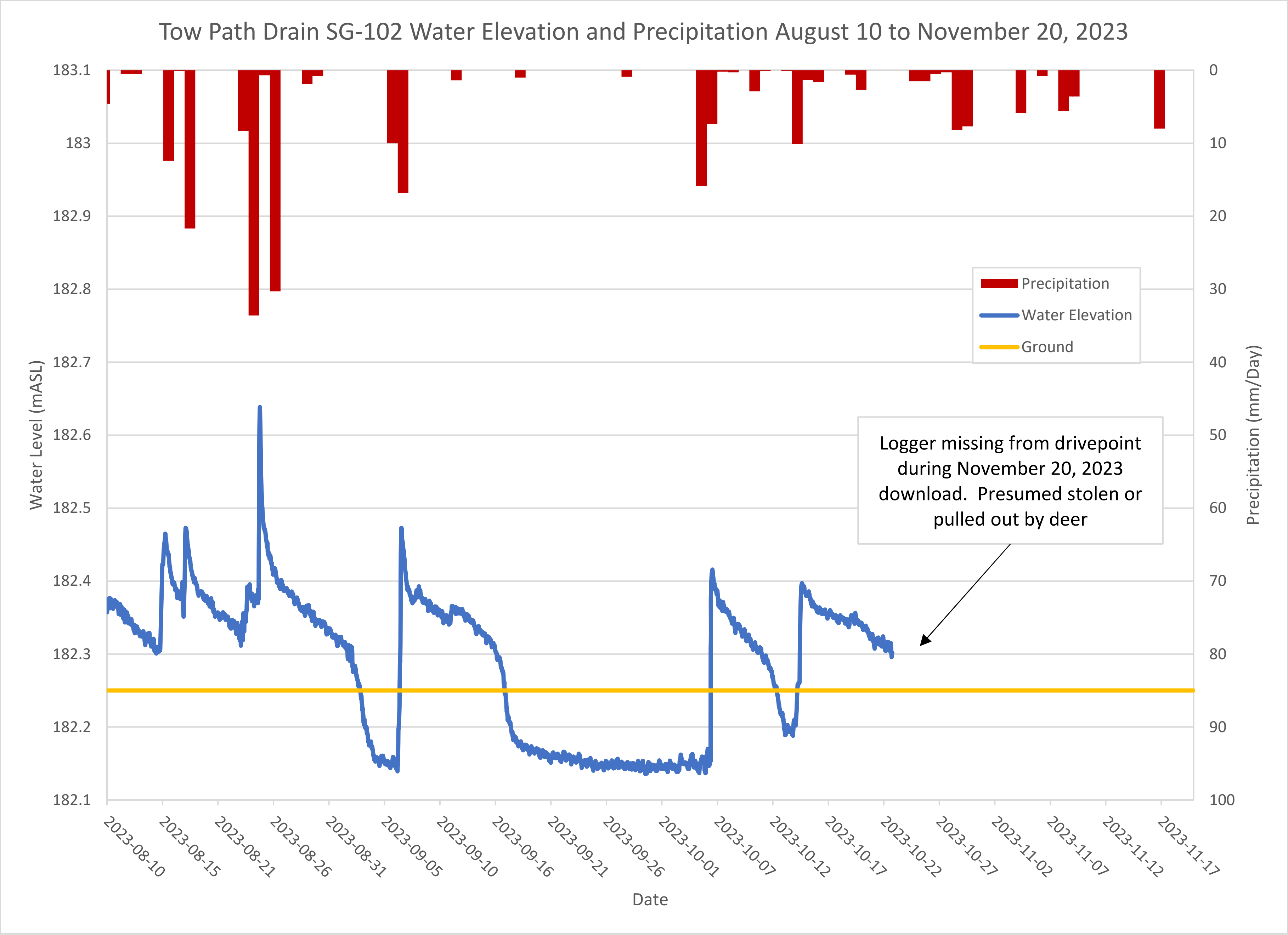
Tow Path Drain SG-101 Water Level and Precipitation August 10 to November 20, 2023



