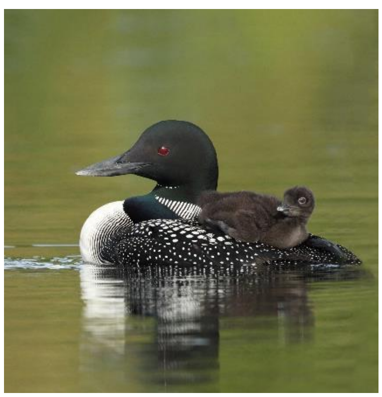
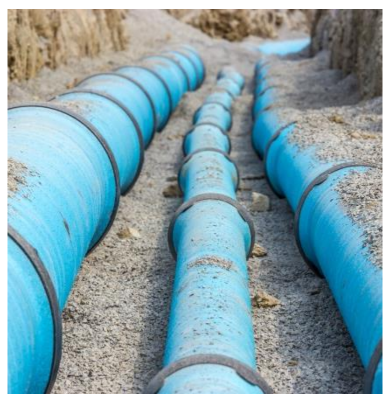
PRELIMINARY STORMWATER MANAGEMENT PLAN AND PRIVATE SEWAGE SYSTEM ASSESSMENT

Bray Lake Subdivision

August 2022 Project # 211851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A limited number of visits to the Site were completed along with an existing condition topographic survey; and as such, the information collected and presented herein applies to the time of the visits only.

This Report contains design opinions, conclusions and recommendations made by TULLOCH using professional judgment and reasonable care for the purpose of stormwater management and site servicing design.

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This report has been prepared with the degree of care, skill and diligence normally provided by engineers in the performance of comparable services for projects of similar nature. The scope of this report includes engineering design of site servicing and stormwater management to support approval of the development by the Municipality and governing authorities.

REVISION LOG

2022/08/31	0	Issued for Approval	B. Belfry	T. Maurer	C. Stilwell
Date (Y/M/D)	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
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REPORT PREPARATION & REVIEW

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1. INTRODUCTION

1.1 General

Bray Lake Subdivision is proposing to develop a 20-lot subdivision along the west shore of Bray Lake. The total site development area is approximately 150 hectares. The lots will front the west bay of Bray Lake and the east limit of Riding Ranch Road. Six (6) of the lots could be accessed via private entrances from Riding Ranch Road and the other fourteen (14) lots via one (1) new 15 m wide private right-of-way from Riding Ranch Road that branches into three (3) new 15 m wide private rights-of-ways.

The site lies approximately 16 km west of the Town of South River, in Geographic Township of Machar, District of Parry Sound. The site is bounded by Bray Lake and vacant land to the northeast, existing vacant land to the northwest, Riding Ranch Road, and vacant land to the southwest and southeast.

TULLOCH Engineering Inc. has been retained by the property owner, to prepare a Preliminary Stormwater Management and Construction Mitigation Plan in support of an anticipated application for draft plan approval. The application for draft plan of subdivision approval will be submitted under separate cover by others. TULLOCH Engineering Inc. has not been retained by the property owner for the design for roads. Private access roadway design is not in the scope and is designed by others.

1.2 Purpose and Scope

The main purpose of this report is to outline a preferred stormwater management and construction mitigation strategy for the proposed subdivision to be implemented as the site is developed. However, preliminary assessments for private sewage system suitability and soils conditions have been included in support of the draft plan of subdivision as incorporated in SWM report Appendix E.

The recommendations and construction details outlined in this report can be used as a reference for the municipality as they review individual development plans for the 20 lots.

The following objectives have been identified in the preparation of this report:

- Assess impact on surface water quantity and quality as a result of the development and review potential impact on receiving water bodies.
- Determine if reduction of peak runoff flows through structural controls are required to control potential flooding downstream from the development.
- If required, identify suitable structural methods to reduce peak runoff flows and volumes from the site and incorporate these methods into the final engineering design drawings.
- Identify methods to control sedimentation and erosion during construction and in the long term.

- Identify required drainage systems to be implemented during construction to safely convey runoff to Bray Lake.

1.3 Reference Reports

The following Provincial guidelines and stormwater management practices have been used for reference in the preparation of this Preliminary Stormwater Management Plan:

i) Stormwater Management Planning and Design Manual, March 2003 - Ministry of the Environment. Conservation and Parks.

ii) Ministry of Transportation Highway Drainage Design Standards, January 2008.

iii) Ministry of Transportation Drainage Management Manual, 1997.

iv) CVC, LSRCA, and TRCA partnered Sustainable Technologies Evaluation Program, Low Impact Development Stormwater Management Planning and Design Manual, March 2022.

v) Ministry of Northern Development, Mines, Natural Resources and Forestry Buffer Zone Guidelines, 1987.

vi) Guidelines on Erosion and Sediment Control for Urban Drainage, RTAC, MTO, 1992.

vii) Bray Lake Subdivision Draft Plan of Subdivision, KPK Surveying Inc., July 22, 2022.

2. EXISTING SITE CONDITIONS

2.1 Topography / Drainage

The topography of the site is hilly, with site elevations ranging between 404.5 m ASL in the central east portion of the site and 349.2 m ASL (Maximum) at the water's edge. The Maximum High-Water Mark is in accordance with the Ontario Power Generation, *OPG*, water management plan upper limit. The OPG Bray Lake water elevation observations and water management plan limits are shown in Appendix D. The field measured High-Water Mark is to be verified with final approval.

The site is heavily vegetated predominantly by deciduous forest in the highland areas, with areas of mixed forested growth on slopes and coniferous forest around the lower elevations and adjacent to wetlands.

The site has four elevation peaks that result in surface runoff on the property draining in all geographic directions with land slopes averaging 1.4%-15%. Ultimately, all surface runoff from the site is routed east, to Bray Lake via naturally occurring intermittent watercourses.

There is an existing well-defined intermittent watercourse within proposed Lot 5 and 6 in a southwest to east direction. This watercourse has been labelled *Watercourse 'A'*. A small wetland, labelled as *Wetland 'A',* exists within proposed Lot 6. Wetland 'A' drains south to north through Watercourse 'A' to *Wetland 'B'.* Wetland 'B' drains west to east via Watercourse 'A' to flooded lands of Bray Lake. These flooded lands are located northeast of the proposed subject lands and are the most northwest limit of Bray Lake.

There is an intermittent watercourse, labelled as *Watercourse 'B',* draining part of proposed Lots 3, 4, 5, 9, 10, and 11 west to east towards Bray Lake. A small wetland, labelled as *Wetland 'E'* exists within proposed Lots 3 and 4. Wetland 'E' drains to Watercourse 'B' and discharges to Bray Lake.

There is an intermittent watercourse, labelled as *Watercourse 'C'*, draining part of proposed Lots 1, 2, 3, and 4 west to east towards abutting vacant land. A small wetland, labelled as *Wetland 'F'* exists within proposed Lot 2. Wetland 'F' drains to Watercourse 'C'. Runoff beyond the east property boundary will travel approximately 140 m down gradient, east, before reaching Bray Lake.

There is an intermittent watercourse just beyond the south subject property boundary labelled as *Watercourse 'D'*. Watercourse 'D' collects runoff from parts of proposed lots 1, 2, 3, and 4. A small wetland, labelled *Wetland 'G'*, drains north to south into another small wetland, labelled as *Wetland 'H'*. Wetland 'H' is considered part of Watercourse 'D' and drains west to east along Watercourse 'D' to a small wetland, labelled as *Wetland 'I'*. Wetland 'I' drains west to east across the south and east subject property boundaries. Runoff beyond the south and east property boundaries will travel approximately 450 m west to east through vacant land, down gradient along Watercourse 'D', prior to reaching Bray Lake.

There is a small wetland within proposed Lot 6, labelled as *Wetland 'D'*. Wetland 'D' has no defined watercourse draining the wetland. However, contours indicate that Wetland 'D' drains northwest to southeast to flooded lands of Bray Lake. These flooded lands are located northeast of the proposed subject lands and are the most northwest limit of Bray Lake.

Various other small wetlands exist throughout the subject lands. These small wetlands were considered in the hydrologic evaluation, however, were not labelled. These small wetlands exist within proposed Lots 2, 3, 4, 13, 14, 16, and 17.

Site topography and the location of noted watercourses and wetlands as identified above are illustrated on drawing SWM-1, found in Appendix B.

2.2 Site Geology

Based on a review of available soils mapping taken from the Ministry of Northern Development, Mines, Natural Resources and Forestry Surficial Geology of Southern Ontario Data mapping for the Bray Lake Area; the site location is identified as follows:

- The north, west, and east portion of the subject property is Type 2a, bedrock drift complex in Precambrian terrain, primarily till cover.
- The central portion of the subject property is Type 5a, silty sand to sand-textured till on Precambrian terrain.

- The southwest portion of the subject property is Type 9, coarse-textured glaciolacustrine deposits consisting of sand, gravel, minor silt and clay.

The hydrologic soil group, *HSG,* for the site was determined to be class B for all surficial geology types within the site. The HSG was determined using design chart 1.08 in the Ministry of Transportation, *MTO,* Drainage Management Manual Part 4, 1997. Design chart 1.08 classifies a B soil as shallow overlying sand, gravel, and loam. The Ministry of Agriculture, Foods, and Rural Affairs, *OMAFRA,* online interactive AgMaps was utilized to confirm a HSG of B. A copy of the surficial geology map soil information, OMAFRA AgMap, and Geotechnical Investigation Plan G-01 has been included in Appendix D of the report.

Invasive soil investigations were also carried out at the site to verify soils conditions and general depth of overburden. Soils conditions identified within the three test pits advanced were, sandy topsoil at ground surface for approximately 0.25 m depth. A well graded brown sand to silty sand with some gravel was observed below the topsoil. Cobble and boulders were observed in test pits. Shallow bedrock was encountered in the three test pits from 0.9 m to 1.2 m below ground surface. Soils were noted to be saturated. However, significant recharge of groundwater in the test pits was not observed; representing the absence of groundwater table. A visual inspection of the site verified shallow well-draining sand with some gravel over bedrock as the predominant condition. A hydrogeological assessment was completed for the site by others. However, a hydrogeological assessment is not part of this report.

For the purposes of the rational method peak runoff rate calculations to follow, an open sand loam was selected when determining rural land use runoff coefficients in design chart 1.07 of the MTO Drainage Management Manual, 1997and weighted runoff coefficients, *C*, were calculated for the site development. Pre-development and post-development runoff coefficients were also weighed to consider the presence of woodlot, wetland, gravel roads, asphalt road, buildings, lawns, building envelopes, and septic filter bed envelopes. Tulloch soils investigation memo has been included in Appendix D.

2.3 Fish Habitat

Shoreline areas throughout the site and at the outfall of Watercourse ‘A’ and ‘B’ have been identified as Type 1, or sensitive spawning habitat. Fish habitat delineations were determined by Riverstone Environmental, as shown on the Draft Plan, appended.

Notwithstanding the identification of fish habitat in this area as “Type 1”, it has generally good engineering practice to treat lakes and rivers as a sensitive receiving water body when selecting the appropriate quality control criteria for new development. Accordingly, an “Enhanced” level of protection is appropriate, and the quality control techniques selected as part of the overall SWM plan should reflect this.

3. HYDROLOGY

3.1 Rational Method Calculations

The Rational Method was used to estimate the peak runoff rates for the 5, 25, and 100-year return period storm events, as presented in Table 3 and 4 below. Rational Method calculations are appended with pre-development and post-development drainage areas demonstrated on Drawings No. D1 and D2 included in Appendix B.

3.2 Design Storms

As per section 3.5.1 recommendations of The Ministry of Environment, Conservation, and Parks, *MECP,* Stormwater Management Planning and Design Manual, 2003, post-development flows shall be attenuated to pre-development rates for storm events up to and including the 100-year storm event. In best practice, the 100-year flood is to be safely conveyed offsite with non-erosive properties. The online MTO Ontario IDF Lookup Tool was used to obtain rainfall data for all storm events up to and including the 100-year in proximity to the site.

The following design storms were selected as part of the evaluation:

- 5-year design storm
- 25-year design storm
- 100-year design storm

The selected stormwater management criteria are discussed further in Section 5.2 of this report.

3.3 Drainage Catchments

Six catchments have been delineated to calculate pre-development and post-development run-off rates leaving the site. The catchments generally represent their individual downstream outlets. The north portion of the property flows north toward Watercourse ‘A’. The northeast portion of the property drains south and east to Bray Lake and north to abutting vacant land. Runoff across the north abutting vacant land drains down gradient approximately 120 m before reaching the flooded lands of Bray Lake. The three catchments throughout the central and east portion of the subject property flow east to Bray Lake either directly or via Watercourse ‘B’ or ‘C’. The south portion of the property flows south to the abutting vacant land consisting of Watercourse ‘D’, ultimately draining east to vacant land and Bray Lake.

The main impact of the proposed development on local surface drainage patterns will be the introduction of impervious and near impervious areas (house roofs, driveways and gravel roadways generally) to an otherwise undisturbed site.

Catchment parameters are listed in Table 1 and 2. The catchment locations are identified on Drawing Sheets D1 and D2.

The hydrologic model parameters for the post-development condition have been selected to represent the maximum allowable development scope. The watershed characteristics such as slope, HSG, and runoff coefficients have been selected to provide a conservative estimate of peak runoff rates. The watershed characteristics utilized are found in the appended rational method design sheets. The entirety of all building envelope areas was modelled with a rural residential C value to account for maximum development within each lot. The maximum runoff coefficient of 0.6 from the MTO published range, 0.4-0.6, for proposed gravel roads and shoulders was used. Septic filter bed areas were considered an average to flat sloped lawn in sandy soils. All woodlot was modelled to be hilly in an open sand loam.

Table 1: Pre-Development Catchment Parameters

Pre-Development	Catchment Area (ha)	Runoff Coefficient (C)
101	55.18	0.18
102	11.85	0.17
103	26.94	0.18
104	28.92	0.16
105	15.48	0.18
106	23.11	0.17

Table 2: Post-Development Catchment Parameters

Post-development	Catchment Area (ha)	Runoff Coefficient (C)
201	55.18	0.18
202	11.85	0.17
203	26.79	0.20
204	29.16	0.17
205	15.40	0.20
206	23.12	0.17

4. PROPOSED DEVELOPMENT

4.1 General

The subject land lot configuration consists of six (6) larger back lots and fourteen (14) smaller waterfront lots. Smaller waterfront lot areas range between approximately 1.0 ha and 1.9 ha. The larger lot areas range between approximately 12 ha and 47 ha.

It is estimated that less than 10% of the overall area will be disturbed to facilitate the construction of hard surface areas such as building envelopes, driveways, and access roads and private sewage systems. All septic envelopes are subject to final approval with building permits and will require additional evaluation during the development of each individual lot.

It is expected that the proposed residential building envelopes will be constructed to fit into the natural topography of the land, and that minimal lot grading and tree removal will be required, except as part of the building envelope, septic envelope, and driveway areas. The hydrologic model for post-development conditions is based on rural residential building envelopes between 0.4 ha and 1.0 ha for the smaller waterfront lots, and 0.4 ha for the larger back lots. Although alternative filter bed locations are presented in Drawing SWM-1, a maximum of one private sewage filter bed per lot was considered in the post-development hydrologic analysis.

The proposed development layout and existing topography are identified on Drawing SWM-1 as appended.

4.2 Design Run-Off Peak Flow Rates

The results of the Rational Method peak runoff flow rate calculations for the pre and post-development conditions are presented in Table 3 and 4 below. Rational Method calculations are presented in Appendix A with pre and post-development drainage areas shown on Drawings No. D1 and D2 in Appendix B.

Table 3: Pre-Development Peak Flow Rate Over Property Boundaries (m^3/s)

Drainage Area	Catchment Area (ha)	Return Period Storm (Years)	Pre-Development Flows
101	55.18	5 25 100	0.55 m^3/s 0.87 m^3/s 1.21 m^3/s
102	11.85	5 25 100	0.34 m^3/s 0.52 m^3/s 0.71 m^3/s
103	26.94	5 25 100	0.77 m^3/s 1.23 m^3/s 1.71 m^3/s
104	28.92	5 25 100	0.36 m^3/s 0.54 m^3/s 0.75 m^3/s

105	15.48	5 25 100	0.31 m^3/s 0.46 m^3/s 0.67 m^3/s
106	23.11	5 25 100	0.36 m^3/s 0.58 m^3/s 0.80 m^3/s

Table 4: Post-Development Peak Flow Rate Over Property Boundaries (m^3/s)

Drainage Area	Catchment Area (ha)	Return Period Storm (Years)	Post-Development Flows	Diff. Pre/Post Flows	% Increase
201	55.18	5 25 100	0.55 m^3/s 0.88 m^3/s 1.22 m^3/s	0.00 m^3/s 0.01 m^3/s 0.01 m^3/s	0.00 % 1.15 % 0.83 %
202	11.85	5 25 100	0.34 m^3/s 0.52 m^3/s 0.71 m^3/s	0.00 m^3/s 0.00 m^3/s 0.00 m^3/s	0.00 % 0.00 % 0.00 %
203	26.79	5 25 100	0.86 m^3/s 1.30 m^3/s 1.90 m^3/s	0.09 m^3/s 0.07 m^3/s 0.19 m^3/s	16.88 % 11.38 % 11.11 %
204	29.16	5 25 100	0.38 m^3/s 0.58 m^3/s 0.80 m^3/s	0.02 m^3/s 0.04 m^3/s 0.05 m^3/s	5.55 % 7.41 % 6.67 %
205	15.37	5 25 100	0.34 m^3/s 0.54 m^3/s 0.74 m^3/s	0.03 m^3/s 0.08 m^3/s 0.07 m^3/s	9.68 % 17.39 % 10.45 %
206	23.11	5 25 100	0.37 m^3/s 0.59 m^3/s 0.81 m^3/s	0.01 m^3/s 0.01 m^3/s 0.01 m^3/s	2.78 % 1.72 % 1.25 %

Catchments 202 shows a 0.0% change in peak runoff from pre to post-development conditions. No changes are expected for Catchment 202, with land use remaining unchanged between pre and post-development.

Peak runoff rates from Catchments 201, 204 and 206 increase ≤ 10% from pre to post-development conditions. Catchments 201, 204, and 206 peak runoff rates increase by 0.0% -

1.15%, 5.55% - 7.41%, and 1.25% - 2.78% respectively from pre to post-development. Catchment 201 contains the largest catchment area. Catchment 201 encompasses part of Lots 5 and 6, part of the access road, and external lands to the southwest containing Riding Ranch Road. Catchment 201 conveys runoff along the Riding Ranch Road, however, ultimately discharges to Bray Lake via Watercourse ‘A’. The alteration of land use within catchment 201 is minimal compared to the catchment size. Catchment 204 conveys part of the catchment runoff along Riding Ranch Road, however, ultimately discharges to Bray Lake via Watercourse ‘B’. Catchment 206 drains the upper limit of the catchment along Riding Ranch Road. Ultimately discharging runoff to vacant lands beyond the northeast and southeast property boundaries via Watercourse ‘D’. Although catchment 201, 204, and 206 convey runoff along Riding Ranch Road, the public right-of-way is located in the upper most limit of all three catchments. Aside from access roadway intersection and private entrances, no post-development alteration is anticipated to increase peak runoff within the right-of-way corridor. Peak runoff rate increases of ≤ 10.0% from pre to post-development can be considered negligible. No flooding of adjacent Bray Lake, Watercourse ‘D’, and abutting northeast and southeast vacant lands under post-development conditions is anticipated.

Catchment 203 and 205 increase by 11.11% - 16.88% and 9.68% - 17.39% respectively from pre to post-development. Catchment 203 discharges to Bray Lake and flooded lands of Bray Lake between Watercourse ‘A’ and ‘B’. Catchment 203 shows a increase in peak runoff rates due to approximately 22% of the catchment being developed. Catchment 205 discharges to Bray Lake and adjacent northeast vacant lands via Watercourse ‘C’. The greatest increase from pre to post-development runoff in Catchment 203 is approximately 0.19 m^3/s. The greatest increase from pre to post-development runoff in Catchment 205 is approximately 0.07 m^3/s. Almost all the altered land in Catchment 205 will drain directly to Bray Lake from Lots 7, 8, and part of 9. The remainder of Catchment 205 will likely remain unchanged as drainage continues to Watercourse ‘C’. Watercourse ‘C’ drains across northeast abutting vacant land, before reaching Bray Lake. It is not anticipated that the increase in peak runoff within Catchment 203 or 205 will flood adjacent lands or increase the Bray Lake water level significantly.

The total development site results in peak runoff rate increases of 5.7%, 4.7%, and 5.7% for the 5, 25, and 100- year storm events respectively. A total increase of <10% can be considered negligible. It is not anticipated that peak flow rate increases will impact the Bray Lake water level significantly or cause flooding on adjacent lands. All storm water runoff ultimately discharges to Bray Lake from the subject land boundaries within a maximum runoff route distance of 450m.

5. Preliminary Stormwater Management Plan

5.1 Objectives

The intent of Stormwater Management is to reduce the risk of impact from stormwater runoff on neighboring properties caused by the change in land use conditions. These specifically include the risk of damage to property due to erosion, flooding and the possibility of impairing surface water quality as a result of construction, or by creating a more impervious watershed.

5.2 Design Criteria

The design criteria considered for the site has been derived from the following resources:

- Buffer Zone Guidelines, MNDMNRF, 1987.
- Stormwater Management Planning and Design Manual, MECP, March 2003.
- Guidelines on Erosion and Sediment Control for Urban Drainage, RTAC, MTO., 1992.
- Highway Drainage Design Standards, MTO, January 2008.
- Drainage Management Manual, MTO, 1997.
- CVC, LSRCA, and TRCA partnered Sustainable Technologies Evaluation Program, Low Impact Development Stormwater Management Planning and Design Manual, March 2022.

A. Quantity Controls

- Minor system entrance culvert designs to accommodate 5-year return interval storm.
- Rural road cross-culverts to accommodate 25-year return interval storm.
- Major system ditch and easement swale design to accommodate all runoff with consideration of flooding.
- Attenuation of post-development peak flows to pre-development levels for all storm events including the 100-year return storm where warranted.
- Evaluation of peak run-off rates for post-development flows compared to pre-development flows for the 2 to 100-year return period storm events using Ontario IDF Curve Lookup for rainfall data.
- Roadside ditches designed to convey the 100-year major storm event.
- Scour protection for up to the 100-year storm event runoff velocities.

B. Quality Controls

- The Buffer Zone guidelines, MNDMNRF, 1987 requires rural developments such as this to provide 30m natural buffer for quality concerns.
- 23 m building setback from shoreline and 15 m vegetated natural shoreline buffer determined by Riverstone Environmental, as shown on the Draft Plan, 2022.
- Minimum stormwater quality measures are to be in accordance with the MECP SWM Planning and Design Manual, 2003. Permanent system design should address control parameters as outlined in Table 3.2, Water Quality Storage Requirements based on Receiving Waters. The ultimate receiving outlet of site drainage is Bray Lake, at least 30 m down gradient of proposed altered land. Accordingly, the receiving watercourse should be considered "sensitive”, and an enhanced level of quality control, 80% long-term suspended solids removal, should be applied.
- A quality control solution should be designed considering both construction mitigation measures and permanent system design.

5.3 Roadworks and Ditching

Private roadway access will be provided via one (1) new proposed 15 m wide private right-of-way from Riding Ranch Road that branches into three (3) new 15 m wide private rights-of-way. The private roadways are proposed with a 6.0 m minimum travelled width with 1.0 m shoulders. The road will be surfaced with gravel, although it is recommended that in areas where gradients exceed 5.0%, a double high float surface treatment or asphalt be placed to prevent erosion. A typical cross section is shown on Drawing Sheet SWM-2.

Conveyance structures including culverts and drainage ditches will need to be provided to intercept overland flow along the private access roads and direct drainage to existing watercourses. The private road surfaces will be constructed with a crown to direct drainage to sideline ditches.

In order to size the culverts and ditches along the access roads, the largest contributing drainage area (internal and external) was delineated using available contour mapping. The drainage areas are illustrated on Drawing D2. Post-development 200-series catchment peak flow rates were used in culvert and ditch sizing. 100-year design flows were used to size the roadside ditches. 25-year design flows were used to size cross culverts beneath the private roadways. 5-year design flows were considered for entrance culvert capacity.

Where grades are 5% or less, the ditch surface should be stabilized with a vegetation cover. Where grades exceed 5%, ditches will require a rip-rap lining consisting of 150 mm diameter stone with geotextile beneath. The rip-rap should extend a minimum 300 mm above the ditch invert along the side slope. Typical details for the erosion and sediment control measures required at the outfall of the roadside ditches to existing watercourses are included on Drawing SWM-1 and SWM-2 included in Appendix B.

Grading of the individual lots should not block existing overland flow paths to Bray Lake. 600 mm and 450 mm diameter cross culverts have been sized to convey runoff collected by the access road ditches. The proposed 600 mm diameter cross culvert at the intersections of the proposed private access roadway and Riding Ranch Road is to be installed with a minimum gradient of 2.0%. The remaining proposed 600 mm and 450 mm diameter cross culverts within the access roadways are to be installed with a minimum gradient of 4.0%. Entrance culverts to Lots 7, 16, and 19 are to be 450 mm diameter with minimum gradient of 0.5%. Entrance culverts within Catchments 201 and 203 are to have minimum gradients of 3.5% and 4.0% respectively. Entrance culverts within Catchments 204, 205, and 206 are to have minimum gradients of 2.0%.

A Preliminary Culvert Design Sheet of all crossing and entrance culverts is provided in Appendix C.

5.4 Vegetative Buffers

The shoreline along Bray Lake is characterized by sensitive shoreline, with mixed forest backlot. As a condition of development, the integrity of the shoreline vegetation units should be required to be maintained. According to the Ministry of Environment Storm Water Management Planning and Design Manual, 2003, wetland type vegetation enhances water quality by filtering stormwater and binding soils to prevent erosion.

