Preliminary Stormwater Management Report

Black Bear Ridge GP Inc

Corbyville (Belleville), ON

Revised

January 31, 2025

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1 Introduction and Background

Jewell Engineering (JE) has been engaged by Black Bear Ridge GP Inc (BBR) to assist with the servicing design for the proposed development of the Black Bear Ridge lands for residential and commercial uses. BBR is proposing to construct a series of connected housing clusters throughout the property to support the thriving golf course. The number of units is yet to be confirmed and choices pertaining to the mix of single-family dwellings and medium to high density dwellings has not been made.

The lands are situated along Harmony Road, just west of Highway 37, between the communities of Foxboro and Corbyville. This site encompasses an area of approximately 370ha.

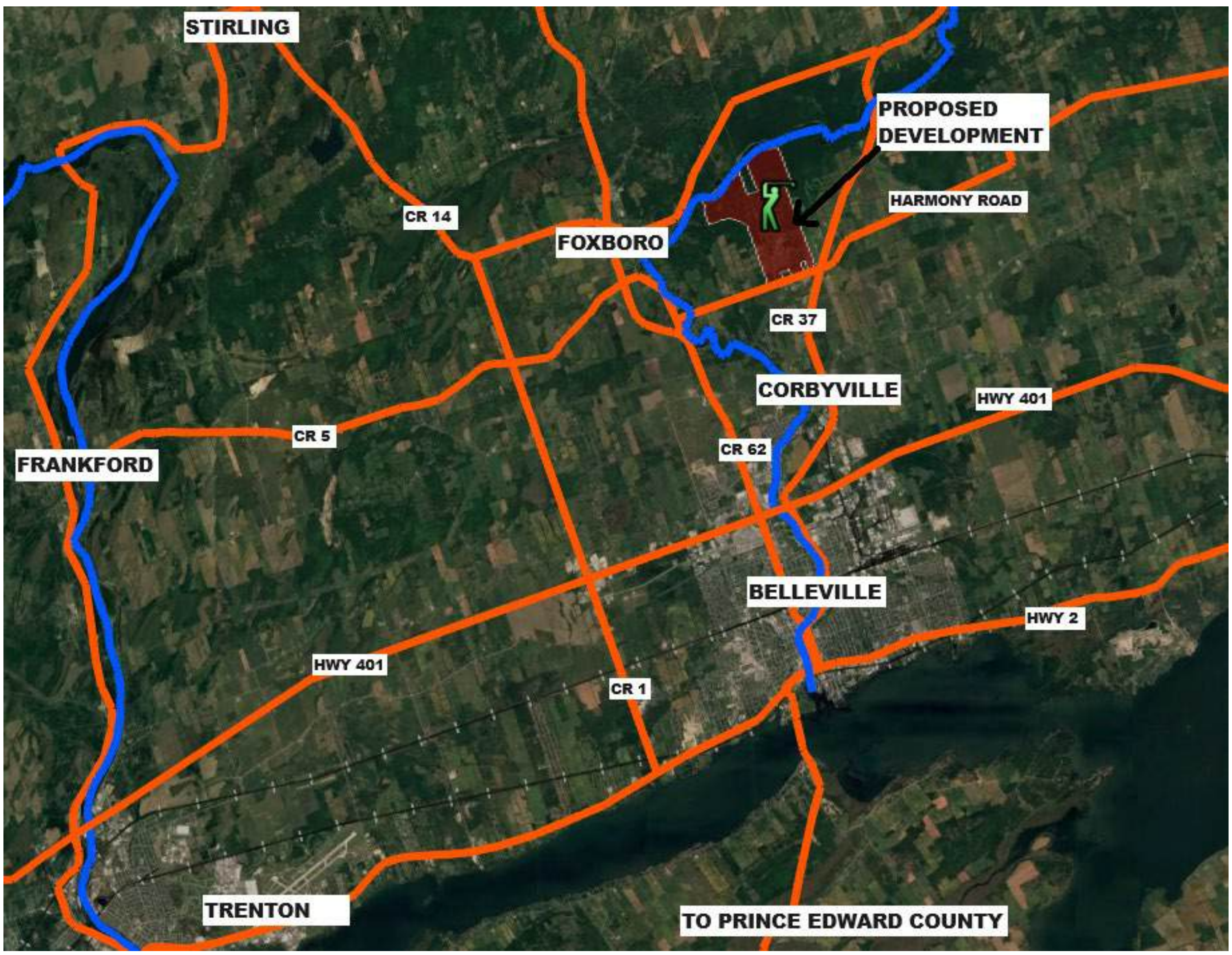


Figure 1-1: Development Site Location (Adapted from Google Earth, 2025)

The property was subject to a Municipal Zoning Order providing ministry approval for up to 3,049 dwellings.

Full municipal servicing will be extended to BBR, which includes drinking water and sewer. New municipal storm sewers will be included. Access to lots will be provided by a public road network throughout the property. Lots will be sized to maximize building envelopes with suburban cross-sections blended with rural living.

This report is intended to support the draft plan of subdivision application and will also serve as the Master Stormwater Management Plan, influencing design choices to conform to the vision proposed by this report.

2 Existing Conditions

The Black Bear Ridge lands are partially developed with a thriving 18-hole golf course. The existing site consists of predominately dense forest in the northern regions which gradually transitions into the golf course with trees lining the sparsely covered fairways. Towards the southern extents of the property there are several private residences as well as a 16-unit condominium-style estate residential development.

On the west side are active and fallow agricultural fields and densely vegetated lands. Along the east perimeter is the Trillium Woods golf course. The BBR lands extend to the Moira River along the north limits. Associated with the river are floodplains and extensive wetlands. The wetlands extend easterly into the Trillium Woods lands and are designated as provincially significant.

A large portion of the BBR lands drains to the Moira River except for the southern third which drains towards Harmony Road. There have been extensive earth works and drainage improvements on the lands particularly associated with the golf course construction, the majority of which are within the southerly portion that drains to Harmony Road.

Eastern Ontario Trails Alliance owns a small trail which runs through the west side of the property. This trail is typically used for recreational walking, hiking and motorized activities. A large hydro corridor also extends through the lands along a north-south direction.

South of Harmony Road are private residences, the Thurlow Community Centre and Fire Hall as well as the Harmony Public School.

The property boundary is highlighted in Figure 2-1.

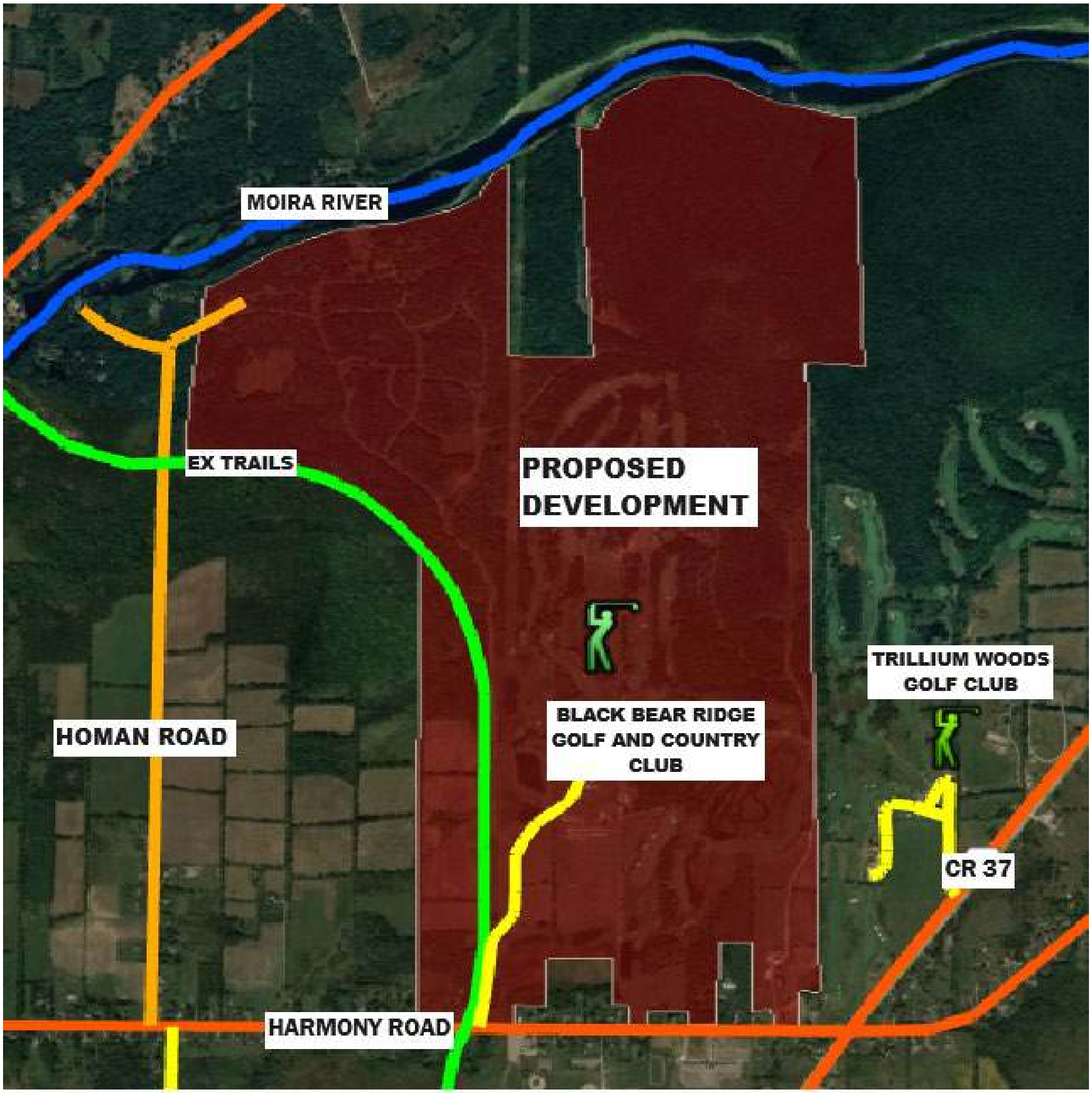


Figure 2-1: Existing Conditions (Adapted from Google Earth, 2025)

2.1 Soils

Soils were reviewed from the Soil Survey of Hastings County (Ontario Department of Agriculture, 1962). The predominant soil type at the development site is Bondhead Loam which drains well both internally and externally. The second most abundant soil type is Otonabee Loam which drains well internally and externally but suffer due to the stoniness incurred by proximity to Dummer Soils. There are poorly drained Sidney Clays and Elmbrook Clays which have slow internal drainage; thus, they drain imperfectly.

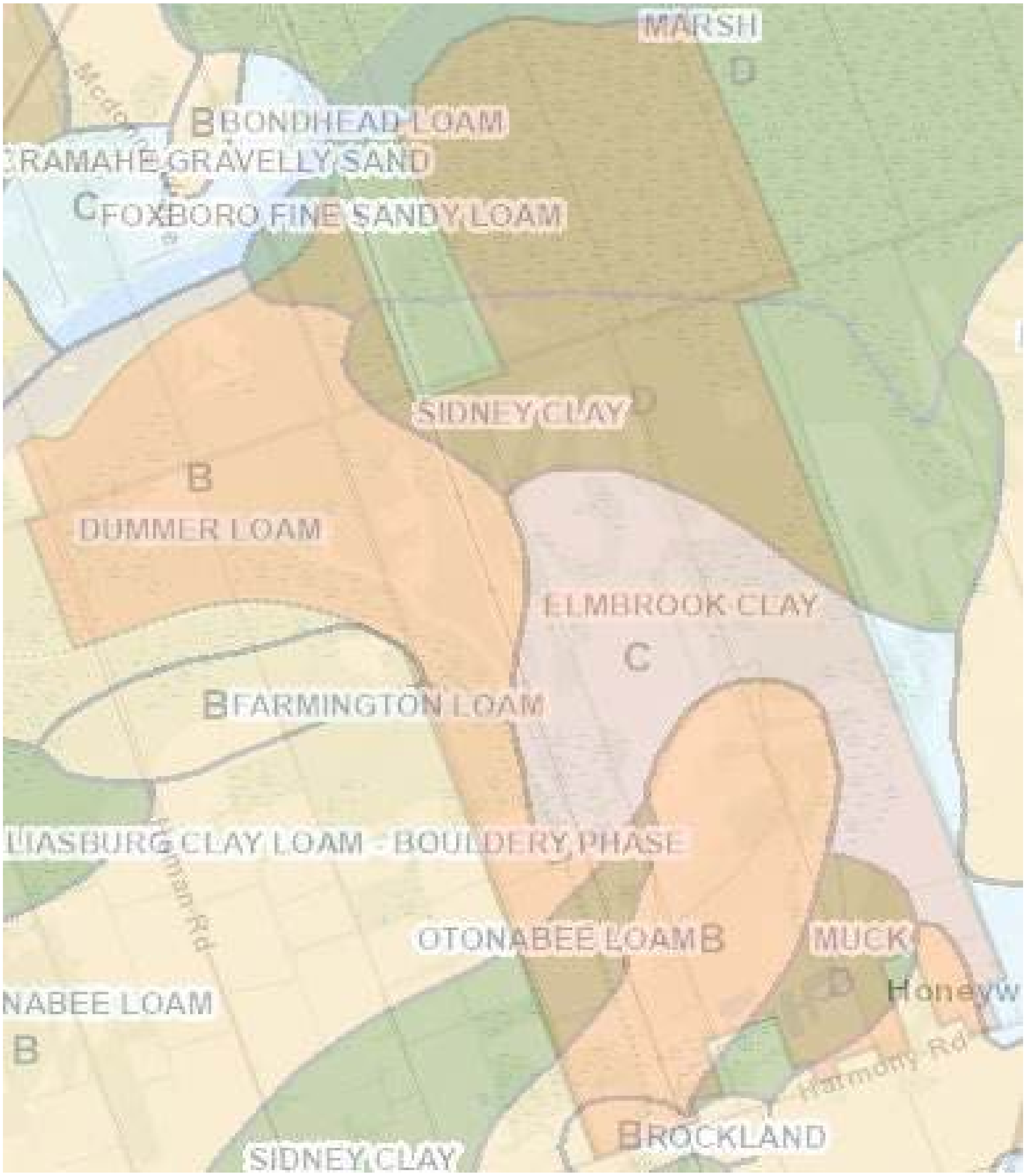


Figure 2-2: OMAFRA Hydrologic Soils Groups

2.1.1 Bondhead Loam

Bondhead is formed by a highland ridge in areas that are moderate to steeply sloping. They are generated by parent materials with course texture, typically Bondhead is a classification for sandy loams. Bondhead loam is approximately three inches thick of rich dark soil, excellent for root development, underlain by a grey highly porous layer in areas with minimal slope.

Bondhead ranges from slightly to moderate stoniness, influenced by the proximity to sandy or gravelly bars. Bondhead Loam may sometimes be grouped with Elmbrook Clay Loam due to remarkable similarities making it difficult to determine where one starts and the other ends.

2.1.2 Otonabee Loam

The Otonabee series are typically found in the south-central Hastings belt, in townships such as Stirling, Tyendinaga, and Thurlow. These soils have moderately sloping topography. The parent materials consist of loam and sandy loam textured glacial till containing moderate amounts of stones. Otonabee soils are principally derived from Limestone. The surface layer is usually loam but can sometimes be sandy loam. Uncultivated soil appears dark and rich on top with prominent texture, but when cultivated the lighter layers find their way to the top.

2.1.3 Sidney Clay

Sidney soils are poorly drained soils, naturally occurring in the greater Sidney and Tyendinaga townships. The topography is generally level and, in some cases, slightly depressional. The parent material is a light grey limestone-based clay with effectively no stones. The surface is a dark grey which can become clotted if plowed when too wet or too dry. The subsoil is brown to light brown, the soil is only slowly permeable to water. The percentage of clay varies from 45 in the surface soil to 80 in the parent soil. Hay grows exceptionally well, but the winter will certainly kill the alfalfa.

2.1.4 Elmbrook Clay

Elmbrook soils are important for agriculture in Hastings County, they offer an optimal conditions hay and grain growth. Elmbrook Clay is the major soil type of the region, it dominates the Hastings area. These soils are developed on stone free calcareous clay, with a clay percentage of around 80 in the parent material. The topography is gently sloping to almost flat, so some surface drainage can happen, but the internal drainage is slow, therefore the drainage is imperfect. The cultivated layer is 5-6 inches thick, dark brown in color, and a crumbling consistency.

2.2 SWM Targets

The stormwater management plan focuses on three environmental objectives when considering the treatment and conveyance of stormwater runoff. The objectives are to mitigate flooding, water quality impairments, and erosion impacts to the receiving system.

The Stormwater Management Planning and Design Manual (MOE, 2003) outlines potential negative impacts as the result of development, including water quality degradation, increase in surface runoff, soil erosion, and higher downstream flow velocities. The effects of development are understood on the basis of imperviousness.

Based on the guidance above, JE has prepared a SWM solution to achieve the following targets:

Target #1: Quantity Control

- Ensure the post-development peak flows do not exceed pre-development peak flows for all return period events.

Target #2: Quality Control

- Ensure effluent meets **Enhanced** quality control objectives.

Target #3 Erosion and Sediment Control

- Minimize the potential for erosion of soils.
- Mitigate the release of sediment offsite.

3 Hydrologic Modelling

The objective of the hydrologic modelling is to establish baseline conditions for the existing lands and simulate the effects of the proposed development such that impacts may be understood and mitigation measures proposed.

3.1 Existing Conditions

The development site drains naturally towards marsh and wetland areas along the shore of the Moira River directly connecting to the river. The southern and a portion of the eastern extents drain into wetland areas which separates the golf course from the existing residential properties along Harmony Road.

The drainage scheme will follow the natural drainage patterns to the wetlands and toward the north limits of the property. Flow towards Harmony Road will converge upon a culvert within the wetland which is a legal outlet for drainage. The municipal road allowance is also a legal outlet for drainage. Flow towards the western wetland does not have a culvert, instead it is a natural convergence point.

A review of the drainage is considered at the southern discharge points as they are susceptible to changes resulting in upstream and downstream impacts. The discharge points, which will be henceforth referred to as Nodes A, B etc., will be controlled as required to best maintain the pre-development conditions. Node A is a natural convergence point along the west property line. The runoff drains southwards from that point to a significant wetland on the west property line. Node B is a centerline culvert under Harmony Road at 15+240. The 750mm HDPE pipe is responsible for conveying the runoff from all southern areas which drain into the southeast wetland. Harmony Road and the 750mm culvert form a control for the entire catchment.