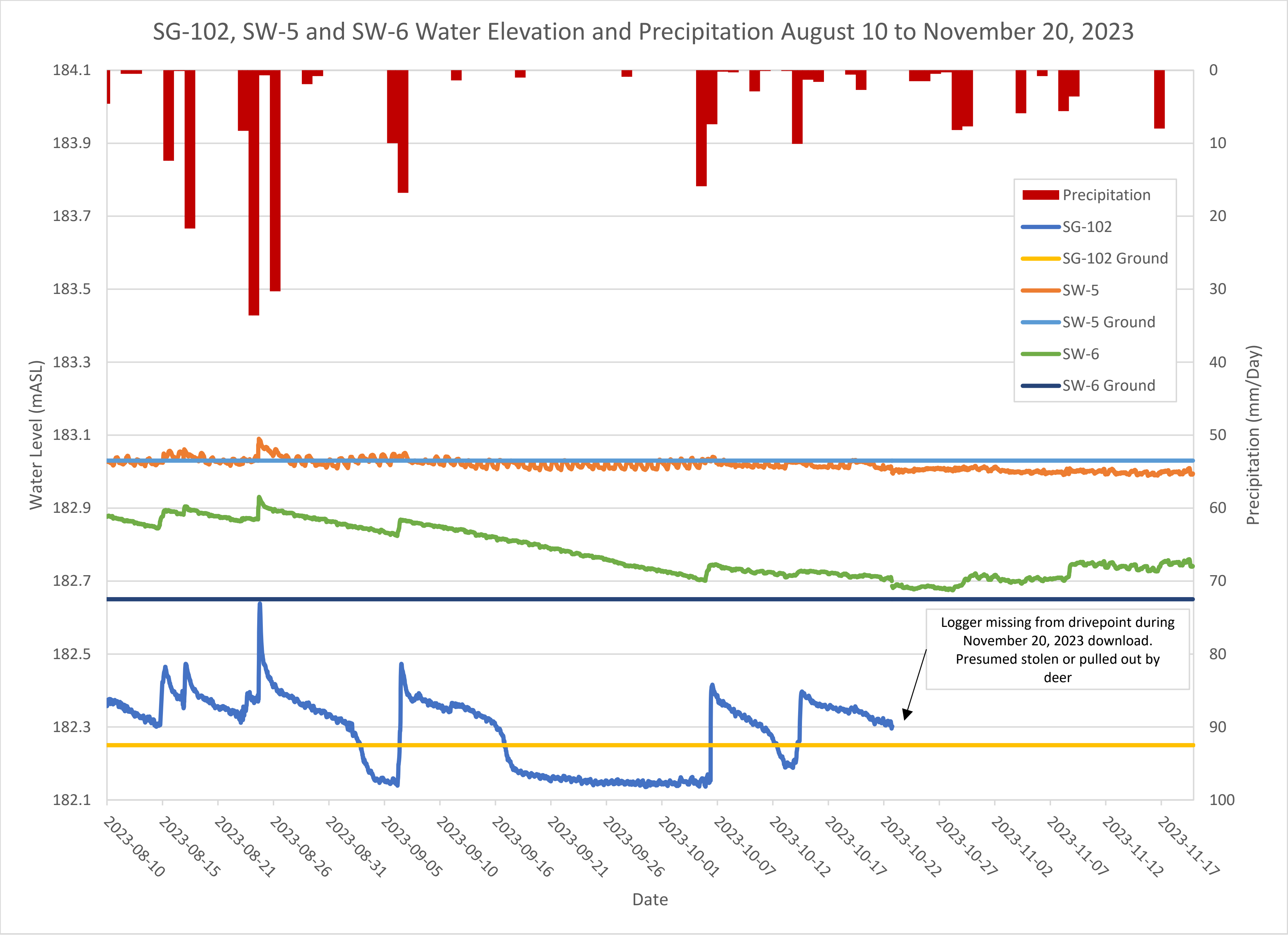

Tow Path Drain SG-101 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
183.9
183.8
183.7
183.6
183.5
183.4
183.3
183.2
183.1
183
182.9
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Water Elevation
Ground
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

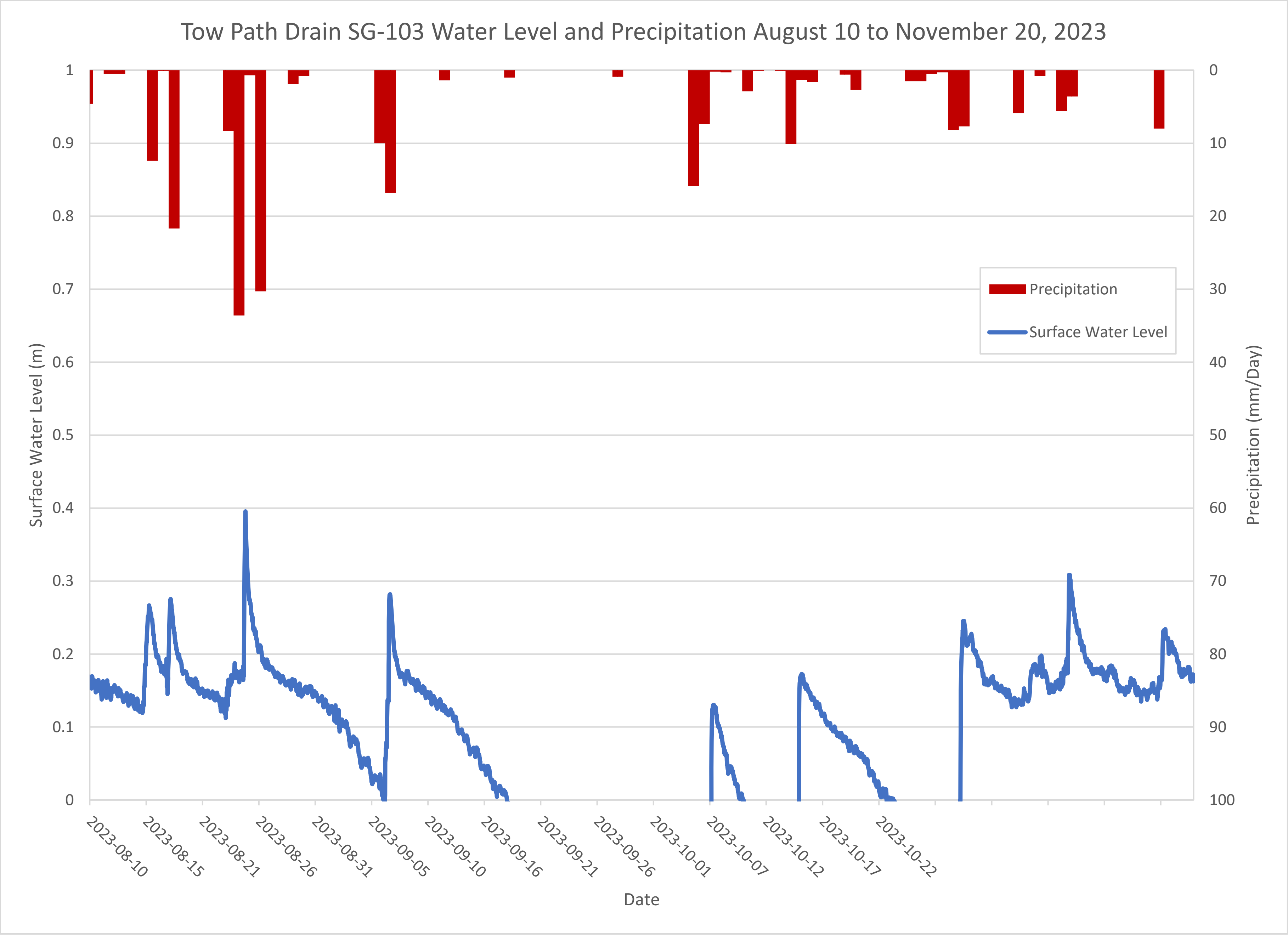


Logger missing from drivepoint during November 20, 2023 download. Presumed stolen or pulled out by deer