The designation of a thirty (30) m natural "buffer zone" between the moose aquatic feeding area, wetlands, and watercourses and proposed disturbed areas is recommended. The designation of a fifteen (15) m natural vegetated buffer and twenty-three (23) m building setback from shoreline is also recommended. Setbacks from aquatic features and shoreline were determined by Riverstone Environmental as shown on the Draft Plan. The establishment of a designated buffer zone would not preclude allowing minor incursion for the establishment of water access and construction of docks. The proponents of individual building permit applications should be required to delineate the extent of vegetation removal proposed, and any remedial measures required, as part of the application.

5.5 Stormwater Quantity

As outlined in section 3.5.1 the MECP Stormwater Management Practices Planning and Design Manual, 2003, limiting post-development peak runoff flow rates to pre-development rates is generally accepted criteria where stormwater runoff may adversely affect adjacent property's. However, since the proposed development discharges runoff to Bray Lake it is not anticipated that the runoff flow rate increases assessed for this development will have any significant or measurable impact on the subject property's Internal wetlands or the corresponding Bray Lake water level that may otherwise cause flooding to adjacent property's.

Under post-development conditions drainage patterns within Catchments 203, and part of 202 and 205, will continue to sheet drain to the Bray Lake shoreline as in pre-development conditions. Part of post-development catchments 202 and 205 will sheet drain to the abutting north and east vacant land properties, respectively. Post-development Catchment 201, 204, 206, and part of 205 will continue to channel flow to the Bray Lake Shoreline as in pre-development conditions. Under post-development conditions the drainage patterns will be partially altered in Catchments 201, 203, 204, and 205 with the introduction of roadway ditches. However, the overall topography within the drainage area and drainage outlet will remain unchanged to that of pre-development. It is also expected that the existing drainage course crossings proposed at Lots 4 and 10 will remain unaltered under post-development conditions.

In reviewing the potential for flooding on the proposed lots, it has been resolved that internal flooding should not be a concern. Proposed building envelopes as demonstrated on Drawing SWM 1 having frontage on Bray Lake will have a natural land slope to the shoreline varying in relief from 1.5 m to 10.9 m of elevation above the noted high-water elevation. Building envelopes of the larger Lots 1-6 were assumed to be 0.4 ha and having more than 1.5m of relief above the wetland water levels.

Runoff from the house roof drains are to outlet to grade at the building corners with drainage directed away from the building.

All driveways will require pipe culverts within the ditch line, with a minimum diameter of 450 mm, as per Tulloch's culvert sizing review included in Appendix C.

Based on peak runoff flow calculations for development of the proposed subdivision, increases in runoff rates will be experienced in all cases. However, it is not expected that the runoff rate increases will cause flooding or adversely impact adjacent lands, watercourses or the receiving water body with proper attention given to erosion protection. Attenuation of post-development peak flows to pre-development levels have been considered unwarranted for the proposed development for the following reasons:

- Provided the maximum building coverage allowed by the residential zoning, the low density of the proposed development results in marginal runoff flow increases in all storm event cases. The runoff increase can be considered marginal given that flooding of adjacent residential properties within the affected Bray Lake drainage catchments is not anticipated. The storage capacity of Bray Lake and the Bray Lake OPG outlet control dam will result in insignificant downstream runoff increase. Natural attenuation of runoff within the site, such as through wetlands, has not been modelled. Coupling the Bray Lake storage capacity, outlet dam control, and on-site natural attenuation, downstream post-development peak runoff rates are expected to be less than has been modelled with this review.
- Due in part to the considerable change in topographic relief above lake level along the Bray Lake shoreline that provides well defined watercourses routing the overland flows to the lake. This, coupled with the natural attenuation expected to occur within the localized perched wetland areas that have not been modelled with this peak flow review.
- The proposed lot configuration is such that drainage from the building envelopes demonstrated on each lot will maintain existing drainage patterns introducing lot line drainage swales where necessary to direct runoff away from adjacent lot's building envelope and towards the proposed 15 m vegetated natural shoreline buffer or 30 m vegetated buffer from wetlands and watercourses.
- Naturally occurring site vegetation and localized surface depressions or undulations in the terrain will provide partial conveyance control of peak run-off flows in addition to filtering runoff before it reaches the local watercourse and/or lake shoreline. These naturally occurring conveyance controls are not reflected in the peak flow rate calculations that will act to further reduce flow rates.
- Through the introduction of roadside ditch outlets that will safely convey surface runoff from the proposed private roadway rights-of-way to the site's natural drainage courses. It is proposed to provide the necessary erosion protection within the ditches using rip-rap lining where grades are greater than 5% and rock flow check dams that will slow run-off and help to maintain existing flow patterns.

- Infiltration of surface water should be encouraged within the proposed development through the use of pervious landscaping within the building envelope and by leaving as much as possible of the existing lands undisturbed.

The proposed storm water management plan for this development therefore includes the following components:

- Maintaining existing natural drainage paths.
- Placement of proposed development building envelopes outside of the natural drainage paths.
- The installation of appropriate drainage ditching and conveyance structures (culverts) in the development areas to safely convey drainage through the site to the lake.
- Protecting the roadway surface from erosion where surface slopes exceed 5%.
- Maintaining existing vegetated buffers between the proposed development area and the water body.
- Ensure the protection of existing watercourses through the implementation of proper erosion and sediment control techniques at the roadway culverts and ditch outfalls.
- Protection against erosion as a result of site development.
- Installation of appropriate construction mitigation measures to protect against erosion and sediment migration during the construction period.

5.6 Stormwater Quality

Shoreline areas throughout the site and at the outfall of Watercourse ‘A’ and ‘B’ have been identified as Type 1, or sensitive spawning habitat.

Existing Watercourse ‘A’ crossing the proposed Lots 5 and 6 is seasonally intermittent and has not been identified as being sensitive in nature, such as being a creek with base flow.

The Ministry of Natural Resources and Forestry have <u>not</u> identified the existing wetlands ‘A’ through ’I’ as being provincially significant.

An “enhanced” level of protection has been considered as appropriate for the receiving waters of Bray Lake and the quality control practices selected as part of the overall SWM plan are to reflect this.

A natural vegetated buffer of 15 m in width has been proposed along the Bray Lake shoreline for quality protection, determined by Riverstone Environmental as shown on the Draft Plan. A 30 m vegetated buffer has been proposed along specified wetlands, moose aquatic feeding areas, and watercourses within the site, in keeping with the Ministry of Natural Resources Buffer Zone guidelines, 1987. House construction will be limited to having a minimum shoreline setback of 23 m, determined by Riverstone Environmental as shown on the Draft Plan.

In as much as the proposed development is rural in nature, maintaining large, vegetated buffers between the more impervious houses, laneways and roadway will provide permanent runoff quality control. 86% of the site's drainage flows toward Bray Lake, catchment areas 201, 202, 203, 204, and 205. The remainder of the site drains south and east to the existing Watercourse 'D' within the south and east abutting vacant land property. The naturally occurring vegetated buffers and wetlands will serve to filter stormwater runoff, controlling sediment migration on a permanent basis. Internal roadside ditches are to be grass lined with gradients of less than 5% and rip-rap lined with gradients of more than 5% to provide permanent erosion and sediment control. Enhanced grass swales where possible within building envelope areas will provide water quality treatment through conveyance control.

Additionally, sediment control and erosion protection can be provided for roadside ditch flows within the private roadway ditches by attenuating peak ditch flows during the 2-year, common erosion event, and greater. The physical constraints for enhanced infiltration-based quality control grass swales and ditches according to Table 4.1 in The MECP Stormwater Management Planning and Design Manual, 2003, are as follows:

- Topography slope must be less than 5%.
- Catchment area requiring treatment must be less than 2 ha.

Rock flow check dams are to be installed at the down gradient limit of each proposed roadside ditch to provide runoff attenuation, improved infiltration and suspended solids settling. Rock flow check dam calculations are provided in Appendix C assessing the required storage volumes. Table 5 shows all catchment areas requiring treatment are less than 2 ha. The rock flow check dams are to be constructed in a 0.7 m depth ditch with 1 m flat bottom width. The specified flat bottom ditch with 2:1 (H:V) side slopes are to continue at least 20 m upstream of all rock flow check dams at less than 1%. Locations of rock flow check dams are shown on the Preliminary Stormwater Management, Private Sewage Assessment, and Construction Mitigation Plan – SWM-1. Detail cross sections of the proposed 1.0 bottom width infiltration ditch and rock flow check dams are shown on Notes and Details Drawing – SWM-2. The flat bottom ditch allows for greater runoff storage, attenuating peak flows, and improved infiltration. Ditches and rock flow check dams can provide the required storage volume for quality treatment of sediment. Rock flow check dams within the proposed quality control ditch lengths identified on SWM-1 have been designed with a 0.20 m ponding depth. Rock flow check dams are to be installed in accordance with Ontario Provincial Standard Drawing 219.211.

Table 3.2 in the MECP Stormwater Management Planning and Design Manual, 2003, requires a water quality storage volume, *WQV*, of 30.7 m^3/ha for *enhanced* 80% long-term suspended solids removal of a 57% impervious catchment. Table 5 outlines the required WQV for each treated catchment. Most catchments require one (1) to three (3) rock flow check dams located within the specified ditch length to provide the required WQV. All catchments requiring sediment treatment are designed with a minimum of two (2) infiltration based quality control ditches per catchment, one (1) per each roadside ditch, exceeding the required WQV. All catchments have been designed with quality control ditches that exceed the required WQV. Infiltration based quality control ditch (Enhanced Swale) calculations have been included in Appendix C.

Delineated catchments requiring treatment can be found on drawing D2 in Appendix B.

Table 5: Water Quality Storage Requirement Based on Receiving Waters (m^3)

Catchment ID	Area, Ha	Required Water Quality Storage Volume (WQV), m^3	0.2 m Depth Storage Volume at One (1) Rock Flow Check Dam with Upstream Slope of 1%, m^3	Number of Check Dams Required	Number of Check Dams Designed	Total Volume of Designed Number of Check Dams, m^3
301	0.31	9.51	2.842	4	4	11.37
302	0.25	7.67	2.842	3	4	11.37
303	0.10	3.07	2.842	2	2	5.68
304	0.15	4.60	2.842	2	2	5.68
305	0.06	1.84	2.842	1	2	5.68
306	0.10	3.07	2.842	2	2	5.68
307	0.40	12.27	2.842	5	6	17.05
308	0.28	8.59	2.842	4	4	11.37
309	0.05	1.53	2.842	1	2	5.68
310	0.05	1.53	2.842	1	2	5.68
311	0.19	5.83	2.842	3	4	11.37
312	0.77	23.62	2.842	9	10	28.42
313	0.25	7.67	2.842	3	4	11.37

6. SEDIMENT CONTROL AND CONSTRUCTION MITIGATION

6.1 General

In order to protect the downstream water body from sediment carried by storm runoff during construction, it is recommended that silt fence as per Ontario Provincial Standard Drawing 219.130 and straw bale check dams as per Ontario Provincial Standard Drawing 219.180 should be employed, at a minimum in the locations shown on the Preliminary Stormwater Management, Private Sewage System Assessment and Construction Mitigation Plan – SWM-1 in Appendix B. Such measures should be in place prior to the commencement of construction and be maintained until all open soils are stabilized. In order to assure proper operation of the silt fence and straw bale check dams during construction it is suggested that regular maintenance be carried for the duration of construction until the site is stabilized on completion of construction.

The storm drainage areas are heavily wooded throughout. The subdivision development will have little effect on the present drainage characteristics of the area. Migration of sediments due to the development of the site is expected to be minimal.

Generally, silt fence should be installed at the toe of all fill slopes and along the roadside / driveway ditches. Staked straw bales should be provided along the length of roadside and driveway ditches at intervals of no more than 50 m.

Rip-rap end treatments in accordance with OPSD 810.010 are recommended at the inlet and outlet of roadside culverts to prevent erosion and the “stirring” of particulate matter in these locations.

Where the roadside ditches discharge to existing watercourses, settling areas should be constructed in addition to straw bale flow checks being placed.

Stripped or stockpiled earth material should be located a minimum of 30 m away from natural drainage paths and always be placed up-gradient of the siltation controls. In addition, the stockpiles should be located a minimum of 30 m away from the top of any existing embankment.

It is recommended that as a condition of building permit issuance, the Township require proponents to provide individual lot grading and construction mitigation plans suited to the proposed lot development plan.

The location of areas deemed to be susceptible to erosion, as well as recommended erosion protection measures are shown on Drawing SWM-1 in Appendix B.

6.2 Monitoring and Maintenance

It is the responsibility of the contractor and owner to maintain construction mitigation / siltation control devices until suitable vegetation cover has been established and / or the site has been stabilized from erosion.

A regular review of the facilities by the contractor and/or owner shall be carried out during the construction period to ensure that the facilities are being properly maintained, and if necessary, replaced.

The construction mitigation / siltation devices should be inspected immediately after each significant rainfall event. Damaged devices should be repaired immediately, and additional devices installed, if necessary, in order to maintain affective mitigation controls.

Silt should be removed from the fencing and straw bale dams when deposits reach approximately 250 mm above original ground.

In the event that the proposed works cannot be completed within one construction season or adequate vegetation has not been established prior to winter freeze up, a review of the site by the engineer and contractor should be carried out as part of the owner's responsibility to assess potential problem erosion areas that might occur during the spring thaw or at times of heavy surface run-off.

6.3 Contingency Plan

Should the erosion control measures fail, and sediment migrate beyond the limits of the control works, the following tasks should be carried out.

- The Township of Machar should be notified of the event. The area will be assessed and cleaned up to the satisfaction of the Township.
- Additional sedimentation facilities should be installed in the area of the migration and down gradient to contain the sediment.
- The Department of Fisheries and Oceans should be contacted in the event that sediment reaches the receiving lake or any fish habitat in the lower reaches of the on-site watercourses.

7. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are based on the information and analysis presented in this report:

- The comparison of pre-development and post-development flows indicate marginal increases in peak flow rates as a result of the proposed development.
- It is not anticipated that flooding of adjacent lands will result due to increases in run-off rates from this development.
- A 15 m vegetated natural buffer and 23 m building setback be established to ensure the integrity of the existing Bray Lake shoreline, which will serve to naturally attenuate and filter storm runoff and reduce the potential of shoreline erosion.
- Stormwater management requirements for the site can be addressed by safely conveying drainage from the development area through the property to the natural waterbodies.
- Suitable drainage facilities can be installed to convey drainage to the lake and protect against surface erosion and quality impairment of runoff.
- A suitable construction mitigation plan can be implemented for the site to protect Bray Lake and adjacent lands from sediment migration.

It is recommended that:

- This report and drawings be submitted to the Township of Machar for review and approval.
- The conveyance systems specified in this report be implemented in order to ensure that post-development drainage is directed to Bray Lake without impact.
- The construction mitigation measures outlined in this report be implemented and a monitoring program be conducted until such time as the site development is complete.
- The Township require a detailed grading and construction mitigation plan be submitted in support of each building permit application. These plans should identify and provide

sizing for conveyance structures (culverts) on private property, demonstrate that the proposed lot development does not impact overland drainage routes, and illustrate the site-specific erosion and sediment control measures to be implemented.

All of which is respectfully submitted,

TULLOCH Engineering Inc.

APPENDIX A

MTO Intensity-Duration-Frequency Data

Rational Method Calculations

Ontario IDF CURVE LOOKUP

Active coordinate

45° 54' 15" N, 79° 29' 45" W (45.904167,-79.495833)

Retrieved: Wed, 19 Jan 2022 02:42:35 GMT

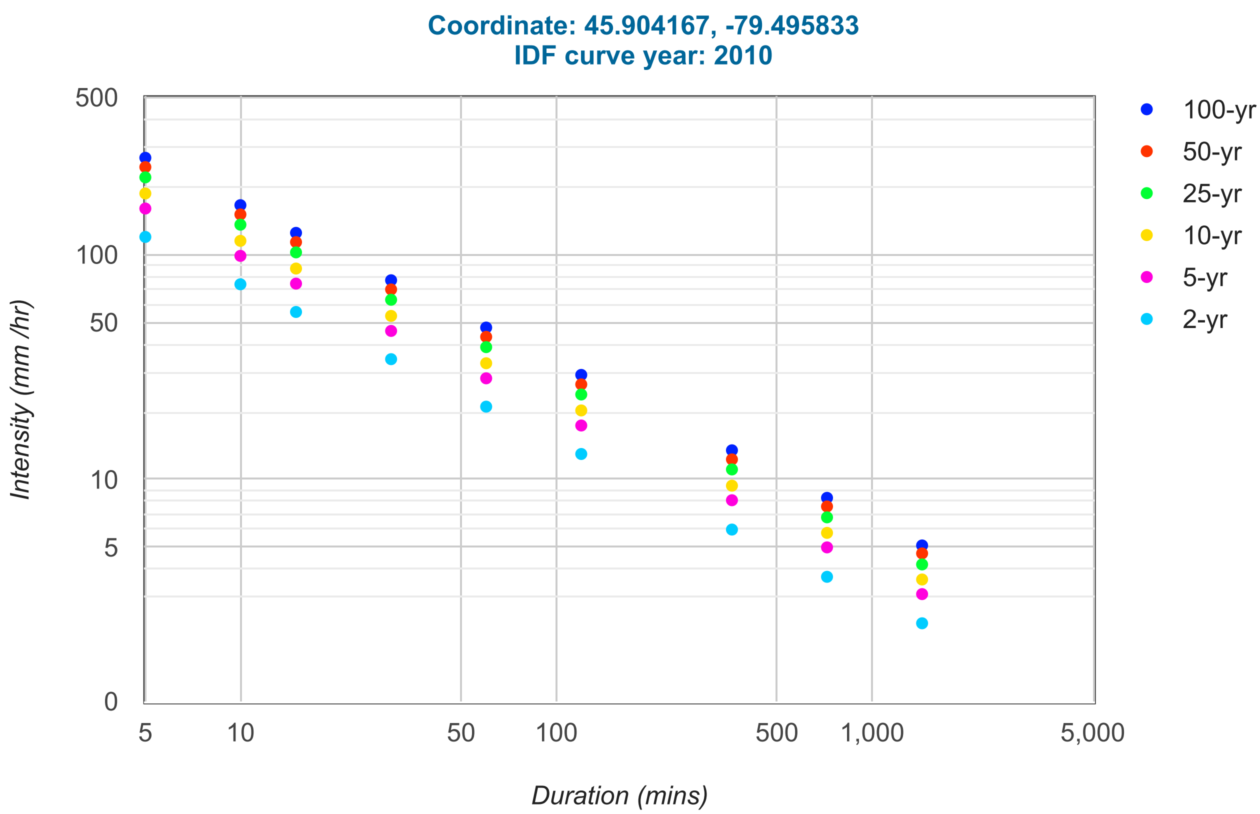
Location summary

These are the locations in the selection.

IDF Curve: 45° 54' 15" N, 79° 29' 45" W (45.904167,-79.495833)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 45° 54' 15" N, 79° 29' 45" W (45.904167,-79.495833)

Retrieved: Wed, 19 Jan 2022 02:42:35 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	21.1	28.2	32.9	38.8	43.1	47.4
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	119.8	73.8	55.6	34.3	21.1	13.0	6.0	3.7	2.3
5-yr	160.2	98.7	74.3	45.8	28.2	17.4	8.1	5.0	3.1
10-yr	186.9	115.1	86.7	53.4	32.9	20.3	9.4	5.8	3.6
25-yr	220.4	135.8	102.3	63.0	38.8	23.9	11.1	6.8	4.2
50-yr	244.8	150.8	113.6	70.0	43.1	26.5	12.3	7.6	4.7
100-yr	269.2	165.8	124.9	76.9	47.4	29.2	13.5	8.3	5.1

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	10.0	12.3	13.9	17.1	21.1	26.0	36.2	44.6	54.9
5-yr	13.3	16.4	18.6	22.9	28.2	34.7	48.4	59.6	73.4
10-yr	15.6	19.2	21.7	26.7	32.9	40.5	56.4	69.5	85.6
25-yr	18.4	22.6	25.6	31.5	38.8	47.8	66.5	82.0	101.0
50-yr	20.4	25.1	28.4	35.0	43.1	53.1	73.9	91.1	112.2
100-yr	22.4	27.6	31.2	38.5	47.4	58.4	81.3	100.1	123.4

Terms of Use

TULLOCH	**Project:** Bray Lake Subdivision SWM	**Date:** 04-Aug-22
	File No: 21-1851	**Designed:** BB
	Subject: Catchment 101	**Checked:** TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	Bransby-Williams Formula	Peak Flow Calculation
$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c = time of concentration C = runoff coefficient L = watershed length (m) S_w = watershed slope (%)	*where: t_c = time of concentration L = watershed length (m) S_w = watershed slope (%) A = watershed area (ha)*	*where: Q = peak flow (m^3/s) C = runoff coefficient i = rainfall intensity (mm/h) A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 1683.00 Watershed Fall (m) = 17.94 Watershed Slope, S_w = 1.42%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	44.54	0.18	*Woodland Hilly (Sandy Loam)*
2	8.79	0.05	*Lakes/Wetlands*
3	0.12	0.60	*Gravel Roadway*
4	1.73	0.88	*Impervious Roadway*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$ = 55.18	$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$ = 0.18	*If C_w < 0.4 - use Airport Formula If $C_w \geq$ 0.4 - use Bransby-Williams Formula*
	source: MTO Drainage Manual	source: MTO Drainage Manual

Design Chart 1.06

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow	
2	0.18	Airport	109.33	14.62	**0.41**	**m^3/s**
5	0.18	Airport	109.33	19.56	**0.55**	**m^3/s**
10	0.18	Airport	109.33	22.82	**0.64**	**m^3/s**
25	0.20	Airport	107.16	28.37	**0.87**	**m^3/s**
50	0.22	Airport	104.99	31.48	**1.05**	**m^3/s**
100	0.23	Airport	103.91	34.66	**1.21**	**m^3/s**

Project:	Bray Lake Subdivision SWM	Date:	04-Aug-22
File No:	21-1851	Designed:	BB
Subject:	Catchment 102	Checked:	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = *time of concentration*
C = runoff coefficient
L = watershed length (m)
S_w = *watershed slope (%)*

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = *time of concentration*
L = watershed length (m)
S_w = *watershed slope (%)*
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: Q = peak flow (m^3/s)
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 365.00 Watershed Fall (m) = 40.61 Watershed Slope, S_w = 14.83%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	11.12	0.18	*Woodland Hilly (Sandy Loam)*
2	0.73	0.05	*Lakes/Wetlands*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$A_{total} = A_1 + A_2 + A_3$

= 11.85

Weighted Runoff Coefficient

$$C_w = \frac{A_1{*}C_1 + A_2{*}C_2 + A_3{*}C_3}{A_{total}}$$

= 0.17

source: MTO Drainage Manual

Time of Concentration Formula

If C_w *< 0.4 - use Airport Formula*
If C_w *≥ 0.4 - use Bransby-Williams Formula*

source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.17	Airport	23.74	44.95	**0.25** m^3/s
5	0.17	Airport	23.74	60.05	**0.34** m^3/s
10	0.17	Airport	23.74	70.05	**0.40** m^3/s
25	0.19	Airport	23.30	82.65	**0.52** m^3/s
50	0.21	Airport	22.86	91.80	**0.62** m^3/s
100	0.21	Airport	22.64	100.90	**0.71** m^3/s

TULLOCH	Project: Bray Lake Subdivision SWM	Date: 04-Aug-22
	File No: 21-1851	Designed: BB
	Subject: Catchment 103	Checked: TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	Bransby-Williams Formula	Peak Flow Calculation
$t_c = \dfrac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \dfrac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c = time of concentration *C = runoff coefficient* *L = watershed length (m)* *S_w = watershed slope (%)*	*where: t_c = time of concentration* *L = watershed length (m)* *S_w = watershed slope (%)* *A = watershed area (ha)*	*where: Q = peak flow (m^3/s)* *C = runoff coefficient* *i = rainfall intensity (mm/h)* *A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 389.00 Watershed Fall (m) = 42.96 Watershed Slope, S_w = 14.72%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	26.53	0.18	*Woodland Hilly (Sandy Loam)*
2	0.18	0.05	*Lakes/Wetlands*
3	0.05	0.83	*Building/Roof*
4	0.15	0.18	*Steep Lawn (Sandy Loam)*
5	0.03	0.60	*Gravel Roadway*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$ = 26.94	$C_w = \dfrac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$ = 0.18	*If C_w < 0.4 - use Airport Formula* *If $C_w \geq 0.4$ - use Bransby-Williams Formula*
	source: MTO Drainage Manual	source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.18	Airport	24.33	42.82	**0.58** m^3/s
5	0.18	Airport	24.33	57.20	**0.77** m^3/s
10	0.18	Airport	24.33	66.72	**0.90** m^3/s
25	0.20	Airport	23.85	82.65	**1.23** m^3/s
50	0.22	Airport	23.37	91.80	**1.49** m^3/s
100	0.23	Airport	23.13	100.90	**1.71** m^3/s

TULLOCH	**Project:** Bray Lake Subdivision SWM	**Date:** 04-Aug-22
	File No: 21-1851	**Designed:** BB
	Subject: Catchment 104	**Checked:** TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	**Bransby-Williams Formula**	**Peak Flow Calculation**
$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c = time of concentration	*where: t_c = time of concentration*	*where: Q = peak flow (m^3/s)*
C = runoff coefficient	*L = watershed length (m)*	*C = runoff coefficient*
L = watershed length (m)	*S_w = watershed slope (%)*	*i = rainfall intensity (mm/h)*
S_w = watershed slope (%)	*A = watershed area (ha)*	*A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 1090.00   Watershed Fall (m) = 22.71   Watershed Slope, S_w = 2.78%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	23.14	0.18	*Woodland Hilly (Sandy Loam)*
2	5.24	0.05	*Lakes/Wetlands*
3	0.09	0.18	*Steep Lawn (Sandy Loam)*
4	0.16	0.88	*Asphalt Roadway*
5	0.29	0.60	*Gravel Roadway*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$	$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$	*If C_w < 0.4 - use Airport Formula*
= 28.92	= 0.16	*If C_w ≥ 0.4 - use Bransby-Williams Formula*
	source: MTO Drainage Manual	source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.16	Airport	71.87	20.29	**0.27** m^3/s
5	0.16	Airport	71.87	27.12	**0.36** m^3/s
10	0.16	Airport	71.87	31.64	**0.42** m^3/s
25	0.18	Airport	70.61	37.31	**0.54** m^3/s
50	0.20	Airport	69.34	41.44	**0.66** m^3/s
100	0.21	Airport	68.71	45.58	**0.75** m^3/s