JE selected OTTHYMO for the hydrologic modelling analysis. OTTHYMO is a single event hydrologic model that was developed for use in Ontario and has been recommended for use by the Ministry of Transportation and the Ministry of the Environment. The model allows the user to simulate the hydrologic response of a watershed to meteorological inputs and can analyze the effects of storage.

3.2 Developed Conditions

Under post development conditions, the subject site will feature five distinct housing clusters, connected by a series of looped roads with branching cul-de-sacs. The development will be accessed from Harmony Road and potentially Homan Road. Post-development hydrology is interpreted using numerous catchments and sub-catchments that have been numbered using 200 series based on the pre-development conditions that are numbered using 100 series. Sub-catchments have a letter identifier to note that it has originated from a larger area and has been segmented to provide more detailed analysis. All references to sloping topography are made in relation to the development, not to any quantifiable definition of steep versus mild slopes.

Catchment 200

This area is on the most northwestern portion of the property, with a large portion of the catchment area on the west side of Homan Road. The outlet point is the Moira River. This land will not experience any development as it is outside the property limits.

Catchment 201A

201A is the first byproduct of the 101 area, development in this area will be low density residential units with a green space in the middle. Easements have been placed throughout the area to allow for drainage pathways between units, specifically in areas where there are multiple units backing onto each other. This area will be drained towards the Moira River.

Catchment 201B

This area is a conglomerate mixture of green space, low density, medium density and mixed-use sections, connected by a looped road network. The green space will act as a drainage easement where swales or other technologies can be used to moderate the flow rate and quality of runoff if needed throughout the area. Ultimately the end goal is for this runoff to continue feeding the Moira River, but it first must travel through the dense thicket of 201.

Catchment 201C

One of the smaller 201 catchments, true to its roots of multiple land uses with low density, medium density and mixed-use; this area drains straight to the right of way from which point the runoff is directed towards the 201F woodland which starts its superfluous journey to the Moira River.

Catchment 201D

Bordering the river, this catchment contains the new River Club and their facilities. The area is also comprised of a small part of low-density residential properties set back from the water to maintain the forest and wetland along the shore of the Moira River.

Catchment 201E

As the smallest sub-catchment of the group, Catchment 201E includes the road that connects to the River Club and receives the front yard drainage of the low-density units. Catchment 201E drains into the 201D catchment, which is a straight shot to the Moira River.

Catchment 201F

Consisting of important woodland, the rather large catchment has minimal development; most of the developed runoff stems from the rear yards of mostly low-density residential uses. This catchment is on the furthest side from the river. The area is heavily wooded with a small pocket of medium density development on south-west corner, access is provided by Homan Road.

Catchment 202

The southern point contains some medium density residential development which drains to the north, crossing the road through a small centerline culvert. The north side of the road through to the waters edge is dense forest and significant woodland to be protected and remain undeveloped. The undeveloped forest and developed housing are mild to steeply sloping, gradually softening in slope near the water's edge.

Catchment 203

This area will experience some change as a road is paved along the east side with medium density residential land use to the east as well. The west side is woodland with a hydro cut corridor leading to the river. The runoff is naturally inclined to find its way towards the hydro cut, and into the river.

Catchment 204

With very gentle topography, 204 will see sheet flow runoff across properties into the streets, and potentially be caught by appropriately spaced catch basins. Along the east border of the property, there will be low and medium density residential development with a beautiful view of the neighboring Trillium Woods Golf Course. The outlet point for this catchment will be in the northeast corner, draining onto the neighboring property.

Catchment 205

Undeveloped land on the west of the property, bordered to the north and east by a trail owned by Eastern Ontario Trails Alliance. This area discharges to the west across active agricultural land.

Catchment 206

On the 3,000ft scale, this land will remain undeveloped, with the only exception being the small portion of backyard drainage which will be directed into the woods. The runoff from the few low density residential properties is minuscule compared to the path which it must take to reach the discharge point to the northwest. The discharge point is large agricultural land which would benefit from a marginal increase in water, if any.

Catchment 207A

The existing tree separation between the development property and agricultural land will act as a natural flow attenuation feature to help absorb the runoff in the field and some of the rainfall that lands on the developed properties. The east border will be developed with low density housing, but only the backyard drainage is included in this sub-catchment.

Catchment 207B

This area will be completely developed with a combination of low and medium density residential lots. There is certainly an expected increase in runoff from developing this area, unfortunately the outlet point is upstream of a significant wetland and residential area. Thus, the increase in runoff could have negative consequences on sensitive downstream conditions. Quantity and quality control will be used for this catchment and those that feed into this area.

Catchment 208A

Home to the irrigation pond used by the golf course to maintain the lush green grass via a sprinkler system, 208A will be developed with mixed use property to the east, and the pond to the west. The area that drains to the pond in both pre and post development conditions will be considered a sink and will not contribute to any discharge nodes.

Catchment 208B

208B is undeveloped apart from the road which will be paved along the hydro cut. The smaller irrigation pond will be used to control excess flow generated by developing the sub-catchments in the greater 108 area. The small pond will need to be controlled as the existing conditions have all runoff crossing the 207B area and entering the sensitive wetland area in the southwest. Quantity control will be required for this catchment family.

Catchment 208C

Once part of the greater 108 catchment, this area will be almost completely developed with some green space pathways separating land uses. This area has steep topography and will be draining into a nearby pond when it can be treated and discharged in a controlled manner.

Catchment 208D

Derived from the greater 108 catchment, this area is under the powerlines which is undevelopable lands located west of the road that goes around the irrigation ponds leading to the northern region. The runoff is unable to cross the road to join the rest of the 208 runoff which outlets into Pond 1. This area however will be directed westerly towards the 207 catchments to outlet into the underground storage units.

Catchment 209

This area drains into provincially significant wetland along the west border of the catchment which acts a concentration point for runoff. The development in this catchment is considered minimal as it receives the rear yard drainage of the large low density residential lots. The woodland around the wetland will remain intact to reduce runoff generated from the low to mild sloping topography.

Catchment 210

Catchment 210 is a small area on the west side of the Harmony Road entrance that will drain along the roadside ditch toward a driveway culvert before ultimately reaching the wetland and Culvert B. A small portion of this area consists of split drainage runoff from proposed single-family dwellings on the north and south borders, the rest is medium density woodland.

Catchment 211A

Catchment 211A is the first sub-catchment of what used to be known as 111 and has adopted a small piece of 112. This catchment is single detached family homes with green space in the center island. The impervious roads and houses increase runoff while the green space acts as pervious land, helping infiltration, decreasing runoff. There is a small green space easement, likely to be short grasses used as park space for the community.

Catchment 211B

The second sub-catchment is similar to the first however it includes a large medium density space around the clubhouse, this area is assumed to be connected by walking paths between units with a road passing around its perimeter. Split drainage may be used to direct backyard runoff straight into the wetland in 211. Without a dedicated greenspace and the medium density community around the clubhouse, this land is slightly more impervious. This catchment identification is used to represent all the smaller areas around it as a simpler way to represent 211D-G within this report.

Catchment 211C

Catchment 211C is the primary source of runoff; it is the largest catchment which experiences the most development. 211C is the undeveloped area directly connected to Culvert B, and exists in the lowland gap between 211A and B. This catchment is very flat with minimal change in elevation with respect to the most remote point relative to Culvert B. This area is covered in lowland vegetation such as cattails, trees under 30’, and tall grasses. This area is dominated by natural features.

Catchment 212

This land is east of the school along Harmony Road and extends north on County Road 37. It encompasses part of Trillium Wood Golf Club and some agricultural fields. There are residential properties lining the road contributing to an area which is sparsely populated with significant vegetation. This runoff drains into the roadside ditches and finds its way downhill to Culvert B.

Catchment 213

An area that is quite flat, with medium density tree cover, the abstractions are moderate to high. A proposed road runs through it with houses on one side increase runoff generation, which is directed towards to the neighboring property and the undeveloped forest in 214. Nearly half the area is undeveloped and undisturbed woodland, with another third of the area taken by a few holes at the golf course with groups of trees separating them.

Catchment 214

A dense forest and undeveloped section in the northeast corner of the property, Catchment 214 is the transfer station for part of 213 as the runoff is directed into the river. This large catchment is bound by the river in the north and Trillium Woods to the east, however its flat topography and dense vegetation attracts and prevents runoff that might have otherwise been directed towards the neighboring lands.

Summarizing all catchments into a digestible synopsis of the changes that have been made and the breakdown that has ensued, see the table below.

Table 3-1: List of all Pre- and Post-Development Catchments with Corresponding Areas

Pre-Development Catchments	Area (ha)	Post-Development Catchment	Area(ha)
100	6.34	200	6.36
101	71.06	201A	19.12
		201B	9.09
		201C	4.16
		201D	11.59
		201E	1.96
		201F	23.78
102	11.95	202	12.01
103	6.40	203	6.20
104	86.33	204	87.42
105	5.30	205	5.30
106	7.89	206	7.22
107A	1.68	207A	2.74
107B	8.63	207B	8.57
108A	2.83	208A	3.27
108B	8.21	208B	2.15
		208C	4.48
		208D	2.23
109	2.95	209	2.73
110	6.74	210	6.63
111	84.36	211A	5.67
		211B	3.87

		211C	72.49
		211D	0.45
		211E	1.75
		211F	0.48
		211G	0.67
112	50.83	212	50.20
113	28.05	213	28.41
114	71.86	214	71.45

3.3 Master SWM Planning Zones

All catchments have been grouped into zones which correspond to discharge locations. Development is expected to progress in stages following the zone numbering starting from the south, with zones 1 and 2 as the first to be built. Less detail is available about later stages of development but will be expanded upon in subsequent stages of design and approval.

3.3.1 Zone 1

Zone 1 encompasses the lands draining to the west property in the first section to be constructed, based on the anticipated construction sequencing. This zone includes catchments 207A, 207B, 208A-D, and 209, which all drain into a significant wetland along the border of 209. Currently, Catchments within Zone 1 feature a paved road from Harmony Road to the clubhouse in 208, a few irrigation ponds used to keep the grass green around the course, woodland, and a long undeveloped hydro corridor. The Eastern Ontario Trails Alliance (EOTA) also maintains a trail alongside the driveway which sweeps to the east, eventually following the property line to Homan Road. Communication will be required with EOTA to understand any implications of developing around their trail, as well as the potential need for maintenance access within the Black Bear Ridge property. Drainage from Zone 1 discharges to a small wetland on private property west of the BBR lands.

Proposed development will include a pump station, low/medium density residential, and green pathways between lots. There will be an increase in runoff generated by constructing impervious structures and since this discharge point is to private lands quantity controls will be triggered. Controls will be provided using a combination of above ground ponds and underground storage.

The 208 properties will be routed first into the south irrigation pond, which is located within the hydro corridor. The exceptions are 208D which bypasses the pond and 208A that drains into the north irrigation pond and does not discharge. The south pond will be engaged as a stormwater management pond that will be over-controlled to relieve the burden of the underground storage in 207B. The underground storage units supplied by Stormtech will be buried in the greenspace and receive the discharge from the first pond and the direct runoff generated by 207B. The underground storage is then routed into the wetland at pre-development peak levels. This strategy within Zone 1 will be sufficient for quantity control, while the quality control will be achieved with a combination of technologies approach using OGS units and underground treatment units such as the Isolator Rows from Stormtech.

3.3.2 Zone 2

Catchments 210, 211, and 212 contribute to the flow through Zone 2, discharging through a centerline culvert under Harmony Road. The flow collects in a central wetland basin which acts as a large reservoir to manage the flow in large storms and discharge it in a controlled manner. Runoff arrives from 210 in the west, 211 in the north, and 212 in the east, all of which collect in the basin and exits through a 750mm HDPE existing culvert. The area is mostly undeveloped wetland with developed areas to the east. The anticipated order of implementation will have this zone prioritized as part of the first phase of construction.

Parts of 211 will be developed; the southern portion redistributes the corner of 212 to be transferred to 211 lands. The increased runoff generated by 211A-G is substantial and could impact private property south of Harmony Road, implying that quantity control is required. Jewell reviewed opportunities to harness the natural storage provided by the existing wetlands and low land area and found that by adjusting the invert of the 750m centreline culvert by 0.05m would be sufficient to moderate the flows. Alternatively a change in the diameter of the pipe would have a similar effect controlling post-development peak flows to pre-development levels.

Quality control will also be required in this zone to protect the natural environment. This can be achieved using a combination of technologies approach including but not limited to Oil Grit Separators, isolator rows, or other equivalent alternatives.

3.3.3 Zone 3

The third zone, located on the east side of the property is entirely made up by catchment 204. The major flow path is from west to east across the golf course, into the neighbouring property, eventually draining into the Moira River. Existing conditions for the golf course portion will remain unchanged following development, there are no plans to adjust the layout of the course as part of the extensive residential development. As such, there is a reduced development opportunity in Zone 3, which will include small areas of mixed low and medium density residential developments.

The increase in imperviousness will contribute to an expected increase in peak flows. Since the lands contribute drainage directly into the large riparian wetland associated with the Moira River, no quantity controls are triggered. Nevertheless, measures should be taken to assure there will be no increased erosion risks stemming from the runoff pathway to the wetland. This can be accomplished by mitigation measures that reduce velocity such as check dams or level spreaders. Quality treatment will be needed to prevent runoff that terminates at the Moira

River from impacting water quality. This can be achieved with a combination of technologies approach using OGS units and ditching enhancements.

3.3.4 Zone 4

Zone 4 is comprised of Catchments 205 and 206 that are situated west of the EOA trail. This area is within the Corbyville Creek watershed and drains westerly onto privately owned lands that are in agricultural use. No development is proposed within this area except for backyards of four or five single family dwellings. Post-Development peak flows are not expected to change appreciably. will not experience substantial development and will outlet across agricultural fields, eventually reaching the minor Corbyville Creek watershed. There is no risk of impact due to increased runoff rates and no quality or quantity mitigation is anticipated to be needed.

3.3.5 Zone 5

Zone 5 is situated to the northwest along the Moira River. This area is comprised of Catchments 200, 201, 202, 203, 213, and 214 that drain directly into the Moira River. The region is mostly wooded except for pathways that were carved out decades ago. The planned development has a mix of residential and commercial land uses. Access is via Harmony Road to the south and Homan Road to the west. This area will likely be the last to be developed. Part of this zone includes private lands with frontage along the river as well as a power line corridor.

Portions of this zone are expected to be set aside for environmental protection, in particular the lands along the riverfront and those fronting onto the EOA trail. Since drainage will discharge directly into the Moira River, no quantity controls are triggered. Stormwater quality impacts can be expected and for this reason water quality mitigation measures will be needed. A combination of technologies approach is again anticipated for this zone and at least seven points of discharge are conceptually planned. Oil and Grit separators may be used in conjunction with other non-mechanical treatment technologies to achieve the Enhanced water quality treatment objectives. Commercial developments will be required to provide on-site quality treatment and may also need quantity controls to minimize the impact on the future municipal stormwater conveyance system.

Since the development in Zone 5 is only conceptually conceived at this point, it is premature to undertake design calculations for quality treatment. Consequently, the plan is to apply a distributed stormwater quality treatment concept generally within the locations shown on the concept drawings.

3.4 Model Inputs

Typical hydrologic inputs for OTTHYMO include:

- Precipitation
- Area (ha)
- Time of Peak (for Nash)
- Curve Number
- Initial Abstraction
- Imperviousness (for Standhyd)
- Slope (for Standhyd)
- Length (for Standhyd)

3.4.1 Precipitation

Precipitation records from Environment Canada were used for the Belleville station 6150689. The most recent Intensity Duration Frequency curves v3.3 (IDF curves) was released January 2023, and the Belleville station contains data from 1965-2017.

Precipitation statistics supplied to the model require the user to select:

- Station (i.e. Belleville)
- Duration (of the event in hours)
- Frequency (return period)

The MTO Drainage Manual (1997) recommends that the storm duration for smaller urban catchments to be in the range of 1-hr to 6-hr duration. The BBR development is larger and durations of up to 24 hours were reviewed.

3.4.2 Area

The contributing areas of each of the catchments is topographically determined using LiDAR data and OWIT (Ontario Watershed Information Tool). OTTHYMO requires catchment areas to be assigned in hectares.

3.4.3 Time of Peak

The time of peak was calculated as 2/3 of the time of concentration as recommended in the OTTHYMO user's manual.

The time of concentration is calculated using the Airport Method that is suitable for catchments with runoff coefficients less than 0.4. The Airport Method equation is shown below in Equation 1.

Equation 1: Time of Concentration by Airport Method

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

Where:

T_C = Time of concentration in min
L = Length of Watershed in metres
C = Runoff Coefficient
S_W = Watershed Slope in %
A = Watershed area in hectares

The slope of each drainage area was determined using 85/10 Average Slope Method per Equation B2.2 of the MTO Drainage Manual.

3.4.4 Curve Number

Weighted Curve Number is calculated based on hydrologic soil group and land use characteristics within each catchment per MTO design charts 1.08 and 1.09.

3.4.5 Initial Abstraction

The initial abstraction is the amount of precipitation that is directly removed from the calculations. This represents the depth of precipitation that is stored in depressions. This is typically applied as 2mm for asphalt and 5mm for landscaped areas.

3.4.6 Imperviousness

The imperviousness is an input for the Standhyd command used to represent developed catchments. An estimate of imperviousness was made for each of the catchments where development is occurring.

3.4.7 Slope

The Standhyd command requires a slope value to be applied to each of the pervious and impervious areas. Slopes were estimated to represent the expected gradients of the catchments.

3.4.8 Length

The Standhyd routine also requires a drainage length to be provided for each of the pervious and impervious areas. This value helps the model to interpret the shape of the catchment. JE used a generalized approach to length using the formula provided below.