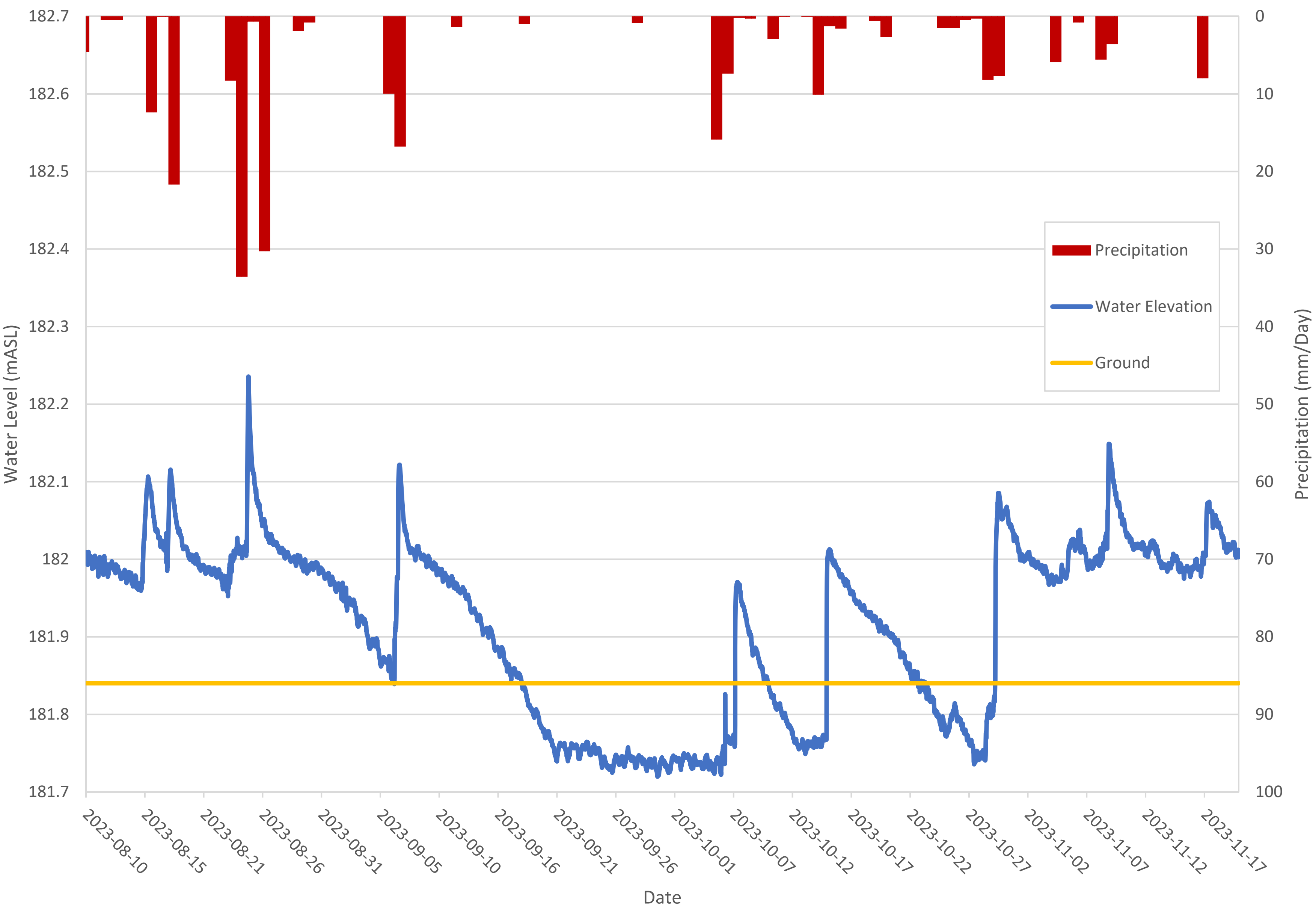


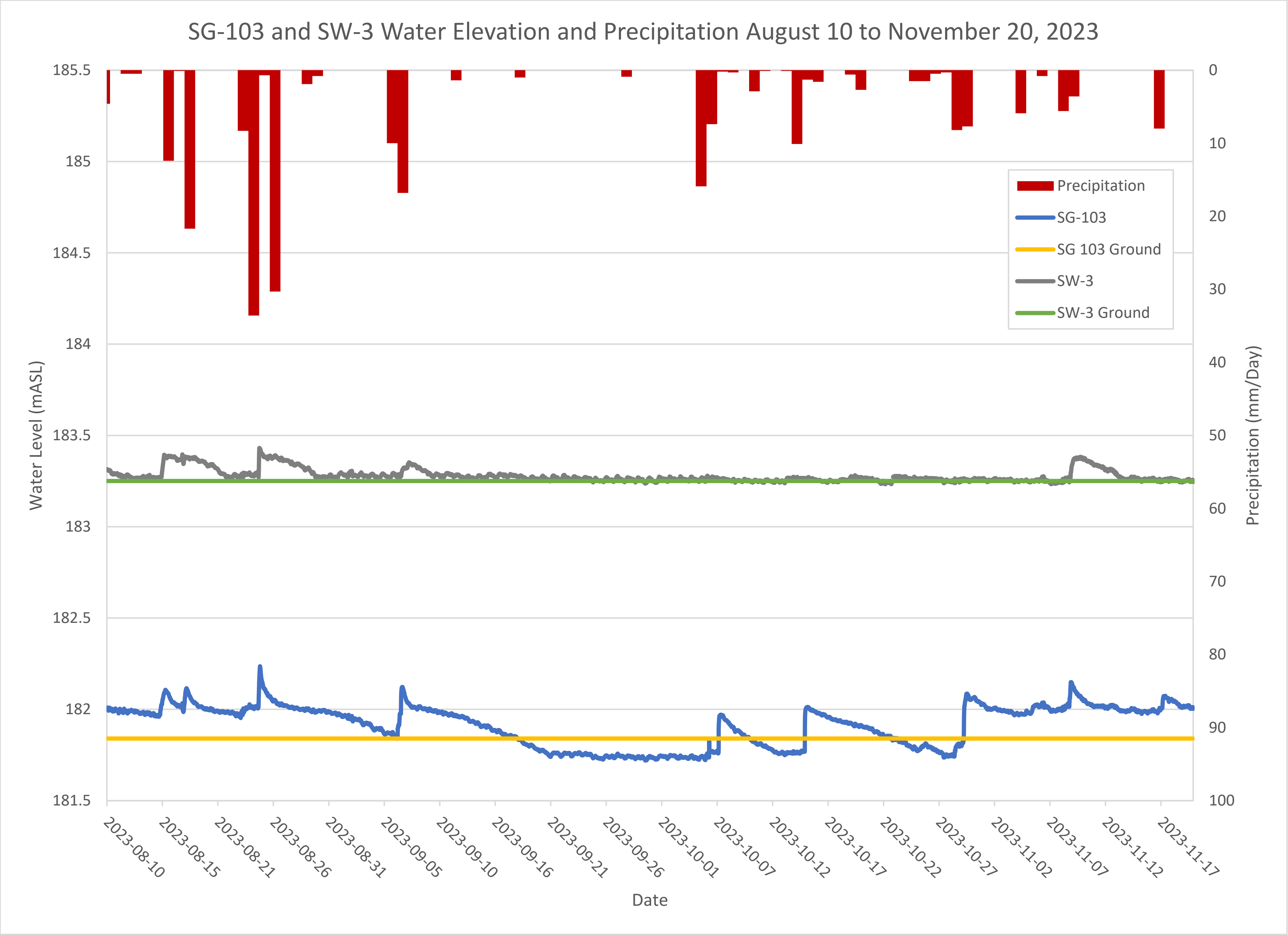
Logger missing from drivepoint during November 20, 2023 download. Presumed stolen or pulled out by deer