TULLOCH

Project:	Bray Lake Subdivision SWM	Date:	04-Aug-22
File No:	21-1851	Designed:	BB
Subject:	Catchment 105	Checked:	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	**Bransby-Williams Formula**	**Peak Flow Calculation**
$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c *= time of concentration* *C = runoff coefficient* *L = watershed length (m)* S_w *= watershed slope (%)*	*where:* t_c *= time of concentration* *L = watershed length (m)* S_w *= watershed slope (%)* *A = watershed area (ha)*	*where: Q = peak flow (m^3/s)* *C = runoff coefficient* *i = rainfall intensity (mm/h)* *A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 516.00 | Watershed Fall (m) = 19.36 | Watershed Slope, S_w = 5.00%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	14.99	0.18	*Woodland Hilly (Sandy Loam)*
2	0.49	0.05	*Lakes/Wetlands*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$ = 15.48	$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$ = 0.18	*If* $C_w < 0.4$ *- use Airport Formula* *If* $C_w \geq 0.4$ *- use Bransby-Williams Formula*
	source: MTO Drainage Manual	source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.18	Airport	40.23	30.34	**0.23** m^3/s
5	0.18	Airport	40.23	40.52	**0.31** m^3/s
10	0.18	Airport	40.23	47.25	**0.36** m^3/s
25	0.19	Airport	39.46	55.74	**0.46** m^3/s
50	0.21	Airport	38.70	64.62	**0.59** m^3/s
100	0.22	Airport	38.31	71.00	**0.67** m^3/s

TULLOCH	Project: Bray Lake Subdivision SWM	Date: 04-Aug-22
	File No: 21-1851	Designed: BB
	Subject: Catchment 106	Checked: TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = time of concentration
C = runoff coefficient
L = watershed length (m)
S_w = watershed slope (%)

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = time of concentration
L = watershed length (m)
S_w = watershed slope (%)
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: Q = peak flow (m^3/s)
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 695.00 Watershed Fall (m) = 19.99 Watershed Slope, S_w = 3.84%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	20.23	0.18	*Woodland Hilly (Sandy Loam)*
2	2.76	0.05	*Lakes/Wetlands*
3	0.12	0.88	*Asphalt Roadway*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$A_{total} = A_1 + A_2 + A_3$

= 23.11

Weighted Runoff Coefficient

$$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$$

= 0.17

source: MTO Drainage Manual

Time of Concentration Formula

If C_w < 0.4 - use Airport Formula
If $C_w \geq$ 0.4 - use Bransby-Williams Formula

source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.17	Airport	51.40	25.06	**0.27** m^3/s
5	0.17	Airport	51.40	33.48	**0.36** m^3/s
10	0.17	Airport	51.40	39.05	**0.42** m^3/s
25	0.18	Airport	50.47	48.48	**0.58** m^3/s
50	0.20	Airport	49.54	53.86	**0.70** m^3/s
100	0.21	Airport	49.08	59.20	**0.80** m^3/s

TULLOCH

Project:	Bray Lake Subdivision SWM	**Date:**	04-Aug-22
File No:	21-1851	**Designed:**	BB
Subject:	Catchment 201	**Checked:**	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = *time of concentration*
C = runoff coefficient
L = watershed length (m)
S_w = *watershed slope (%)*

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = *time of concentration*
L = watershed length (m)
S_w = *watershed slope (%)*
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: Q = peak flow (m^3/s)
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 1683.00   Watershed Fall (m) = 17.94   Watershed Slope, S_w = 1.42%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	43.63	0.18	*Woodland Hilly (Sandy Loam)*
2	8.79	0.05	*Lakes/Wetlands*
3	0.17	0.60	*Gravel Roadway*
4	1.73	0.88	*Asphalt Roadway*
5	0.80	0.30	*Rural Residential*
6	0.06	0.10	*Landscaped Area (Septic Filter Bed)*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$A_{total} = A_1 + A_2 + A_3$

= 55.18

Weighted Runoff Coefficient

$$C_w = \frac{A_1{*}C_1 + A_2{*}C_2 + A_3{*}C_3}{A_{total}}$$

= 0.18

source: MTO Drainage Manual

Time of Concentration Formula

If $C_w < 0.4$ *- use Airport Formula*
If $C_w \geq 0.4$ *- use Bransby-Williams Formula*

source: MTO Drainage Manual

Design Chart 1.06

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow	
2	0.18	Airport	109.08	14.62	**0.41**	**m^3/s**
5	0.18	Airport	109.08	19.56	**0.55**	**m^3/s**
10	0.18	Airport	109.08	22.82	**0.64**	**m^3/s**
25	0.20	Airport	106.89	28.37	**0.88**	**m^3/s**
50	0.22	Airport	104.70	31.48	**1.07**	**m^3/s**
100	0.23	Airport	103.60	34.66	**1.22**	**m^3/s**

TULLOCH

Project:	Bray Lake Subdivision SWM	**Date:**	04-Aug-22
File No:	21-1851	**Designed:**	BB
Subject:	Catchment 202	**Checked:**	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = *time of concentration*
C = runoff coefficient
L = watershed length (m)
S_w = *watershed slope (%)*

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = *time of concentration*
L = watershed length (m)
S_w = *watershed slope (%)*
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: *Q = peak flow (m^3/s)*
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 365.00 Watershed Fall (m) = 40.61 Watershed Slope, S_w = 14.83%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	11.12	0.18	*Woodland Hilly (Sandy Loam)*
2	0.73	0.05	*Lakes/Wetlands*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$A_{total} = A_1 + A_2 + A_3$

= 11.85

Weighted Runoff Coefficient

$$C_w = \frac{A_1{*}C_1 + A_2{*}C_2 + A_3{*}C_3}{A_{total}}$$

= 0.17

source: MTO Drainage Manual

Time of Concentration Formula

If $C_w < 0.4$ *- use Airport Formula*
If $C_w \geq 0.4$ *- use Bransby-Williams Formula*

source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.17	Airport	23.74	44.95	**0.25** m^3/s
5	0.17	Airport	23.74	60.05	**0.34** m^3/s
10	0.17	Airport	23.74	70.05	**0.40** m^3/s
25	0.19	Airport	23.30	82.65	**0.52** m^3/s
50	0.21	Airport	22.86	91.80	**0.62** m^3/s
100	0.21	Airport	22.64	100.90	**0.71** m^3/s

Project:	Bray Lake Subdivision SWM	Date:	04-Aug-22
File No:	21-1851	Designed:	BB
Subject:	Catchment 203	Checked:	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = time of concentration
C = runoff coefficient
L = watershed length (m)
S_w = watershed slope (%)

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = time of concentration
L = watershed length (m)
S_w = watershed slope (%)
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: Q = peak flow (m^3/s)
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 413.00 Watershed Fall (m) = 44.50 Watershed Slope, S_w = 14.37%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	19.16	0.18	*Woodland Hilly (Sandy Loam)*
2	1.73	0.05	*Lakes/Wetlands*
3	5.05	0.30	*Rural Residential*
4	0.30	0.10	*Landscaped Area (Septic Filter Bed)*
5	0.55	0.60	*Gravel Roadway*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$$A_{total} = A_1 + A_2 + A_3$$
$$= 26.79$$

Weighted Runoff Coefficient

$$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$$
$$= 0.20$$

source: MTO Drainage Manual

Time of Concentration Formula

If C_w < 0.4 - use Airport Formula
If $C_w \geq$ 0.4 - use Bransby-Williams Formula

source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.20	Airport	24.69	42.82	**0.64** m^3/s
5	0.20	Airport	24.69	57.20	**0.86** m^3/s
10	0.20	Airport	24.69	66.72	**1.00** m^3/s
25	0.22	Airport	24.14	78.72	**1.30** m^3/s
50	0.24	Airport	23.58	91.80	**1.66** m^3/s
100	0.25	Airport	23.31	100.90	**1.90** m^3/s

	Project: Bray Lake Subdivision SWM	Date: 04-Aug-22
TULLOCH	File No: 21-1851	Designed: BB
	Subject: Catchment 204	Checked: TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	**Bransby-Williams Formula**	**Peak Flow Calculation**
$t_c = \dfrac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \dfrac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c = time of concentration C = runoff coefficient L = watershed length (m) S_w = watershed slope (%)	*where: t_c = time of concentration L = watershed length (m) S_w = watershed slope (%) A = watershed area (ha)*	*where: Q = peak flow (m^3/s) C = runoff coefficient i = rainfall intensity (mm/h) A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 1090.00 Watershed Fall (m) = 22.71 Watershed Slope, S_w = 2.78%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	22.05	0.18	*Woodland Hilly (Sandy Loam)*
2	5.24	0.05	*Lakes/Wetlands*
3	0.16	0.88	*Asphalt Roadway*
4	0.57	0.60	*Gravel Roadway*
5	1.08	0.30	*Rural Residential*
6	0.06	0.10	*Landscaped Area(Septic Filter Bed)*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$ = 29.16	$C_w = \dfrac{A_1{*}C_1 + A_2{*}C_2 + A_3{*}C_3}{A_{total}}$ = 0.17	*If C_w < 0.4 - use Airport Formula If C_w ≥ 0.4 - use Bransby-Williams Formula*
	source: MTO Drainage Manual	source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.17	Airport	71.22	20.29	**0.28** m^3/s
5	0.17	Airport	71.22	27.12	**0.38** m^3/s
10	0.17	Airport	71.22	31.64	**0.44** m^3/s
25	0.19	Airport	69.89	37.31	**0.58** m^3/s
50	0.21	Airport	68.56	41.44	**0.70** m^3/s
100	0.22	Airport	67.90	45.58	**0.80** m^3/s

TULLOCH	Project: Bray Lake Subdivision SWM	Date: 04-Aug-22
	File No: 21-1851	Designed: BB
	Subject: Catchment 205	Checked: TM/CS

Rational Method for Calculating Peak Flows

Airport Formula	Bransby-Williams Formula	Peak Flow Calculation
$t_c = \dfrac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$	$t_c = \dfrac{0.057 * L}{S_W^{0.2} * A^{0.1}}$	$Q = 0.00278 * C * i * A$
where: t_c = time of concentration C = runoff coefficient L = watershed length (m) S_w = watershed slope (%)	*where: t_c = time of concentration L = watershed length (m) S_w = watershed slope (%) A = watershed area (ha)*	*where: Q = peak flow (m^3/s) C = runoff coefficient i = rainfall intensity (mm/h) A = watershed area (ha)*
source: MTO Drainage Manual 8.16	*source: MTO Drainage Manual 8.15*	*source: MTO Drainage Manual 8.19*

Watershed Characteristics

Watershed Length, L (m) = 516.00 Watershed Fall (m) = 19.36 Watershed Slope, S_w = 5.00%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	12.61	0.18	*Woodland Hilly (Sandy Loam)*
2	0.49	0.05	*Lakes/Wetlands*
3	0.21	0.60	*Gravel Roadway*
4	1.94	0.30	*Rural Residential*
5	0.15	0.10	*Landscaped Area (Septic Filter Bed)*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area	Weighted Runoff Coefficient	Time of Concentration Formula
$A_{total} = A_1 + A_2 + A_3$	$C_w = \dfrac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$	*If C_w < 0.4 - use Airport Formula If C_w ≥ 0.4 - use Bransby-Williams Formula*
= 15.40	= 0.20	
	source: MTO Drainage Manual	source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.20	Airport	39.36	30.34	**0.25** m^3/s
5	0.20	Airport	39.36	40.52	**0.34** m^3/s
10	0.20	Airport	39.36	47.25	**0.40** m^3/s
25	0.22	Airport	38.50	58.16	**0.54** m^3/s
50	0.24	Airport	37.65	64.62	**0.65** m^3/s
100	0.24	Airport	37.22	71.00	**0.74** m^3/s

TULLOCH

Project:	Bray Lake Subdivision SWM	Date:	04-Aug-22
File No:	21-1851	Designed:	BB
Subject:	Catchment 206	Checked:	TM/CS

Rational Method for Calculating Peak Flows

Airport Formula

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S_w^{0.33}}$$

where: t_c = *time of concentration*
C = runoff coefficient
L = watershed length (m)
S_w = *watershed slope (%)*

source: MTO Drainage Manual 8.16

Bransby-Williams Formula

$$t_c = \frac{0.057 * L}{S_W^{0.2} * A^{0.1}}$$

where: t_c = *time of concentration*
L = watershed length (m)
S_w = *watershed slope (%)*
A = watershed area (ha)

source: MTO Drainage Manual 8.15

Peak Flow Calculation

$$Q = 0.00278 * C * i * A$$

where: Q = peak flow (m^3/s)
C = runoff coefficient
i = rainfall intensity (mm/h)
A = watershed area (ha)

source: MTO Drainage Manual 8.19

Watershed Characteristics

Watershed Length, L (m) = 695.00 | Watershed Fall (m) = 19.99 | Watershed Slope, S_w = 3.84%

Area Number	Area (ha)	Runnoff Coefficient	Description
1	19.78	0.18	*Woodland Hilly (Sandy Loam)*
2	2.79	0.05	*Lakes/Wetlands*
3	0.12	0.88	*Asphalt Roadway*
4	0.40	0.30	*Rural Residential*
5	0.03	0.10	*Landscaped Area (Septic Filter Bed)*
	from ACAD Drawing	*Design Chart 1.07*	*Design Chart 1.07*

Watershed Calculations

Total Area

$A_{total} = A_1 + A_2 + A_3$

= 23.12

Weighted Runoff Coefficient

$$C_w = \frac{A_1*C_1 + A_2*C_2 + A_3*C_3}{A_{total}}$$

= 0.17

source: MTO Drainage Manual

Time of Concentration Formula

If C_w *< 0.4 - use Airport Formula*
If $C_w \geq$ *0.4 - use Bransby-Williams Formula*

source: MTO Drainage Manual

Peak Flow Calculations

Storm Frequency	Adjusted Runoff Coefficient	T_c Formula	T_c (min)	i, Intensity (mm/h)	Q, Peak Flow
2	0.17	Airport	51.30	25.06	**0.27** m^3/s
5	0.17	Airport	51.30	33.48	**0.37** m^3/s
10	0.17	Airport	51.30	39.05	**0.43** m^3/s
25	0.19	Airport	50.36	48.48	**0.59** m^3/s
50	0.20	Airport	49.42	53.86	**0.71** m^3/s
100	0.21	Airport	48.96	59.20	**0.81** m^3/s

APPENDIX B

Preliminary Stormwater Management, Private Sewage System Assessment and Construction Mitigation Plan – SWM-1 & SWM-2

Pre-Development and Post-Development Drainage Areas Plan - D1 & D2

BRAY LAKE SUBDIVISION DRAFT PLAN - COPY

6m-ENTRANCE CULVERT TYP.	
LOT #	CPP DIAMETERS Ø
1	450
2	450
3	450
4	450
5	450
6	450
7	450
8	450
9	450
10	450
11	525
12	525
13	525
14	525
15	525
16	450
17	525
18	525
19	450
20	-

QUALITY CONTROL CATCHMENT AREAS (ha) & WATER QUALITY VOLUME (WQV)			
CONTROLLED			
I.D.	CATCHMENT AREA (Ha.)	NUMBER OF CHECK DAMS DESIGNED	(WQV) DESIGNED (m^3)
301	0.31	4	11.37
302	0.25	4	11.37
303	0.10	2	5.68
304	0.15	2	5.68
305	0.06	2	5.68
306	0.10	2	5.68
307	0.40	6	17.05
308	0.28	4	11.37
309	0.05	2	5.68
310	0.05	2	5.68
311	0.19	4	11.37
312	0.77	10	28.42
313	0.25	4	11.37

LEGEND

- PROPERTY LINE
- EXISTING CONTOURS
- (PROPOSED) EDGE OF ASPHALT
- 30m SETBACK
- WETLAND
- (PROPOSED) DOCK LOCATION
- (PROPOSED) DRIVEWAY
- (PROPOSED) BUILDING ENVELOPE
- (PROPOSED) FILTER BED LOCATION
- (EXISTING) OVERLAND FLOW
- (PROPOSED) OVERLAND FLOW
- 100YR. SHEET FLOW
- (PROPOSED) SILT FENCE (OPSD 219.130)
- ROCK FLOW CHECK DAM — RFC
- STRAW BALE CHECK DAM — SFC
- AREA OF INFILTRATION BASED STORAGE
- (PROPOSED) ℄ DITCH
- DENOTES TYPE 1 FISH HABITAT
- DENOTES TYPE 2 FISH HABITAT

REVISION:	No.	DATE	BY
ISSUED FOR APPROVAL	1	AUGUST 31, 2022	C.S

TULLOCH ENGINEERING

BRAY LAKE SUBDIVISION
BRAY LAKE, MACHAR, ON

PRELIMINARY STORMWATER MANAGEMENT, PRIVATE SEWAGE SYSTEM ASSESSMENT & CONSTRUCTION MITIGATION PLAN

ENGINEER'S SEAL

LICENSED PROFESSIONAL ENGINEER — AUG 31, 2022 — C. J. STILWELL — 90308063 — PROVINCE OF ONTARIO

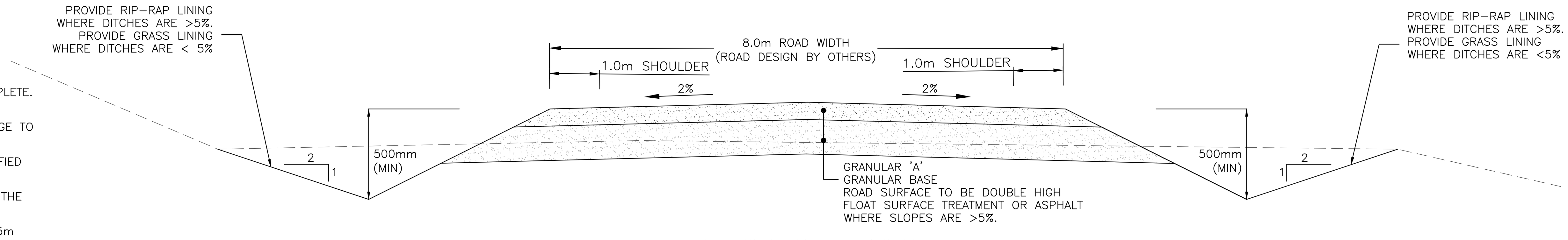
SCALE	1:2500
DRAWN	E.V
CHECKED	C.S/T.M/B.B
DATE	AUGUST 31, 2022
PROJECT No.	21-1851
SHEET	SWM 1

GENERAL NOTES:

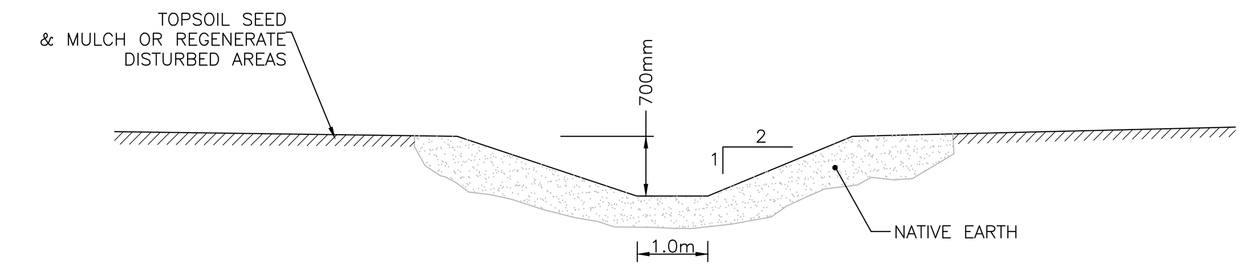
1. DO NOT SCALE DRAWINGS.
2. ALL STANDARDS ARE TO BE IN ACCORDANCE WITH CURRENT ONTARIO PROVINCIAL STANDARD DRAWINGS (OPSD) AND ONTARIO PROVINCIAL STANDARD SPECIFICATIONS (OPSS) UNLESS OTHERWISE NOTED.
3. THE LOCATION OF UTILITIES AND SERVICES SHOWN ON DRAWINGS IS APPROXIMATE AND MAY BE INCOMPLETE. CONFIRM EXACT LOCATION OF UTILITIES WITH MINISTRY, MUNICIPALITY OR UTILITIES. THE CONTRACTOR IS RESPONSIBLE TO DETERMINE LOCATIONS OF ALL UTILITIES PRIOR TO CONSTRUCTION AND WILL BE RESPONSIBLE FOR PROTECTING AGAINST DAMAGE. THE CONTRACTOR ASSUMES ALL LIABILITY FOR DAMAGE TO UTILITY AND ROAD WORKS.
4. ALL DIMENSIONS ARE IN METERS, EXCEPT PIPE DIAMETERS, WHICH ARE IN MILLIMETERS, UNLESS SPECIFIED OTHERWISE.
5. LATEST APPROVED DRAWINGS TO BE USED FOR CONSTRUCTION AND ALL DISCREPANCIES REPORTED TO THE ENGINEER.
6. DOMESTIC WATER SUPPLIES SHALL BE LOCATED UPGRADIENT OF FILTER BED LOCATIONS BY MINIMUM 15m FOR DRILLED WELLS WITH CASINGS AND 30m FOR DUG WELLS.
7. ALL ROADWAYS TO BE DESIGNED BY OTHERS.
8. ANY DISCREPANCY FROM THE DRAWINGS SHALL BE REPORTED TO THE ENGINEER PRIOR TO PROCEEDING.
9. ALL CULVERTS SHALL BE COMPLETED WITH RIP RAP END TREATMENT IN ACCORDANCE WITH OPSD 810.010.

CONSTRUCTION MITIGATION:
FINAL MEASURES TO INCLUDE THE FOLLOWING:

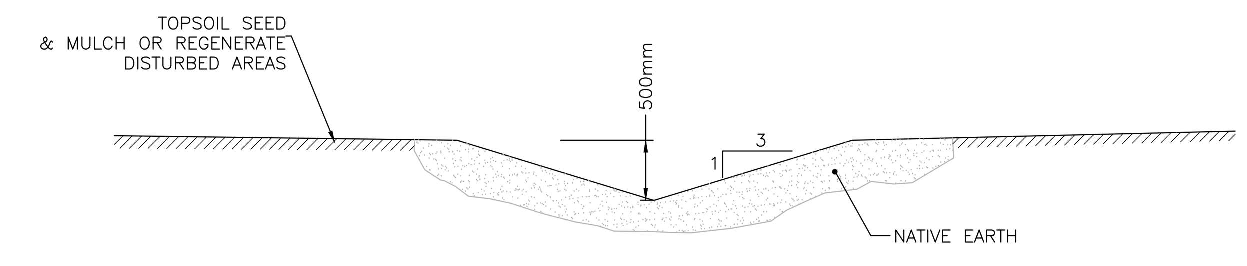
1. ALL SEDIMENT CONTROL FENCING IS TO BE INSTALLED PRIOR TO ANY GRADING OR EXCAVATION.
2. EROSION CONTROL FENCING TO BE INSTALLED AROUND THE BASE OF ALL STOCKPILES.
3. ADDITIONAL EROSION CONTROL MEASURES MAY BE REQUIRED AS SITE DEVELOPMENT PROGRESSES. CONTRACTOR TO PROVIDE ALL ADDITIONAL EROSION CONTROL STRUCTURES, AS NEEDED. TO THE SATISFACTION OF THE APPROPRIATE APPROVAL AUTHORITY i.e. MNR, MECP, HON1, ENGINEER
4. THE CONSTRUCTOR TO MONITOR EROSION CONTROL STRUCTURES TO ENSURE FENCING IS INSTALLED AND MAINTENANCE IS PERFORMED TO TOWN REQUIREMENTS. THE SATISFACTION OF THE APPROPRIATE APPROVAL AUTHORITY i.e. MNR, MECP, HON1, MUNICIPALITY.
5. EROSION CONTROL STRUCTURES ARE TO BE MONITORED REGULARLY AND ANY DAMAGE REPAIRED IMMEDIATELY. SEDIMENT IS TO BE REMOVED WHEN ACCUMULATIONS BUILD UP INSIDE THE CONTROL FENCE.
6. ALL EROSION CONTROL STRUCTURES ARE TO REMAIN IN PLACE UNTIL ALL DISTURBED GROUND HAS BEEN RESTABLIZED EITHER BY GRAVEL OR RESTORATION OF VEGETATIVE GROUND COVER.
7. NO ALTERNATE METHODS OF EROSION PROTECTION SHALL BE PERMITTED UNLESS APPROVED BY THE ENGINEER AND/ OR THE DEPARTMENT OF APPROPRIATE APPROVAL AUTHORITY SUCH AS i.e. MNR, MECP, HON1, MUNICIPALITY ETC.
8. THE CONTRACTOR IS RESPONSIBLE TO REMOVE ANY SEDIMENT THAT HAS TRACKED OFF SITE ONTO ADJACENT PROPERTY OWNED BY OTHERS DAILY. RESTORATION AND/OR MAINTENANCE TO ADJACENT PROPERTY MUST BE COMPLETED TO EQUAL OR BETTER CONDITION.
9. THE CONTRACTOR IS RESPONSIBLE FOR MUNICIPAL ROADWAY TO ENSURE ROADS ARE CLEARED OF ALL SEDIMENT TRACKED BY VEHICLES AT THE END OF EACH DAY.
10. INFILTRATION BASED DITCH SHALL PROVIDE CHECK DAM PONDING DEPTH OF 200mm AT <1% FOR 20m LENGTH OF INFILTRATION DITCH WITH 1m BOTTOM WIDTH.