Equation 2: Relationship between Watershed Area and Length

$$A = 1.5L^2$$

Where:

A = Area in m^2
L = Length in m

3.4.9 Summary of Inputs

Table 3-2: Summary of inputs for Pre-Development Model Zone 1

Catchment	Area (ha)	Tp (hr)	CN	Slope (%)	Length (m)
107A	1.68	0.41	73.12	2.3	350
107B	8.63	0.46	78.26	1.7	360
108B	8.78	0.47	76.05	2.5	490
109	2.95	0.29	65.5	3.2	210
Total Area	**22.04**				

Table 3-3:Summary of inputs for Post-Development Model Zone 1

Catchment	Area (ha)	T.Imp	CN	IA	Standhyd Length (m)
207A	2.74	N/A	73.12	N/A	N/A
207B	8.57	0.4	78.26	5	239
208B	2.15	N/A	76.05	N/A	N/A
208C	4.48	0.45	76.05	5	172.8
208D	2.23	N/A	80.48	N/A	N/A
209	2.73	N/A	76.67	N/A	N/A
Total Area	**22.90**				

Table 3-4: Summary of inputs for Pre-Development Model Zone 2

Catchment	Area (ha)	Tp (hr)	CN	Slope (%)	Length (m)
110	6.75	0.7	74.25	1.2	650
111	84.36	2.2	72.6	0.2	1600
112	51.25	1.1	80.27	1.0	1400
Total Area	**142.36**				

Table 3-5: Summary of inputs for Post-Development Model Zone 2

Catchment	Area (ha)	T.Imp	CN	IA	Standhyd Length (m)
210	6.63	N/A	74.96	N/A	N/A
211A	5.67	0.41	72.6	5	194.4
211B	7.22	0.5	72.6	5	219.4
211C	72.49	N/A	72.6	N/A	N/A
212	50.20	N/A	80.62	N/A	N/A
Total Area	**142.21**				

Table 3-6: Summary of inputs for Pre-Development Model Zone 3

Catchment	Area (ha)	Tp (hr)	CN	Slope (%)	Length (m)
104	86.32	1.46	68.48	0.4	1360
Total Area	**86.32**				

Table 3-7: Summary of inputs for Post-Development Model Zone 3

Catchment	Area (ha)	T.Imp	CN	IA	Standhyd Length (m)
204	87.42	0.115	68.48	5	763.41
Total Area	**87.42**				

Hydrologic modelling was not conducted for Zones 4 and 5.

3.5 Peak Flow and Quantity Control Strategies

The runoff from each catchment is directed either to a concentration point on the edge of the property, called nodes, or to an internal pond, or to the nearby watercourse. The following tables demonstrate the initial conditions prior to any further development in the area, and the impacts of proposed stormwater management controls. Only the zones which need quantity control have been assessed for changes in peak flow leaving the site.

Pre-development conditions were analysed using the Nashyd subroutine while post-development parameters were modelled with the StandHyd sub-routine. Flows were analysed for the 5-yr and 100-yr events. The 5-yr event was selected for analysis to demonstrate the versatility of modifications under contrasting storm events.

3.5.1 Node A

Table 3-5 contains the predevelopment peak flows for each event and duration for 5-, 25-, and 100-year events converging at Node A. Table 3-6 provides a summary post-development peak flow rates after control structures are implemented.

During pre-development conditions, the runoff travels overland across multiple catchments including 208, 207 and 209, where it ultimately discharges to the wetlands at Node A.

Table 3-8: Summary of Controlled Pre-Development OTTHYMO Outputs Zone 1

Return Period (yr)	Peak Flow (cms)		
	6-Hr	12-Hr	24-Hr
5	0.49	0.56	0.64
25	0.84	0.96	1.08
100	1.18	1.34	1.49

Following development, the longest travel path is from the outer reaches of 208C, overland into a convergence point where it is drained into pond 1, slowly discharged through an orifice and piped under the hydro cut into the underground storage. The storage facilities will connect flows from 207B and 208, then discharge the water in a controlled manner to prevent impacts to downstream conditions. The water travels to the significant wetland, joining the flow from 207A and 209. The system is best described visually in Appendix C.

Table 3-9: Summary of Post-Development Peak Flows from OTTHYMO Zone 1

Return Period	Storm Duration (hours)	Underground Storage (m^3)	Peak Flow (cms)	Water Surface Elevation P1 (m)	Water Surface Elevation US (m)
5 Years	6	394	**0.49**	111.22	108.26
5 Years	12	408	**0.54**	111.23	108.29
5 Years	24	427	**0.59**	111.25	108.33
25 Years	6	497	**0.79**	111.30	108.48
25 Years	12	515	**0.88**	111.33	108.52

Return Period	Storm Duration (hours)	Underground Storage (m^3)	Peak Flow (cms)	Water Surface Elevation P1 (m)	Water Surface Elevation US (m)
25 Years	24	537	**1.00**	111.36	108.57
100 Years	6	554	**1.13**	111.38	108.61
100 Years	12	579	**1.26**	111.41	108.69
100 Years	24	598	**1.42**	111.44	108.74

There is approximately 2,000m^3 of available storage in the pond (SWM #2). The underground facility will provide just under 700m^3 of storage (SWM #1). The latter storage is more compact, but is more expensive, so it will be fully used in an effort to reduce wasted units. During detailed design, the units may be added or deleted as needed to ensure just the needed amount is provided. At this stage of design, a 30 cm freeboard within the units has been retained in reserve to account for any climate change or significant changes in the future.

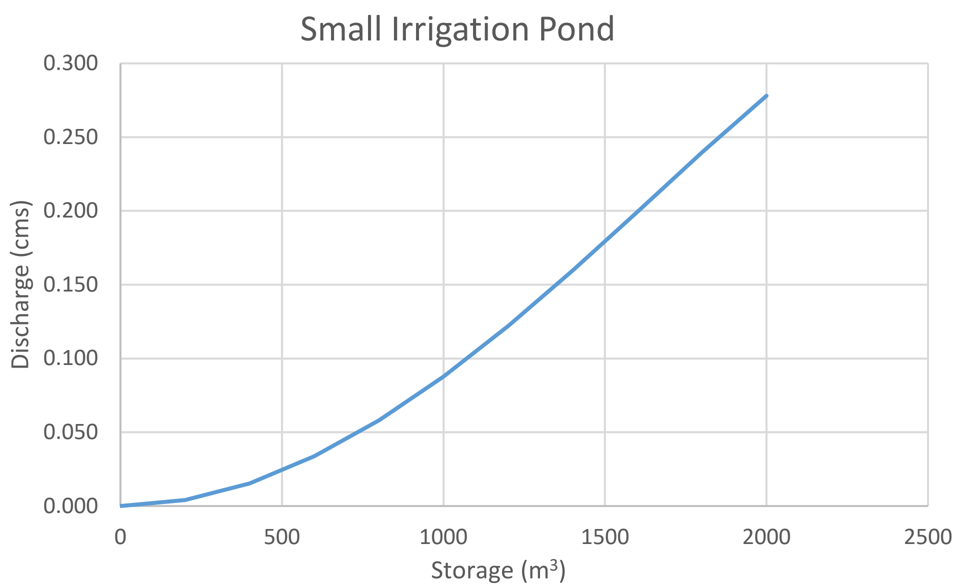


Figure 3-1: Storage-Discharge for small pond in 208B

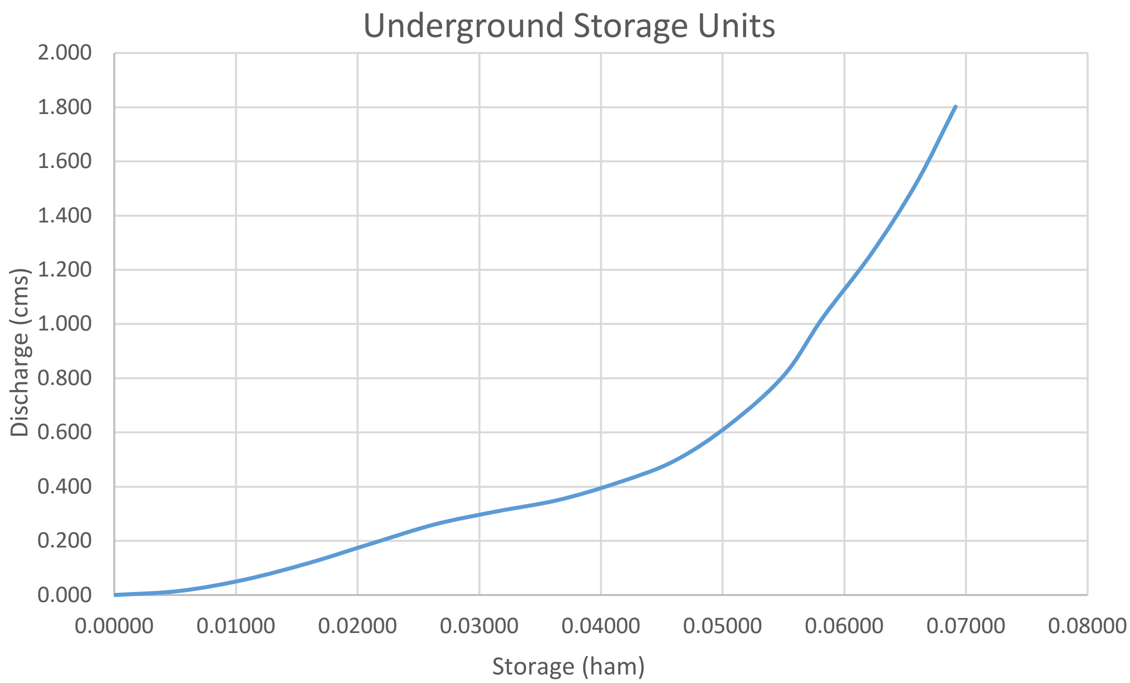


Figure 3-2: Storage-Discharge relationship for the MC-7200 units (Advanced Drainage Systems, 2022) in 207B

A comparison of the pre- and post-development peak flows can be found in Table 3-10. In all studied events, the proposed stormwater management plan indicates that the post-development peak flows can be reduced to pre-development targets and confirms that the lands set aside for the SWM facilities are adequate.

Table 3-10: Comparison of Pre-Development and Post-Development Peak Flows Zone 1 (at Node A)

Storm Duration	Q_5 (cms)		Q_{25} (cms)		Q_{100} (cms)		Requirement Met
	Pre	Post	Pre	Post	Pre	Post	
6 Hours	0.49	0.49	0.84	0.79	1.18	1.13	✓
12 Hours	0.56	0.54	0.96	0.89	1.33	1.26	✓
24 Hours	0.64	0.59	1.08	1.00	1.49	1.42	✓

Each post-development event meets or exceeds the corresponding pre-development peak flow, such that the downstream impacts will be mitigated. The flow is constrained using two controls, the first being SWM #2 which manages the 208 series catchments except for 208C, and the second is the underground storage (SWM #1). By implementing the two controls, we have demonstrated that the peak flow targets can be achieved.

Drainage through the underground storage facility ignores the stormwater that will be retained within the lower gravel area. This is a conservative assumption that also benefits shorter duration events by promoting infiltration.

The wetland at Node A will not experience flooding as the inflow has been matched to produce nearly identical pre and post conditions. Additionally, the underground chambers will help to promote infiltration of the routine runoff events and this will help to draw out the discharge curve and support the hydrology of the wetland.

3.5.2 Node B

Table 3-11 contains the pre-development peak flows for each event and duration for 5-year, 25 year and 100-year events at Culvert B. A summary of post development peak flow rates is included in Table 3-12.

It is observed that the post-development peak flows are not increased under the proposed development conditions. This is due in part to the timing of incoming peak flows from the large catchments and the storage effect.

Table 3-11: Summary of Pre-Development Peak Flows from OTTHYMO Zone 2

Return Period	Storm Duration (hours)	Storage (m^3)	Peak Flow (cms)	Water Surface Elevation (m)	H/D
5 Years	6	11700	**0.25**	106.42	0.56
5 Years	12	14000	**0.30**	106.47	0.63
5 Years	24	15000	**0.33**	106.49	0.65
25 Years	6	17600	**0.39**	106.54	0.72
25 Years	12	21800	**0.47**	106.61	0.81
25 Years	24	24500	**0.52**	106.65	0.87
100 Years	6	23800	**0.52**	106.64	0.85
100 Years	12	31900	**0.62**	106.75	1.00
100 Years	24	36900	**0.68**	106.81	1.08

Table 3-12: Summary of Controlled Post-Development OTTHYMO Outputs Zone 2

Return Period	Storm Duration (hours)	Storage (m^3)	Peak Flow (cms)	Water Surface Elevation (m)	H/D
5 Years	6	13000	**0.23**	106.45	0.53
5 Years	12	16000	**0.29**	106.51	0.61
5 Years	24	17600	**0.32**	106.54	0.65
25 Years	6	20600	**0.38**	106.59	0.72
25 Years	12	25200	**0.46**	106.66	0.81
25 Years	24	27300	**0.51**	106.69	0.85
100 Years	6	27300	**0.50**	106.69	0.85
100 Years	12	34400	**0.61**	106.78	0.97
100 Years	24	37800	**0.65**	106.82	1.04

The controlled discharge-storage relationship for the raised culvert can be seen below in Figure 3-3. The alteration results in slightly less flow at each storage benchmark, but the higher runoff rates will compensate at the outlet.

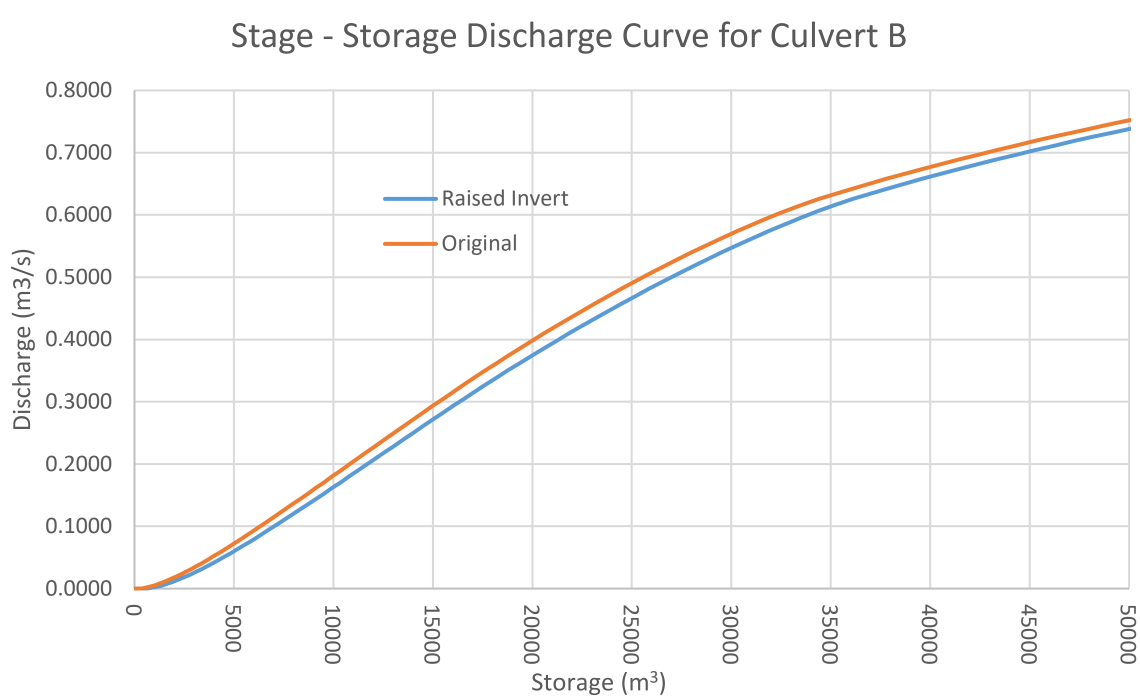


Figure 3-3: Storage-Discharge relationship for 750mm HDPE culvert in 211C

A comparison of the pre- and post-development peak flows can be found in Table 3-13.

Table 3-13: Comparison of Pre-Development and Post-Development Peak Flows Zone 2

Storm Duration	Q_5 (cms)		Q_{25} (cms)		Q_{100} (cms)		Requirement Met
	Pre	Post	Pre	Post	Pre	Post	
6 Hours	0.25	0.23	0.39	0.38	0.52	0.50	✓
12 Hours	0.30	0.29	0.47	0.46	0.62	0.61	✓
24 Hours	0.33	0.32	0.52	0.51	0.68	0.65	✓

In each studied event, the post-development peak flows will be improved as compared to the pre-development peaks. The maximum predicted pre-development peak flow from all cases checked was around 0.68m^3/s in the pre-development 100-yr 24-hr duration event. The post-development peak flows will be reduced to 0.65m^3/s representing a reduction of 0.03m^3/s or 30 L/s.

It can be observed that the 12-hour duration storms matched more closely to the target outflows while the longer duration, less frequent storms saw marginally greater flow reduction indicating that the storage is slightly more effective in the longer duration storms.

The analysis also suggests there would be no increased erosion potential downstream of Node B. These results have been achieved by raising the invert of the existing 750mm HDPE culvert by 50mm and engaging more of the natural storage.

Wetlands are adapted to fluctuating water levels and the changes expected as a consequence of the minor culvert improvements would not be expected to negatively impact on the hydrology of the wetland. During normal conditions, the water level within the wetland will be maintained 0.05m higher. Should there be a desire to maintain the existing elevation of the wetland, a small subdrain may be added to slowly drain out the 0.05m depth to mimic the original elevation. The need for this adaptation can be determined during detailed design.

3.5.3 Node C

Table 3-14 contains the pre-development peak flows for each event and duration for 5-year, 25 year and 100-year events at Culvert B. Table 3-15 provides a summary of post development peak flow rates.

The development within the area is expected to produce higher flow rates, demonstrated through the analysis of the peak flow rates. 204 is a large catchment with low slope, consequently resulting in a longer time to peak. Considering that the area is so large with a relatively low area being developed, the peaks would not be offset enough to accurately portray the resulting flow rates if the catchment were to be segmented. No controls are planned at this node to attenuate flow or provide any treatment.

All runoff generated travel on a path from west to east, running across the golf course towards the Trillium Woodlands, which eventually connects to the Moira River.

Table 3-14: Summary of Controlled Pre-Development OTTHYMO Outputs Zone 3

Return Period	Storm Duration (hours)	Peak Flow (cms)
5 Years	6	**0.69**
5 Years	12	**0.78**
5 Years	24	**0.89**
25 Years	6	**1.20**
25 Years	12	**1.36**
25 Years	24	**1.54**
100 Years	6	**1.69**
100 Years	12	**1.90**
100 Years	24	**2.13**

When changes are made and structures are erected, there will be a surge of runoff generated from the southeast quadrant of 204, such that the anticipated impervious area will be 60% for that area only. To account for this increase, a weighted curve number has been used to adjust the model to reflect the increase from approximately 2% impervious area overall, to 11.5% impervious area overall. Segmenting the catchments to provide a more accurate peak flow rate from the developed areas alone caused the model to develop inaccurate total results for the entire 204 catchment. The system is best described visually in Appendix C.

Table 3-15: Summary of Controlled Post-Development OTTHYMO Outputs Zone 3

Return Period	Storm Duration (hours)	Peak Flow (cms)
5 Years	6	**1.41**
5 Years	12	**1.41**
5 Years	24	**1.42**
25 Years	6	**2.08**
25 Years	12	**2.09**
25 Years	24	**2.11**

100 Years	6	**2.74**
100 Years	12	**2.75**
100 Years	24	**2.79**

A comparison of the pre- and post-development peak flows can be found in Table 3-15.