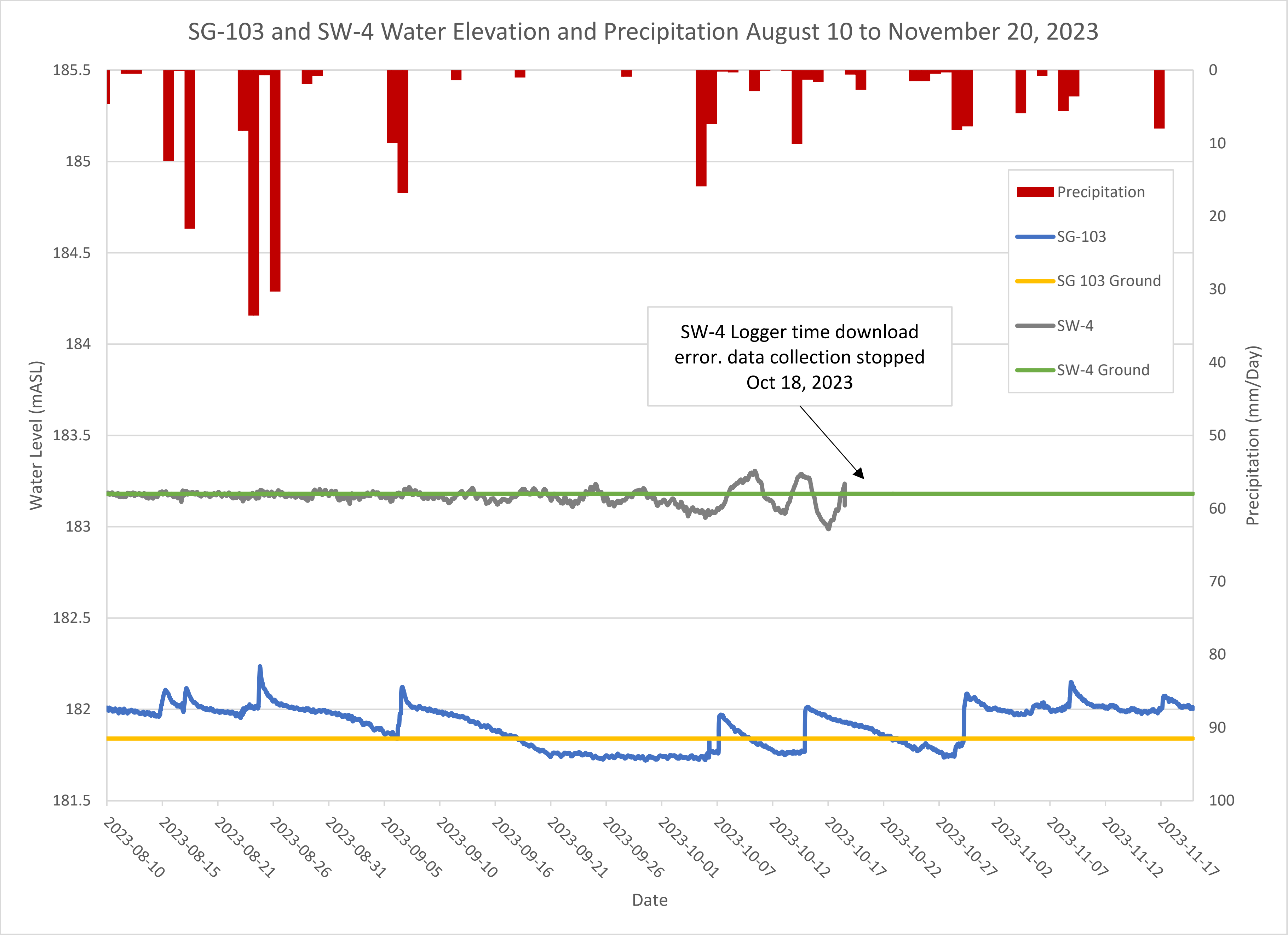

SG-102, SW-5 and SW-6 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
184.1
183.9
183.7
183.5
183.3
183.1
182.9
182.7
182.5
182.3
182.1
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
SG-102
SG-102 Ground
SW-5
SW-5 Ground
SW-6
SW-6 Ground
Logger missing from drivepoint during November 20, 2023 download. Presumed stolen or pulled out by deer
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

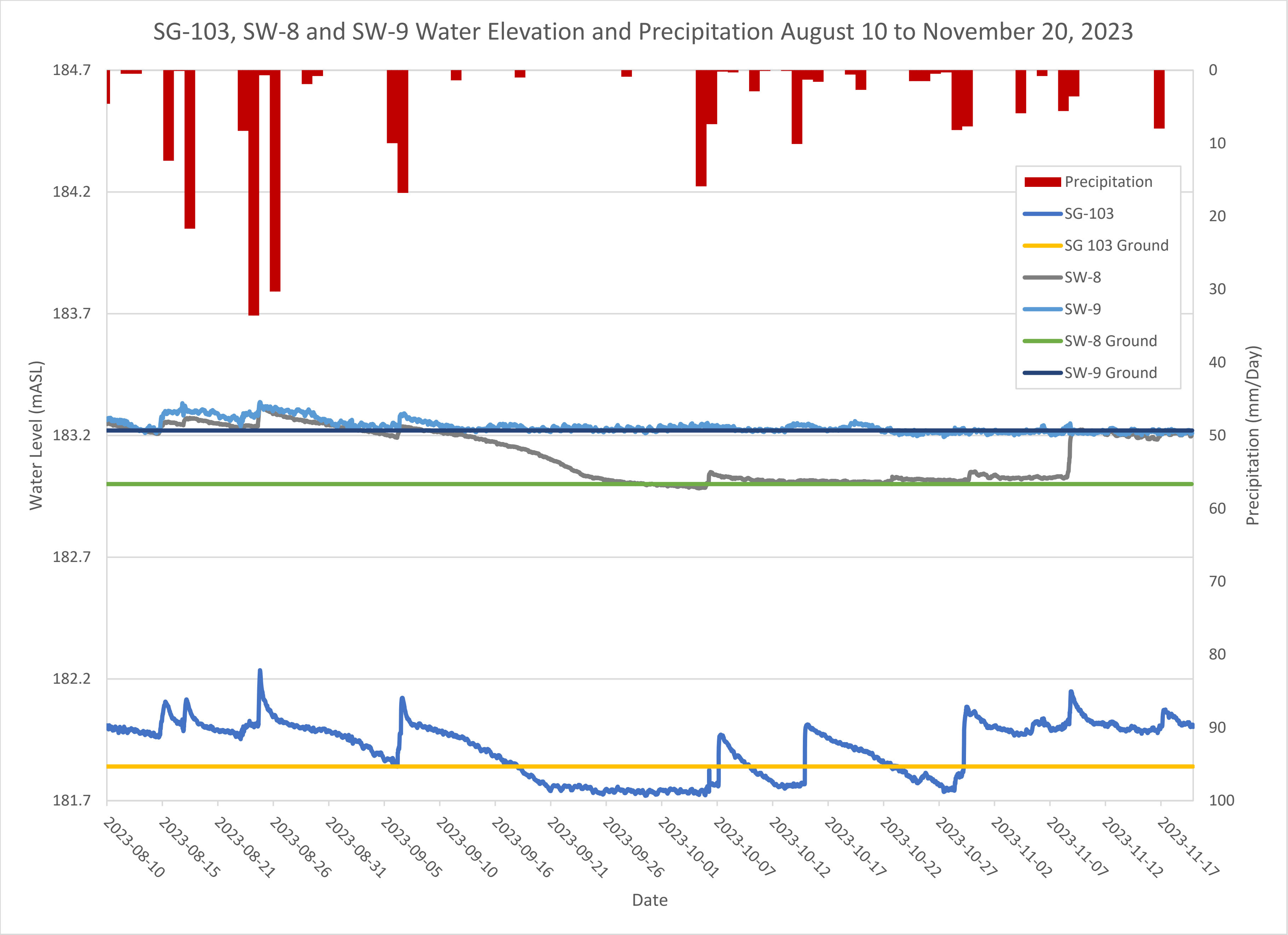

Tow Path Drain SG-103 Water Level and Precipitation August 10 to November 20, 2023
Surface Water Level (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
Date