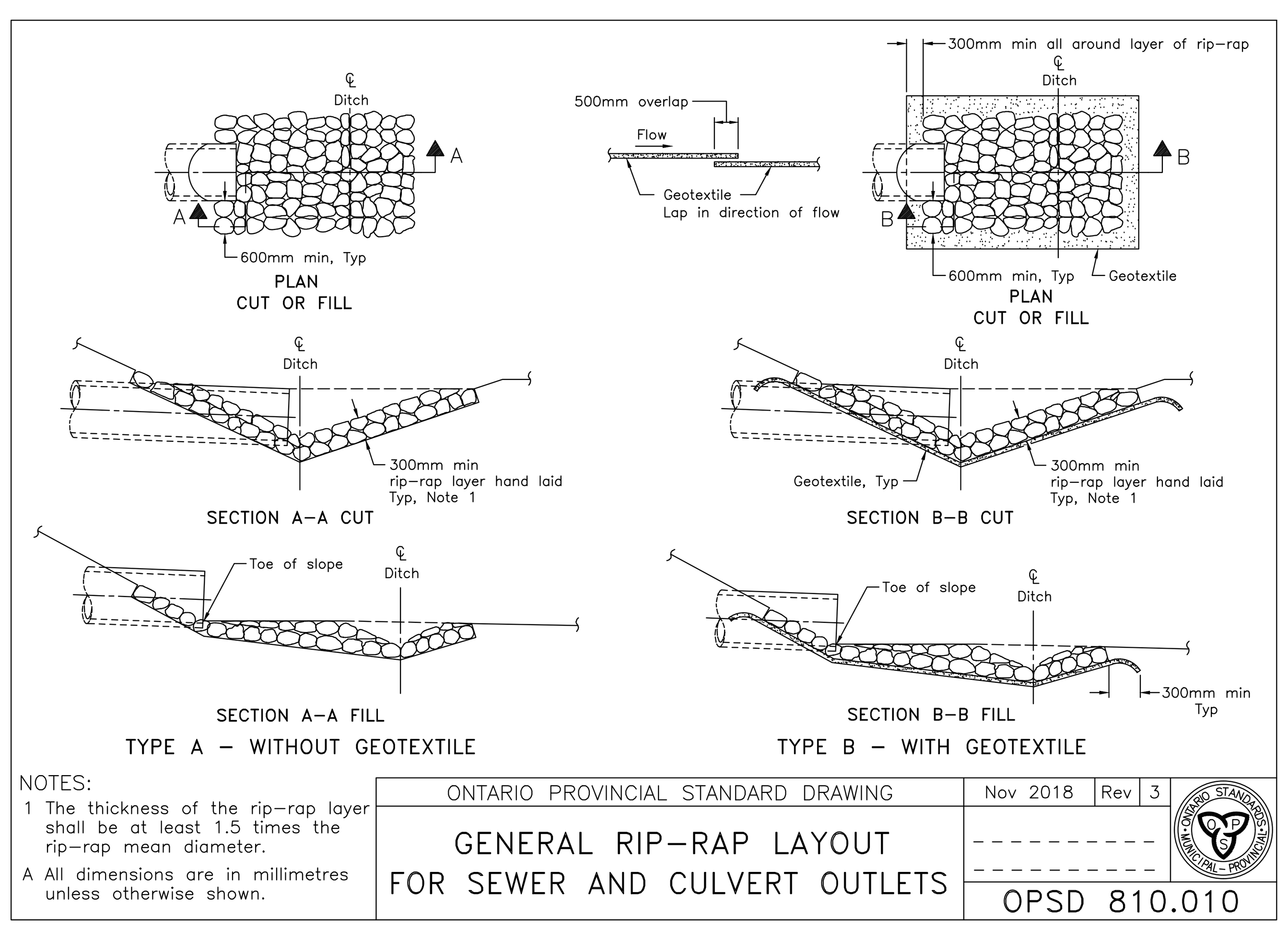
PRIVATE ROAD TYPICAL X-SECTION
N.T.S

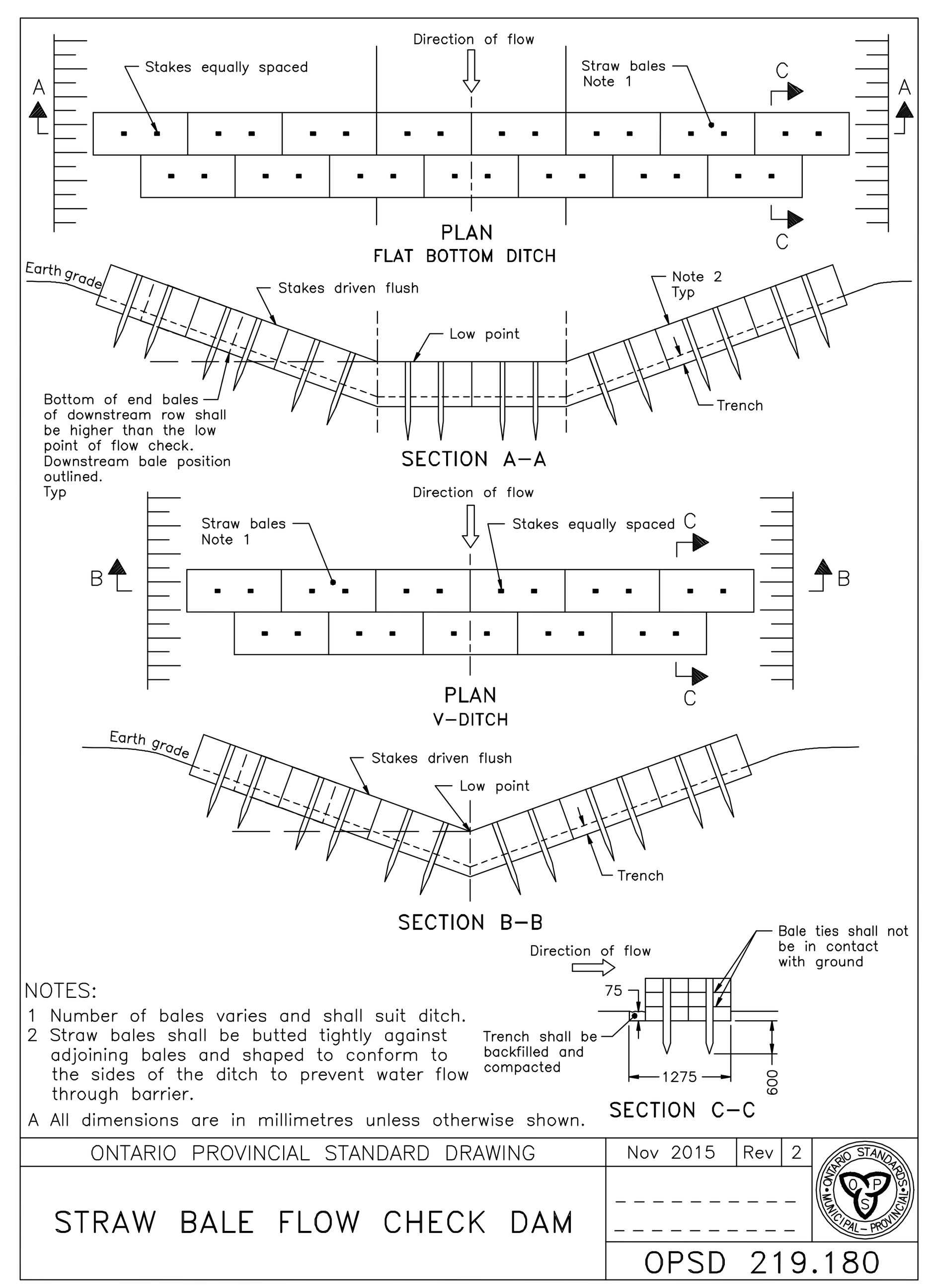


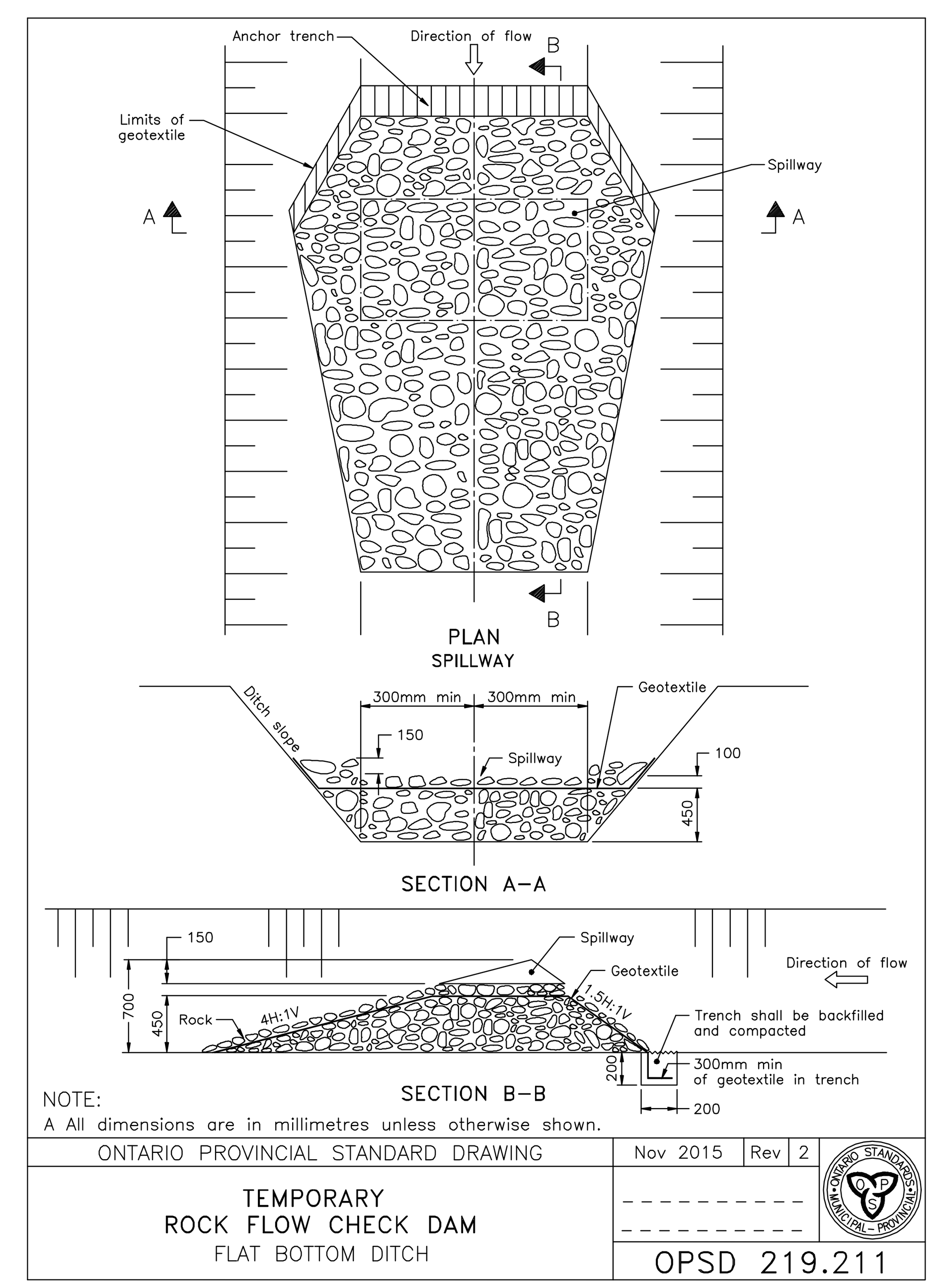
INFILTRATION DITCH WITH 1.0m BOTTOM WIDTH
TO BE USED AT ROCK FLOW CHECK DAMS FOR 20m UPSTREAM AT <1% SLOPE
N.T.S

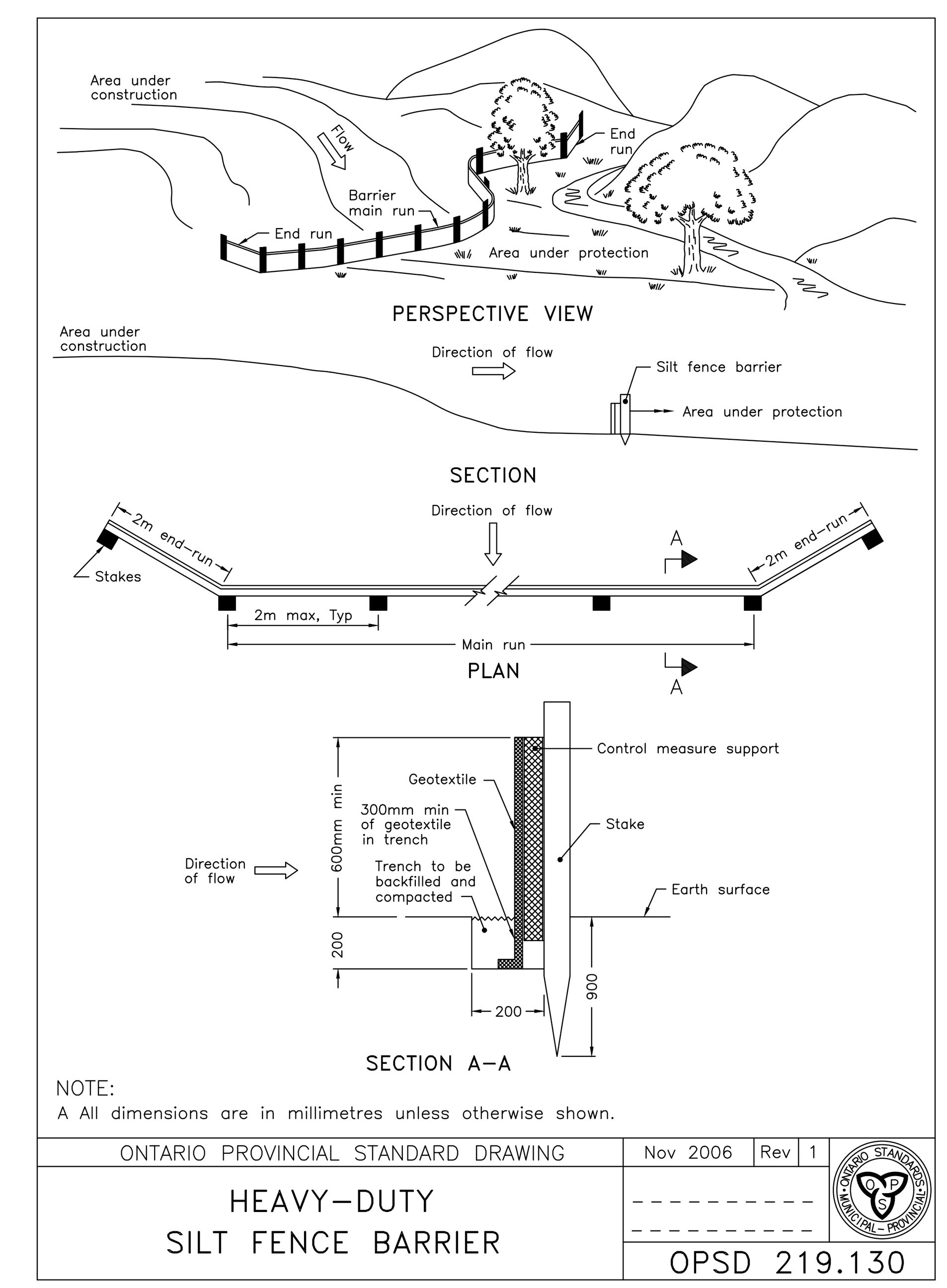


TYPICAL LOT LINE SWALE
N.T.S









REVISION:	No.	DATE	BY
ISSUED FOR APPROVAL	1	AUG 31, 2022	C.S

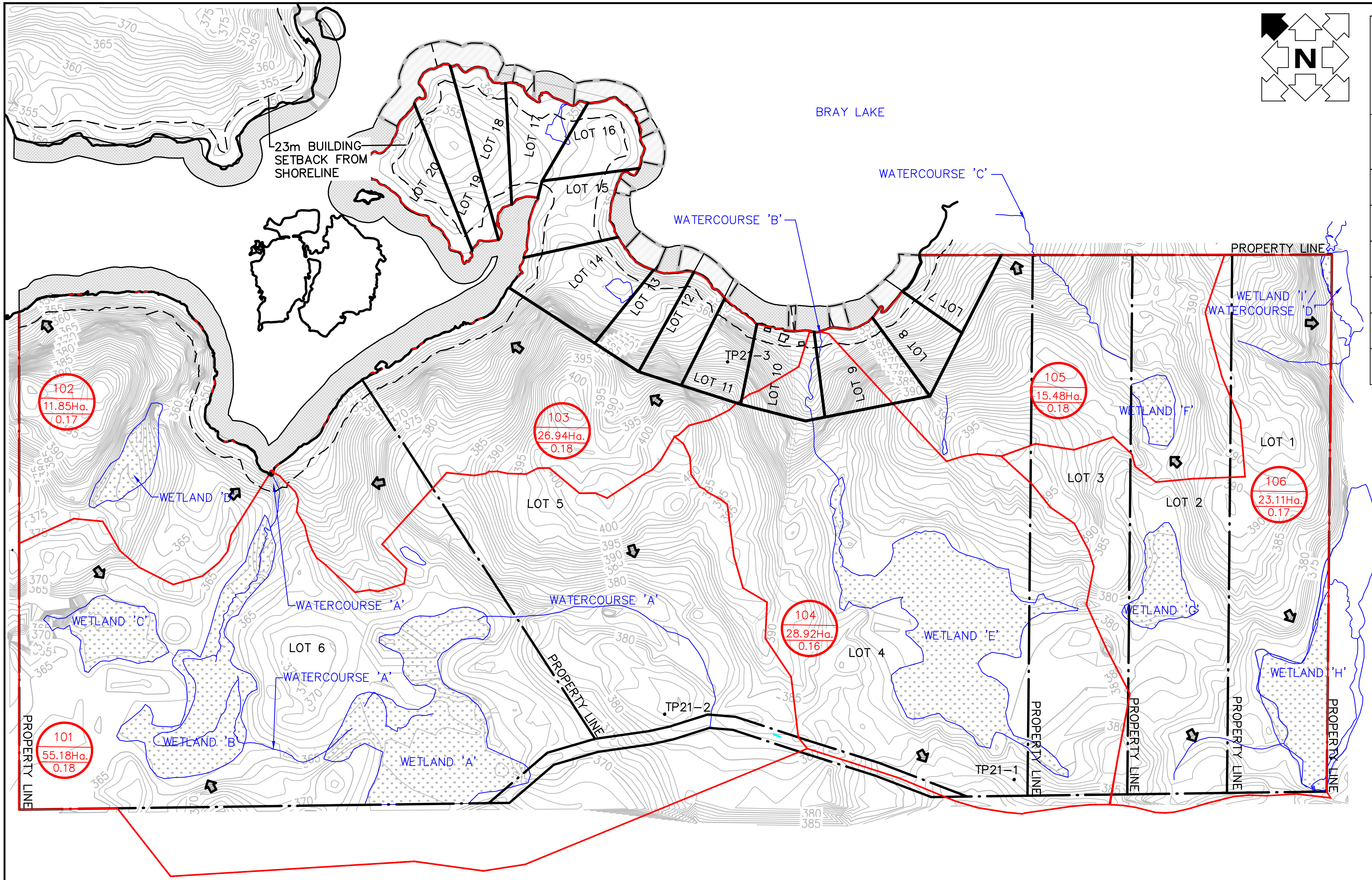
TULLOCH ENGINEERING

BRAY LAKE SUBDIVISION
BRAY LAKE, MACHAR, ON

NOTES & DETAILS

ENGINEER'S SEAL: LICENSED PROFESSIONAL ENGINEER, AUG 31, 2022, C. J. STILWELL, PROVINCE OF ONTARIO

SCALE	1:2500
DRAWN	E.V
CHECKED	C.S/T.M/B.B
DATE	AUG 31, 2022
PROJECT No.	21-1851
SHEET	SWM 2



PRE-DEVELOPMENT STORM WATER CATCHMENT AREAS (ha)

I.D.	CATCHMENT AREA (Ha.)
101	55.18
102	11.85
103	26.94
104	28.92
105	15.48
106	23.11

LICENSED PROFESSIONAL ENGINEER
AUG 31, 2022
C. J. STILWELL
90328063
PROVINCE OF ONTARIO

No.	DATE	BY	ISSUES / REVISIONS
1	AUG 31, 2022	C.S	ISSUED FOR APPROVAL

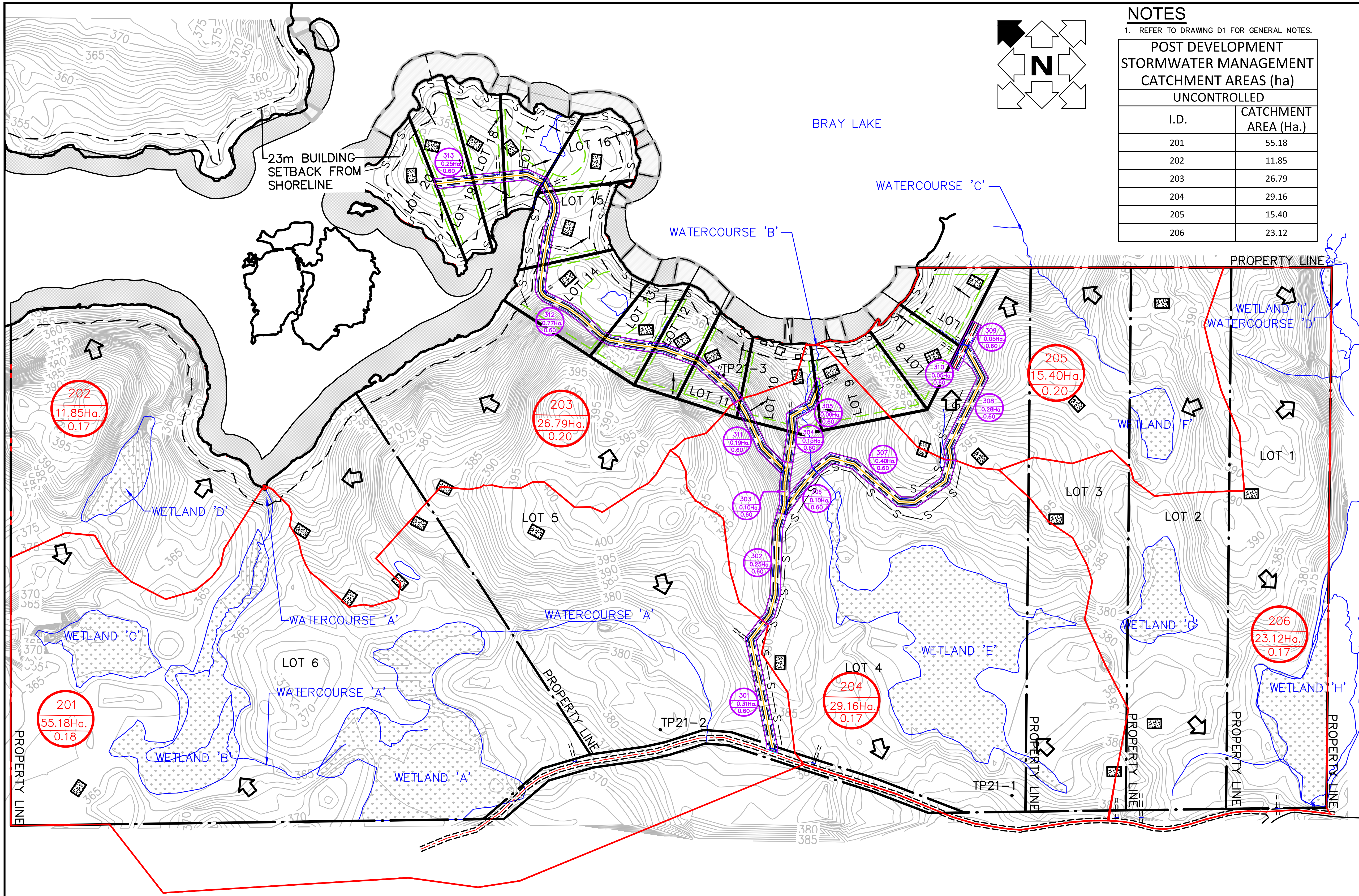
LEGEND
CATCHMENT AREA
AREA (ha)
RUNOFF COEFFICIENT
101
3.99Ha.
0.18
CATCHMENT AREA
PROPERTY LINE
EXISTING CONTOURS
WETLAND
(EXISTING) FLOOD SPILLWAY

TULLOCH ENGINEERING

DRAWING:
BRAY LAKE SUBDIVISION

PROJECT:
STORMWATER PRE-DEVELOPMENT DRAINAGE AREAS

DRAWN BY:	CHECKED BY:	PROJECT No. :
E.V	T.M/B.B	21-1851
DESIGNED BY: T.M/B.B	APPROVED BY: C.S	DRAWING No. D1 / REVISION No. 1
SCALE: 1:6000	DATE: AUG 31, 2022	



NOTES

1. REFER TO DRAWING D1 FOR GENERAL NOTES.

POST DEVELOPMENT STORMWATER MANAGEMENT CATCHMENT AREAS (ha)	
UNCONTROLLED	
I.D.	CATCHMENT AREA (Ha.)
201	55.18
202	11.85
203	26.79
204	29.16
205	15.40
206	23.12

QUALITY CONTROL CATCHMENT AREAS (ha) & WATER QUALITY VOLUME (WQV)			
CONTROLLED			
I.D.	CATCHMENT AREA (Ha.)	(WQV) REQUIRED (m³)	(WQV) DESIGNED (m³)
301	0.31	9.51	11.37
302	0.25	7.67	11.37
303	0.10	3.07	5.68
304	0.15	4.60	5.68
305	0.06	1.84	5.68
306	0.10	3.07	5.68
307	0.40	12.27	17.05
308	0.28	8.59	11.37
309	0.05	1.53	5.68
310	0.05	1.53	5.68
311	0.19	5.83	11.37
312	0.77	23.62	28.42
313	0.25	7.67	11.37

NOTE:
FOR SWMP TYPES AND DESCRIPTIONS SEE PRELIMINARY STORMWATER MANAGEMENT REPORT SECTION 5.6.