Table 3-16: Comparison of Pre-Development and Post-Development Peak Flows Zone 3

Storm Duration	Q_5 (cms)		Q_{25} (cms)		Q_{100} (cms)		Requirement Met
	Pre	Post	Pre	Post	Pre	Post	
6 Hours	0.69	1.41	1.20	2.08	1.69	2.74	✖
12 Hours	0.78	1.41	1.36	2.09	1.90	2.75	✖
24 Hours	0.89	1.42	1.54	2.11	2.13	2.79	✖

As anticipated, the peak flows will increase due to increasing imperviousness across the catchment without any control structures. This increase will be reported to the neighboring property management team to determine whether they will accept the unregulated and untreated flows onto their property. If they accept the increase, acknowledging the potential for erosion during intense storm events, then all is well. Otherwise, the flow will need to be diverted along the property line towards the woodland using a vegetated swale. The swale would need to support a flow rate of 2.79 m^3/s (the 100-year, 24-hour event) to control all flow.

This trapezoidal open channel would have a 0.5% slope with a 1.0m bottom width and 3:1 side slope, with peak flow reaching a maximum depth of 0.88m. This is of course if the best course of action with regards to the increased flow rate discharging towards the neighboring property is to accept full responsibility for all flows leaving the property. The swale can be reduced in size if the neighbor relies on the flow rate from this property to sustain their business and decrease irrigation costs. The swale could be designed to handle only the difference between pre and post development, in this case ranging between 0.7 m^3/s and 1.05 m^3/s.

4 Stormwater Management Controls

4.1 Drainage Scheme

The unique road layout in this development presents an opportunity to adjust the drainage scheme to minimize site alterations. With this objective in mind, JE proposes a drainage plan that maximizes grassy contact and reduces flow concentrations that occur in ditches and swales. Where these are not necessary, rear yard and side yard swales will be avoided.

The drainage design follows the hierarchy of controls listed below in order of application:

1. Source Controls
2. Conveyance Controls
3. End of Pipe Controls

4.1.1 Source Controls

Source controls include techniques such as reduced lot grading, reductions in site imperviousness, and disconnection of roof drainage. Such types of controls reduce runoff volumes and minimize treatment facilities required to mitigate quality impairments. Source controls are not transferred to municipal control.

4.1.2 Conveyance Controls

Conveyance controls provide treatment opportunities at flow concentrations where drainage is being collected and conveyed. These include grassed swales, ditches and storm sewers that are modified to infiltrate runoff. Most ditches and some grassed swales may be transferred to municipal control. Grassed swales and ditches will be used in this subdivision where possible.

4.1.3 End of Pipe Controls

When the source and conveyance controls are insufficient to achieve the targets, end of pipe controls may be applied. These typically include stormwater management ponds and constructed wetlands as well as Oil-Grit Separators. This development will use both ponds and OGS/isolator rows as needed to produce the best possible management strategy.

The water quantity and quality mitigation techniques offered in the design manual are sized relative to the site imperviousness. Flooding and erosion impacts can be mitigated using techniques that will reduce and/or slow down runoff. Water quality impacts can be mitigated through techniques that will encourage infiltration, filtration and settling of suspended sediment.

Ponds have been used at Node A to over-control the flow that goes to the second control, the underground storage. Implementing multiple end of pipe controls will greatly influence the drainage scheme.

A culvert control was implemented at Culvert B to attenuate the peak flow such the pre-development flow was not exceeded by the post. Using MTO Drainage Management Manual - Design Chart 2.31, the invert of the existing 750mm HDPE culvert was raised by 50 millimetres to take advantage of the dead storage that had previously been under-utilized. Using the OTTHYMO model to demonstrate the impact of making this change under the conditions imposed by catchments 210, 211, 211ABC, and 212. The access roads and all critical infrastructure are also not in danger of being in the floodplain during the 5 or 100-Yr storms according to LiDAR scans.

4.2 Stormwater Conveyance

Given that the proposed development would be described by most as a rural environment, the use of purely urban stormwater conveyance techniques is ill-fitting. This will require the expert use of a combination of pipe systems in areas where the water has no other place to go than onto neighboring properties. Ditches and enhanced swales will be used in combination with minimalist conveyance elements. The natural features are excellent at managing the varying flow rates, specifically natural ponding and pooling in the dense forest floors. The tree canopy provides intensity attenuation while the root systems are excellent check dams to slow the flow. Sheet flow off the lots into the dense forest works well to evenly distribute the flow. Vegetation can effectively treat the runoff on its way to the nearby waterways, reducing the need to disturb the natural systems with pipes and catch basins.

The least intrusive option will always be the preferred option, especially for this property where the natural features such as dense forests, ponds, wetlands, marshland, are all in an abundance. The inclusion of the green spaces in the housing clusters supports this, by simply providing park space, which does not need to be disturbed during construction. Currently the pipe network supporting individual housing clusters will get the water to the natural features which are attuned to constraining the flow and offering consistency.

4.3 Quality Treatment

Quality treatment will be done using a treatment train approach, the treatment train will involve using options such as OGS units, detention ponds, or low slope swales. These will work together to remove the total suspended solids accumulated as the runoff travels overland. Silt and sand are frequently collected by runoff, as well as oils or salts off vehicles. Suspended solids need to be removed before reaching a major waterway, otherwise it could have an impact on the downstream ecology. Nodes A, B, and C all receive quality treatment to protect downstream collectors from excessive sedimentation. The First Defense OGS units are sized based on the maximum flowrate that they can sustain without causing a backwater effect. The number of units required for the isolator rows is based on the depth to which the subdrain can be at with sufficient cover over the unit as well. If the unit cannot drain via gravity because it would be too deep, then more units will be used until they all drain efficiently.

Zone 1

Downstream of the underground storage outlet, an FD-8HC OGS unit and Isolator Row PLUS will be installed to treat the effluent. These will work in tandem to remove more than 80% TSS, which qualifies as Enhanced Treatment. The stormwater will then be discharged at the same flow rate out to Node A.

Zone 2

There will be five OGS and isolator rows placed throughout this zone to treat the runoff from the various sub catchments. 211A will receive treatment using a FD-8HC, separately 211BF will also receive a FD-8HC. Both areas will also be equipped with IR PLUS' which are sized based on the physical area which they can take advantage of. 211E, 211F, and 211G will all have a FD-4HC as the OGS unit and an IR PLUS in series to complete the treatment train. These areas are much smaller, which means that the runoff rates are much lower.

Zone 3

This area is not intended to receive any quantity control, however the maximum discharge rate for the biggest OGS unit is 1.416 m^3/s. This unit will only be prescribed for the medium density development close to the property line, which on its own has a peak flow rate of 2.000 m^3/s which would exceed the capacity of the OGS unit. Since there is no need for quantity control, a weir would be provided to allow the excess flow during extreme rain events to bypass the OGS unit. Enhanced 80% TSS removal can still be achieved by maximalizing the efficiency of the IR PLUS units. Over controlling the quality treatment may be an acceptable alternative.

Zone 4

This area does not experience substantial development; thus, it will not receive quality or quantity control.

Zone 5

The northern region will eventually have quality controls to protect the Moira River, but at this point the plans are far from fruition.

Summarising all of this into a digestible medium, see Table 4-1 below.

Table 4-1: Summary of quality treatment at each minor discharge point

Zone ID	Quality Treatment?	Storm Outlet ID	Contributing Catchments	Treated Area (ha)	OGS Unit ID	Isolator Row ID
1	✓	1	207B + 208B + 208C + 208D	17.43	FD-8HC	IR PLUS
2	✓	2	211A	5.67	FD-8HC	IR PLUS
		3	211B +211F	4.35	FD-8HC	IR PLUS
		4	211E	1.75	FD-4HC	IR PLUS
		5	211F	0.45	FD-4HC	IR PLUS
		6	211G	0.67	FD-4HC	IR PLUS
3	✓	7	204	14.33	FD-10HC	IR PLUS
4	✗	N/A	N/A	N/A	N/A	N/A
5	✗	N/A	N/A	N/A	N/A	N/A

5 Low-Impact Development

Low Impact Development is a requirement of the 2020 Provincial Policy Statement. This requires that all developments consider LID strategies to reduce the impact of development on the hydrologic regime.

The Low Impact Development Guidelines (Toronto and Region Conservation Authority, 2010) states that "increases in the quantity, rate, and frequency of runoff can be linked to two root causes:

- the conversion of undeveloped or agricultural land cover to urban uses, and
- the application of storm sewer systems."

The goal of LID site design strategies is to minimize these two sources of hydrologic impacts (Toronto and Region Conservation Authority, 2010, p. 3.3). Large urban areas are negatively impacted by flash flooding associated with extensive hardening. The LID design techniques seek to mitigate flooding and erosion associated with urbanization. While water quality improvements are associated with the recommended techniques, quantity control remains the focus of LID.

The guidelines provide some site design strategies for reducing the hydrologic impact postulating 4 major groupings or "themes":

1) Preserving important hydrologic features and functions;
2) siting and layout of development;
3) reducing impervious area; and
4) using natural drainage systems.

The site design incorporates all four of the themes. Some strategies are applied with greater care since municipal requirements limit such techniques as setbacks, road design, parking, and drainage design. The LID guidelines provide a hierarchy of applying the LID techniques by first invoking the use of natural hydrologic areas and then development of green infrastructure. As such, the design adds limited green technologies that will encourage infiltration.

Discussion of the LID design used in the stormwater management design is provided below.

5.1 Theme 1 – Preserving Important Hydrologic Features

This theme focuses on preservation. Site design is adjusted to preserve natural features that benefit hydrology.

- Preserve stream buffers, including along intermittent and ephemeral channels
- Preserve areas of undisturbed soil and vegetation cover
- Avoid development on permeable soils
- Preserve existing trees and, where possible, tree clusters

Important hydrologic features include:

- Highly permeable soils
- Pocket wetlands
- Significant small (headwater) drainage features
- Riparian buffers
- Floodplains
- Undisturbed natural vegetation
- Tree clusters

5.2 Theme 2 – Application of Siting and Layout Techniques

Siting and layout techniques aim to reduce the environmental impacts of the development by fitting the development within the framework of the natural heritage features.

- Fit the design to the terrain
- Use open space or clustered development
- Use innovative street network designs
- Reduce roadway setbacks and lot frontages

Clustering Development into five distinct zones helps to retain the natural environment between clusters to support the ecosystem. Without the need to clear the site of vegetation, native species will retain their habitat. Using the existing roads to connect to clusters also reduces impact, preserving the isolated feeling of rural living.

5.3 Theme 3 – Reducing the Impervious Area

Imperviousness can be reduced by minimizing unnecessary surface hardening. Some strategies include:

- Reducing street width
- Reducing building footprints
- Reducing parking footprints
- Considering alternatives to cul-de-sacs
- Eliminating unnecessary sidewalks and driveways

With respect to the unique combination of looped networks and cul-de-sacs, the number of hard surfaces is limited and constrained. The integration with the golf course allows cart paths to be used instead of roads, reducing the width of asphalt.

5.4 Theme 4 – Using Natural Drainage Systems

These strategies focus on the use of existing natural drainage systems where available "to take advantage of undisturbed vegetated areas and natural drainage patterns."

- "Disconnect" impervious areas
- Preserve or create micro-topography
- Extend drainage flow paths

Where possible, flows are encouraged to drain across pervious grassed surfaces prior to collection in the storm sewers. Pervious grassed surfaces will encourage infiltration into the soils.

5.5 LID Summary

The development site design follows the LID strategies provided in the Low Impact Development guide and makes extensive use of techniques to preserve natural drainage features, adjust the layout to the site, reduce impervious areas, and take advantage of natural drainage features.

6 Erosion and Sediment Control

Erosion and sediment control is one of the three targets identified in Section 2.3. The following measures are proposed to prevent the negative erosion and sediment impacts of development.

Typical site development requires removal of some vegetated cover. While it is the intention to reduce vegetation removal, exposed soils from the work will be at risk of eroding into the receiving drainage system. Measures will need to be put in place to reduce erosion during construction, and for a period of up to one year after construction is completed. Typical erosion and sediment control measures include:

- Siltation fencing.
- Strawbale check dams.
- Rip-rap check dams.
- Filter sock inserts in catch basins.

Controls are to be placed downstream of all active work areas and upstream of protected receivers. Controls should also be placed around stockpiles of topsoil and fill materials.

Typical OPSDs provide good instruction on the correct placement and construction of the controls. The controls provide some protection if they are properly maintained, but they should be considered last-resort measures. The most effective means of control are those which prevent or reduce erosion at the source. This would include diligent stabilization of exposed areas immediately after grading is completed. Stabilization measures include sod, erosion blankets, or riprap and filter cloth on steep slopes, as well as topsoil and hydroseed on gently sloped areas (with slope 10% or less).

The site developer and contractor should actively maintain the new drainage works to remove accumulations of sediment within catch basin sumps.

A silt fence should be located along the upland perimeter of all sensitive features during the construction process, which should be maintained until the lands have stabilized or as directed by the municipality. There would be benefit in maintaining this silt fence for up to two growing seasons.

7 Conclusions

BBR is proposing to construct a series of connected housing clusters throughout the property to support the thriving golf course. This development will be a mix of low and medium density housing types. The proposed development is 8 kilometers north of Highway 401 and 6 kilometers east of Foxboro. This site is approximately 370 hectares.

The planned development has been divided into five Zones depending on the location and ultimate drainage receiver.

Zone 1 includes lands in the south that drain westerly onto private property. The discharge location is to a small riparian wetland. This zone requires quantity and quality controls. Quantity controls are provided with a stormwater management pond and underground storage. Storage volumes of approximately 1,800m^3 and 600m^3 are required in the pond and underground storage respectively to match pre-development peak flows. Volumes of 2,000m^3 and 690m^3 are proposed. Quality treatment is achieved using a combination of OGS units and Isolator Row.

Zone 2 lands are also in the south, which drain southerly to a 750mm culvert under Harmony Road. Quantity and quality controls are required. Quantity control is provided by taking advantage of the significant natural storage and a small (50mm) change in the invert of the 750mm culvert. Quality treatment is provided at each outlet (five in total) using a combination of technologies approach involving OGS units and enhanced grassed swales.

Zone 3 lands are in the northeastern portion of the lands which drain easterly to the Moira River through the Trillium Woods lands. OGS units will be provided at various storm outlets to achieve Enhanced quality treatment targets. Permission should be sought from Trillium Woods to drain across their lands to the Moira River.

Zone 4 lands have no appreciable development and will not require any treatment.

Zone 5 lands occupy the northeastern portion of the development and drain directly into the Moira River. The Zone 5 lands will require quality treatment using a combination of technologies approach using OGS units and enhanced grassed swales. Development in these lands is not contemplated in the near future and is considered at the Master Planning stages only.

Climate change considerations have included the provision of 10% more storage in catchments requiring quantity controls.

Stormwater management requirements are summarized by Zone on Table 7-1.

Table 7-1: Stormwater Management Treatment Summary

Zone	Quantity	Quality	Time Horizon (yrs)
1	1,800m^3 600m^3	OGS, Isolator Rows	**1 – 5**
2	Natural, Raise 750mm Culv 50mm	OGS Units, Enhanced Swales	**5 - 10**
3	Not Required providing Trillium Woods agrees	OGS Units, Enhanced Swales	**10 - 15**
4	NA	NA	**10 - 15**
5	Not Required	OGS Units, Isolator Rows, Enhanced Swales	**15 – 20**

8 References

The information used to prepare this report is based on the following documents and information provided as noted below:

Advanced Drainage Systems. (2022). – *Stormtech MC-7200 Chamber Product Sheet.*

MTO. (2008). Highway Drainage Design Standards

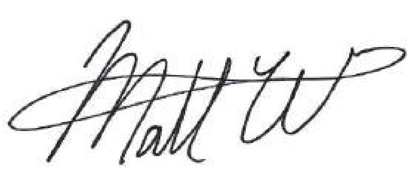
Ontario Ministry of Agriculture and Food. (1974). *Soils of Quinte West.*

Ontario Ministry of Environment. (2003) – *Stormwater Management Planning and Design Manual, 2003*

Ontario Ministry of Transportation – *Drainage Management Manual, 1997*

Toronto and Region Conservation Authority. (2010). – *Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0.*

Prepared by



Matthew Warner

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Reviewed by

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APPENDIX A

Environment Canada IDF Curves

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2022/10/31

==

BELLEVILLE ON 6150689
(composite)
Latitude: 44 9'N Longitude: 77 23'W Elevation/Altitude: 76 m

Years/Années : 1960 - 2016 # Years/Années : 44

==

****

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1960	6.3	9.1	12.4	23.4	25.4	35.1	53.8	55.1	55.9
1961	6.1	7.9	8.9	12.2	18.0	18.8	23.9	34.0	36.3
1963	12.4	19.0	23.1	28.4	30.7	31.0	31.0	31.7	44.4
1964	4.3	5.6	7.4	12.2	12.4	20.6	45.2	45.7	45.7
1966	6.3	8.9	10.4	11.9	13.2	16.0	32.8	37.8	38.1
1967	7.4	9.9	10.4	10.4	11.9	13.2	26.4	42.4	58.7