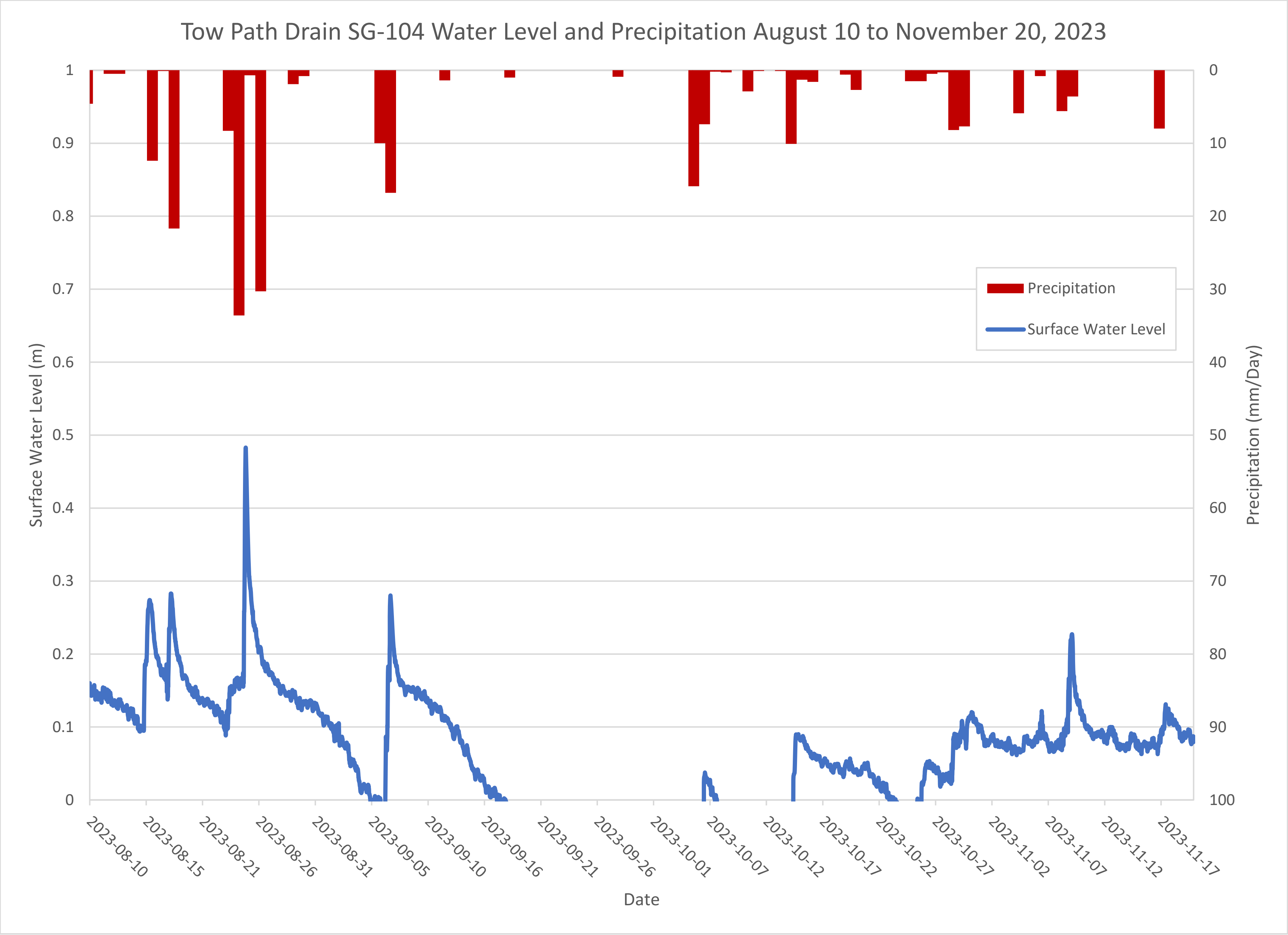
SG-103 Water Elevation and Precipitation August 10 to November 20, 2023




SG-103 and SW-3 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
185.5
185
184.5
184
183.5
183
182.5
182
181.5
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
SG-103
SG 103 Ground
SW-3
SW-3 Ground
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