LICENSED PROFESSIONAL ENGINEER
AUG 31, 2022
C. J. STILWELL
90308063
PROVINCE OF ONTARIO

No.	DATE	BY	ISSUES / REVISIONS
1	AUG 31, 2022	C.S	ISSUED FOR APPROVAL

LEGEND
200 3.99Ha. 0.18 — CATCHMENT AREA, AREA (ha), RUNOFF COEFFICIENT (C)
305 0.044Ha. 0.60
CATCHMENT AREA
PROPERTY LINE
EXISTING CONTOURS
WETLAND
FLOOD

TULLOCH ENGINEERING

DRAWING: BRAY LAKE SUBDIVISION

PROJECT: **STORMWATER POST-DEVELOPMENT DRAINAGE AREAS**

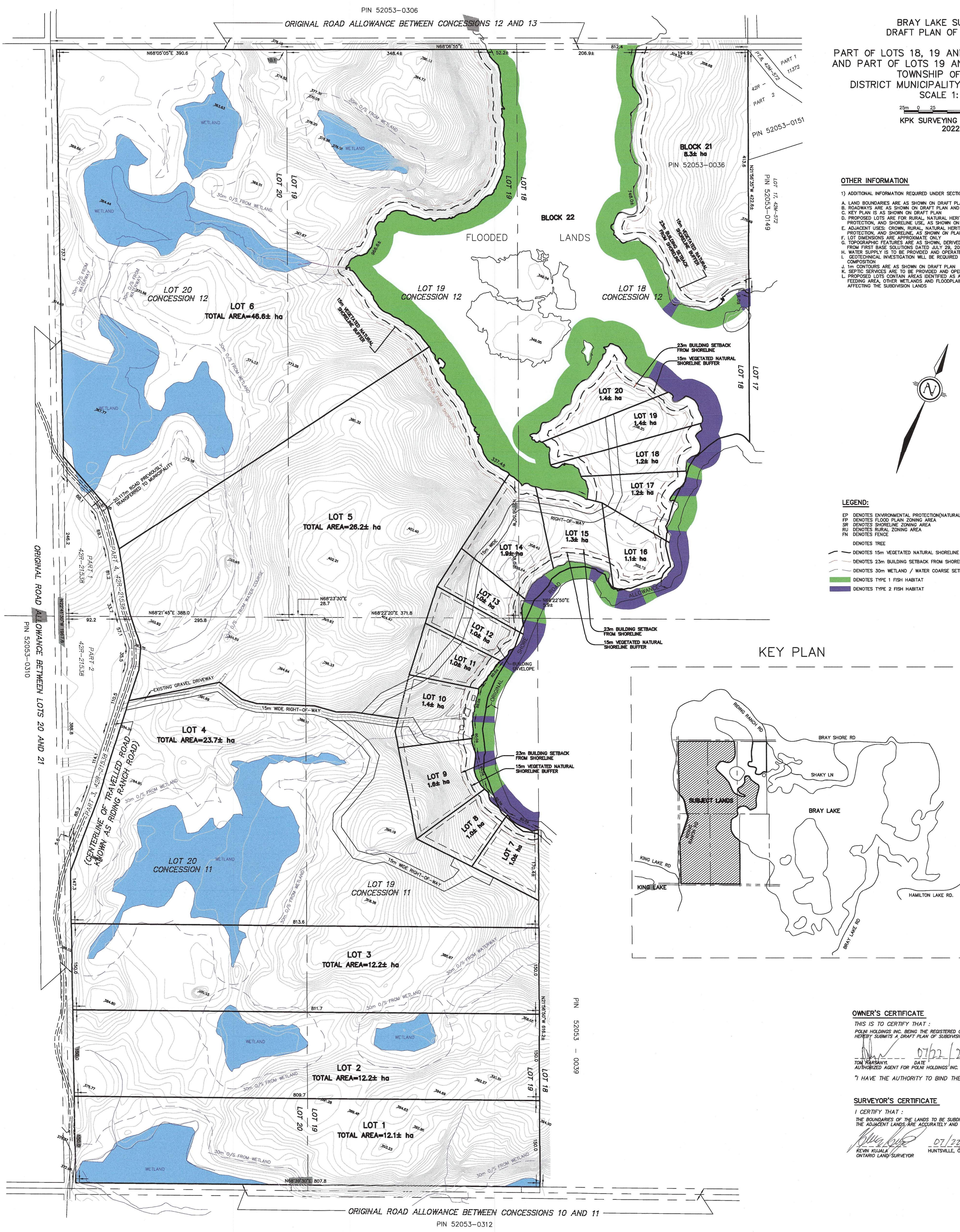
DRAWN BY:	CHECKED BY:	PROJECT No. :
E.V	T.M/B.B	21-1851
DESIGNED BY: T.M/B.B	APPROVED BY: C.S	DRAWING No. D2
SCALE: 1:6000	DATE: AUG 31, 2022	REVISION No. 1

BRAY LAKE SUBDIVISION
DRAFT PLAN OF SUBDIVISION

PART OF LOTS 18, 19 AND 20, CONCESSION 12
AND PART OF LOTS 19 AND 20, CONCESSION 11
TOWNSHIP OF MACHAR
DISTRICT MUNICIPALITY OF PARRY SOUND
SCALE 1:2500

25m 0 25 125m

KPK SURVEYING INC., O.L.S.
2022



OTHER INFORMATION

1) ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT:

A. LAND BOUNDARIES ARE AS SHOWN ON DRAFT PLAN
B. ROADWAYS ARE AS SHOWN ON DRAFT PLAN AND KEY PLAN
C. KEY PLAN IS AS SHOWN ON DRAFT PLAN
D. PROPOSED LOTS ARE FOR RURAL, NATURAL HERITAGE PROTECTION/ENVIRONMENTAL PROTECTION, AND SHORELINE USE, AS SHOWN ON PLAN
E. ADJACENT USES: CROWN, RURAL, NATURAL HERITAGE PROTECTION/ENVIRONMENTAL PROTECTION, AND SHORELINE, AS SHOWN ON PLAN
F. LOT DIMENSIONS ARE APPROXIMATE ONLY
G. TOPOGRAPHIC FEATURES ARE AS SHOWN, DERIVED FROM ORTHO PHOTOGRAPHIC IMAGERY FROM FIRST BASE SOLUTIONS DATED JULY 29, 2020
H. WATER SUPPLY IS TO BE PROVIDED AND OPERATED BY INDIVIDUAL LAND OWNERS
I. GEOTECHNICAL INVESTIGATION WILL BE REQUIRED TO CONFIRM SOIL AND GROUND COMPOSITION
J. 1m CONTOURS ARE AS SHOWN ON DRAFT PLAN
K. SEPTIC SERVICES ARE TO BE PROVIDED AND OPERATED BY INDIVIDUAL LAND OWNERS
L. PROPOSED LOTS CONTAIN AREAS IDENTIFIED AS A WATERCOURSE, MOOSE AQUATIC FEEDING AREA, OTHER WETLANDS AND FLOODPLAIN AS SUCH WILL HAVE RESTRICTIONS AFFECTING THE SUBDIVISION LANDS

LEGEND:

EP DENOTES ENVIRONMENTAL PROTECTION(NATURAL HERITAGE PROTECTION) ZONING AREA
FP DENOTES FLOOD PLAIN ZONING AREA
SR DENOTES SHORELINE ZONING AREA
RU DENOTES RURAL ZONING AREA
FN DENOTES FENCE

DENOTES TREE

DENOTES 15m VEGETATED NATURAL SHORELINE BUFFER

DENOTES 23m BUILDING SETBACK FROM SHORELINE

DENOTES 30m WETLAND / WATER COARSE SETBACK

DENOTES TYPE 1 FISH HABITAT

DENOTES TYPE 2 FISH HABITAT

OWNER'S CERTIFICATE

THIS IS TO CERTIFY THAT :

POLNI HOLDINGS INC. BEING THE REGISTERED OWNERS OF THE SUBJECT LANDS, HEREBY SUBMITS A DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

07/22/22

TOM HARSANYI. *DATE*
AUTHORIZED AGENT FOR POLNI HOLDINGS INC.

"I HAVE THE AUTHORITY TO BIND THE CORPORATION"

SURVEYOR'S CERTIFICATE

I CERTIFY THAT :

THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN ON THIS PLAN

07/22/22

KEVIN KUJALA
ONTARIO LAND SURVEYOR
HUNTSVILLE, ONTARIO

KPK SURVEYING
KPK SURVEYING INC.
HUNTSVILLE, ON
705.788.2701 KPKSURVEY.CA

DRAFTED: SV/KPK	FILE NO: 202405

\2020\202405\PROJECT DRAWINGS\202405 Bray Lake DSP 2500m.DWG

APPENDIX C

Infiltration Based Storage/Rock Flow Check Dam Calculations

Culvert Sizing Calculations

TULLOCH

Project:	Bray Lake Subdivision SWM	Date:	04-Aug-22
File No:	21-1851	Designed:	BB
Subject:	Rock Flow Check Dam Sizing	Checked:	TM/CS
Infiltration Ditch / Rock Flow Check Dam Sizing			

Ditch Characteristics

Channel Depth	Channel Type	Base Width	Side Slopes	Max. Slope
0.70 m	Grass lined	1.00 m	2H : 1V	1.00%

Depth, m	Slope, %	Cross Sectional Area, m^3	Length of Spacing Between Consecutive Check Dams, m	Storage Volume Per Check Dam, m^3
0.55	1.0%	1.16	55	32.38
0.45	1.0%	0.855	45	19.53
0.3	1.0%	0.48	30	7.308
0.2	1.0%	0.28	20	2.842

Water Quality Storage Requirement based on Reciving Waters.				
Catchment ID	Area, Ha	% Imperviousness	Storage Volume for Impervious Level for Infiltration Based Storage(m^3 /Ha)	Required Water Quality Storage Volume (WQV), m^3
301	0.31	57%	30.67	9.51
302	0.25	57%	30.67	7.67
303	0.10	57%	30.67	3.07
304	0.15	57%	30.67	4.60
305	0.06	57%	30.67	1.84
306	0.10	57%	30.67	3.07
307	0.40	57%	30.67	12.27
308	0.28	57%	30.67	8.59
309	0.05	57%	30.67	1.53
310	0.05	57%	30.67	1.53
311	0.19	57%	30.67	5.83
312	0.77	57%	30.67	23.62
313	0.25	57%	30.67	7.67

Note: Storage Volume for Impervious Level (m^3/ha) was interpolated from Table 3.2 in the MECP Stormwater Management

% Imperviouss was determined from $\%_{imp}$=(C-0.2)/0.7 found in Section 7.2 of the City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines, 2020.

Catchment ID	Area, Ha	Required Water Quality Storage Volume (WQV), m^3	0.2 m Depth Storage Volume at One (1) Rock Flow Check Dam with Upstream Slope of 1%, m^3	Number of Check Dams Required	Number of Check Dams Designed	Total Volume of Designed Number of Check Dams, m^3
301	0.31	9.51	2.842	4	4	11.37
302	0.25	7.67	2.842	3	4	11.37
303	0.10	3.07	2.842	2	2	5.68
304	0.15	4.60	2.842	2	2	5.68
305	0.06	1.84	2.842	1	2	5.68
306	0.10	3.07	2.842	2	2	5.68
307	0.40	12.27	2.842	5	6	17.05
308	0.28	8.59	2.842	4	4	11.37
309	0.05	1.53	2.842	1	2	5.68
310	0.05	1.53	2.842	1	2	5.68
311	0.19	5.83	2.842	3	4	11.37
312	0.77	23.62	2.842	9	10	28.42
313	0.25	7.67	2.842	3	4	11.37

Note: Rock Flow Check Dams to be installed in accordance with OPSD 219.211.

	SHEET	TULLOCH ENGINEERING	DATE:	04-Aug-22
TULLOCH	1	Bray Lake Subdivision SWM - 21-1851	DESIGN/CHECK:	BB/TM
		Culvert Design Sheet - 25 Year Cross Culverts - 5 Year Entrance Culverts	PROJECT NO:	21-1851

Equations and Constants

Peak Flow

$Q = 0.00278 \cdot A \cdot i \cdot C$

where: A = catchment area (ha)
i = 100 yr rainfall intensity (mm/h)
C = weighted runoff coefficient

Source: *MTO DMM Equation 8.19*

Hydraulic Radius

$R = \frac{D}{4}$

where: D = Pipe diameter

Source: *MTO DMM Design Chart 2.29*

Full Pipe Velocity

$V = \frac{R^{0.667} S^{0.5}}{n}$

where: R = Hydraulic Radius
S = Pipe Slope
n = Manning's n

Source: *MTO DMM Design Chart 2.29*

Pipe Capacity

$Q_{full} = V \cdot area$

where: V = Velocity
area = πr^2

Source: *MTO DMM Design Chart 2.29*

Bransby-Williams Formula

$T_c = \frac{0.057 \cdot L}{S_w^{0.2} \cdot A^{0.1}}$

where: L = Watershed length
S_w = Watershed slope
A = Watershed area

Source: *MTO DMM Design Equation 8.15*

Airport Formula

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

where: L = Watershed length
S_w = Watershed slope
C = Runoff coefficient

Source: *MTO DMM Design Equation 8.16*

Manning's n

Smooth-walled HDPE = 0.012

Source: *MTO GPD Guidelines Appendix C*

Runoff Constants

Woodland Hilly (Sandy Loam) =	***0.25***
Lake/Wetlands =	***0.05***
Gravel Roadway =	***0.60***
Landscaped Areas (Septic Filter Bed) =	***0.10***
Rural Residential =	***0.30***
Asphalt Roadway =	***0.88***

Source: *MTO DMM Design Chart 1.07*

Weighted Runoff Constant

$C_w = \frac{(C_1A_1)+(C_2A_2)+...}{A_{total}}$

where: 1, 2,.. = Drainage sub-areas

Source: *MTO DMM Design Equation 8.10*

Rainfall Intensity (i)

Interpolated values from MTO IDF Curve Lookup Tool for Huntsville

Source: http://www.mto.gov.on.ca/IDF_Curves

LOCATION		DRAINAGE AREA				RUNOFF				PIPE SELECTION								
Catchment Area	Street	Area (A) (ha)	Cum. Area (A) (ha)	Weighted Runoff C (const.)	A*C (ha)	T_c (min)	i (mm/h)	$Q_{catchment}$ (m^3/s)	Q_{total} (m^3/s)	Pipe Length (m)		Pipe Slope (m/m)	Pipe Diameter (m)	Hydraulic Radius (m)	Full Pipe Velocity (m/s)	Pipe Capacity (m^3/s)	% Capacity	Actual Velocity (m/s)
201	Pvt. Rd. Culvert Between Lot 4/5 at Riding Ridge Road Intersection.	55.18	55.18	0.20	11.04	106.89	28.37	0.87	0.87	12.0		0.020	0.600	0.150	3.32	0.94	0.93	3.82
203	Pvt. Rd. Culvert, Between Lot 16/17 at Station 2+648.	26.79	26.79	0.22	5.89	24.14	78.72	1.29	1.29	10.0		0.040	0.600	0.150	4.70	1.33	0.97	5.45
204	Pvt. Rd. Culvert, Between Lot 4/5 at Station 1+377.	29.16	29.16	0.19	5.54	69.89	37.31	0.57	0.57	23.0		0.040	0.450	0.113	3.88	0.62	0.93	4.46
204	Pvt. Rd. Culvert, Between Lot 4/5 at Station 1+433.	29.16	29.16	0.19	5.54	69.89	37.31	0.57	0.57	12.0		0.040	0.450	0.113	3.88	0.62	0.93	4.46
204	Pvt. Rd. Culvert Between Lot 9/10 at Station 1+541.	29.16	29.16	0.19	5.54	69.89	37.31	0.57	0.57	10.0		0.040	0.450	0.113	3.88	0.62	0.93	4.46
204	Pvt. Rd. Culvert Within Lot 4 at Station 3+081.	29.16	29.16	0.19	5.54	69.89	37.31	0.57	0.57	10.0		0.040	0.450	0.113	3.88	0.62	0.93	4.46
205	Pvt. Rd. Culvert Within Lot 4 at Station 3+529.	15.40	15.40	0.22	3.39	38.50	58.16	0.55	0.55	12.0		0.040	0.450	0.113	3.88	0.62	0.89	4.42
205	Pvt. Rd. Culvert Between Lot 4/7 at Station 3+535.	15.40	15.40	0.22	3.39	38.50	58.16	0.55	0.55	12.0		0.040	0.450	0.113	3.88	0.62	0.89	4.42
201	All Entrance Culverts in Catchment 201.	55.18	55.18	0.18	9.93	109.08	19.56	0.54	0.54	6.0		0.035	0.450	0.113	3.63	0.58	0.94	4.18
203	All Entrance Culverts in Catchment 203.	26.79	26.79	0.20	5.36	23.90	60.05	0.89	0.89	6.0		0.040	0.525	0.131	4.30	0.93	0.96	4.99
	Lot 16 Entrance Culvert	0.77	0.77	0.60	0.46	30.24	45.80	0.06	0.06	6.0		0.005	0.450	0.113	1.37	0.22	0.27	1.13
	Lot 19 Entrance Culvert	0.25	0.25	0.60	0.15	8.59	117.59	0.05	0.05	6.0		0.005	0.450	0.113	1.37	0.22	0.22	1.07
204	All Entrance Culverts in Catchment 204.	29.16	29.16	0.17	4.96	71.22	27.12	0.37	0.37	6.0		0.020	0.450	0.113	2.74	0.44	0.86	3.10
	Lot 7 Entrance Culvert	0.05	0.05	0.6	0.03	3.41	160.20	0.01	0.01	6.0		0.005	0.450	0.113	1.37	0.22	0.06	0.71
205	All Entrance Culverts in Catchment 205.	15.40	15.40	0.2	3.08	39.36	40.52	0.35	0.35	6.0		0.020	0.450	0.113	2.74	0.44	0.79	3.06
206	All Entrance Culverts in Catchment 206.	23.12	23.12	0.17	3.93	51.30	33.48	0.37	0.37	6.0		0.020	0.450	0.113	2.74	0.44	0.84	3.09

Notes:

Cross culvert flows are based on a 25-year storm event.

Entrance culvert flows are based on a 5-year storm event.

DMM- Drainage Management Manual, GPDG- Gravity Pipe Design Guidelines

Total post-development 200-series catchment flows were used for preliminary culvert sizing calculation to determine acceptability of minimum 450 mm culvert diameters.

APPENDIX D

Tulloch Private Sewage System Assessment and Geotechnical Soils Assessment with Preliminary Recommendations

Ministry of Northern Development, Mines, Natural Resources, and Forestry – Surficial Geology Map and Legend

Ministry of Agriculture, Food, and Rural Affairs – Hydrologic Soil Group Map

Ontario Power Generation – Bray Lake Water Elevation Observations and Water Management Plan Limits

TULLOCH
ENGINEERING

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huntsville@TULLOCH.ca
WWW.TULLOCH.ca

Polni Holdings
P.O. Box 910 King City,
On L7B 1A9

August 31, 2022

C/O: JPG Planning, Mr. John Gallagher, RPP.

Re: Preliminary Review for Private Sewage Disposal Assessment
Bray Lake Subdivision Development
Machar, Ontario

Further to your request, Tulloch Engineering has reviewed the draft subdivision lands and offers the following opinion regarding use of private sewage systems on the proposed lots as demonstrated on Tulloch's Preliminary Stormwater Management, Private Sewage Disposal Assessment and Construction Mitigation Plan – SWM1, dated August 31, 2022.

Tulloch visited the development site in January 2022 and reviewed the proposed building envelopes on each of the twenty-three proposed lots to determine suitability for private sewage system construction. It was noted that much of the terrain is rocky and hilly terrain with shallow soils over bedrock. A desk top review of available online soils mapping information in the area indicates the following conditions:

The Ministry of Northern Development, Mines, Natural Resources, and Forestry Ontario Geological Survey Surficial Geology Map for the Bray Lake Area shows local surficial geology along the Bray Lake west shoreline and surrounding area as follows:

- The north, west, and east portion of the subject property is Type 2a, bedrock drift complex in Precambrian terrain, primarily till cover.
- The central portion of the subject property is Type 5a, silty sand to sand-textured till on Precambrian terrain.
- The southwest portion of the subject property is Type 9, coarse-textured glaciolacustrine deposits consisting of sand, gravel, minor silt and clay.

Utilizing Design Chart 1.08 in the Ministry of Transportation Drainage Management Manual, 1997, all subject site soils were determined to be a hydrologic soil group, *HSG,* 'B'. The Ontario Ministry of Agriculture, Foods, and Rural Affairs online tool AgMaps confirmed a HSG of 'B'. A surficial geology map of the site from the Ontario Geological Survey information, and a HSG map of the site from the OMAFRA AgMaps tool has been attached.

Tulloch also completed an in-situ soil investigation to verify soil conditions. The sand-gravel till soils type generally identified with soil depths varying from 0.55 m to 1.3 m over bedrock. A visual inspection of the site verified shallow sand and till overlying bedrock. A geotechnical soils assessment memo has been attached for reference to the findings.

Tulloch's assessment of the proposed lot layout for the suitability of private sewage systems is as follows:

- With proposed lot sizing ranging between approximately 1.0 ha to 1.9 ha for the smaller waterfront lots, and 12 ha - 47 ha for the larger lots there is sufficient lot area on each lot to accommodate a private sewage system while adhering to required setbacks;
- The private sewage systems will need to comply with Part 8 of the Ontario Building code, being designed and installed by a licensed sewage system installer under OBC requirements;
- Domestic water supplies shall be located up gradient of sewage system locations by a minimum 15 m distance for drilled wells with casings and 30 m for dug wells as indicated by the OBC.
- Where bedrock outcrops and ecologically sensitive areas occur within the lots, the private sewage system may require a tertiary treatment system solution to minimize footprint and impact of the system. A tertiary treatment solution can be achieved within the OBC Part 8 criteria;
- Preliminary filter bed envelopes have been indicated on each of the proposed lots that meets the requirements for a Class 4F raised filter bed. Due to the nature of shallow overburden soils over bedrock, it is expected that a private sewage system solution will include a raised filter bed, sewage pump chamber and septic tank treatment unit as a minimum. Typical 50 square metre filter bed envelopes have been identified on each lot as shown on the Preliminary Stormwater Management Plan – SWM1 as attached. Alternative filter bed envelopes have also been provided on the larger Lots 1-6. Final design will need to be completed at the building permit stage for the appropriate sizing of each private sewage system.

We trust this will assist you with your current draft plan approvals. Please contact the undersigned if you require further information or clarification in the above regard.

Respectfully Submitted:
TULLOCH ENGINEERING INC

Prepared by:

Ben Belfry, E.I.T
Engineer In Training
ben.belfry@tulloch.ca

Reviewed by:

Ted Maurer, C.E.T.
Project Manager
ted.maurer@tulloch.ca

Approved by:

Chris Stilwell, P. Eng.
Principal and Senior Project Manager
chris.stilwell@tulloch.ca

Attached:

- Preliminary Stormwater Management, Private Sewage Disposal Assessment and Construction Mitigation Plan – SWM1, dated August 31, 2022.
- Geotechnical Soils Assessment and Preliminary Recommendations for the Proposed Bray Lake Subdivision in Machar, Ontario, dated August 30, 2022.
- Ministry of Northern Development, Mines, Natural Resources, and Forestry – Surficial Geology Map and Legend.
- Ministry of Agriculture, Food, and Rural Affairs – Hydrologic Soil Group Map.
- Ontario Power Generation – Bray Lake Water Elevation Observations and Water Management Plan Limits.

M E M O R A N D U M

Date: Tuesday, August 30, 2022

To: Mr. Tom Harsanyi
Polni Holdings
P.O. Box 910
King City, Ontario
L7B 1A9

From: Erik Giles, P.Eng.

CC: Ted Maurer, C.E.T.

RE: Geotechnical Soils Assessment and Preliminary Recommendations for the Proposed Bray Lake Subdivision in Machar, Ontario

Dear Mr. Harsanyi,

This memorandum documents TULLOCH's findings from the preliminary geotechnical site investigation conducted on November 22nd, 2021, for the proposed Bray Lake Subdivision development located in Machar, Ontario. This memorandum details the findings of the geotechnical investigation, supplemental laboratory testing of select soil samples and provides preliminary recommendations as it pertains to geotechnical foundation design and construction considerations. Recommendations are based on the findings of the investigation in conjunction with visual assessment of soils observed during the investigation and on inference between test pits. A plot summarizing the Dynamic Cone Penetrometer (DCP) results as well as the results of the laboratory testing and a site photo log are attached to the memorandum.

1. SUBSURFACE CONDITIONS ON SITE CONDITIONS

A series of four shallow test pits referenced as TP21-01 to TP21-04 were excavated to help support a hydrogeological investigation across the property. TP21-01 to TP21-03 were left open for investigation and soils examination by TULLOCH. Table 1-1 shown below contains the approximate coordinates of the three test pit locations. Coordinates were taken by a handheld GPS with an accuracy of ±3 m. A site plan indicating the Test Pit Locations is attached to this memorandum.

Table 1-1: Test Pit Summary

Test Pit No.	Test Pit Location		Refusal Depth (mbgs) [1]
	Northing (m)	Easting (m)	
TP21-01	5083288	616580	1.2
TP21-02	5083814	616479	1.2
TP21-03	5083929	617008	0.9

Note(s):[1]mbgs = meters below ground surface

Samples were also collected by the hydrogeological investigation in-situ and were provided for index testing by TULLOCH to help categorize the soils within the test pit. Dynamic Cone Penetrometer tests were conducted where possibly from ground surface beside each test pit to help understand the compactness of the surficial soils for foundation recommendations. DCP testing could not be completed in TP21-03 due to shallow refusal on inferred bedrock. DCP testing results are attached to this memorandum.