1968	7.9	11.9	13.7	18.5	21.8	27.2	43.9	57.1	57.1
1969	5.8	9.7	13.0	17.5	24.4	31.0	37.8	43.2	62.2
1971	7.4	11.4	13.0	23.9	25.1	25.4	25.7	25.7	32.5
1972	9.4	10.7	11.7	12.4	14.7	20.6	28.2	33.5	50.5
1973	7.4	10.7	11.9	18.0	21.3	21.8	37.3	45.5	48.0
1974	10.9	15.2	17.8	25.4	25.4	25.4	34.3	42.7	42.7
1977	4.8	8.1	9.9	14.7	25.1	30.2	60.5	66.0	66.0
1980	13.2	16.9	19.0	20.5	20.5	34.6	46.9	47.6	59.6
1981	-99.9	-99.9	13.3	25.5	29.4	34.6	46.2	49.2	57.4
1982	4.6	8.5	10.1	14.2	18.3	24.7	39.8	45.0	45.0
1983	6.5	8.9	10.5	18.4	22.2	30.7	39.6	39.6	50.3
1984	5.1	8.1	10.1	11.3	19.7	23.7	33.4	51.4	55.1
1985	10.5	16.2	20.0	27.0	27.4	42.3	42.3	44.5	44.5
1986	9.1	14.4	16.4	23.2	25.2	35.0	59.2	68.8	78.9
1987	4.3	6.6	9.3	14.2	24.7	37.1	39.2	39.2	39.2
1988	3.7	6.2	7.4	8.6	9.2	10.6	20.8	22.2	28.2
1989	14.5	16.7	17.9	18.4	24.2	24.2	27.7	27.7	37.7
1990	6.9	8.3	10.0	12.3	13.6	20.8	29.7	34.8	38.7
1991	8.5	13.8	18.5	18.8	32.0	32.4	32.4	32.4	32.7
1992	6.3	7.6	8.4	13.2	18.8	21.9	38.2	48.3	50.1
1993	8.2	15.8	23.6	28.3	28.3	28.3	-99.9	-99.9	69.6
1994	8.8	10.2	14.5	18.3	23.6	25.5	38.2	49.2	52.8
1995	8.0	12.9	14.9	19.3	27.5	31.5	48.5	58.5	67.3
1996	6.9	10.4	13.4	19.2	25.1	41.3	41.5	53.8	53.8
1997	10.3	16.8	20.9	25.5	42.8	50.0	56.0	56.0	56.0
1998	9.5	12.1	15.1	22.1	25.0	32.6	38.6	38.6	50.2
1999	9.6	13.1	17.9	23.2	29.4	36.9	42.8	72.7	72.7
2000	10.4	13.4	14.7	16.8	29.0	39.8	52.0	52.4	53.0
2001	7.4	10.1	11.0	11.8	16.7	17.4	21.2	31.6	39.8
2002	7.1	9.4	14.0	21.0	22.4	26.0	39.4	44.2	49.8
2003	7.6	13.5	20.1	26.2	27.0	27.0	31.1	-99.9	56.2
2004	14.4	22.1	28.8	33.3	33.3	49.0	89.9	114.4	124.5
2006	9.0	14.7	18.8	19.5	19.5	19.5	37.3	42.7	59.8
2009	6.3	10.7	14.1	20.2	21.7	30.6	36.9	52.3	68.0
2011	12.7	20.3	25.8	31.1	39.7	44.3	49.1	49.1	51.2
2012	6.2	11.3	16.1	26.0	30.0	30.8	44.4	64.6	65.4

2013	7.4	11.6	15.7	19.3	21.5	23.2	29.0	32.8	33.9
2014	7.7	12.0	14.7	16.6	18.1	26.7	34.0	42.4	63.2
2015	5.3	8.5	11.4	17.0	29.0	48.2	56.4	60.6	73.7
2016	7.0	9.8	14.7	22.9	24.4	24.6	32.2	41.6	41.6
# Yrs. Années	45	45	46	46	46	46	45	44	46
Mean Moyenne	8.0	11.8	14.7	19.4	23.7	29.2	39.9	47.0	53.4
Std. Dev. Écart-type	2.6	3.8	4.9	5.9	6.8	9.2	12.5	15.5	16.1
Skew. Dissymétrie	0.80	0.78	0.86	0.26	0.30	0.43	1.54	1.96	1.88
Kurtosis	3.48	3.43	3.72	2.61	3.95	3.11	7.71	10.31	10.23

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité
pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
2004	6 h	89.9	78.9
2004	12 h	114.4	95.6
2004	24 h	124.5	104.0

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	7.6	9.9	11.4	13.3	14.8	16.2	45
10 min	11.1	14.5	16.7	19.5	21.5	23.6	45

15 min	13.9	18.2	21.0	24.6	27.3	29.9	46
30 min	18.4	23.6	27.1	31.4	34.7	37.9	46
1 h	22.6	28.5	32.5	37.5	41.3	45.0	46
2 h	27.7	35.8	41.1	47.9	52.9	57.9	46
6 h	37.8	48.8	56.1	65.3	72.2	78.9	45
12 h	44.5	58.1	67.2	78.6	87.1	95.6	44
24 h	50.8	65.0	74.5	86.4	95.2	104.0	46

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	90.7	118.5	136.9	160.1	177.4	194.5	45
	+/- 8.4	+/- 14.2	+/- 19.2	+/- 25.9	+/- 31.0	+/- 36.1	45
10 min	66.8	86.8	100.0	116.7	129.1	141.4	45
	+/- 6.1	+/- 10.2	+/- 13.8	+/- 18.6	+/- 22.2	+/- 25.9	45
15 min	55.5	72.7	84.0	98.4	109.1	119.6	46
	+/- 5.2	+/- 8.7	+/- 11.7	+/- 15.8	+/- 18.9	+/- 22.0	46
30 min	36.9	47.3	54.2	62.9	69.3	75.8	46
	+/- 3.1	+/- 5.3	+/- 7.1	+/- 9.6	+/- 11.5	+/- 13.4	46
1 h	22.6	28.5	32.5	37.5	41.3	45.0	46
	+/- 1.8	+/- 3.0	+/- 4.1	+/- 5.5	+/- 6.6	+/- 7.7	46
2 h	13.8	17.9	20.6	24.0	26.5	29.0	46
	+/- 1.2	+/- 2.0	+/- 2.8	+/- 3.7	+/- 4.5	+/- 5.2	46
6 h	6.3	8.1	9.4	10.9	12.0	13.2	45
	+/- 0.6	+/- 0.9	+/- 1.3	+/- 1.7	+/- 2.0	+/- 2.4	45
12 h	3.7	4.8	5.6	6.6	7.3	8.0	44
	+/- 0.3	+/- 0.6	+/- 0.8	+/- 1.1	+/- 1.3	+/- 1.5	44
24 h	2.1	2.7	3.1	3.6	4.0	4.3	46

+/- 0.2 +/- 0.3 +/- 0.4 +/- 0.5 +/- 0.7 +/- 0.8 46

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)

RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	33.1	43.0	49.6	57.9	64.0	70.1
Std. Dev. /Écart-type (RR)	31.6	41.3	47.7	55.8	61.9	67.8
Std. Error/Erreur-type	7.6	9.6	10.9	12.6	13.9	15.1
Coefficient (A)	20.5	26.5	30.5	35.5	39.3	43.0
Exponent/Exposant (B)	-0.676	-0.677	-0.678	-0.679	-0.679	-0.679
Mean % Error/% erreur moyenne	8.5	8.1	8.0	7.8	7.7	7.7

APPENDIX C

Hydraulics and Hydrology

Potential Vegetated Swale for use at Node C:

Manning's - Open Channel Flow

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Black Bear Ridge
Design: M. Warner
Date: 28-Jun-24

Equations **Continuity** **Manning's**

Q = VA

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

Where:

V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **2.785** **cms**

Channel Configuration *Does not include Freeboard*

Given:			Find:		
Bottom Width	**1**	m	V =	**0.876**	
Side Slopes	**3**	:1	Q =	**2.81**	**cms**
Slope	**0.005**	m/m	A =	3.203	m^2
Roughness	**0.05**		P =	6.566	m
Channel Depth	**0.88**	m	R =	0.488	m

Capacity of the Proposed Channel is 2.81 cms, which is adequate to convey desired flow of 2.785 cms.

Time of concentration for applicable catchments:

Time of Concentration - Catchment 104

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min			<u>Slope Calculation</u>		
			85/10 Method		
L = Watershed length in metres =	1360	m	Longest Flow Length =	1360	m
C = Runoff Coefficient =	0.30		Elevation at 85% =	111	m
S_w = Watershed Slope in %	0.4	%	Elevation at 10% =	107	m
A = Watershed area in hectares	86.33	ha	Length at 85/10 =	1020	m
T_c = 131.0 min			Slope =	0.004	m/m

<u>Time to Peak Calculation (for hydrologic modelling if required)</u>

Tp = 2/3 Tc

T_p =	87.3	min
Use T_p =	**87.3**	**min**
	1.46	**hr**

Time of Concentration - Catchment 107A

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:			Slope Calculation	
T_c = Time of Concentration in min			85/10 Method	
L = Watershed length in metres =	350 m		Longest Flow Length =	350 m
C = Runoff Coefficient =	0.30		Elevation at 85% =	115 m
S_w = Watershed Slope in %	2.3 %		Elevation at 10% =	109 m
A = Watershed area in hectares	1.68 ha		Length at 85/10 =	262.5 m
T_c = **37.1 min**			Slope =	0.023 m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	24.7	min
Use T_p =	**24.7**	**min**
	0.41	**hr**

Time of Concentration - Catchment 107B

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min			<u>Slope Calculation</u>		
			85/10 Method		
L = Watershed length in metres =	360	m	Longest Flow Length =	360	m
C = Runoff Coefficient =	0.30		Elevation at 85% =	113	m
S_w = Watershed Slope in %	1.7	%	Elevation at 10% =	108.5	m
A = Watershed area in hectares	8.63	ha	Length at 85/10 =	270	m
T_c = 41.8 min			Slope =	0.017	m/m

<u>Time to Peak Calculation (for hydrologic modelling if required)</u>

Tp = 2/3 Tc

T_p =	27.9	min
Use T_p =	**27.9**	**min**
	0.46	**hr**

Time of Concentration - Catchment 108

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min			Slope Calculation		
			85/10 Method		
L = Watershed length in metres =	490	m	Longest Flow Length =	900	m
C = Runoff Coefficient =	0.30		Elevation at 85% =	129	m
S_w = Watershed Slope in %	2.5	%	Elevation at 10% =	112	m
A = Watershed area in hectares	8.78	ha	Length at 85/10 =	675	m
T_c = 42.6 min			Slope =	0.025	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	28.4	min
Use T_p =	**28.4**	**min**
	0.47	**hr**

Time of Concentration - Catchment 109

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min				
L = Watershed length in metres =	210 m			
C = Runoff Coefficient =	0.30			
S_w = Watershed Slope in %	3.2 %			
A = Watershed area in hectares	2.95 ha			
T_c = 25.8 min				

<u>Slope Calculation</u>

85/10 Method

Longest Flow Length =	210 m
Elevation at 85% =	111.5 m
Elevation at 10% =	106.5 m
Length at 85/10 =	157.5 m
Slope =	0.032 m/m

<u>Time to Peak Calculation (for hydrologic modelling if required)</u>

Tp = 2/3 Tc

T_p =	17.2	min
Use T_p =	**17.2**	**min**
	0.29	**hr**

Time of Concentration - Catchment 110

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		
L = Watershed length in metres =	450	m
C = Runoff Coefficient =	0.30	
S_w = Watershed Slope in %	2.1	%
A = Watershed area in hectares	6.75	ha
T_c =	**43.5**	**min**

Slope Calculation

85/10 Method

Longest Flow Length =	450	m
Elevation at 85% =	114	m
Elevation at 10% =	107	m
Length at 85/10 =	337.5	m
Slope =	0.021	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	29.0	min
Use T_p =	**29.0**	**min**
	0.48	**hr**

Time of Concentration - Catchment 112

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		
L = Watershed length in metres =	1200	m
C = Runoff Coefficient =	0.30	
S_w = Watershed Slope in %	0.7	%
A = Watershed area in hectares	50.83	ha
T_c = 103.3 min		

Slope Calculation

85/10 Method

Longest Flow Length =	1200	m
Elevation at 85% =	118	m
Elevation at 10% =	112	m
Length at 85/10 =	900	m
Slope =	0.007	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	68.9	min
Use T_p =	**68.9**	**min**
	1.15	**hr**

Time of Concentration - Catchment 207A

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		<u>Slope Calculation</u>		
		85/10 Method		
L = Watershed length in metres =	650 m	Longest Flow Length =	650	m
C = Runoff Coefficient =	0.30	Elevation at 85% =	113	m
S_w = Watershed Slope in %	1.2 %	Elevation at 10% =	107	m
A = Watershed area in hectares	2.74 ha	Length at 85/10 =	487.5	m
T_c = 62.1 min		Slope =	0.012	m/m

<u>Time to Peak Calculation (for hydrologic modelling if required)</u>

Tp = 2/3 Tc

T_p =	41.4	min
Use T_p =	**41.4**	**min**
	0.69	**hr**

Time of Concentration - Catchment 208B

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		**Slope Calculation**	
		85/10 Method	
L = Watershed length in metres =	180 m	Longest Flow Length =	180 m
C = Runoff Coefficient =	0.30	Elevation at 85% =	113 m
S_w = Watershed Slope in %	0.7 %	Elevation at 10% =	112 m
A = Watershed area in hectares	2.15 ha	Length at 85/10 =	135 m
T_c = 38.6 min		Slope =	0.007 m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	25.7	min
Use T_p =	**25.7**	**min**
	0.43	**hr**

Time of Concentration - Catchment 208D

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min			Slope Calculation		
			85/10 Method		
L = Watershed length in metres =	225	m	Longest Flow Length =	225	m
C = Runoff Coefficient =	0.30		Elevation at 85% =	112	m
S_w = Watershed Slope in %	1.2	%	Elevation at 10% =	110	m
A = Watershed area in hectares	2.23	ha	Length at 85/10 =	168.75	m
T_c = 37.0 min			Slope =	0.012	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	24.7	min
Use T_p =	**24.7**	**min**
	0.41	**hr**

Time of Concentration - Catchment 209

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		**Slope Calculation** (85/10 Method)		
L = Watershed length in metres =	160 m	Longest Flow Length =	160	m
C = Runoff Coefficient =	0.30	Elevation at 85% =	110	m
S_w = Watershed Slope in %	2.9 %	Elevation at 10% =	106.5	m
A = Watershed area in hectares	2.73 ha	Length at 85/10 =	120	m
T_c = 23.2 min		Slope =	0.029	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p = 15.5 min

Use T_p = **15.5 min**

0.26 hr

Time of Concentration - Catchment 210

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		
L = Watershed length in metres =	450	m
C = Runoff Coefficient =	0.30	
S_w = Watershed Slope in %	2.1	%
A = Watershed area in hectares	6.63	ha
T_c =	**43.5**	**min**

Slope Calculation

85/10 Method

Longest Flow Length =	450	m
Elevation at 85% =	114	m
Elevation at 10% =	107	m
Length at 85/10 =	337.5	m
Slope =	0.021	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	29.0	min
Use T_p =	**29.0**	**min**
	0.48	**hr**

Time of Concentration - Catchment 211C

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min

L = Watershed length in metres = 1600 m

C = Runoff Coefficient = 0.30

S_w = Watershed Slope in % 0.2 %

A = Watershed area in hectares 72.49 ha

T_c = 195.1 min

Slope Calculation

85/10 Method

Longest Flow Length =	1600	m
Elevation at 85% =	107.8	m
Elevation at 10% =	106	m
Length at 85/10 =	1200	m
Slope =	0.002	m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p = 130.1 min

Use T_p = **130.1 min**

2.17 hr

Time of Concentration - Catchment 212

(Based on Curve Number for 100Yr Return Period)

Calculate Time of Concentration by ***Airport Method***

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

Where:

T_c = Time of Concentration in min		**Slope Calculation**	
		85/10 Method	
L = Watershed length in metres =	1350 m	Longest Flow Length =	1350 m
C = Runoff Coefficient =	0.30	Elevation at 85% =	122 m
S_w = Watershed Slope in %	1.0 %	Elevation at 10% =	112 m
A = Watershed area in hectares	50.20 ha	Length at 85/10 =	1012.5 m
T_c = 96.2 min		Slope =	0.010 m/m

Time to Peak Calculation (for hydrologic modelling if required)

Tp = 2/3 Tc

T_p =	64.1	min
Use T_p =	**64.1**	**min**
	1.07	**hr**

At each southern discharge location, the control structures have a stage-storage-discharge relationship. These relationships are individual to the control; thus, Node A has two curves which work in series. The details for these controls are shown together, with Figure 2 representing the control responsible for discharge out of the underground storage units shown in Figure 1. Figure 3 controls the flow in Irrigation Pond 1.

Node A Irrigation Pond 1

Pond Elevations		Outlet 1		Outlet 2		Outlet 3	
Perm.Pool	111	Use Outlet 1?	Yes	Use Outlet 2?	No	Use Outlet 3?	No
Max. Elev	111.5	Type	Orifice				
Increment	0.05	Invert	111				
		diam (m)	0.525				
		No. of Outlets	1				

Orifice Equation:

$$= (h \leq 2r)0.6 * \left[\left(arccos\left(\frac{r-h}{r}\right)\right)r^2 - r(r-h) * sin\left(arccos\left(\frac{r-h}{r}\right)\right)\right] * \sqrt{2g * \left(\frac{4r * sin^3\left(arccos\left(\frac{r-h}{r}\right)\right)}{3\left(2\left(arccos\left(\frac{r-h}{r}\right)\right) - sin\left(2\left(arccos\left(\frac{r-h}{r}\right)\right)\right)\right)} - (r-h)\right)}$$

$$+ (h > 2r)0.6\pi r^2 * \sqrt{2g(h-r)}$$

Elevation m	Incr.Vol m3	Cum.Vol m3	Head on inv., m	Q, m3/s	Head on inv., m	Q, m3/s	Head on inv., m	Q, m3/s	Q.total m3/s
111.00	200	0	0	0.000	-	0.000	-	0.000	0.000
111.05	200	200	0.05	0.004	-	0.000	-	0.000	0.004
111.10	200	400	0.1	0.015	-	0.000	-	0.000	0.015
111.15	200	600	0.15	0.034	-	0.000	-	0.000	0.034
111.20	200	800	0.2	0.058	-	0.000	-	0.000	0.058
111.25	200	1000	0.25	0.088	-	0.000	-	0.000	0.088
111.30	200	1200	0.3	0.122	-	0.000	-	0.000	0.122
111.35	200	1400	0.35	0.160	-	0.000	-	0.000	0.160
111.40	200	1600	0.4	0.199	-	0.000	-	0.000	0.199
111.45	200	1800	0.45	0.240	-	0.000	-	0.000	0.240
111.50	200	2000	0.5	0.278	-	0.000	-	0.000	0.278

Node A Underground Storage

Pond Elevations			Outlet 1			Outlet 2			Outlet 3	
Perm.Pool	107.5		Use Outlet 1?	Yes		Use Outlet 2?	Yes		Use Outlet 3?	Yes
Max. Elev	109		Type	Orifice		Type	Weir		Type	Weir
Increment	0.1		Invert	107.5		Invert	108.2		Invert	108.4
			diam (m)	0.5		Length	0.5		Length	0.8
			No. of Outlets	1		No. of Outlets	1		No. of Outlets	1