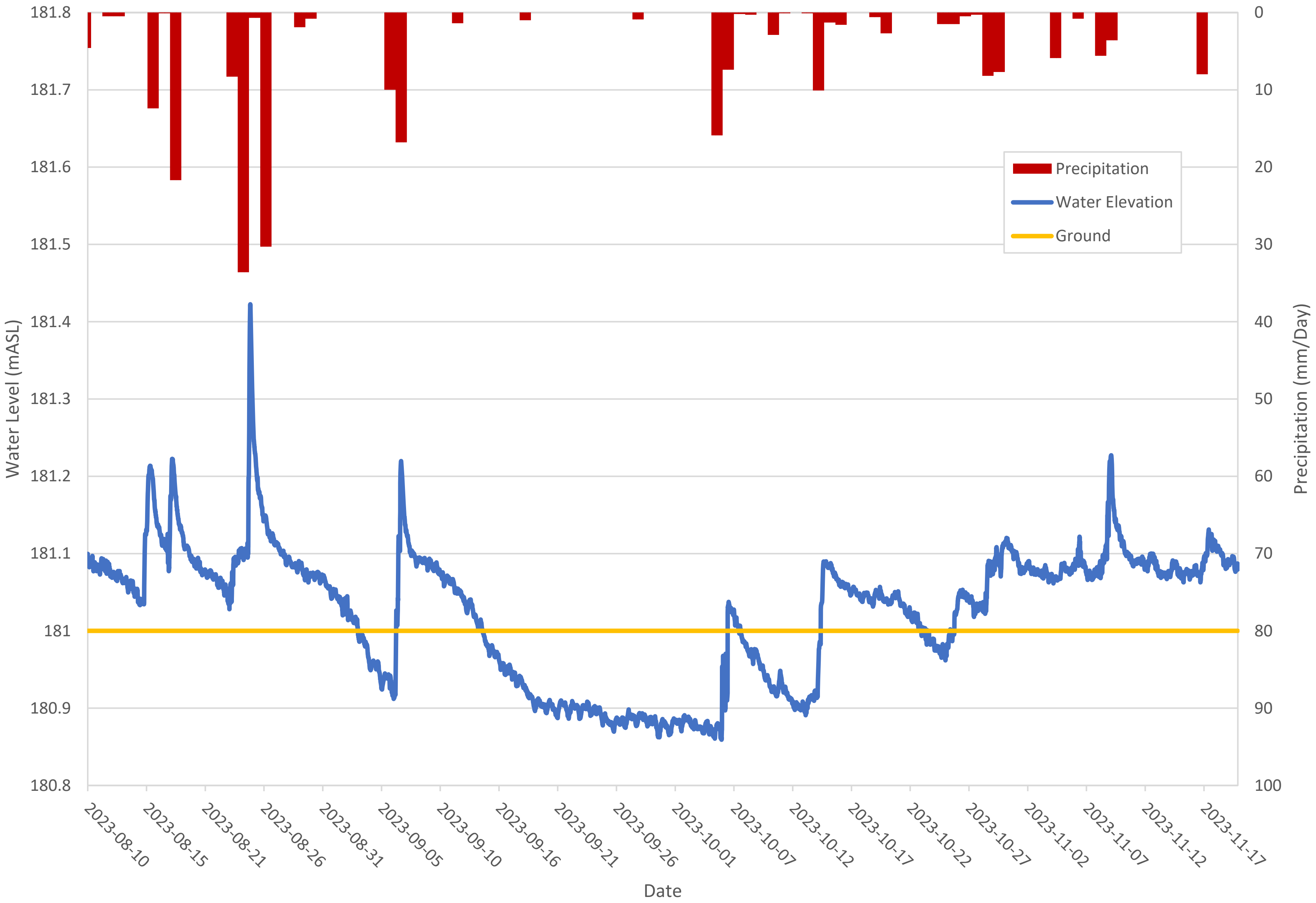

SG-103 and SW-4 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
185.5
185
184.5
184
183.5
183
182.5
182
181.5
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
SG-103
SG 103 Ground
SW-4
SW-4 Ground
SW-4 Logger time download error. data collection stopped Oct 18, 2023
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

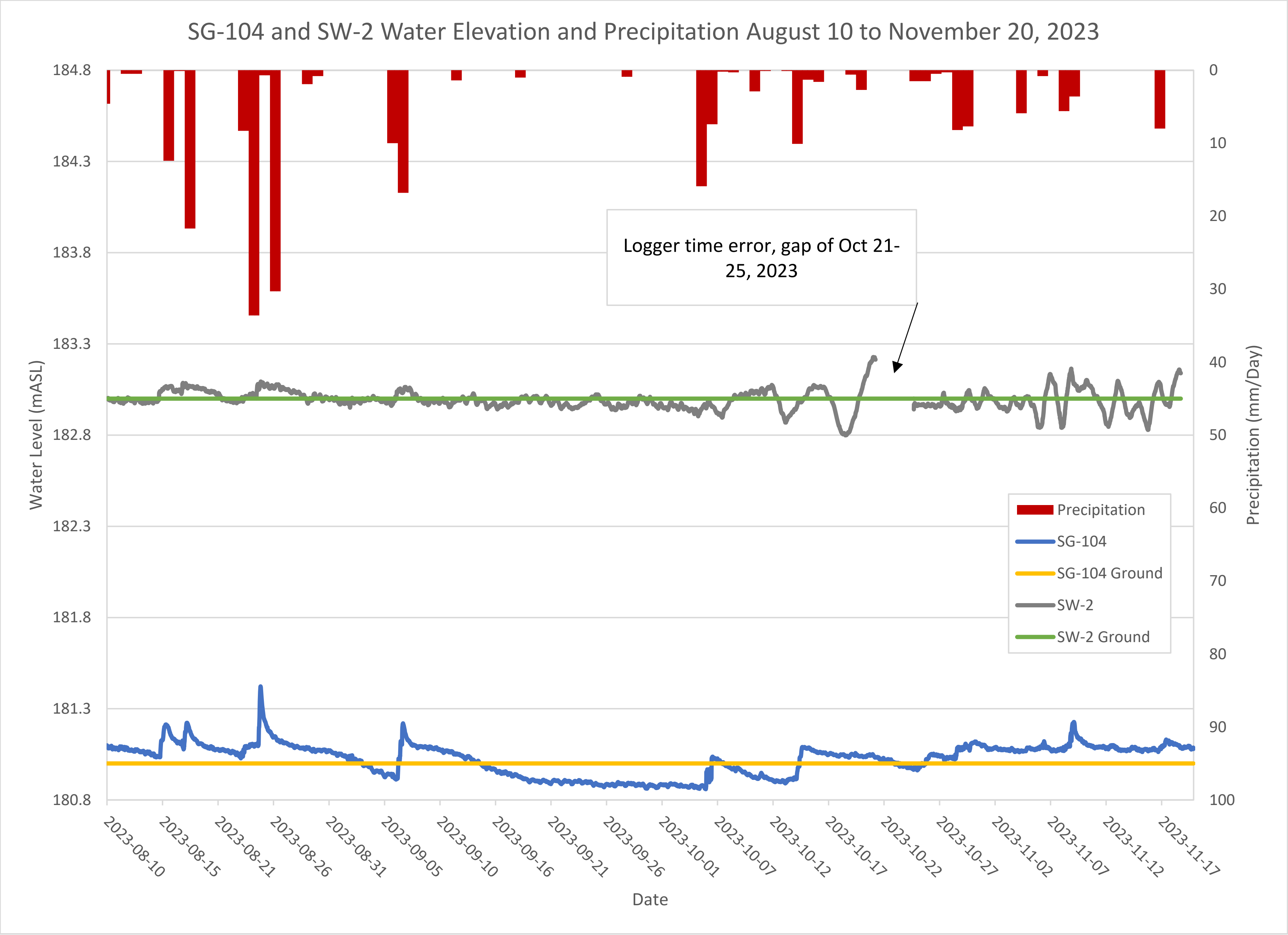

SG-103, SW-8 and SW-9 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
184.7
184.2
183.7
183.2
182.7
182.2
181.7
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
SG-103
SG 103 Ground
SW-8
SW-9
SW-8 Ground
SW-9 Ground
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date



Tow Path Drain SG-104 Water Level and Precipitation August 10 to November 20, 2023
Surface Water Level (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Precipitation
Surface Water Level
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