Test pits were excavated to refusal at each location ranging from 0.9 m below ground surface (mbgs) in TP21-03 and to approximately 1.2 mbgs in TP21-01 and TP21-02. A hard bottom was encountered at all test pits with both the DCP and hand probe meeting refusal on a hard surface. Refusal of this nature infers a shallow bedrock although it could not be confirmed due to the standing water and lack of bedrock coring. subsurface soils were relatively uniform across the test pits typically consisted of a sandy topsoil with organics at ground surface ranging in thickness form 0.2 m to 0.3 m. Below the topsoil a well graded sand to silty sand with some gravel was encountered, the material was brown in colour, non-cohesive and generally moist. This material extended the depth of all test pits that were examined on site. Beneath the topsoil in TP21-04 a sandy silt with trace clay was found, this material was found to also be non-cohesive and was wet with free standing water observed in the sample bag. This material was examined from the retrieved sample taken during the hydrogeological investigation, TP21-04 was backfilled prior to TULLOCH's arrival on site and further examination was not possible. It should be noted that throughout all test pits a significant fraction of cobbles and boulders was observed throughout the soil stratum. Visible bedrock knobs were observed on both sides of the access road in the areas of high relief. A wet creek area was also observed south of the existing access road and was observed to run down towards Bray Lake, from visual examination surficial soils appeared to contain organics and were soft underfoot.

Representative laboratory testing was conducted on select samples obtained from TP21-02 through TP21-04. Moisture content testing was conducted on the sand to silty sand samples in TP21-02 and TP21-03 and ranged from 17% to 23.9%. The elevated water contents are likely due to the saturated nature of the soils from the open test pits at the time of TULLOCH's arrival. The sandy silt material in TP21-04 yielded a moisture content of 42.6%. Particle size distribution testing was conducted on the silty sand to sand material in TP21-02 and TP21-03 which yielded a particle size distribution ranging from of 6.3% to 24.4% gravel, 46.3% to 67.7% sand and 29.3% to 26% fines.

Particle size distribution for the sandy silt encountered at TP21-04 yielded a particle size distribution of 0% gravel, 32.6% sand, 63.9% silt and 3.5% clay.

Atterberg limits testing was conducted on the recovered silt sample from TP21-04, upon examination for the test the material was found to be non-plastic.

Based on the DCP test results conducted on the native sand to silty sand soils exposed below the topsoil, the in-situ density of the sandy soils were generally found to be compact and often met with early refusal on likely cobbles and boulders and/or shallow bedrock.

With respect to ground water all test pits were found to have standing water within each excavation. The water was bailed, and generally significant seepage was not observed however soil conditions were saturated and it was difficult to determine a ground water level. Given the above, it is likely that the water observed was accumulated surface water that had run into the open excavations, and ground water where present would be near the shallow bedrock interface. Higher near surface ground water is likely in the low-lying wet areas near the creek where ponded water was observed at ground surface. For a more detailed opinion on ground water levels the hydrogeological report prepared by others should be consulted for confirmation as the test pits were freshly excavated at that time and observation with respect to seepage and inflow would be more apparent. It should be noted that groundwater level is subject to seasonal fluctuations with high levels occurring during wet weather conditions in the spring and fall and lower levels during dry weather conditions. As such additional precautions should be taken for ground water management if necessary.

2. GEOTECHNICAL RECOMMENDATIONS

2.1. General

This section of the memorandum provides guidelines on the geotechnical design aspects of the project based on the visual examination of in-situ soils presented above, the laboratory testing on select soil samples and the DCP data taken across the site. The recommendations included in this section are preliminary in nature and intended to provide guidance to the Client with respect to the foundation design and other geotechnical components of the project. Additional geotechnical investigation is recommended prior to detailed design to help better characterize the subsurface conditions of the site. The construction recommendations are intended to provide preliminary information regarding geotechnical concerns and issues during construction. Contractors bidding on or undertaking the construction should make their own interpretation of the provided subsurface information with respect to their planned construction methods, equipment selection, scheduling, and the like.

While site plans have not been provided, it is TULLOCH's understanding that the buildings will consist of relatively lightly loaded residential structures that will be applicable to Part 9 of the Ontario Building Code. Placement of the proposed structures is not known at this time, and it is recommended that the site plans be shared with TULLOCH further in development to help create an appropriate scope of work to provide additional geotechnical input and help verify/confirm the assumptions made in this report.

Based on the limited investigation and site overview it is anticipated that shallow bedrock will exist along the majority of the site particularly in areas of high relief, given the sloping nature of the site and visible bedrock/ shallow refusal in test pits it is likely that a significant cut/fill balance will be required including blasting to create appropriate foundation pads for the proposed development. The low-lying wet area is not recommended for construction without further investigation it is likely that poorer soils and a high water table will exist in this area which could be problematic for construction.

2.2. Foundation Recommendations

Based on the results of the subsurface investigation, foundations for various single-story buildings can be founded on conventional spread or strip style footings either on the native silty sand to sand soils, on competent bedrock, or on compacted fill placed on competent bedrock. The footing size can be determined based on the applied loads on the foundation. The loading information was not available to the geotechnical engineer at the time of writing this report. The designers should share the loading information and anticipated structures and locations with the geotechnical engineer when available. This section provides preliminary estimated bearing capacity of shallow foundations placed on the undisturbed native sand to silty sand materials as well as on competent rock/engineered fill on competent rock.

A conservative estimate for bedrock bearing capacity was given from engineering experience within the area, however, it should be noted that bedrock was not confirmed or inspected for competence as part of the investigation. Foundations placed directly on bedrock should be dowelled/pinned to the rock to prevent sliding. Further detail can be discussed once design drawings have been provided.

For the bearing capacities for engineered fill on rock the perched foundations should consist of a well compacted granular pad consisting of either OPSS 1010 Granular Type A, B Type II or approved equivalent.

Table 2-1 summarizes the recommended design Ultimate limit State (ULS) and Serviceability Limit State (SLS) for the various bearing conditions discussed above. In determining the settlement characteristics of the proposed building, the SLS loads are required to be provided by the Structural or Design Engineer. At the time of preparing this report, information about the foundation settlement tolerance, or the footing size and embedment was not available to TULLOCH. As such, the geotechnical reaction at SLS was determined assuming that 25 mm of total settlement is acceptable. Foundation calculations are based on a minimum embedment of 1.2 m with foundations ranging in width from 0.5 to 1.0 m. If the design requires larger foundations, TULLOCH should be contacted to revise the recommendations.

Table 2-1: Bearing Capacity for Shallow Foundations

Limit State	Bearing Capacity (kPa)
ULS – Sand to Silty Sand	150
SLS – Sand to Silty Sand	100
ULS Competent Bedrock	300
SLS Competent Bedrock	Does not govern
ULS – Granular Pad over Competent Rock	250
SLS – Granular Pad over Competent Rock	150

It should be noted that care should be taken for foundations partially on bedrock and on soil due to the potential for differential settlement at the interface between the two media. Mitigation measures should be considered if such arrangements cannot be avoided. Generally, if there is not a minimum of 0.5 – 1.0 m of native competent sand to silty sand soil cover under foundation footprints to ensure a uniform foundation pad, it is recommended that the soil be removed down to the bedrock surface and foundations be placed either directly onto bedrock or on compacted engineered fill.

Further geotechnical investigation is recommended to confirm the results in Table 2-1.

2.3. Foundation Preparation Soils

The design specifications must include the following recommendations regarding preparation of subgrade for placement of concrete for the foundation.

- All topsoil including existing topsoil, any organics, deleterious material and or saturated material must be removed from the subgrade. This would also include removal of any oversize particles such as large cobbles or boulders within foundation footprints.
- If material at the bottom of the excavation for the foundation is disturbed, it must be recompacted to its original density or 95% of the standard proctor maximum dry density (SPMDD).
- If any soft spots are detected, the material must be sub-excavated and replaced with compacted Granular A to 95% SPMDD.
- The subgrade should be compacted in the dry with no presence of excess water in the material. If the material is dryer than the optimum moisture content, water must be added prior to compaction to ensure the subgrade material is within 2 percent of the optimum moisture content.
- The subgrade and any fill shall be kept from freezing.
- All subgrade material shall be inspected and certified by a professional geotechnical engineer or their representative to verify the subgrade are reflective of the soils encountered and discussed in this memorandum. Inspection should take place prior to forming and the placement of concrete. If significant variation in soils are encountered additional engineering input will be required.

2.4. Foundation Preparation Bedrock

The design specifications must include the following recommendations regarding preparation of rock subgrade for placement of foundation concrete.

- All weathered, fragmented, or loose rock either from blasting or excavation should be scaled and removed to expose competent rock with a rock mass quality of fair to good as deemed by a geotechnical engineer.
- Upon completion of construction the surface should be thoroughly cleaned, and pressure washed to ensure the rock surface is free of dirt, debris, standing water, snow, or other deleterious materials.
- If the rock is found to be undulating lean concrete (min 5 MPa strength) should be added to level the foundation area for proper placement of concrete.
- The exposed and cleaned bedrock surface shall be inspected by a geotechnical engineer or their representative to determine the competency and cleanliness of the exposed rock. Construction of foundations may not commence until the bedrock subgrade surface has been certified by the geotechnical engineer in writing.

If significant pitting, undulation, or fissures are encountered after exposure of the bedrock surface the use of dental concrete may be required. TULLOCH should be contacted to provide further guidance if required/deemed necessary upon exposure.

2.5. Frost Protection

The estimated frost penetration depth at the site is 1.8 m as per OPSD 3090.101, as such, all exterior footings and footings in unheated areas placed on native soils should be situated at 1.8 m below ground surface to provide adequate insulation against frost heaving. Permanently heated structures may place footings at an estimate of 1.4 m. Alternatively, insulation equivalent or soil cover can be used to raise the frost line. If shallower embedment is needed, Expanded Polystyrene (EPS) insulation or equivalent can be designed to prevent frost action. If the insulation material is expected to take any load, the design engineer should check the product specification(s) from the manufacturer and ensure the selected product(s) satisfy the expected loading conditions.

2.6. Open Cut Excavations

Excavation safety and the stability of temporary construction slopes and excavation support systems are the Contractor’s responsibility. Where workers must enter excavations deeper than

1.2 m, the trench excavations must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act (OHSA), Ontario Regulation 213/9, Construction Projects, January 1, 2010, Part Ill - Excavations, Section 226. Alternatively, the excavation walls should be supported by engineered shoring, bracing, or trench boxes complying with Sections 235 to 239 and 241 under 0. Reg. 231/91, s. 234(1).

Based on the OHSA, the in-situ native soils may be classified as Type 3 soils above the groundwater table. As the groundwater table was not encountered during the limited scope of this investigation, the in-situ soils are to be classified as Type 4 soils below the water table, if encountered during construction. Temporary excavation side slopes in Type 3 soils should remain stable at a slope of 1H:1V. Temporary excavation side slopes in Type 4 soils should remain stable at a slope of 3H:1V. The in-situ soils can be excavated using conventional earthmoving equipment.

Exposed bedrock faces should be scaled of all loose rock and inspected to help determine the safe cut angle. For reference a strong competent bedrock may be stable under temporary conditions at an approximate slope of 4V:1H.

2.7. Groundwater and Surface Water Control

Groundwater did not appear to be encountered during the investigation, however if soils become saturated de-watering will be required. It is anticipated that sump and pump techniques should be sufficient for de-watering excavations that can be limited to less than 0.3 m below the water table. It is likely that the soil/bedrock boundary will provide a preferential conduit for water as such management of seepage along the bedrock face should be anticipated. Furthermore, due to the steep topography and hilly terrain site surface water management will be important for excavations. Surface water should be shed away from open excavations and positive drainage should be promoted away from foundations and excavations during construction. The actual dewatering methods should be established at the contractor's discretion within the context of a performance specification of the project while following any applicable guidelines and rules under the Ontario Water Resource Act and the Water Taking and Transfer Regulation 387/04.

2.8. Reuse of Existing Fill

The sandy to silty native soils encountered during the investigation may be re-used as general fills. However due to a fines content in excess of 10% the material is likely frost susceptible and should not be used in areas where long term settlement is of concern including structural fills. Environmental sample testing was not part of the scope of this project; however, the contractor must be prepared to test excavated material per Ontario Regulation 406/19 “Excess Soil Management”. Furthermore, soil disposal is considered outside the scope of this document. If required TULLOCH can provide further guidance with respect to excess soils management.

3. CLOSURE

This memorandum has been prepared for the exclusive use of the Polni Holdings. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering, for the proposed building. Classification and identification of soils, and geologic units have been based upon by visual inspection only and commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood.

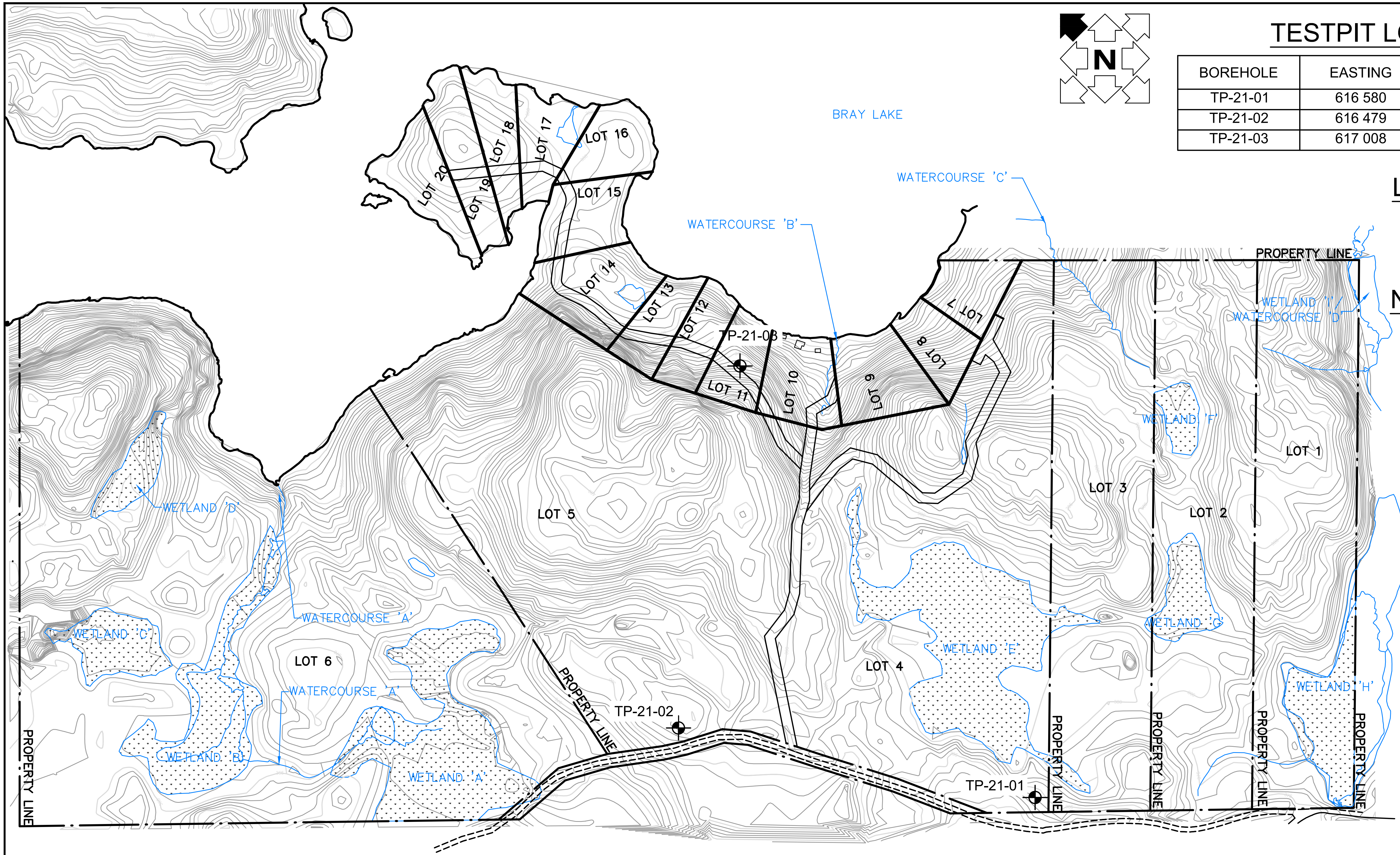
We trust that the information and recommendations in this memorandum will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

Sincerely,

Erik Giles, P. Eng.
Geotechnical Engineer

Attachment(s)/Enclosure: Site Plan, Site Photo Logs, Laboratory Testing, DCP Results, Notice to Reader

Site Plan



TESTPIT LOCATIONS

BOREHOLE	EASTING	NORTHING	ELEVATION
TP-21-01	616 580	5 083 288	385.97
TP-21-02	616 479	5 083 814	384.08
TP-21-03	617 008	5 083 929	372.09

LEGEND:

TP-21-01 TESTPIT INVESTIGATIONS

NOTES:

1. CO-ORDINATES ARE IN UTM ZONE 17 (NAD83 CSRS).

No.	DATE	BY	ISSUES / REVISIONS
1	2022-08-29	DAM	PROPERTY BOUNDARIES UPDATED
0	2022-08-04	K.K	ISSUED FOR USE
A	2022-08-04	K.K	ISSED FOR INTERNAL REVIEW

TULLOCH ENGINEERING

PROJECT: BRAY LAKE SUBDIVISION

DRAWING: **GEOTECHNICAL INVESTIGATION PLAN**

DRAWN BY:	CHECKED BY:	PROJECT No. :	
K.K	E.G.	21-1851	
DESIGNED BY: E.G.	APPROVED BY: E.G.	DRAWING No. G-01	REVISION No. 1
SCALE: 1:6000	DATE: 2022-08-04		

Site Photo Logs

Photo 1: TP21-01 Excavated from previous investigation – standing water in bottom of test pit.

Photo 2: TP21-01 note large boulders in test pit at time of investigation.

CLIENT Polni Holdings		PROJECT Bray Lake Subdivision	
CONSULTANT TULLOCH ENGINEERING	YYYY-MM-DD: 2022-02-16	TITLE **Soil Assessment**	
	PREPARED: E.Giles		
	DESIGNED: E.Giles		
	REVIEWED: T. Maurer	PROJECT NO. **21-1851**	Phase/Task
	APPROVED: T. Maurer	Rev. **Rev 0**	FIGURE **1**

25 mm
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
0

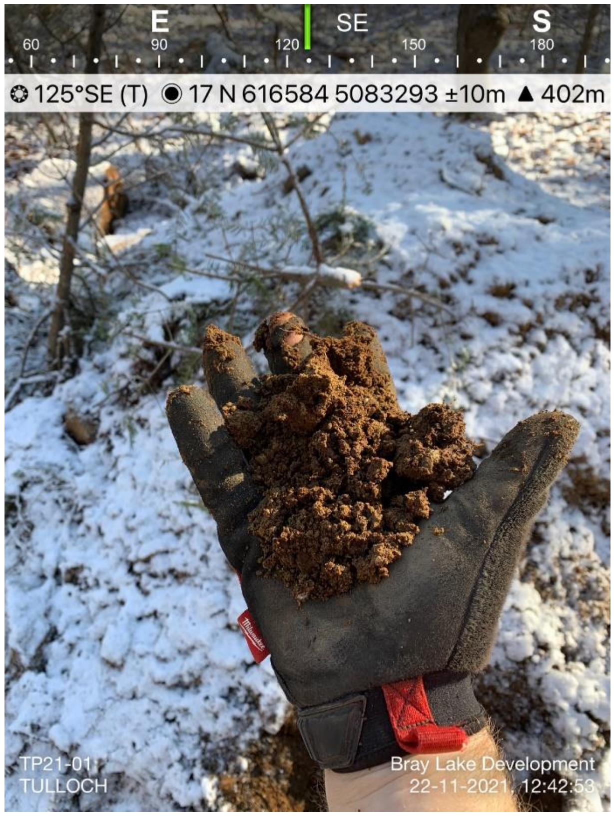


Photo 3: Typical sandy soil encountered at all Test pit locations contained gravel, cobbles and boulders

Photo 4: TP21-02 note standing water in bottom of test pit.

CLIENT Polni Holdings	PROJECT Bray Lake Subdivision
CONSULTANT TULLOCH ENGINEERING	TITLE **Soil Assessment**

YYYY-MM-DD	2022-02-16
PREPARED	E.Giles
DESIGNED	E.Giles
REVIEWED	T. Maurer
APPROVED	T. Maurer

PROJECT NO.	Phase/Task	Rev.	FIGURE
21-1851		**Rev 0**	**2**

25 mm
0

Photo 5: TP21-02 excavation note sandy soil stratum and standing water, hard surface noted at bottom of test pit.

Photo 6: TP 21-03 excavation – shallow refusal at approximately 0.9 m. Excavated into hillside with visible bedrock knobs.

CLIENT
Polni Holdings

PROJECT
Bray Lake Subdivision

CONSULTANT
TULLOCH ENGINEERING

YYYY-MM-DD	2022-02-16
PREPARED	E.Giles
DESIGNED	E.Giles
REVIEWED	T. Maurer
APPROVED	T. Maurer

TITLE
Soil Assessment

PROJECT NO.	Phase/Task	Rev.	FIGURE
21-1851		**Rev 0**	**3**

Photo 7: TP21-03 – note standing water in test pit.

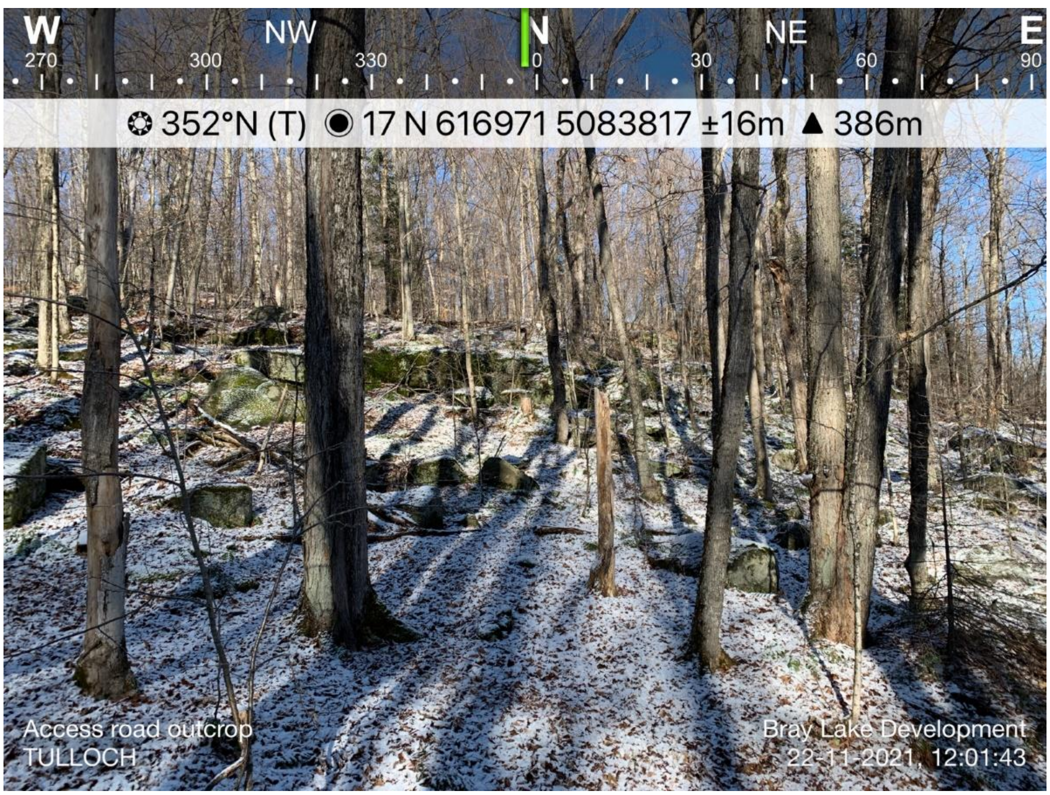


Photo 8: Hillside view from access road facing north, note significant bedrock outcrops.

CLIENT Polni Holdings		PROJECT Bray Lake Subdivision	
CONSULTANT TULLOCH ENGINEERING	YYYY-MM-DD: 2022-02-16 PREPARED: E.Giles DESIGNED: E.Giles REVIEWED: T. Maurer APPROVED: T. Maurer	TITLE **Soil Assessment**	

PROJECT NO.	Phase/Task	Rev.	FIGURE
21-1851		**Rev 0**	**4**

Photo 11: low lying wet area with stream south of access road.

Photo 12: Low lying wet area south of access road possible creek in this area.