Orifice Equation:

$$= (h \le 2r)0.6 * \left[\left(arccos\left(\frac{r-h}{r}\right)\right)r^2 - r(r-h) * sin\left(arccos\left(\frac{r-h}{r}\right)\right)\right] * \sqrt{2g * \left(\frac{4r * sin^3\left(arccos\left(\frac{r-h}{r}\right)\right)}{3\left(2\left(arccos\left(\frac{r-h}{r}\right)\right) - sin\left(2\left(arccos\left(\frac{r-h}{r}\right)\right)\right)\right)} - (r-h)\right)}$$

$$+ (h > 2r)0.6\pi r^2 * \sqrt{2g(h-r)}$$

Elevation m	Incr.Vol ham	Cum.Vol ham	Head on inv., m	Q, m3/s	Head on inv., m	Q, m3/s	Head on inv., m	Q, m3/s	Q.total m3/s
107.50	0	0.00000	0	0.0000	-	0.000	-	0.000	0.000
107.60	0.00534	0.00534	0.1	0.0150	-	0.000	-	0.000	0.015
107.70	0.00533	0.01068	0.2	0.0564	-	0.000	-	0.000	0.056
107.80	0.00528	0.01596	0.3	0.1177	-	0.000	-	0.000	0.118
107.90	0.00524	0.02120	0.4	0.1908	-	0.000	-	0.000	0.191
108.00	0.00517	0.02637	0.5	0.2609	-	0.000	-	0.000	0.261
108.10	0.00508	0.03145	0.6	0.3087	-	0.000	-	0.000	0.309
108.20	0.00499	0.03644	0.7	0.3501	-	0.000	-	0.000	0.350
108.30	0.00487	0.04131	0.8	0.3870	0.1	0.026	-	0.000	0.413
108.40	0.00475	0.04605	0.9	0.4207	0.2	0.075	-	0.000	0.495
108.50	0.00459	0.05064	1	0.4519	0.3	0.137	0.1	0.042	0.631
108.60	0.00442	0.05506	1.1	0.4811	0.4	0.211	0.2	0.119	0.812
108.70	0.00317	0.05823	1.2	0.5086	0.5	0.295	0.3	0.220	1.023
108.80	0.00401	0.06224	1.3	0.5347	0.6	0.388	0.4	0.338	1.261
108.90	0.00370	0.06594	1.4	0.5596	0.7	0.489	0.5	0.472	1.521
109.00	0.00320	0.06914	1.5	0.5834	0.8	0.597	0.6	0.621	1.802

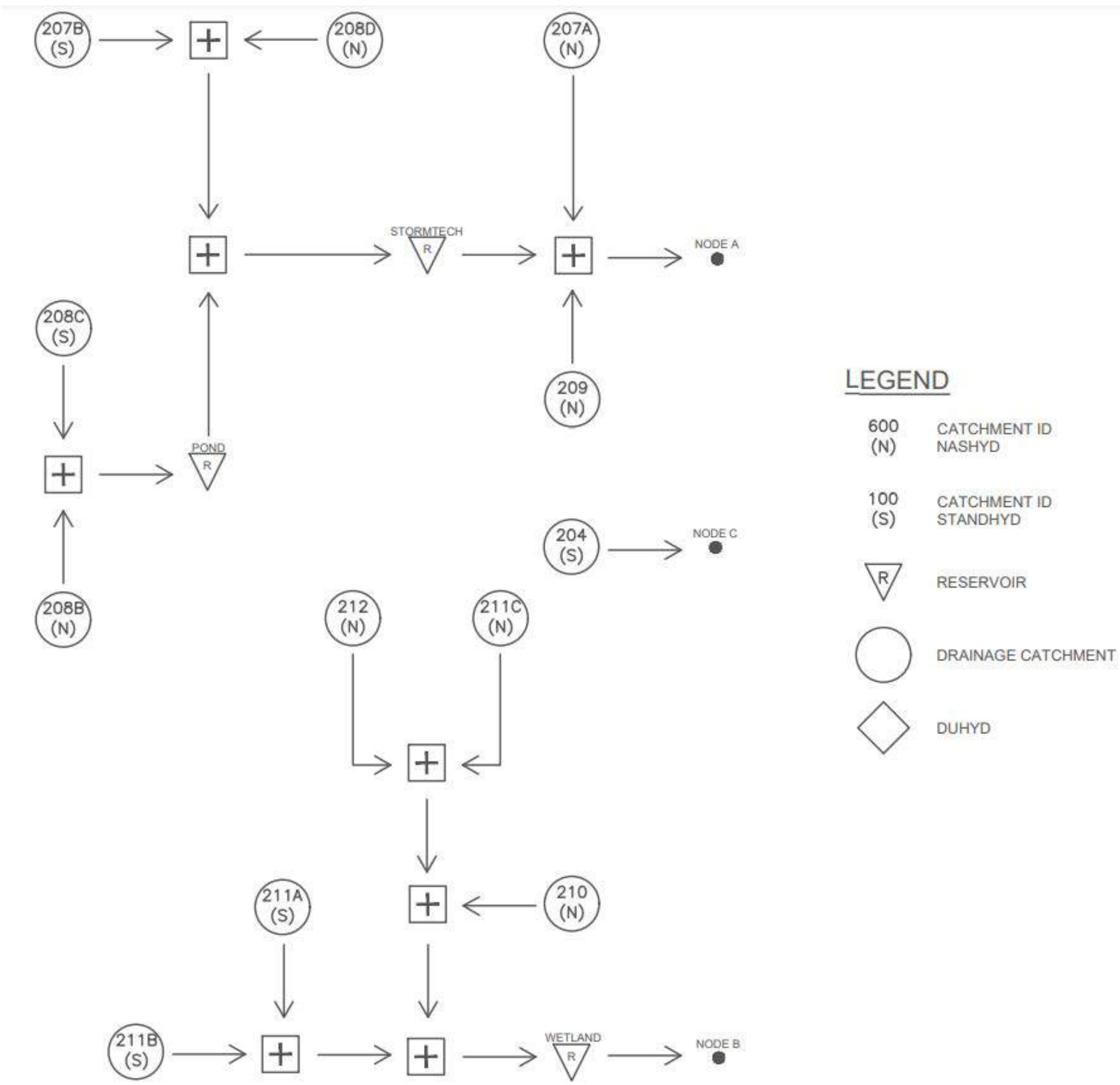
Node B Stage-Storage-Discharge		
Elevation (m)	**Total Volume (ham)**	**Discharge (cms)**
106	0.042	0.000
106.1	0.164	0.005
106.2	0.444	0.041
106.3	0.884	0.110
106.4	1.484	0.207
106.5	2.242	0.324
106.6	3.119	0.457
106.7	4.073	0.594
106.8	5.104	0.719
106.9	6.213	0.809
107	7.400	0.890
107.1	8.683	0.965
107.2	10.083	1.034
107.3	11.600	1.098
107.4	13.234	1.159
107.5	14.984	1.217
107.6	16.851	1.273
107.7	18.835	1.326
107.8	20.936	1.377
107.9	23.153	1.426
108	25.487	1.474
108.1	27.938	1.520
108.2	30.506	1.564

APPENDIX D

OTTHYMO Model Output

The following are summary output files which are the direct result of tests at each node. The reported files are for the 100-year 24-hour storms at each node in alphabetical order. The results of other events can be provided upon request.

The following logic trees visualize how the OTTHYMO program receives information and how it is then configured to output the results. The nodes correspond to each post development outlet point, the pre-development conditions are sufficiently similar and can be inferred when looking at the schematic.



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

        OOO    TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     I N T E R H Y M O
       O   O     T      T    H   H   Y Y   MM MM  O   O   * * * 1989a * * *
       O   O     T      T    HHHHH    Y    M M M  O   O
       O   O     T      T    H   H    Y    M   M  O   O
        OOO      T      T    H   H    Y    M   M   OOO     __________00002

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  Input   filename: BBA1YR.DAT
  Output  filename: BBA1YR.OUT
  Summary filename: BBA1YR.SUM



DATE: 05-16-2024                      TIME: 21:41:43


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 25, 2024
*                   Matthew Warner
*
*                   21.6 ha
*
*                   Pre-development Peak Flow at Node A
*                   Belleville, ON
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                        used in:   INTENSITY =  A / (t + B)^C
```

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .33

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
------------------------------------------------------------------------------
*                    Pre-development, Catchment 107
--------------------
| CALIB              |
| NASHYD    (0001) |    Area    (ha)=   8.63   Curve Number   (CN)= 78.3
|ID= 1 DT= 5.0 min |    Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------    U.H. Tp(hrs)=    .46

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
     Unit Hyd Qpeak  (cms)=    .72

     PEAK FLOW       (cms)=    .64 (i)
     TIME TO PEAK    (hrs)=   8.50
     RUNOFF VOLUME    (mm)=  61.40
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .57

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

--------------------------------------------------------------------------------
*                   Pre-development, Catchment 107A
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=   1.68   Curve Number   (CN)= 73.1
|ID= 2 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .41

     Unit Hyd Qpeak  (cms)=    .16

     PEAK FLOW       (cms)=    .11 (i)
     TIME TO PEAK    (hrs)=   8.42
     RUNOFF VOLUME    (mm)=  54.23
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .50

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

--------------------------------------------------------------------------------
*                   Pre-development, Catchment 108
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=   8.34   Curve Number   (CN)= 76.1
|ID= 3 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .47

     Unit Hyd Qpeak  (cms)=    .68

     PEAK FLOW       (cms)=    .57 (i)
     TIME TO PEAK    (hrs)=   8.50
     RUNOFF VOLUME    (mm)=  58.24
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .54

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

--------------------------------------------------------------------------------
*                   Pre-development, Catchment 109
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=   2.95   Curve Number   (CN)= 65.5
```

```
|ID= 4 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .29

     Unit Hyd Qpeak  (cms)=    .39

     PEAK FLOW       (cms)=    .20 (i)
     TIME TO PEAK    (hrs)=   8.33
     RUNOFF VOLUME    (mm)=  44.99
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .41

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   8.63
| ID= 1   PCYC=305 |   QPEAK     (cms)=    .64 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  61.40
  Filename: 107PRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   1.68
| ID= 2   PCYC=297 |   QPEAK     (cms)=    .11 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.42
--------------------   VOLUME     (mm)=  54.23
  Filename: 107APRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   8.34
| ID= 3   PCYC=305 |   QPEAK     (cms)=    .57 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  58.24
  Filename: 108PRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   2.95
| ID= 4   PCYC=295 |   QPEAK     (cms)=    .20 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.33
--------------------   VOLUME     (mm)=  44.99
```

```
  Filename: 109APRE.TXT
  Comments:

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

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0001) |
|   1 +  2 =  5    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0001):     8.63      .64     8.50    61.40
        + ID2= 2 (0001):     1.68      .11     8.42    54.23
          ==================================================
          ID = 5 (0001):    10.31      .75     8.50    60.24

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0001) |
|   4 +  3 =  6    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 4 (0001):     2.95      .20     8.33    44.99
        + ID2= 3 (0001):     8.34      .57     8.50    58.24
          ==================================================
          ID = 6 (0001):    11.29      .74     8.50    54.78

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0001) |
|   5 +  6 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 5 (0001):    10.31      .75     8.50    60.24
        + ID2= 6 (0001):    11.29      .74     8.50    54.78
          ==================================================
          ID = 1 (0001):    21.60     1.49     8.50    57.38

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  21.60
| ID= 1   PCYC=305 |   QPEAK     (cms)=   1.49 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  57.38
  Filename: NAPRE.TXT
  Comments:
```

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

FINISH

===

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

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
       O   O    T      T    H   H   Y Y   MM MM  O   O   * * * 1989a * * *
       O   O    T      T    HHHHH    Y    M M M  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO    __________00003

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  Input   filename: 1BBP.DAT
  Output  filename: 1BBP.OUT
  Summary filename: 1BBP.SUM




DATE: 06-21-2024                      TIME: =3:17:15


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 26, 2024
*                   Matthew Warner
*
*                   22.9 ha
*
*                   Post-development peak flow at Node A
*                   Belleville, ON
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                       used in:   INTENSITY =  A / (t + B)^C
```

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .33

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
------------------------------------------------------------------------------
*                   Post-development, Catchment 208B
--------------------
| CALIB              |
| NASHYD    (0001) |   Area    (ha)=   2.15   Curve Number   (CN)= 76.1
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .43

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
     Unit Hyd Qpeak  (cms)=    .19

     PEAK FLOW       (cms)=    .15 (i)
     TIME TO PEAK    (hrs)=   8.50
     RUNOFF VOLUME    (mm)=  58.20
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .54

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

------------------------------------------------------------------------------
*                   Post-development, Catchment 208C
--------------------
| CALIB              |
| STANDHYD  (0001) |   Area    (ha)=   4.48
|ID= 2 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  35.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.02          2.46
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       4.00          4.00
     Length            (m)=     172.80        172.80
     Mannings n           =       .013          .250

     Max.eff.Inten.(mm/hr)=     138.96         66.38
                over (min)      10.00         20.00
     Storage Coeff.  (min)=       2.05 (ii)   18.30 (ii)
     Unit Hyd. Tpeak (min)=       5.00         20.00
     Unit Hyd. peak  (cms)=        .31           .06
                                                              *TOTALS*
     PEAK FLOW       (cms)=        .80           .30              .89 (iii)
     TIME TO PEAK    (hrs)=       8.08          8.33             8.08
     RUNOFF VOLUME    (mm)=     106.35         63.10            78.22
     TOTAL RAINFALL   (mm)=     108.44        108.44           108.44
     RUNOFF COEFFICIENT   =        .98           .58              .72

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR RAINFALL LOSSES:
            CN*  =  76.1    Ia = Dep. Storage  (Above)
      (ii) COMPUTATIONAL TIME STEP SHOULD BE SMALL OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   2.15
| ID= 1   PCYC=298 |   QPEAK     (cms)=    .15 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  58.20
  Filename: 208BPOST.TXT
```

```
  Comments: 208B Post 100 Year

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   4.48
| ID= 2   PCYC=298 |   QPEAK     (cms)=    .89 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.08
--------------------   VOLUME     (mm)=  78.22
  Filename: 208CPOST.TXT
  Comments: 208C Post 100 Year

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

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0001) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0001):     2.15      .15     8.50    58.20
        + ID2= 2 (0001):     4.48      .89     8.08    78.22
          ==================================================
          ID = 3 (0001):     6.63      .96     8.08    71.73

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
*                    Route 208B and 208C through the first pond


*                    Pond discharges to US through 525mm oriface
--------------------
| RESERVOIR (0001) |
| IN= 3---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                            .000       .000   |     .122       .120
                            .004       .020   |     .160       .140
                            .015       .040   |     .199       .160
                            .034       .060   |     .240       .180
                            .058       .080   |     .278       .200
                            .088       .100   |     .000       .000

                                AREA     QPEAK     TPEAK        R.V.
                                (ha)     (cms)     (hrs)        (mm)
     INFLOW : ID= 3 (0001)      6.63       .96      8.08       71.73
     OUTFLOW: ID= 1 (0001)      6.63       .23      9.17       71.53

                         PEAK   FLOW   REDUCTION [Qout/Qin](%)= 24.37
                         TIME SHIFT OF PEAK FLOW         (min)= 65.00
```

```
                    MAXIMUM  STORAGE   USED       (ha.m.)=   .18

------------------------------------------------------------------------------
*                   Invert of 111. 5cm increments strt .05
*                   end at 111.5
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   6.63
| ID= 1   PCYC=617 |   QPEAK     (cms)=    .23 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   9.17
--------------------   VOLUME     (mm)=  71.53
  Filename: NAPPost.TXT
  Comments: Reservoir behaviour from only 208B and 208C

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

------------------------------------------------------------------------------
*                   Post-development, Catchment 207B
--------------------
| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=   8.57
|ID= 4 DT= 5.0 min |   Total Imp(%)=  40.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.43         5.14
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       2.90         2.90
     Length            (m)=     239.00       239.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     138.96        61.02
                over (min)       10.00        25.00
     Storage Coeff.  (min)=       2.74 (ii)   25.23 (ii)
     Unit Hyd. Tpeak (min)=       5.00        30.00
     Unit Hyd. peak  (cms)=        .28          .04
                                                           *TOTALS*
     PEAK FLOW       (cms)=       1.23          .52           1.36 (iii)
     TIME TO PEAK    (hrs)=       8.08         8.50           8.08
     RUNOFF VOLUME    (mm)=     106.35        65.82          77.96
     TOTAL RAINFALL   (mm)=     108.44       108.44         108.44
     RUNOFF COEFFICIENT   =        .98          .61            .72

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR RAINFALL LOSSES:
            CN*  =  78.3    Ia = Dep. Storage  (Above)
      (ii) COMPUTATIONAL TIME STEP SHOULD BE SMALL OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
*                   Post-development, Catchment 208D
--------------------
```

```
| CALIB              |
| NASHYD    (0001) |   Area    (ha)=   2.23   Curve Number   (CN)= 80.5
|ID= 5 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .41

     Unit Hyd Qpeak  (cms)=    .21

     PEAK FLOW       (cms)=    .19 (i)
     TIME TO PEAK    (hrs)=   8.42
     RUNOFF VOLUME    (mm)=  64.70
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .60

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

-------------------------------------------------------------------------------
*                   weighted curve number due to 0.45ha developed
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   8.57
| ID= 4   PCYC=306 |   QPEAK     (cms)=   1.36 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.08
--------------------   VOLUME     (mm)=  77.96
  Filename: 207BPOST.TXT
  Comments: 207B Post 100 Year

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   2.23
| ID= 5   PCYC=298 |   QPEAK     (cms)=    .19 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.42
--------------------   VOLUME     (mm)=  64.70
  Filename: 208CPOST.TXT
  Comments: 208D Post 100 Year

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

-------------------------------------------------------------------------------
*                   combining 207B and 208D

--------------------
| ADD HYD   (0001) |
|   4 +  5 =  2    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 4 (0001):      8.57     1.36     8.08    77.96
       + ID2= 5 (0001):      2.23      .19     8.42    64.70
         ==================================================
         ID = 2 (0001):     10.80     1.45     8.08    75.22

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

```
-------------------------------------------------------------------------------
*                   combining the first pond outlet with 207B(8D)

--------------------
| ADD HYD   (0001) |
|   1 +  2 =  4    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0001):     6.63      .23     9.17    71.53
        + ID2= 2 (0001):    10.80     1.45     8.08    75.22
          ==================================================
          ID = 4 (0001):    17.43     1.49     8.08    73.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  17.43
| ID= 4   PCYC=617 |   QPEAK     (cms)=   1.49 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.08
--------------------   VOLUME     (mm)=  73.61
  Filename: PondIN.TXT
  Comments: Inflow hydrograph to storage units