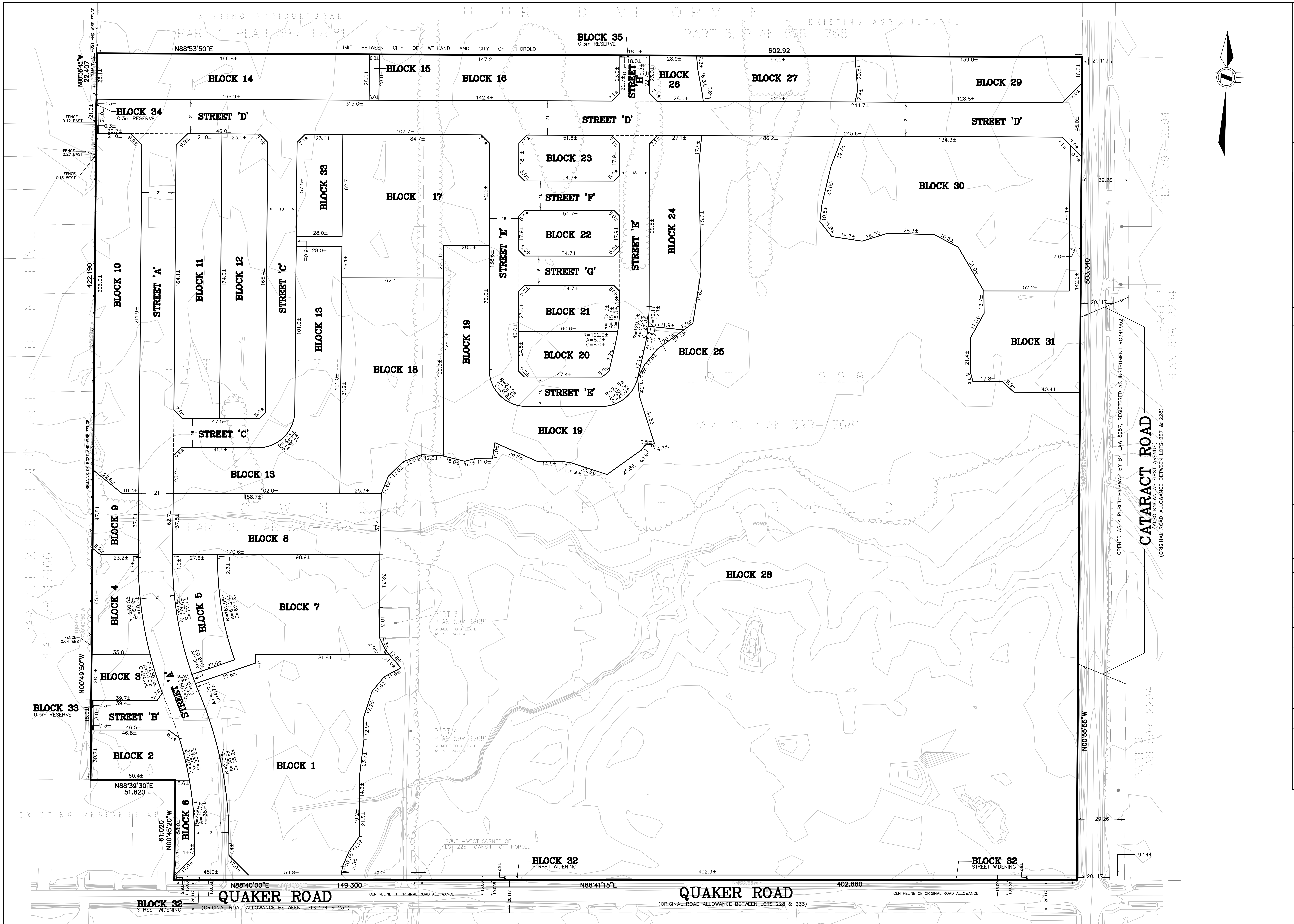
Tow Path Drain SG-104 Water Elevation and Precipitation August 10 to November 20, 2023




SG-104 and SW-2 Water Elevation and Precipitation August 10 to November 20, 2023
Water Level (mASL)
184.8
184.3
183.8
183.3
182.8
182.3
181.8
181.3
180.8
Precipitation (mm/Day)
0
10
20
30
40
50
60
70
80
90
100
Logger time error, gap of Oct 21-25, 2023
Precipitation
SG-104
SG-104 Ground
SW-2
SW-2 Ground
2023-08-10
2023-08-15
2023-08-21
2023-08-26
2023-08-31
2023-09-05
2023-09-10
2023-09-16
2023-09-21
2023-09-26
2023-10-01
2023-10-07
2023-10-12
2023-10-17
2023-10-22
2023-10-27
2023-11-02
2023-11-07
2023-11-12
2023-11-17
Date

Appendix G

Supporting Information



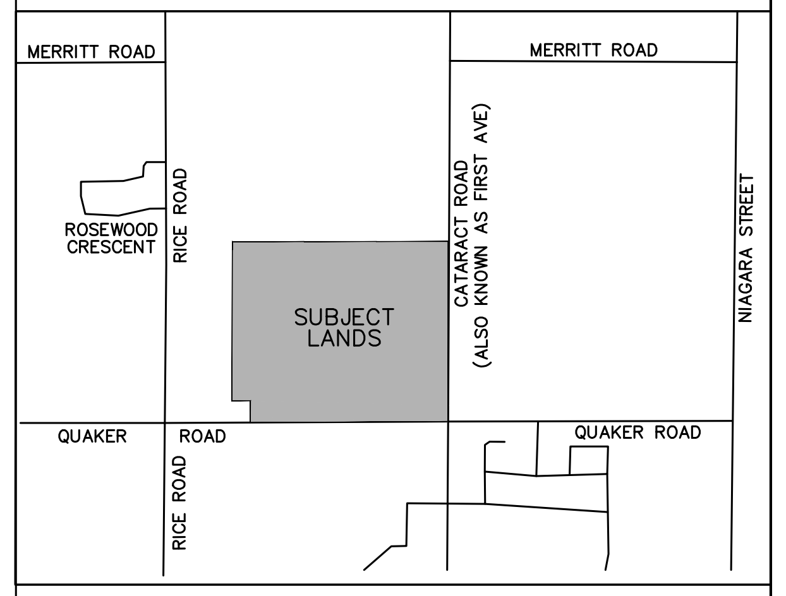
DRAFT PLAN OF SUBDIVISION

PRIMONT (THOROLD / WELLAND) INC.

PART OF TOWNSHIP LOTS 174 AND 228,
GEOGRAPHIC TOWNSHIP OF THOROLD,
IN THE CITY OF WELLAND, REGIONAL
MUNICIPALITY OF NIAGARA

SCALE 1:1000 METRIC

20 10 0 20 40 60 metres



KEY MAP - NOT TO SCALE

INFORMATION REQUIRED

UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O. 1990. c.P.13
AS AMENDED FEBRUARY 21, 2024

(a) - AS SHOWN
(b) - AS SHOWN
(c) - AS SHOWN
(d) - AS LISTED BELOW
(e) - AS SHOWN
(f) - AS SHOWN
(g) - AS SHOWN
(h) - MUNICIPAL WATER
(i) - CLAY LOAM
(j) - AS SHOWN
(k) - MUNICIPAL SANITARY AND STORM SEWERS
(l) - AS SHOWN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