CLIENT
Polni Holdings

PROJECT
Bray Lake Subdivision

CONSULTANT
TULLOCH ENGINEERING

YYYY-MM-DD	2022-02-16
PREPARED	E.Giles
DESIGNED	E.Giles
REVIEWED	T. Maurer
APPROVED	T. Maurer

TITLE
Soil Assessment

PROJECT NO.	Phase/Task	Rev.	FIGURE
21-1851		Rev 0	5

Laboratory Testing

CSA A283 Certified Laboratory for Concrete Testing
CCIL Certified Laboratory for Aggregates and Asphalt Testing
CSA/CCIL Certified Technicians

Canadian Council of Independent Laboratories
Conseil canadien des laboratoires indépendants

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO: 21-1851
DATE SAMPLED: 2021-11-09

PROJECT: Bray Lake
SOURCE: Test Pits

DATE TESTED: 2021-12-03
TESTED BY: T. Linley

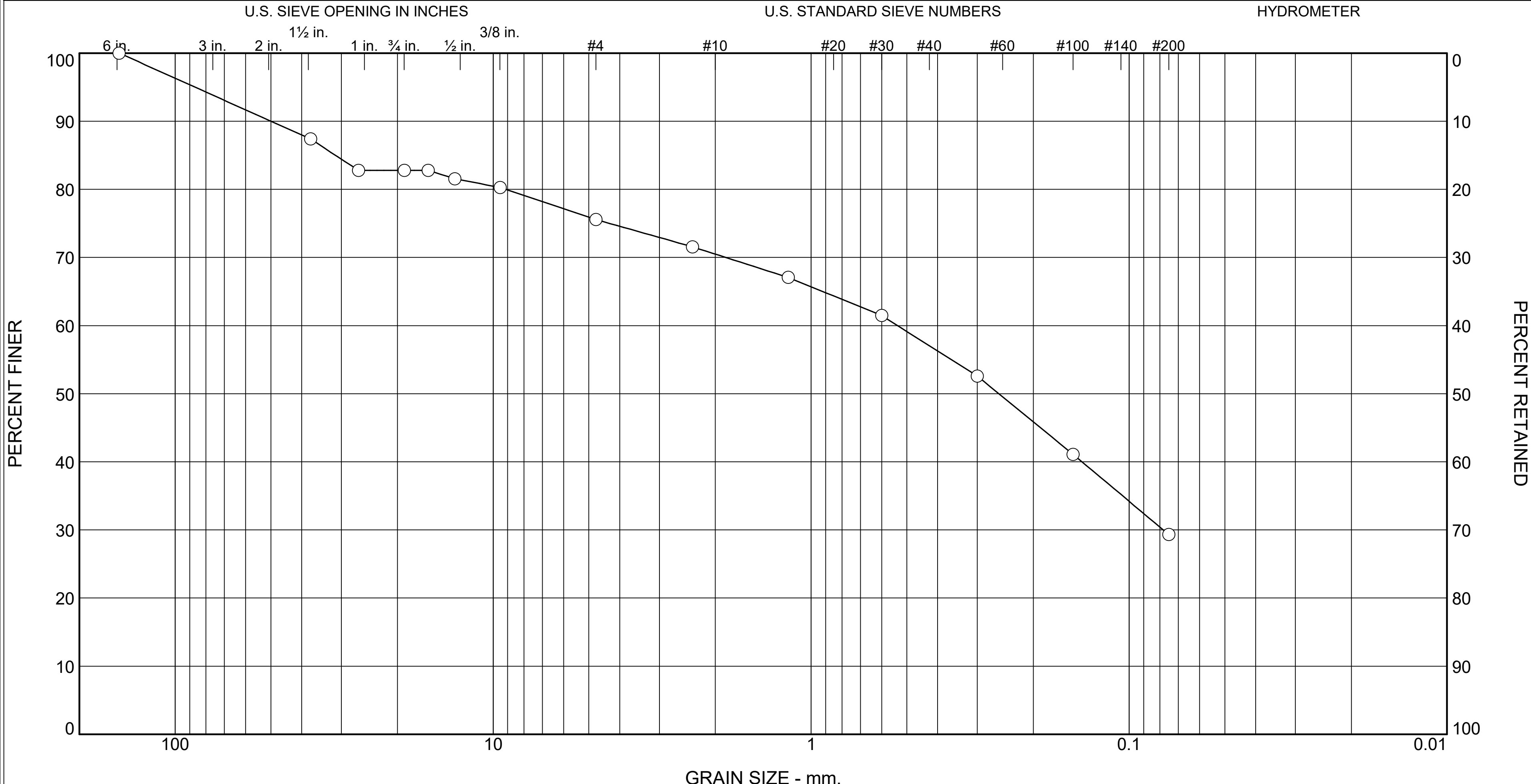
			Gross (inc. Tare) (g)				
Tare ID	Sample ID	Depth (m)	Wet Weight	Dry Weight	TARE	Mass Lost	Water %
	TP21-02 SA1	0.25 to 1.3	1580.49	1373.70	158.49	206.79	17.0%

REMARKS:

CLIENT:

COPIES TO:

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt
○	6.2	11.0	7.2	5.1	13.4	27.8	29.3

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: TP21-02 Depth: 0.25m - 1.3m Sample Number: SA1	Nov 9/21	Dec 3/21	Dec 7/21

Client

Project Bray Lake

Project No. 21-1851 Figure

TULLOCH ENGINEERING
71 Black Road
Unit 8
Sault Ste. Marie, ON
P6B 0A3
T. 705 949.1457
F. 705 949.9606
TF. 866 806.6602
Daren.Stadnisky@TULLOCH.ca

Tested By: L. Roach **Checked By:** T. Linley

GRAIN SIZE DISTRIBUTION TEST DATA

2021-12-09

Project: Bray Lake
Project Number: 21-1851
Location: TP21-02
Depth: 0.25m - 1.3m **Sample Number:** SA1
Date Sampled: Nov 9/21 **Date Received:** Dec 3/21 **Date Tested:** Dec 7/21
Tested by: L. Roach **Checked by:** T. Linley

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 1165.10
Tare Wt. = 158.50
Minus #200 from wash = 17.2%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
1373.70	158.50	150mm	0.00	0.00	100.0	0.0
		37.5mm	153.30	0.00	87.4	12.6
		26.5mm.	55.80	0.00	82.8	17.2
		19mm.	0.00	0.00	82.8	17.2
		16mm.	0.00	0.00	82.8	17.2
		13.2mm.	15.20	0.00	81.5	18.5
		9.5mm.	15.40	0.00	80.3	19.7
		#4	57.30	0.00	75.6	24.4
		#8	48.60	0.00	71.6	28.4
		#16	54.60	0.00	67.1	32.9
		#30	68.00	0.00	61.5	38.5
		#50	107.90	0.00	52.6	47.4
		#100	139.70	0.00	41.1	58.9
		#200	143.10	0.00	29.3	70.7

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
6.2	11.0	7.2	18.2	5.1	13.4	27.8	46.3			29.3

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0781	0.1406	0.2566	0.5349	9.1238	31.3127	49.9853	86.5898

Fineness Modulus
2.86

TULLOCH ENGINEERING

CSA A283 Certified Laboratory for Concrete Testing
CCIL Certified Laboratory for Aggregates and Asphalt Testing
CSA/CCIL Certified Technicians

Canadian Council of Independent Laboratories
Conseil canadien des laboratoires indépendants

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO: 21-1851 DATE SAMPLED: 2021-11-09

PROJECT: Bray Lake SOURCE: Test Pits

DATE TESTED: 2021-12-03 TESTED BY: T. Linley

			Gross (inc. Tare) (g)				
Tare ID	**Sample ID**	**Depth (m)**	**Wet Weight**	**Dry Weight**	**TARE**	**Mass Lost**	**Water %**
	TP21-03 SA1	0.3 to 0.8	1136.36	948.67	162.38	187.69	23.9%

REMARKS:

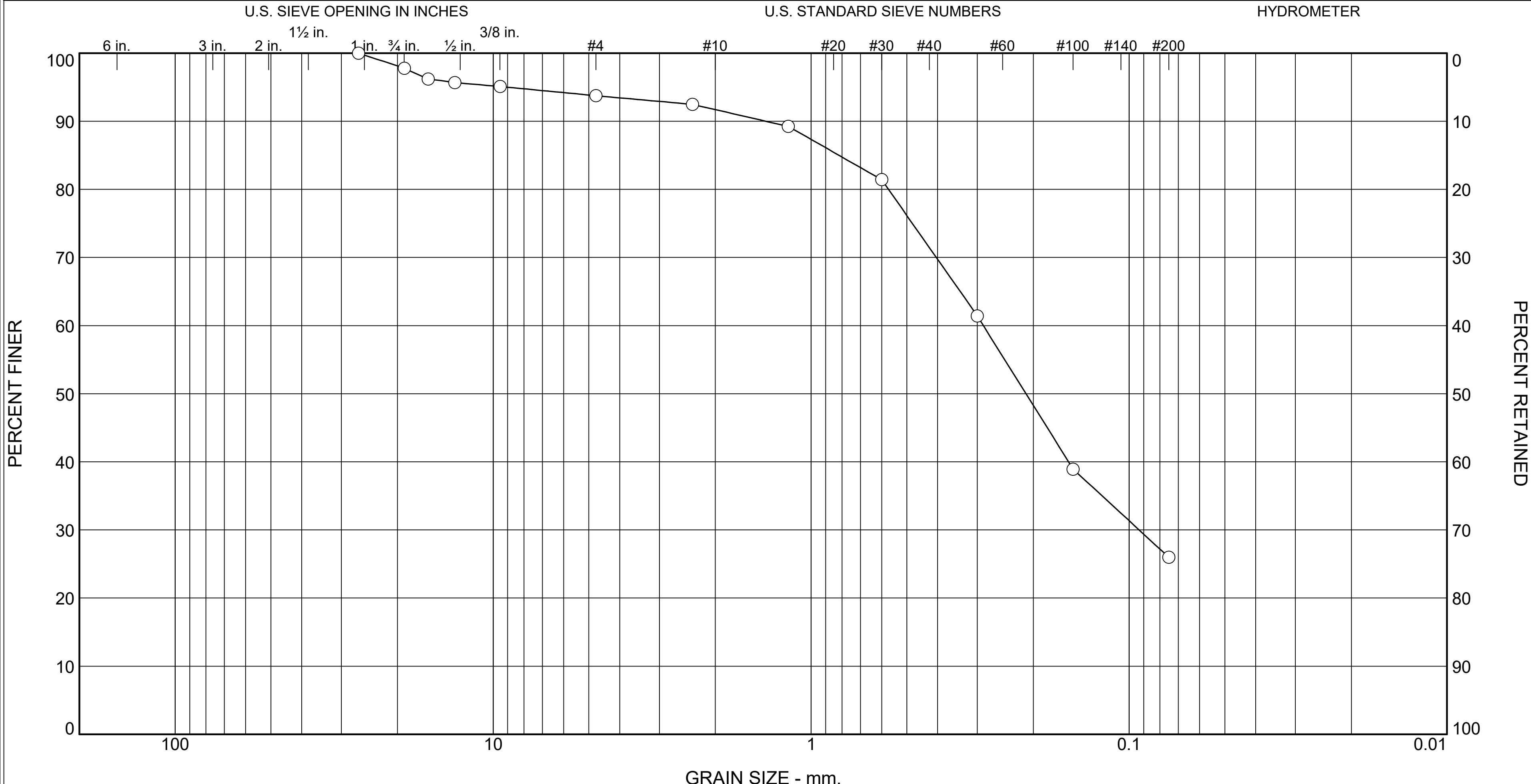
CLIENT:

COPIES TO:

Tulloch Engineering, Materials Testing Laboratory, 71 Black Road - Unit 3, Sault Ste. Marie, ON. Canada P6B 0A3

Tel: (705) 949-1457 Fax: (705) 945-5092 email: daren.stadnisky@tulloch.ca

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt
○	0.0	2.2	4.1	2.0	20.2	45.5	26.0

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: TP21-03 Depth: 0.3m - 0.8m Sample Number: SA1	Nov 9/21	Dec 3/21	Dec 7/21

Client

Project Bray Lake

Project No. 21-1851 Figure

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Tested By: L. Roach **Checked By:** T. Linley

GRAIN SIZE DISTRIBUTION TEST DATA

2021-12-09

Project: Bray Lake
Project Number: 21-1851
Location: TP21-03
Depth: 0.3m - 0.8m **Sample Number:** SA1
Date Sampled: Nov 9/21 **Date Received:** Dec 3/21 **Date Tested:** Dec 7/21
Tested by: L. Roach **Checked by:** T. Linley

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
948.70	162.40	26.5mm.	0.00	0.00	100.0	0.0
		19mm.	17.60	0.00	97.8	2.2
		16mm.	12.20	0.00	96.2	3.8
		13.2mm.	4.20	0.00	95.7	4.3
		9.5mm.	4.60	0.00	95.1	4.9
		#4	10.60	0.00	93.7	6.3
		#8	10.00	0.00	92.5	7.5
		#16	25.40	0.00	89.2	10.8
		#30	61.50	0.00	81.4	18.6
		#50	157.30	0.00	61.4	38.6
		#100	176.80	0.00	38.9	61.1
		#200	101.80	0.00	26.0	74.0

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	2.2	4.1	6.3	2.0	20.2	45.5	67.7			26.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0930	0.1550	0.2110	0.2872	0.5712	0.8178	1.3888	9.0661

Fineness Modulus
1.50

TULLOCH ENGINEERING

CSA A283 Certified Laboratory for Concrete Testing
CCIL Certified Laboratory for Aggregates and Asphalt Testing
CSA/CCIL Certified Technicians

Canadian Council of Independent Laboratories — Conseil canadien des laboratoires indépendants

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO: 21-1851 DATE SAMPLED: 2021-11-09

PROJECT: Bray Lake SOURCE: Test Pits

DATE TESTED: 2021-12-03 TESTED BY: T. Linley

			Gross (inc. Tare) (g)				
Tare ID	Sample ID	Depth (m)	Wet Weight	Dry Weight	TARE	Mass Lost	Water %
	TP21-04 SA2	0.3 to 0.55	1338.11	987.71	164.90	350.4	42.6%

REMARKS:

CLIENT:

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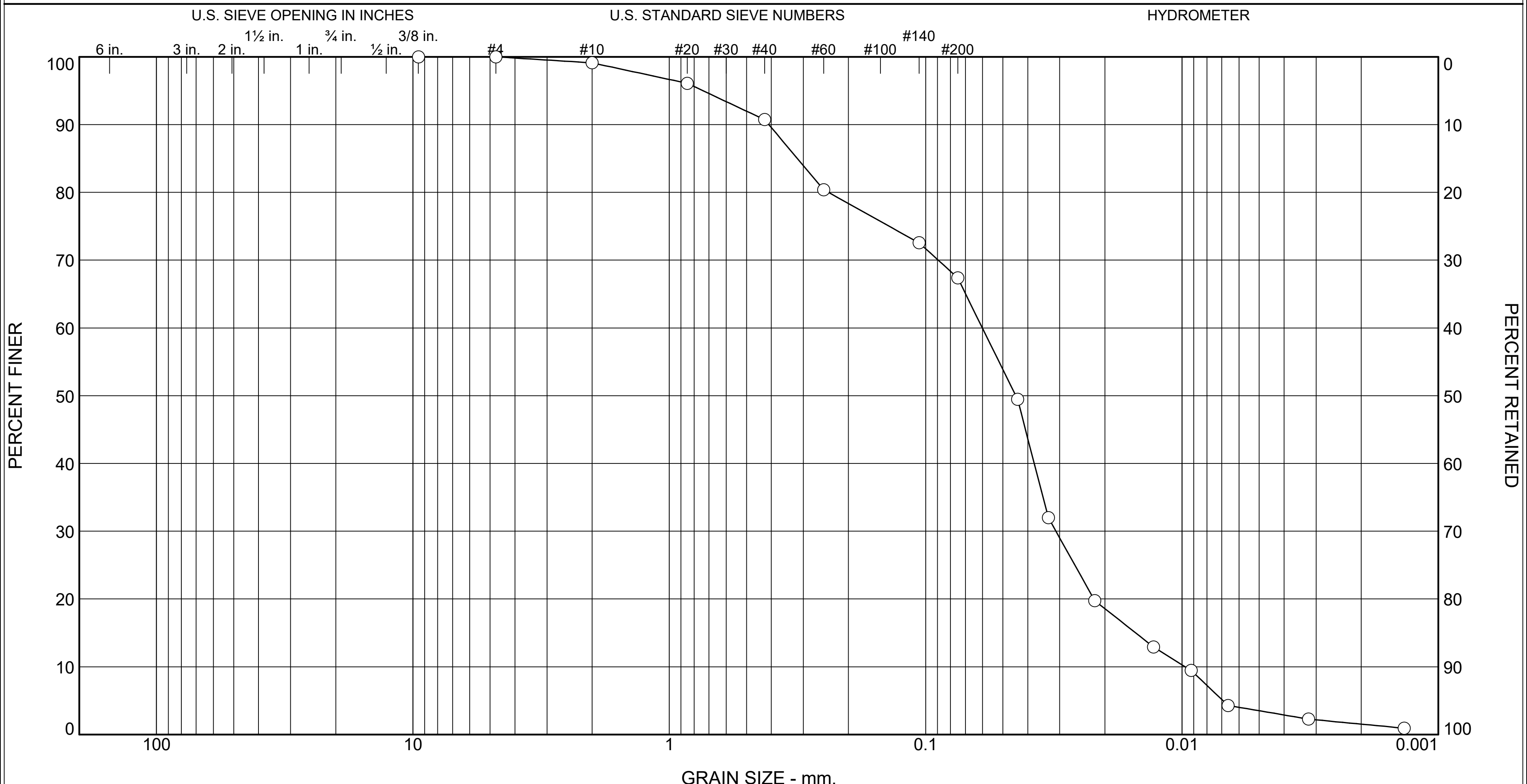
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.9	8.4	23.3	63.9	3.5

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: TP21-04 Depth: 0.3m - 0.55m Sample Number: SA2	Nov 9/21	Dec 3/21	Dec 7/21

Client

Project Bray Lake

Project No. 21-1851 Figure

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Tested By: T. Linley

GRAIN SIZE DISTRIBUTION TEST DATA

2021-12-09

Project: Bray Lake
Project Number: 21-1851
Location: TP21-04
Depth: 0.3m - 0.55m **Sample Number:** SA2
Date Sampled: Nov 9/21 **Date Received:** Dec 3/21 **Date Tested:** Dec 7/21
Tested by: T. Linley

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
987.71	164.90	9.5mm.	0.00	0.00	100.0	0.0
		#4	0.00	0.00	100.0	0.0
56.10	0.00	#10	0.50	0.00	99.1	0.9
		#20	1.70	0.00	96.1	3.9
		#40	3.00	0.00	90.7	9.3
		#60	5.80	0.00	80.4	19.6
		#140	4.40	0.00	72.5	27.5
		#200	2.90	0.00	67.4	32.6

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 99.1
Weight of hydrometer sample =56.1
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.70
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - .164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	21.6	33.0	28.3	0.0132	32.0	11.0	0.0438	49.5	50.5
2.00	21.6	23.0	18.3	0.0132	22.0	12.7	0.0332	32.0	68.0
5.00	21.6	16.0	11.3	0.0132	15.0	13.8	0.0219	19.8	80.2
15.00	21.9	12.0	7.4	0.0131	11.0	14.5	0.0129	12.9	87.1
30.00	22.0	10.0	5.4	0.0131	9.0	14.8	0.0092	9.4	90.6
60.00	22.2	7.0	2.5	0.0131	6.0	15.3	0.0066	4.3	95.7
250.00	23.5	5.5	1.3	0.0129	4.5	15.6	0.0032	2.3	97.7
1440.00	22.5	5.0	0.5	0.0130	4.0	15.6	0.0014	0.9	99.1

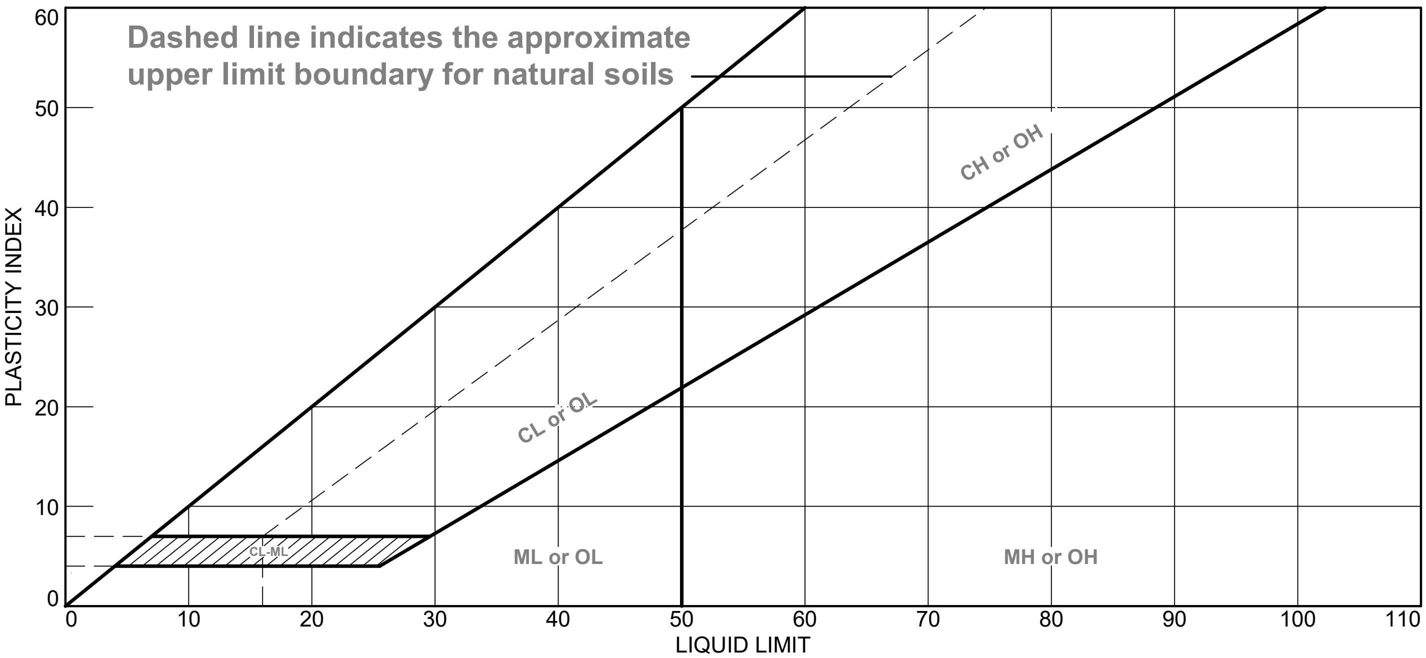
Fractional Components

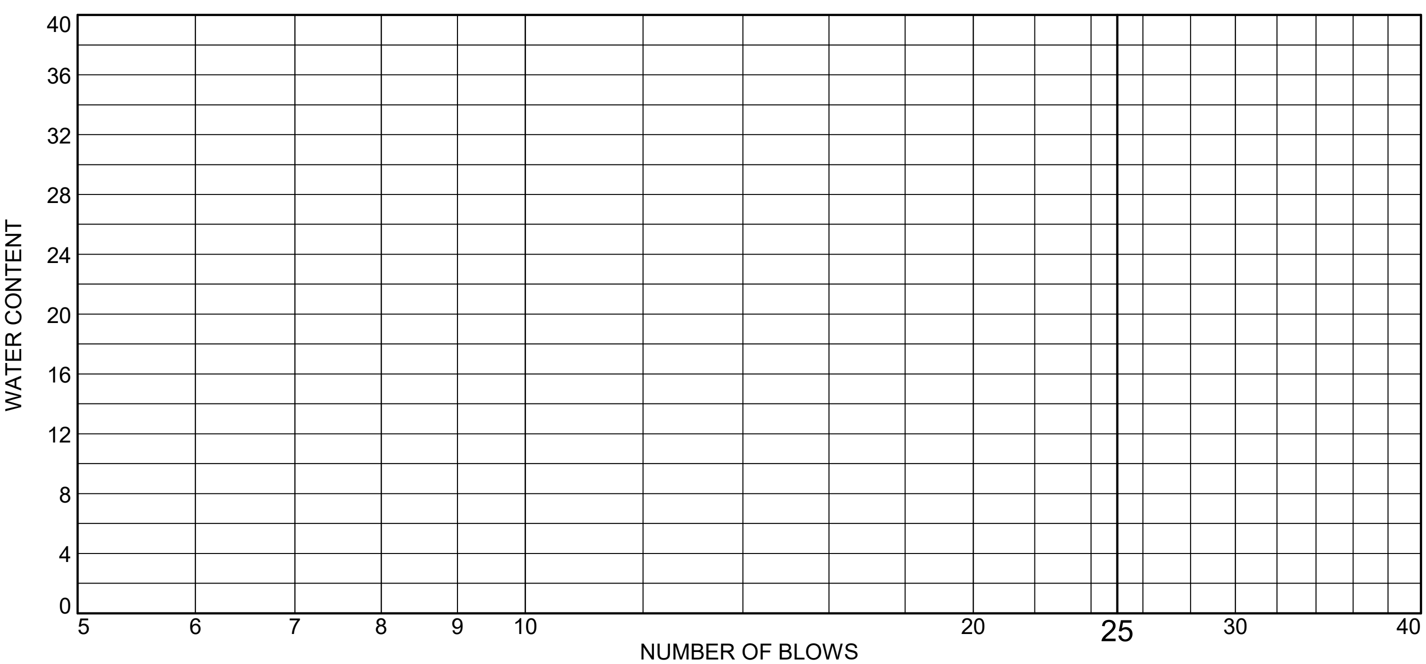
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.9	8.4	23.3	32.6	63.9	3.5	67.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0069	0.0097	0.0152	0.0221	0.0310	0.0377	0.0445	0.0601	0.2395	0.3167	0.4094	0.7391

Fineness Modulus	C_u	C_c
0.50	6.18	1.65

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●					90.7	67.4	

Project No. 21-1851 **Client:**

Project: Bray Lake

Source of Sample: TP21-04 **Depth:** 0.3m - 0.55m

Sample Number: SA2

Remarks:

● Atterberg attempted - material determined to be non-plastic

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Figure

Tested By: T. Linley

DCP Results

Manual Dual Mass Dynamic Cone Penetration Test Report

Project: Bray Lake Subdivision

Project Number: 21-1851

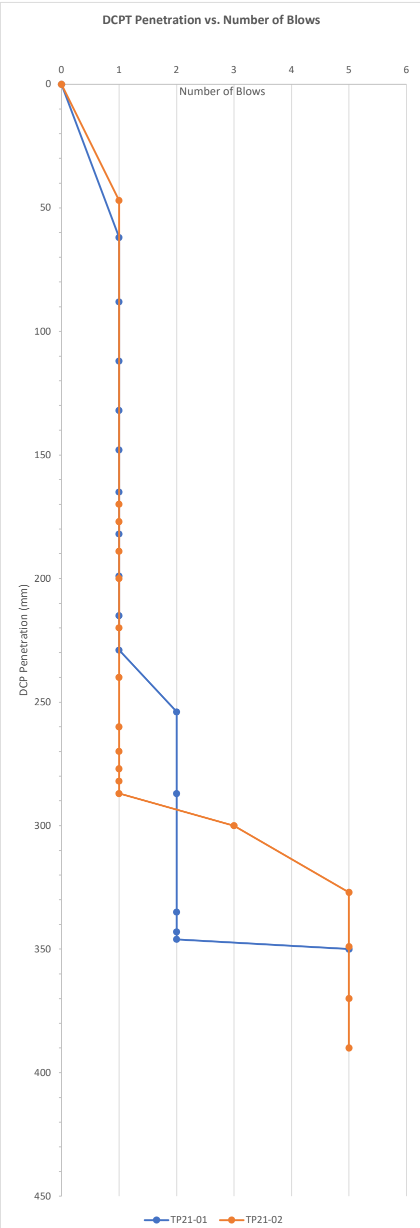
Dynamic Cone Penetration Test Number: DTP21-01 and TP21-02