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

-------------------------------------------------------------------------------
*                   105 MC-7200 sections strt 107.6 and .10m increments,
*                   bottom at 107.5 weir at 108.2, 108.4
--------------------
| RESERVOIR (0001) |
| IN= 4---> OUT= 2 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .000        .000   |      .413       .041
                           .015        .005   |      .495       .046
                           .056        .011   |      .621       .051
                           .118        .016   |      .782       .055
                           .191        .021   |      .968       .058
                           .261        .026   |     1.176       .062
                           .309        .032   |     1.403       .066
                           .350        .036   |     1.647       .069

                              AREA     QPEAK     TPEAK        R.V.
                              (ha)     (cms)     (hrs)        (mm)
     INFLOW : ID= 4 (0001)     17.43      1.49      8.08       73.61
     OUTFLOW: ID= 2 (0001)     17.43      1.11      8.17       73.60

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 74.34
                  TIME SHIFT OF PEAK FLOW         (min)=  5.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=   .06

-------------------------------------------------------------------------------
```

```
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  17.43
| ID= 2   PCYC=618 |   QPEAK     (cms)=   1.11 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.17
--------------------   VOLUME     (mm)=  73.60
  Filename: STRGout.TXT
  Comments: Storage Unit Discharge

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

--------------------------------------------------------------------------------
*                   Post-development, Catchment 207A
--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   2.74   Curve Number   (CN)= 73.1
|ID= 3 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .69

     Unit Hyd Qpeak  (cms)=    .15

     PEAK FLOW       (cms)=    .13 (i)
     TIME TO PEAK    (hrs)=   8.83
     RUNOFF VOLUME    (mm)=  54.24
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .50

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   2.74
| ID= 3   PCYC=307 |   QPEAK     (cms)=    .13 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.83
--------------------   VOLUME     (mm)=  54.24
  Filename: 207APOST.TXT
  Comments: 207A Post 100 Year

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

--------------------------------------------------------------------------------
*                   Post-development, Catchment 209
--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   2.73   Curve Number   (CN)= 76.7
|ID= 8 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .26

     Unit Hyd Qpeak  (cms)=    .40

     PEAK FLOW       (cms)=    .28 (i)
     TIME TO PEAK    (hrs)=   8.25
     RUNOFF VOLUME    (mm)=  59.06
```

```
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .54

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

-------------------------------------------------------------------------------
*                   weighted curve number due to 1ha developed
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   2.73
| ID= 8   PCYC=294 |   QPEAK     (cms)=    .28 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.25
--------------------   VOLUME     (mm)=  59.06
  Filename: 209POST.TXT
  Comments: 209 Post 100 Year

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

-------------------------------------------------------------------------------
*                   207A and 209 come together

--------------------
| ADD HYD   (0001) |
|   3 +  8 =  7    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (0001):     2.74      .13     8.83    54.24
        + ID2= 8 (0001):     2.73      .28     8.25    59.06
          ==================================================
          ID = 7 (0001):     5.47      .35     8.33    56.65

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*                   takes the output from reservoir and adds 207A(9)

--------------------
| ADD HYD   (0001) |
|   7 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 7 (0001):     5.47      .35     8.33    56.65
        + ID2= 2 (0001):    17.43     1.11     8.17    73.60
          ==================================================
          ID = 1 (0001):    22.90     1.41     8.17    69.54

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  22.90
| ID= 1   PCYC=618 |   QPEAK     (cms)=   1.41 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.17
--------------------   VOLUME     (mm)=  69.54
  Filename: NAPTout.TXT
```

Comments: Node A

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

FINISH

==

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

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
       O   O    T      T    H   H   Y Y   MM MM  O   O  * * * 1989a * * *
       O   O    T      T    HHHHH    Y    M M M  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO    __________00002

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  Input   filename: BBR100YR.DAT
  Output  filename: BBR100YR.OUT
  Summary filename: BBR100YR.SUM




DATE: 05-16-2024                      TIME: 21:41:43


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 24, 2024
*                   Matthew Warner
*
*                   142.36 ha
*
*                   Pre-development Runoff at Node B
*                   Belleville, ON
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                        used in:   INTENSITY =  A / (t + B)^C
```

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .33

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
------------------------------------------------------------------------------
*                   Pre-development, Catchment 110
--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   6.75   Curve Number   (CN)= 74.3
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .48

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
     Unit Hyd Qpeak  (cms)=    .54

     PEAK FLOW       (cms)=    .43 (i)
     TIME TO PEAK    (hrs)=   8.58
     RUNOFF VOLUME    (mm)=  55.78
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .51

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

--------------------------------------------------------------------------------
*                   Pre-development, Catchment 111
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=  84.36   Curve Number   (CN)= 72.6
|ID= 2 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   2.17

     Unit Hyd Qpeak  (cms)=   1.48

     PEAK FLOW       (cms)=   1.75 (i)
     TIME TO PEAK    (hrs)=  10.75
     RUNOFF VOLUME    (mm)=  53.61
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .49

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

--------------------------------------------------------------------------------
*                   Pre-development, Catchment 112
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=  51.25   Curve Number   (CN)= 80.3
|ID= 3 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.15

     Unit Hyd Qpeak  (cms)=   1.70

     PEAK FLOW       (cms)=   2.11 (i)
     TIME TO PEAK    (hrs)=   9.33
     RUNOFF VOLUME    (mm)=  64.43
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .59

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   6.75
| ID= 1   PCYC=304 |   QPEAK     (cms)=    .43 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.58
```

```
--------------------   VOLUME     (mm)=  55.78
  Filename: 110PRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  84.36
| ID= 2   PCYC=409 |   QPEAK     (cms)=   1.75 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  10.75
--------------------   VOLUME     (mm)=  53.61
  Filename: 111PRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  51.25
| ID= 3   PCYC=348 |   QPEAK     (cms)=   2.11 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   9.33
--------------------   VOLUME     (mm)=  64.43
  Filename: 112PRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
*                   combining 110 and 111

--------------------
| ADD HYD   (0001) |
|   1 +  2 =  4    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 1 (0001):      6.75      .43     8.58    55.78
       + ID2= 2 (0001):     84.36     1.75    10.75    53.61
         ==================================================
         ID = 4 (0001):     91.11     1.83    10.67    53.77

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*                   add 112 to the rest

--------------------
| ADD HYD   (0001) |
|   4 +  3 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
         ID1= 4 (0001):     91.11     1.83    10.67    53.77
       + ID2= 3 (0001):     51.25     2.11     9.33    64.43
         ==================================================
```

```
        ID = 1 (0001):   142.36     3.66     9.67    57.61

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)= 142.36
| ID= 1   PCYC=409 |   QPEAK     (cms)=   3.66 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   9.67
--------------------   VOLUME     (mm)=  57.61
  Filename: CBPRE.TXT
  Comments:

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

-------------------------------------------------------------------------------
*                   Wetland discharges into 750mm HDPE culvert
--------------------
| RESERVOIR (0001) |
| IN= 1---> OUT= 4 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                            .000        .000   |    1.150     10.080
                            .062        .440   |    1.300     13.230
                            .236       1.480   |    1.470     16.850
                            .450       3.120   |    1.600     20.930
                            .690       5.100   |    1.710     25.490
                            .910       7.400   |     .000       .000

                                AREA      QPEAK     TPEAK       R.V.
                                (ha)      (cms)     (hrs)       (mm)
     INFLOW : ID= 1 (0001)    142.36       3.66      9.67      57.61
     OUTFLOW: ID= 4 (0001)    142.36        .68     17.67      56.08

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 18.55
                   TIME SHIFT OF PEAK FLOW         (min)=480.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  5.00

-------------------------------------------------------------------------------
*                   Current Wetland steps are 0.2m increments
--------------------
| SAVE HYD  (0001) |   AREA       (ha)= 142.36
| ID= 4   PCYC=*** |   QPEAK     (cms)=    .68 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  17.67
--------------------   VOLUME     (mm)=  56.08
  Filename: CBPREout.TXT
  Comments:

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

-------------------------------------------------------------------------------
```

FINISH

==

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

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
       O   O    T      T    H   H   Y Y   MM MM  O   O   * * * 1989a * * *
       O   O    T      T    HHHHH    Y    M M M  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO    __________00002

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  Input   filename: BBB1PST.DAT
  Output  filename: BBB1PST.OUT
  Summary filename: BBB1PST.SUM



DATE: 05-16-2024                      TIME: 21:41:43


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 24, 2024
*                   Matthew Warner
*
*                   142.21 ha
*
*                   Post-Development Node B
*                   Belleville, ON
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                        used in:   INTENSITY =  A / (t + B)^C
```

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .33

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
-------------------------------------------------------------------------------
*                   Post-development, Catchment 212
--------------------
| CALIB              |
| NASHYD    (0001) |   Area    (ha)=  50.20   Curve Number   (CN)= 80.6
|ID= 6 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.07

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
     Unit Hyd Qpeak  (cms)=   1.79

     PEAK FLOW       (cms)=   2.20 (i)
     TIME TO PEAK    (hrs)=   9.25
     RUNOFF VOLUME    (mm)=  64.97
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .60

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

--------------------------------------------------------------------------------
*                   Post-development, Catchment 211C
--------------------
| CALIB              |
| NASHYD    (0001) |   Area    (ha)=  72.49   Curve Number   (CN)= 74.4
|ID= 7 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   2.17

     Unit Hyd Qpeak  (cms)=   1.28

     PEAK FLOW       (cms)=   1.58 (i)
     TIME TO PEAK    (hrs)=  10.67
     RUNOFF VOLUME    (mm)=  55.99
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .52

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

--------------------------------------------------------------------------------
*                   Post-development, Catchment 211A
--------------------
| CALIB              |
| STANDHYD  (0001) |   Area    (ha)=   5.67
|ID= 8 DT= 5.0 min |   Total Imp(%)=  41.00   Dir. Conn.(%)=  41.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       2.32          3.35
     Dep. Storage     (mm)=       2.00          5.00
     Average Slope     (%)=       1.80          1.80
     Length            (m)=     194.40        194.40
     Mannings n           =       .013          .250

     Max.eff.Inten.(mm/hr)=     138.96         36.43
                over (min)      10.00         30.00
     Storage Coeff.  (min)=       2.80 (ii)   30.97 (ii)
     Unit Hyd. Tpeak (min)=       5.00         35.00
     Unit Hyd. peak  (cms)=        .28           .04
                                                              *TOTALS*
     PEAK FLOW       (cms)=       1.11           .20             1.15 (iii)
     TIME TO PEAK    (hrs)=       8.08          8.67             8.08
     RUNOFF VOLUME    (mm)=     106.35         53.62            75.21
```

```
     TOTAL RAINFALL   (mm)=     108.44       108.44         108.44
     RUNOFF COEFFICIENT   =        .98          .49            .69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR RAINFALL LOSSES:
            CN*  =  72.6    Ia = Dep. Storage  (Above)
      (ii) COMPUTATIONAL TIME STEP SHOULD BE SMALL OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*                   Post-development, Catchment 211B
--------------------
| CALIB             |
| STANDHYD  (0001) |   Area    (ha)=   7.22
|ID= 9 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       3.61         3.61
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=       4.80         4.80
     Length            (m)=     219.00       219.00
     Mannings n           =       .013         .250

     Max.eff.Inten.(mm/hr)=     138.96        40.57
                over (min)      10.00        25.00
     Storage Coeff.  (min)=       2.24 (ii)   23.83 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=        .30          .05
                                                            *TOTALS*
     PEAK FLOW       (cms)=       1.80          .25           1.87 (iii)
     TIME TO PEAK    (hrs)=       8.08         8.50           8.08
     RUNOFF VOLUME    (mm)=     106.35        53.62          79.97
     TOTAL RAINFALL   (mm)=     108.44       108.44         108.44
     RUNOFF COEFFICIENT   =        .98          .49            .74

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR RAINFALL LOSSES:
            CN*  =  72.6    Ia = Dep. Storage  (Above)
      (ii) COMPUTATIONAL TIME STEP SHOULD BE SMALL OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*                   Post-development, Catchment 210
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=   6.63   Curve Number   (CN)= 75.0
|ID=10 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .48
```

```
     Unit Hyd Qpeak  (cms)=    .53

     PEAK FLOW       (cms)=    .43 (i)
     TIME TO PEAK    (hrs)=   8.58
     RUNOFF VOLUME    (mm)=  56.74
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .52

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  50.20
| ID= 6   PCYC=343 |   QPEAK     (cms)=   2.20 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   9.25
--------------------   VOLUME     (mm)=  64.97
  Filename: 212POST.TXT
  Comments: 212 Post 100 Year

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  72.49
| ID= 7   PCYC=407 |   QPEAK     (cms)=   1.58 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  10.67
--------------------   VOLUME     (mm)=  55.99
  Filename: 211POST.TXT
  Comments: 211C Post 100 Year

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   5.67
| ID= 8   PCYC=305 |   QPEAK     (cms)=   1.15 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.08
--------------------   VOLUME     (mm)=  75.21
  Filename: 211APOST.TXT
  Comments: 211A Post 100 Year

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   7.22
| ID= 9   PCYC=301 |   QPEAK     (cms)=   1.87 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.08
--------------------   VOLUME     (mm)=  79.97
  Filename: 211BPOST.TXT
  Comments: 211B Post 100 Year
```

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

------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=   6.63
| ID=10   PCYC=304 |   QPEAK     (cms)=    .43 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.58
--------------------   VOLUME     (mm)=  56.74
  Filename: 210POST.TXT
  Comments: 210 Post 100 Year

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

------------------------------------------------------------------------------
*                   ADDING 212 AND 211C

--------------------
| ADD HYD   (0001) |
|   6 +  7 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 6 (0001):    50.20     2.20     9.25    64.97
        + ID2= 7 (0001):    72.49     1.58    10.67    55.99
          ==================================================
          ID = 1 (0001):   122.69     3.39     9.58    59.66

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
*                   ADDING 211A AND 211B

--------------------
| ADD HYD   (0001) |
|   9 +  8 =  2    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 9 (0001):     7.22     1.87     8.08    79.97
        + ID2= 8 (0001):     5.67     1.15     8.08    75.21
          ==================================================
          ID = 2 (0001):    12.89     3.02     8.08    77.87

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
*                   ADDING 210 TO THE COMBINED AREAS

--------------------
| ADD HYD   (0001) |
|  10 +  1 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1=10 (0001):     6.63      .43     8.58    56.74
        + ID2= 1 (0001):   122.69     3.39     9.58    59.66
          ==================================================
```

```
          ID = 3 (0001):   129.32     3.56     9.50    59.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*                   ALL TOGETHER NOW

--------------------
| ADD HYD   (0001) |
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (0001):   129.32     3.56     9.50    59.51
        + ID2= 2 (0001):    12.89     3.02     8.08    77.87
          ==================================================
          ID = 1 (0001):   142.21     3.88     9.33    61.18

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*                   Now all post developments are one entity
--------------------
| SAVE HYD  (0001) |   AREA       (ha)= 142.21
| ID= 1   PCYC=407 |   QPEAK     (cms)=   3.88 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   9.33
--------------------   VOLUME     (mm)=  61.18
  Filename: CBPost.TXT
  Comments: 100 Year Post into Reservoir

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

-------------------------------------------------------------------------------
*                   Wetland discharges into culvert post
--------------------
| RESERVOIR (0001) |
| IN= 1---> OUT=10 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                            .000       .000   |     .765      7.400
                            .004       .132   |     .889     10.080
                            .035       .263   |     .996     13.230
                            .062       .420   |    1.095     16.850
                            .178      1.460   |    1.184     20.930
                            .393      3.100   |    1.267     25.460
                            .618      5.100   |     .000       .000

                                AREA     QPEAK     TPEAK        R.V.
                                (ha)     (cms)     (hrs)        (mm)
     INFLOW : ID= 1 (0001)    142.21      3.88      9.33       61.18
     OUTFLOW: ID=10 (0001)    142.21       .65     18.00       58.67

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 16.62
                   TIME SHIFT OF PEAK FLOW        (min)=520.00
```

```
                   MAXIMUM  STORAGE   USED       (ha.m.)=  5.53

-------------------------------------------------------------------------------
*                   Current Wetland steps are 0.2m increments
*                   invert at 106.05m then 6.1, 6.15, 6.2
--------------------
| SAVE HYD  (0001) |   AREA       (ha)= 142.21
| ID=10   PCYC=*** |   QPEAK     (cms)=    .65 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  18.00
--------------------   VOLUME     (mm)=  58.67
  Filename: CBPTout.TXT
  Comments: Node B

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

-------------------------------------------------------------------------------

 FINISH
===============================================================================
```

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

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     I N T E R H Y M O
       O   O    T      T    H   H   Y Y   MM MM  O   O   * * * 1989a * * *
       O   O    T      T    HHHHH    Y    M M M  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO     __________00002

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  Input   filename: BBC1YR.dat
  Output  filename: BBC1YR.out
  Summary filename: BBC1YR.sum



DATE: 05-16-2024                      TIME: 21:41:43


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 10, 2024
*                   Matthew Warner
*
*                   86.3 ha
*
*                   Pre-development Peak Flow at Node C
*                   2072 MTO IDFs
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                        used in:   INTENSITY =  A / (t + B)^C
```

```
Duration of storm  = 24.00 hrs
Storm time step    =  5.00 min
Time to peak ratio =   .33
```

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
------------------------------------------------------------------------------
*                   Pre-development, golf course and wooded area 104
--------------------
| CALIB             |
| NASHYD    (0001) |   Area    (ha)=  86.30   Curve Number   (CN)= 68.5
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   1.75

        NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
     Unit Hyd Qpeak  (cms)=   1.88

     PEAK FLOW       (cms)=   1.87 (i)
     TIME TO PEAK    (hrs)=  10.17
     RUNOFF VOLUME    (mm)=  48.49
     TOTAL RAINFALL   (mm)= 108.44
     RUNOFF COEFFICIENT   =    .45

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  86.30
| ID= 1   PCYC=384 |   QPEAK     (cms)=   1.87 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  10.17
--------------------   VOLUME     (mm)=  48.49
  Filename: 104PRE.TXT
  Comments:

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

--------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  86.30
| ID= 1   PCYC=384 |   QPEAK     (cms)=   1.87 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=  10.17
--------------------   VOLUME     (mm)=  48.49
  Filename: NCPRE.TXT
  Comments:

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

--------------------------------------------------------------------------------

 FINISH
================================================================================
```

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

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
       O   O    T      T    H   H   Y Y   MM MM  O   O   * * * 1989a * * *
       O   O    T      T    HHHHH    Y    M M M  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO    __________00003

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  Input   filename: 1BBCP.DAT
  Output  filename: 1BBCP.OUT
  Summary filename: 1BBCP.SUM