SIGNED ______________________

ROB A. McLAREN, O.L.S
A.T.McLAREN LIMITED

DATE ____________

OWNER'S CERTIFICATE

I HEREBY CONSENT TO THE FILING OF THIS PLAN

SIGNED ______________________

DATE ____________

LAND USE SCHEDULE

LAND USE	LOTS/BLOCKS	UNITS	AREA
LOW DENSITY RESIDENTIAL (FREEHOLD)	BLOCKS 2-5, 10-14, 16, 19, 20-24, 26, 29, & 33	245-275±	6.127± Ha.
LOW DENSITY RESIDENTIAL (CONDOMINIUM)	BLOCK 1	44±	1.167± Ha.
MEDIUM DENSITY RESIDENTIAL	BLOCK 30	422±	1.109± Ha.
PARK LAND	BLOCK 17		0.749± Ha.
OPEN SPACE	BLOCKS 6, 15, 25		0.101± Ha.
STORM WATER MANAGEMENT	BLOCKS 7, 18, & 31		1.808± Ha.
ENVIRONMENTAL AREA	BLOCKS 27 & 28		14.547± Ha.
CHANNEL	BLOCKS 8 & 9		0.592± Ha.
ROADS, RESERVES & WIDENINGS	STREETS A, B, C, D, E, F, G, & H AND BLOCKS 32, 33, 34 & 35		3.937± Ha.
TOTAL		711-741±	30.118± Ha.

METRIC NOTE:

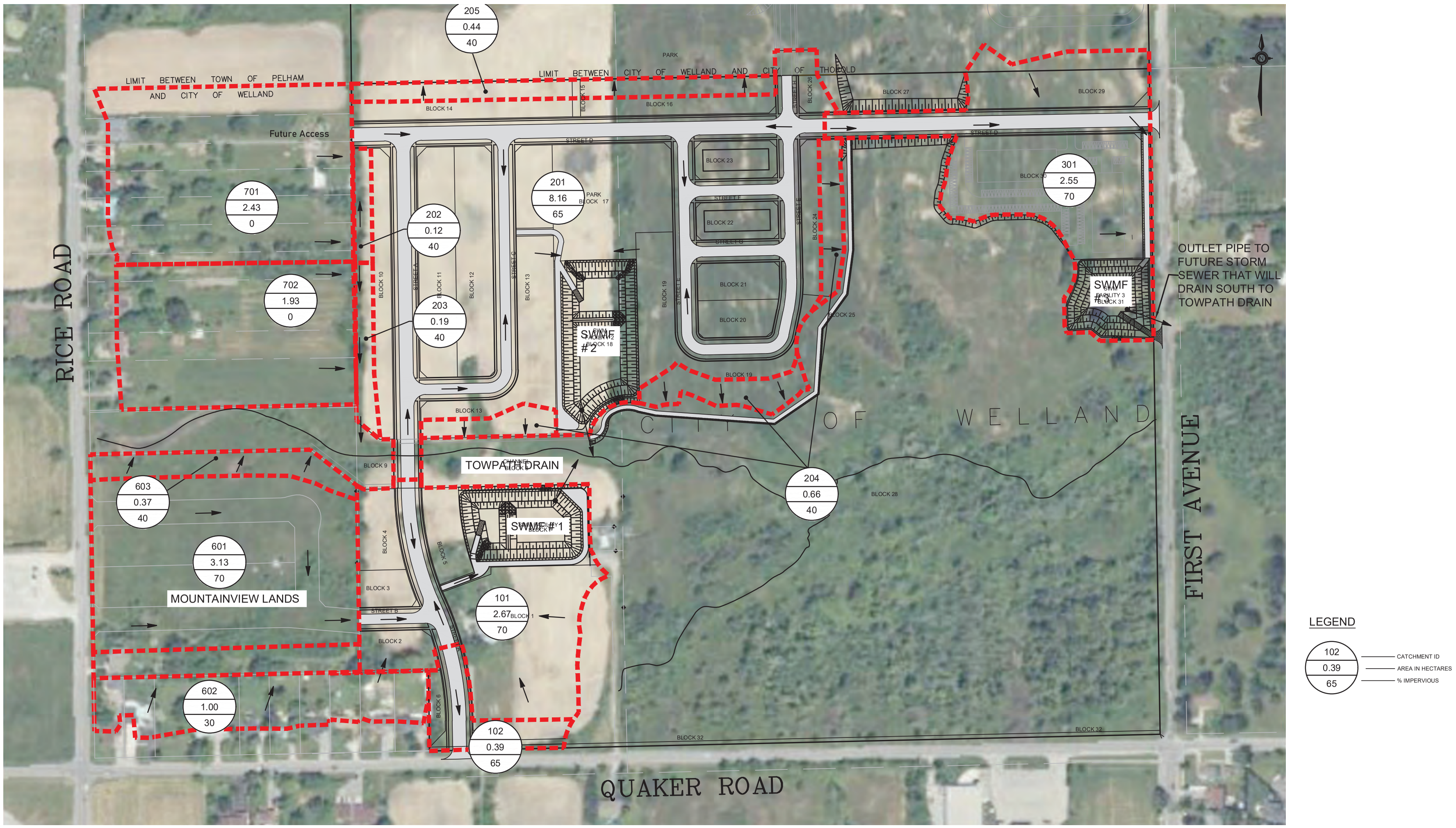
DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

No.	DESCRIPTION	DATE	BY
2	UPDATED STORMWATER BLOCKS	JUNE 13, 2024	KM
1	ORIGINAL DRAWING	MARCH 15,2024	KM

REVISIONS

A.T. McLaren Limited
LEGAL AND ENGINEERING SURVEYS
69 JOHN STREET SOUTH, SUITE 230
HAMILTON, ONTARIO, L8N 2B9
PHONE (905) 527-8559 FAX (905) 527-0032

Drawn	Checked	Crew Chief	Scale	
KM	RBM	SM	1:1000	Dwg.No. 36920-DP



PROJECT:
436 QUAKER ROAD
WELLAND

TITLE:
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN
WELLAND

REPRODUCTION OR DISTRIBUTION FOR PURPOSES OTHER THAN AUTHORIZED BY WALTERFEDY IS FORBIDDEN. CONTRACTORS SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS AND CONDITIONS ON THE JOB AND REPORT ANY VARIATIONS FROM THE DIMENSIONS AND CONDITIONS SHOWN ON DRAWINGS TO WALTERFEDY. DO NOT SCALE THIS DRAWING.

WALTERFEDY
HAMILTON OFFICE
20 Hughson Street South, Suite 1000, Hamilton, Ontario, L8N 2A1
T: 289.799.3547 **Toll Free:** 800.685.1378 **walterfedy.com**

SCALE:	N.T.S	DATE:	2024-04-05
DRAWN BY:	ES	PROJECT NO.:	2022-0091-10
CHECKED BY:	JO	FILE:	2022-0091-10 SDAP
SHEET NO.:			

FIG 7.2

P:\2022\0091\10\05-DSGN\CIVL\Storm\SDAP\2022-0091-10 SDAP; Layout1; None; Eric Salembier; 2024-04-05 12:01:02 PM

APPENDIX H

Drawings