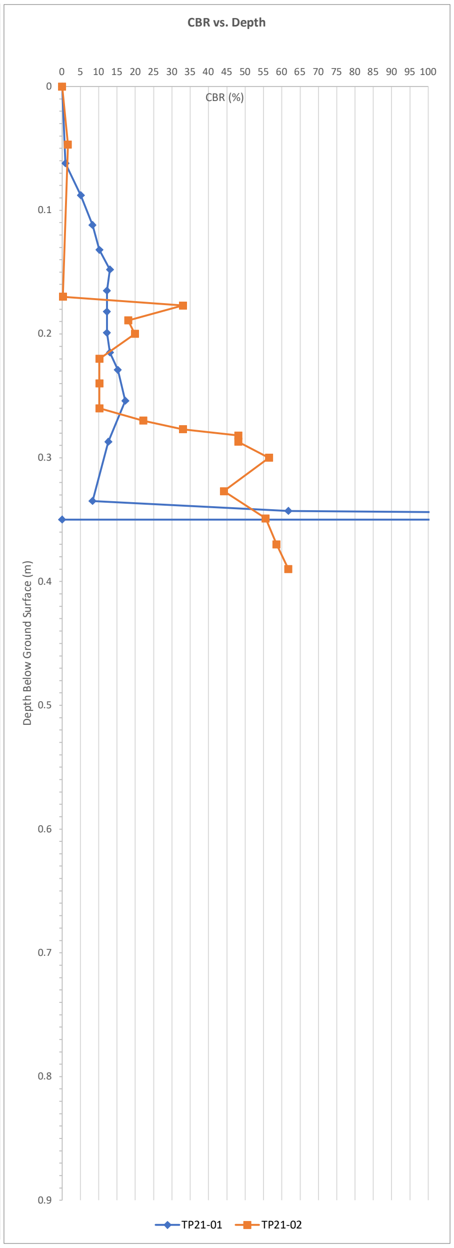
DCP Starting Depth Below Ground Surface: ~0.3m below ground surface

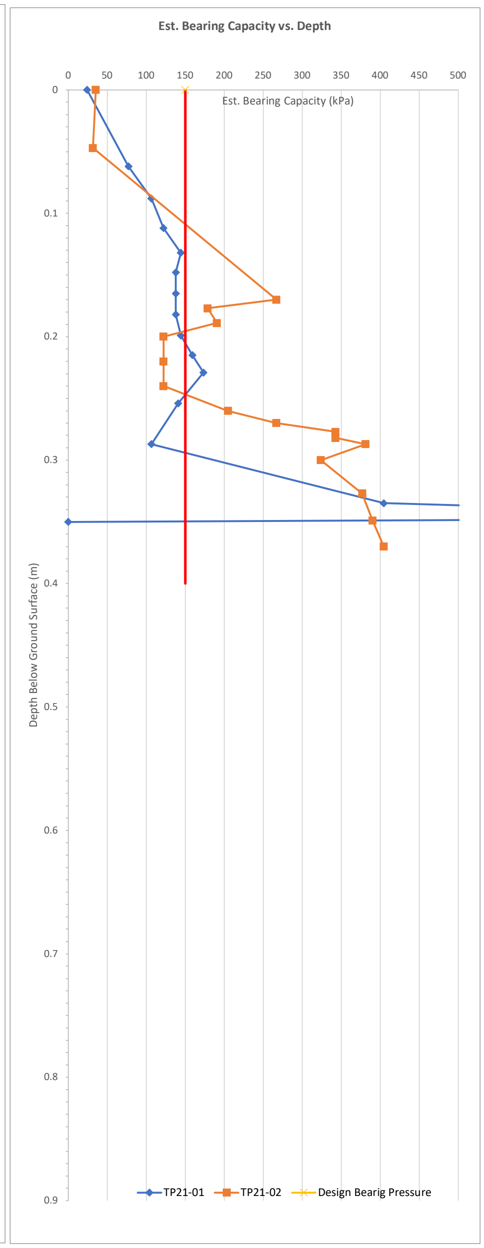
Hammer weight 8.0 kg

Fall of Hammer 0.574 m

TULLOCH ENGINEERING







Notice to Reader

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A visual site assessment was carried out from examination of existing test pits; and as such, the information collected and presented herein applies to visible soils only. The subsurface conditions that were not visible can change and accordingly any use of the data contained in this Report should take into consideration the nature of the materials and potential variation of soils.

This Report contains opinions, conclusions and recommendations made by TULLOCH using professional judgment and reasonable care for the purpose of foundation design for the Development. Use of or reliance on this report by the Client is subject to the following conditions:

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b) the report being read in its entirety. TULLOCH is not responsible for the use of portions of the report without reference to the entire report;
c) the conditions of the site may change over time or may have already changed due to natural forces or human intervention, and TULLOCH takes no responsibility for the impact that such changes may have on the accuracy or validity of the observations, conclusions and recommendations set out in this report;
d) the classification of soils and rocks in this report is based on commonly accepted methods. However, the classification of geologic materials and the boundaries between subsurface layers involves judgement. Boundaries between different soils layers may also be transitional rather than abrupt. TULLOCH does not warrant or guarantee the exactness of these descriptions and boundaries.
e) the subsurface conditions must be verified by a qualified geotechnical engineer during construction to ensure that the borehole data presented herein is representative of the actual site conditions so that the design recommendations contained herein remain valid; and
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This report has been prepared with the degree of care, skill and diligence normally provided by engineers in the performance of comparable services for projects of similar nature. The scope of this report includes foundation engineering design only and it specifically excludes investigation, detection, prevention and assessment of the presence of subsurface contaminants. No conclusions or inferences should be drawn regarding contamination at the site including but not limited to molds, fungi, spores, bacteria, viruses, soil gases such as Radon, PCBs, petroleum hydrocarbons, inorganic and volatile organic compounds, polycyclic aromatic hydrocarbons and or any by products thereof.

6m-ENTRANCE CULVERT TYP.	
LOT #	CPP DIAMETERS Ø
1	450
2	450
3	450
4	450
5	450
6	450
7	450
8	450
9	450
10	450
11	525
12	525
13	525
14	525
15	525
16	450
17	525
18	525
19	450
20	-

QUALITY CONTROL CATCHMENT AREAS (ha) & WATER QUALITY VOLUME (WQV)			
CONTROLLED			
I.D.	CATCHMENT AREA (Ha.)	NUMBER OF CHECK DAMS DESIGNED	(WQV) DESIGNED (m^3)
301	0.31	4	11.37
302	0.25	4	11.37
303	0.10	2	5.68
304	0.15	2	5.68
305	0.06	2	5.68
306	0.10	2	5.68
307	0.40	6	17.05
308	0.28	4	11.37
309	0.05	2	5.68
310	0.05	2	5.68
311	0.19	4	11.37
312	0.77	10	28.42
313	0.25	4	11.37

LEGEND

- PROPERTY LINE
- EXISTING CONTOURS — 192
- (PROPOSED) EDGE OF ASPHALT
- 30m SETBACK
- WETLAND
- (PROPOSED) DOCK LOCATION
- (PROPOSED) DRIVEWAY — 4.0m
- (PROPOSED) BUILDING ENVELOPE — H
- (PROPOSED) FILTER BED LOCATION — FBL
- (EXISTING) OVERLAND FLOW
- (PROPOSED) OVERLAND FLOW
- 100YR. SHEET FLOW
- (PROPOSED) SILT FENCE (OPSD 219.130) — S — S —
- ROCK FLOW CHECK DAM — RFC
- STRAW BALE CHECK DAM — SFC
- AREA OF INFILTRATION BASED STORAGE
- (PROPOSED) ℄ DITCH
- DENOTES TYPE 1 FISH HABITAT
- DENOTES TYPE 2 FISH HABITAT

REVISION:	No.	DATE	BY
ISSUED FOR APPROVAL	1	AUGUST 31, 2022	C.S

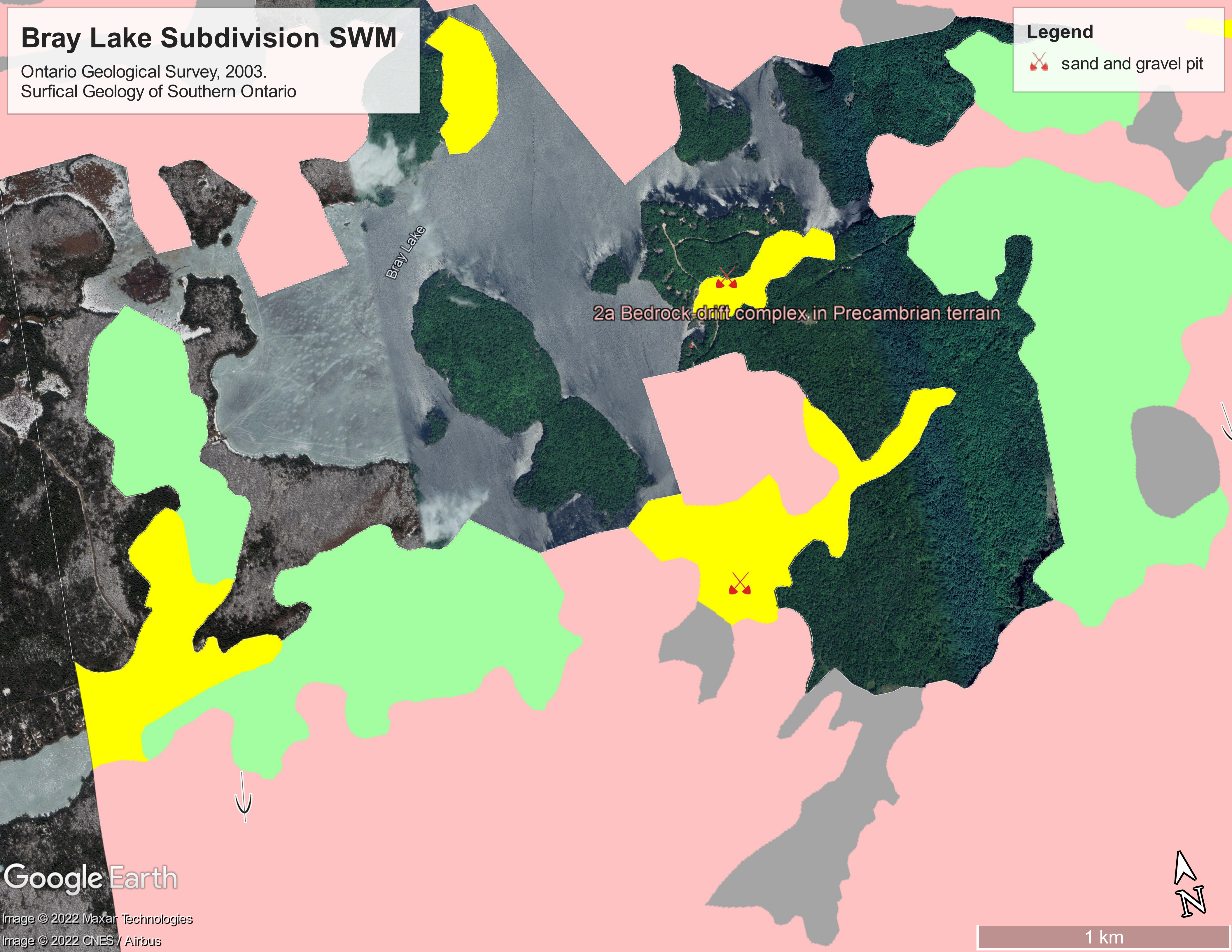
TULLOCH ENGINEERING

BRAY LAKE SUBDIVISION
BRAY LAKE, MACHAR, ON

PRELIMINARY STORMWATER MANAGEMENT, PRIVATE SEWAGE SYSTEM ASSESSMENT & CONSTRUCTION MITIGATION PLAN

ENGINEER'S SEAL: LICENSED PROFESSIONAL ENGINEER — AUG 31, 2022 — C. J. STILWELL — 90308063 — PROVINCE OF ONTARIO

SCALE	1:2500
DRAWN	E.V
CHECKED	C.S/T.M/B.B
DATE	AUGUST 31, 2022
PROJECT No.	21-1851
SHEET	SWM 1



Bray Lake Subdivision SWM
Ontario Geological Survey, 2003.
Surfical Geology of Southern Ontario
Legend
sand and gravel pit
Bray Lake
2a Bedrock-drift complex in Precambrian terrain
Google Earth
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
N
1 km

Ontario

Ontario Geological Survey

SURFICIAL GEOLOGY OF

SOUTHERN ONTARIO

This map is published with the permission of the Senior Manager, Sedimentary Geoscience Section, Ontario Geological Survey.

Location Map

SOURCES OF INFORMATION

Base map: Natural Resources and Values Information System (NRVIS)

Projection: NAD 83

CREDITS

Author: The Ontario Geological Survey

Acknowledgements: John Dodge (OGS), Andy Bajc (OGS), George Gao (OGS), Steve van Haaften (OGS), Shannon Evers (OGS), Steve Leney (MNR), John Ernsting (MNR), Scott Christilaw (MNR), Andrew Moore (GSC)

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Northen Development and Mines does not assume any liabilities for errors that may occur. Users may wish to verify critical information.

Issued 2003.

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

The Ontario Geological Survey. 2003. Surficial Geology of Southern Ontario.

LEGEND

- **Fill**
- **Organic Deposits:** peat, muck and marl
- **Silt**
- **Clay**
- **Sand**
- **Gravel**
- **Till (Diamicton)**
- **Sedimentary (Paleozoic) bedrock**
- **Precambrian bedrock**

Correlation Matrix:

Material	Current map units
Fill	21
Organic Materials	20
Silt & Clay	8, 10, 12, 13, 15, 18, 19
Sand & Gravel	6, 7, 9, 11, 12, 14, 16, 18, 19
Sand	6, 7, 9, 11, 12, 14, 16, 17, 18, 19
Till (Diamicton)	5, 5a, 5b, 5c, 5d, 5e
Sedimentary bedrock	3, 4
Precambrian bedrock	1, 2

LEGEND

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

21 **Man-made deposits:** fill, sewage lagoon, landfill, urban development

20 **Organic Deposits:** peat, muck, marl

19 **Modern alluvial deposits:** clay, silt, sand, gravel, may contain organic remains

18 **Colluvial deposits:** boulders, scree, talus, undifferentiated landslide materials

17 **Eolian deposits:** fine to very fine sand and silt

16 **Coarse-textured marine deposits:** sand, gravel, minor silt and clay
16a Deltaic deposits
16b Littoral deposits
16c Foreshore and basinal deposits

15 **Fine-textured marine deposits:** silt and clay, minor sand and gravel

14 **Coarse-textured lacustrine deposits:** sand, gravel, minor silt and clay
14a Deltaic deposit
14b Littoral deposits
14c Foreshore and basinal deposits

13 **Fine-textured lacustrine deposits:** silt and clay, minor sand and gravel

PLEISTOCENE

12 **Older alluvial deposits:** clay, silt, sand, gravel, may contain organic remains

11 **Coarse-textured glaciomarine deposits:** sand, gravel, minor silt and clay
11a Deltaic deposits
11b Littoral deposits
11c Foreshore and basinal deposits

10 **Fine-textured glaciomarine deposits:** silt and clay, minor sand and gravel
10a Massive to well laminated
10b Interbedded silt and clay and gritty, pebbly flow till and rainout deposits

9 **Coarse-textured glaciolacustrine deposits:** sand, gravel, minor silt and clay
9a Deltaic deposits
9b Littoral deposits
9c Foreshore and basinal deposits

8 **Fine-textured glaciolacustrine deposits:** silt and clay, minor sand and gravel
8a Massive to well laminated
8b Interbedded silt and clay and gritty, pebbly flow till and rainout deposits

7 **Glaciofluvial deposits:** river deposits and delta topset facies
7a Sandy deposits
7b Gravelly deposits

6 **Ice-contact stratified deposits:** sand and gravel, minor silt, clay and till
6a In moraines, eskers, kames and crevasse fills
6b In subaquatic fans

5a **Till:** Silty sand to sand-textured till on Precambrian terrain
5a Silty sand to sand-textured till on Precambrian terrain

5b 5b Stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain

5c 5c Stony, sandy silt to silty sand-textured till on Paleozoic terrain

5d 5d Clay to silt-textured till (derived from glaciolacustrine deposits or shale)

5e 5e Undifferentiated older tills, may include stratified deposits

PALEOZOIC

4 **Bedrock-drift complex in Paleozoic terrain:**
4a Primarily till cover
4b Primarily stratified drift cover

3 **Paleozoic bedrock**

PRECAMBRIAN

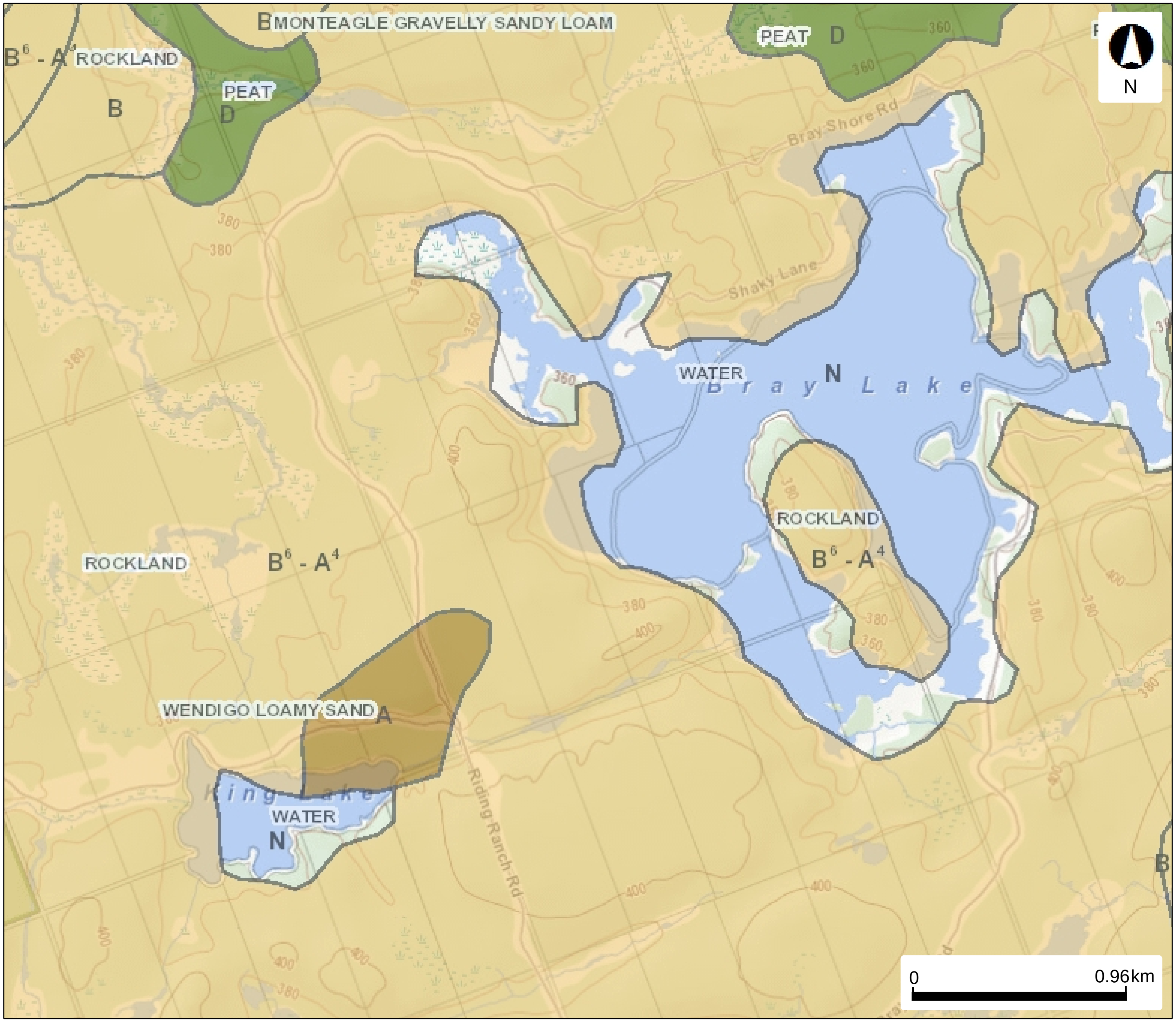
2 **Bedrock-drift complex in Precambrian terrain:**
2a Primarily till cover
2b Primarily stratified drift cover

1 **Precambrian bedrock**

SYMBOLS

- Clay pit (active or inactive)
- Peat and muck pit
- Location of quarry
- Sand or gravel pit;
- Tailings
- Stoss and lee feature; crag and tail
- Delta, glaciolacustrine
- Drumlin or drumlinoid ridges
- Dune
- Glacial fluting
- Fossil locality
- Geotechnical or stratigraphic borehole not reaching bedrock
- Kame
- Solution weathering feature
- Kettle
- Outcrop
- Observed pebble orientation in till
- Reservoir
- Roches moutonee
- Sample site
- Small landslide scar
- Glacial striae; direction of ice movement known
- Glacial striae; direction of ice movement unknown
- Talus
- Area of sand dune
- Area of former lake bed
- Area of ribbed moraine or till ridges transverse to ice flow
- Area of scabland
- Beach ridges and near shore bars
- Shore bluff or scarp
- Crevasse filling
- Crests of large sand dune (eolian)
- Trend of moraine crest
- Bedrock scarp or escarpment
- Esker; direction of flow known
- Esker; direction of flow unknown
- Meltwater channel; inferred direction of flow
- Meltwater channel; direction of flow unknown
- Iceberg keel mark
- Ice-contact slope
- Clint and gryke topography
- Linear feature observed on aerial photograph
- Crest of megaripple
- Meltwater flow; inferred direction of flow
- Meltwater flow; direction of flow unknown
- Minor moraine
- Mapable edge of quarry or pit
- Bedrock pressure release ridge
- Ribbed or rogen moraine
- Edge of a mapable landslide scar
- Slump block, margin
- Abandoned meltwater channel or river channel; terrace escarpment
- Area of landslide scar
- Area of hummocky topography
- Area of moraine with no hummocky topography

Bray Lake Subdivision - Ontario Soil Survey Complex Hydrologic Soil Group



Legend

- Assessment Parcel
- Soil Name Label

Hydrologic Soil Group

- A - High
- B - Moderate
- C - Slow
- D - Very Slow

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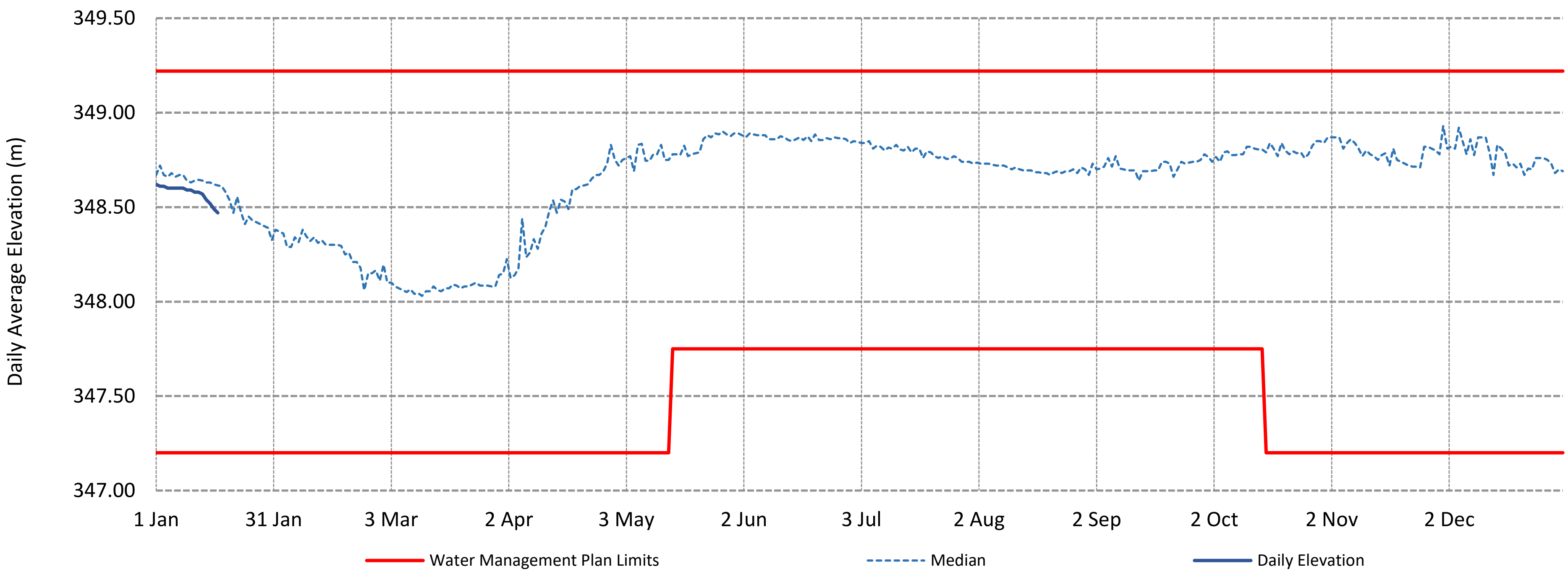
Ontario

Map Created: 1/17/2022
Map Center: 45.89856 N, -79.48826 W

Bray Lake Level 2022

Date	Level (m)	Flow (m^3/s)
1/11/2022	348.58	0.3
1/12/2022	348.58	0.3
1/13/2022	348.57	1.0
1/14/2022	348.54	1.4
1/15/2022	348.52	1.2
1/16/2022	348.49	1.1
1/17/2022	348.47	1.0



Ontario Power Generation Provisional Data

For further info please contact
Kate Cantin
p: (705) 268-9197

Data current as of 1/18/2022