DATE: 06-21-2024                      TIME: =3:17:15


COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
*                   Black Bear Ridge Golf Course
*                   BB
*                   100-yr Event
*                   June 27, 2024
*                   Matthew Warner
*
*                   87.42 ha
*
*                   Post-development peak flow at Node C
*                   Belleville, ON
*
*****************************************************************************
*                   100 Year - 24 Hr Duration
*****************************************************************************
*                   IDF Values from Environment Canada Station 6150689
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1139.082
| Ptotal=108.44 mm |                          B=   5.262
--------------------                          C=    .760
                        used in:   INTENSITY =  A / (t + B)^C
```

Duration of storm = 24.00 hrs
Storm time step = 5.00 min
Time to peak ratio = .33

The CORRELATION coefficient is = .9997

TIME (min)	INPUT INT. (mm/hr)	TAB. INT. (mm/hr)
5.	194.50	194.10
10.	141.40	143.55
15.	119.60	115.74
30.	75.80	75.96
60.	45.00	47.58
120.	29.00	28.99
360.	13.20	12.85
720.	8.00	7.63
1440.	4.30	4.52

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.08	1.11	6.08	3.35	12.08	3.17	18.08	1.56
.17	1.12	6.17	3.47	12.17	3.12	18.17	1.55
.25	1.12	6.25	3.61	12.25	3.07	18.25	1.55
.33	1.13	6.33	3.75	12.33	3.02	18.33	1.54
.42	1.14	6.42	3.91	12.42	2.98	18.42	1.53
.50	1.15	6.50	4.08	12.50	2.93	18.50	1.52
.58	1.16	6.58	4.28	12.58	2.89	18.58	1.51
.67	1.17	6.67	4.49	12.67	2.85	18.67	1.50
.75	1.18	6.75	4.74	12.75	2.81	18.75	1.49
.83	1.19	6.83	5.01	12.83	2.77	18.83	1.48
.92	1.21	6.92	5.33	12.92	2.74	18.92	1.47
1.00	1.22	7.00	5.69	13.00	2.70	19.00	1.46
1.08	1.23	7.08	6.12	13.08	2.67	19.08	1.45
1.17	1.24	7.17	6.63	13.17	2.63	19.17	1.45
1.25	1.25	7.25	7.25	13.25	2.60	19.25	1.44
1.33	1.26	7.33	8.03	13.33	2.57	19.33	1.43
1.42	1.28	7.42	9.01	13.42	2.54	19.42	1.42
1.50	1.29	7.50	10.32	13.50	2.51	19.50	1.41
1.58	1.30	7.58	12.16	13.58	2.48	19.58	1.41
1.67	1.31	7.67	14.95	13.67	2.45	19.67	1.40
1.75	1.33	7.75	19.69	13.75	2.42	19.75	1.39
1.83	1.34	7.83	29.73	13.83	2.39	19.83	1.38
1.92	1.36	7.92	65.78	13.92	2.37	19.92	1.38
2.00	1.37	8.00	194.10	14.00	2.34	20.00	1.37
2.08	1.39	8.08	83.82	14.08	2.32	20.08	1.36
2.17	1.40	8.17	47.82	14.17	2.29	20.17	1.35
2.25	1.42	8.25	33.55	14.25	2.27	20.25	1.35
2.33	1.43	8.33	25.98	14.33	2.24	20.33	1.34
2.42	1.45	8.42	21.30	14.42	2.22	20.42	1.33
2.50	1.47	8.50	18.13	14.50	2.20	20.50	1.33
2.58	1.48	8.58	15.84	14.58	2.18	20.58	1.32

2.67	1.50	8.67	14.10	14.67	2.16	20.67	1.31
2.75	1.52	8.75	12.73	14.75	2.14	20.75	1.31
2.83	1.54	8.83	11.63	14.83	2.12	20.83	1.30
2.92	1.56	8.92	10.72	14.92	2.10	20.92	1.29
3.00	1.58	9.00	9.95	15.00	2.08	21.00	1.29
3.08	1.60	9.08	9.30	15.08	2.06	21.08	1.28
3.17	1.62	9.17	8.74	15.17	2.04	21.17	1.27
3.25	1.64	9.25	8.25	15.25	2.02	21.25	1.27
3.33	1.66	9.33	7.82	15.33	2.00	21.33	1.26
3.42	1.69	9.42	7.44	15.42	1.98	21.42	1.26
3.50	1.71	9.50	7.09	15.50	1.97	21.50	1.25
3.58	1.74	9.58	6.78	15.58	1.95	21.58	1.24
3.67	1.76	9.67	6.50	15.67	1.93	21.67	1.24
3.75	1.79	9.75	6.25	15.75	1.92	21.75	1.23
3.83	1.82	9.83	6.01	15.83	1.90	21.83	1.23
3.92	1.85	9.92	5.80	15.92	1.89	21.92	1.22
4.00	1.88	10.00	5.60	16.00	1.87	22.00	1.22
4.08	1.91	10.08	5.42	16.08	1.86	22.08	1.21
4.17	1.94	10.17	5.25	16.17	1.84	22.17	1.20
4.25	1.97	10.25	5.09	16.25	1.83	22.25	1.20
4.33	2.01	10.33	4.95	16.33	1.81	22.33	1.19
4.42	2.05	10.42	4.81	16.42	1.80	22.42	1.19
4.50	2.08	10.50	4.68	16.50	1.79	22.50	1.18
4.58	2.12	10.58	4.56	16.58	1.77	22.58	1.18
4.67	2.16	10.67	4.44	16.67	1.76	22.67	1.17
4.75	2.21	10.75	4.33	16.75	1.75	22.75	1.17
4.83	2.25	10.83	4.23	16.83	1.73	22.83	1.16
4.92	2.30	10.92	4.13	16.92	1.72	22.92	1.16
5.00	2.35	11.00	4.04	17.00	1.71	23.00	1.15
5.08	2.40	11.08	3.96	17.08	1.70	23.08	1.15
5.17	2.46	11.17	3.87	17.17	1.68	23.17	1.14
5.25	2.52	11.25	3.79	17.25	1.67	23.25	1.14
5.33	2.58	11.33	3.72	17.33	1.66	23.33	1.13
5.42	2.65	11.42	3.65	17.42	1.65	23.42	1.13
5.50	2.71	11.50	3.58	17.50	1.64	23.50	1.12
5.58	2.79	11.58	3.51	17.58	1.63	23.58	1.12
5.67	2.87	11.67	3.45	17.67	1.62	23.67	1.11
5.75	2.95	11.75	3.39	17.75	1.61	23.75	1.11
5.83	3.04	11.83	3.33	17.83	1.60	23.83	1.11
5.92	3.14	11.92	3.27	17.92	1.59	23.92	1.10
6.00	3.24	12.00	3.22	18.00	1.57	24.00	1.10

```
-------------------------------------------------------------------------------
*                    Post-development, Catchment 204
--------------------
| CALIB             |
| STANDHYD  (0001) |   Area    (ha)=  87.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  11.50   Dir. Conn.(%)=  11.50
--------------------
                                 IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      10.05         77.37
```

```
     Dep. Storage     (mm)=       2.00         5.00
     Average Slope     (%)=        .40          .40
     Length            (m)=     763.41       763.41
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                             IMPERVIOUS    PERVIOUS (i)
     Max.eff.Inten.(mm/hr)=     138.96        10.11
                over (min)       10.00       170.00
     Storage Coeff.  (min)=       9.98 (ii)  177.84 (ii)
     Unit Hyd. Tpeak (min)=      10.00       180.00
     Unit Hyd. peak  (cms)=        .11          .01
                                                          *TOTALS*
     PEAK FLOW       (cms)=       2.71         1.22           2.79 (iii)
     TIME TO PEAK    (hrs)=       8.50        11.58           8.50
     RUNOFF VOLUME    (mm)=     106.35        48.49          55.14
     TOTAL RAINFALL   (mm)=     108.44       108.44         108.44
     RUNOFF COEFFICIENT   =        .98          .45            .51

***** WARNING: FOR AREAS WITH IMPERVIOUS LESS THAN 20%
               YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR RAINFALL LOSSES:
            CN*  =  68.5    Ia = Dep. Storage  (Above)
      (ii) COMPUTATIONAL TIME STEP SHOULD BE SMALL OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  87.42
| ID= 1   PCYC=504 |   QPEAK     (cms)=   2.79 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  55.14
  Filename: 204POST.TXT
  Comments: 204 Post 100 Year

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

-------------------------------------------------------------------------------
--------------------
| SAVE HYD  (0001) |   AREA       (ha)=  87.42
| ID= 1   PCYC=504 |   QPEAK     (cms)=   2.79 (i)
| DT= 5.0 min      |   TPEAK     (hrs)=   8.50
--------------------   VOLUME     (mm)=  55.14
  Filename: NCPTout.TXT
  Comments: Node C

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

-------------------------------------------------------------------------------
```

FINISH
==

APPENDIX E

OGS UNITS

Using the Canada Design Sheet made by Hydro International, we can gain insight into how each OGS unit will function under the proposed conditions. Zone 1 has been completed by a designer at Advanced Drained Systems, the supplier of the First Defense OGS units, Isolator Rows, and underground storage units. An example of the treatment train is provided for basic data inputs of Node A, the rainfall in Ottawa is more intense than Belleville so it is conservative, but during detail design we will use the correct rainfall location, inverts, and pipe diameters.

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Treatment Parameters:

Structure ID:	Node A
TSS Goal:	80 % Removal
TSS Particle Size:	ETV
Area:	17.43 ha
Percent Impervious:	23%
Rational C value:	0.44 (Calc. Cn)
Rainfall Station:	Belleville, ONT (MAP)
Peak Storm Flow:	1415 L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	14.0%	62.4%
FD-4HC	23.0%	81.7%
FD-5HC	30.0%	>90%
FD-6HC	34.0%	>90%
FD-8HC	41.0%	>90%
FD-10HC	44.0%	>90%

Model Specification:

Model:	**FD-8HC**
Diameter:	2400 mm
Peak Flow Capacity:	1416.00 L/s
Sediment Storage:	2.14 m^3
Oil Storage:	4240.00 L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	OK
Inlet Pipe 1 Size:		mm	OK
Inlet Pipe 2 Size:		mm	OK
Inlet Pipe 3 Size:		mm	OK
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	OK!
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Designer Notes:

Net Annual Removal Model: FD-8HC

Intensity[1] (mm/hr)	Fraction of Rainfall[1] (%)	FD-8HC Removal Efficiency[2] (%)	Weighted Net Annual Efficiency (%)
0.50	0.4%	55.8%	0.2%
1.00	13.2%	50.8%	6.7%
1.50	14.0%	47.8%	6.7%
2.00	14.0%	45.8%	6.4%
2.50	3.6%	44.2%	1.6%
3.00	2.5%	42.9%	1.1%
3.50	8.4%	41.7%	3.5%
4.00	5.1%	40.8%	2.1%
4.50	1.6%	39.9%	0.6%
5.00	5.1%	39.2%	2.0%
6.00	4.8%	37.9%	1.8%
7.00	4.5%	36.8%	1.7%
8.00	3.5%	35.8%	1.3%
9.00	2.4%	34.9%	0.9%
10.00	2.5%	34.2%	0.9%
20.00	9.7%	29.2%	2.8%
30.00	2.8%	26.3%	0.7%
40.00	0.9%	0.0%	0.0%
50.00	0.4%	0.0%	0.0%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%
tal Net Annual Removal Efficiency:			**41.0%**
tal Annual Runoff Volume Treated:			**>90%**

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Paste

Treatment Parameters:

Structure ID:	211A	
TSS Goal:	80	% Removal
TSS Particle Size:	ETV	
Area:	5.67	ha
Percent Impervious:	41%	
Rational C value:	0.55	Calc. Cn
Rainfall Station:	Belleville, ONT	MAP
Peak Storm Flow:	1146	L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	24.0%	82.8%
FD-4HC	34.0%	>90%
FD-5HC	40.0%	>90%
FD-6HC	43.0%	>90%
FD-8HC	48.0%	>90%
FD-10HC	51.0%	>90%

Model Specification:

Model:	**FD-8HC**	
Diameter:	2400	mm
Peak Flow Capacity:	1416.00	L/s
Sediment Storage:	2.14	m^3
Oil Storage:	4240.00	L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	OK
Inlet Pipe 1 Size:		mm	OK
Inlet Pipe 2 Size:		mm	OK
Inlet Pipe 3 Size:		mm	OK
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	OK!
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Net Annual Removal Model: FD-8HC

Intensity[1]	Fraction of Rainfall[1]	FD-8HC Removal Efficiency[2]	Weighted Net Annual Efficiency
(mm/hr)	(%)	(%)	(%)
0.50	0.4%	62.3%	0.3%
1.00	13.2%	57.3%	7.6%
1.50	14.0%	54.3%	7.6%
2.00	14.0%	52.3%	7.3%
2.50	3.6%	50.7%	1.8%
3.00	2.5%	49.4%	1.3%
3.50	8.4%	48.2%	4.1%
4.00	5.1%	47.3%	2.4%
4.50	1.6%	46.4%	0.7%
5.00	5.1%	45.7%	2.3%
6.00	4.8%	44.4%	2.1%
7.00	4.5%	43.2%	1.9%
8.00	3.5%	42.3%	1.5%
9.00	2.4%	41.4%	1.0%
10.00	2.5%	40.7%	1.0%
20.00	9.7%	35.7%	3.4%
30.00	2.8%	32.8%	0.9%
40.00	0.9%	30.7%	0.3%
50.00	0.4%	29.1%	0.1%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%

tal Net Annual Removal Efficiency: 48.0%

tal Annual Runoff Volume Treated: >90%

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes:

Hydro First Defense® - HC
Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Treatment Parameters:

Structure ID:	211BF
TSS Goal:	80 % Removal
TSS Particle Size:	ETV
Area:	4.35 ha
Percent Impervious:	45%
Rational C value:	0.57 (Calc. Cn)
Rainfall Station:	Belleville, ONT (MAP)
Peak Storm Flow:	1127 L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	28.0%	86.4%
FD-4HC	36.0%	>90%
FD-5HC	41.0%	>90%
FD-6HC	45.0%	>90%
FD-8HC	49.0%	>90%
FD-10HC	53.0%	>90%

Model Specification:

Model:	**FD-8HC**
Diameter:	2400 mm
Peak Flow Capacity:	1416.00 L/s
Sediment Storage:	2.14 m^3
Oil Storage:	4240.00 L

Installation Configuration:

Placement:	Online	
Outlet Pipe Size:	mm	OK
Inlet Pipe 1 Size:	mm	OK
Inlet Pipe 2 Size:	mm	OK
Inlet Pipe 3 Size:	mm	OK
Rim Level:	100.000 m	Calc Invs.
Outlet Pipe Invert:	m	
Invert Pipe 1:	m	OK!
Invert Pipe 2:	m	
Invert Pipe 3:	m	

Net Annual Removal Model: FD-8HC

Intensity[1]	Fraction of Rainfall[1]	FD-8HC Removal Efficiency[2]	Weighted Net Annual Efficiency
(mm/hr)	(%)	(%)	(%)
0.50	0.4%	63.8%	0.3%
1.00	13.2%	58.9%	7.8%
1.50	14.0%	55.9%	7.8%
2.00	14.0%	53.9%	7.5%
2.50	3.6%	52.3%	1.9%
3.00	2.5%	50.9%	1.3%
3.50	8.4%	49.8%	4.2%
4.00	5.1%	48.9%	2.5%
4.50	1.6%	48.0%	0.8%
5.00	5.1%	47.3%	2.4%
6.00	4.8%	46.0%	2.2%
7.00	4.5%	44.8%	2.0%
8.00	3.5%	43.9%	1.5%
9.00	2.4%	43.0%	1.1%
10.00	2.5%	42.3%	1.1%
20.00	9.7%	37.3%	3.6%
30.00	2.8%	34.4%	1.0%
40.00	0.9%	32.3%	0.3%
50.00	0.4%	30.7%	0.1%
100.00	0.6%	25.7%	0.1%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%
tal Net Annual Removal Efficiency:			**49.0%**
tal Annual Runoff Volume Treated:			**>90%**

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes:

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Paste

Treatment Parameters:

Structure ID:	211E	
TSS Goal:	80	% Removal
TSS Particle Size:	ETV	
Area:	1.75	ha
Percent Impervious:	45%	
Rational C value:	0.57	Calc. Cn
Rainfall Station:	Belleville, ONT	MAP
Peak Storm Flow:	453	L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	38.0%	>90%
FD-4HC	45.0%	>90%
FD-5HC	49.0%	>90%
FD-6HC	52.0%	>90%
FD-8HC	56.0%	>90%
FD-10HC	59.0%	>90%

Model Specification:

Model:	**FD-4HC**	
Diameter:	1200	mm
Peak Flow Capacity:	510.00	L/s
Sediment Storage:	0.54	m^3
Oil Storage:	723.00	L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	OK
Inlet Pipe 1 Size:		mm	OK
Inlet Pipe 2 Size:		mm	OK
Inlet Pipe 3 Size:		mm	OK
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	OK!
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Net Annual Removal Model: FD-4HC

Intensity[(1)]	Fraction of Rainfall[(1)]	FD-4HC Removal Efficiency[(2)]	Weighted Net Annual Efficiency
(mm/hr)	(%)	(%)	(%)
0.50	0.4%	60.5%	0.3%
1.00	13.2%	55.5%	7.3%
1.50	14.0%	52.6%	7.3%
2.00	14.0%	50.5%	7.0%
2.50	3.6%	48.9%	1.7%
3.00	2.5%	47.6%	1.2%
3.50	8.4%	46.5%	3.9%
4.00	5.1%	45.5%	2.3%
4.50	1.6%	44.7%	0.7%
5.00	5.1%	43.9%	2.2%
6.00	4.8%	42.6%	2.0%
7.00	4.5%	41.5%	1.9%
8.00	3.5%	40.5%	1.4%
9.00	2.4%	39.7%	1.0%
10.00	2.5%	38.9%	1.0%
20.00	9.7%	33.9%	3.3%
30.00	2.8%	31.0%	0.9%
40.00	0.9%	0.0%	0.0%
50.00	0.4%	0.0%	0.0%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%
		al Net Annual Removal Efficiency:	**45.0%**
		al Annual Runoff Volume Treated:	**>90%**

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.

2. Canada ETV PSD & Test Protocols - ISO14034 Certifed

3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes:

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Paste

Treatment Parameters:

Structure ID:	211F
TSS Goal:	80 % Removal
TSS Particle Size:	ETV
Area:	0.45 ha
Percent Impervious:	45%
Rational C value:	0.57 (Calc. Cn)
Rainfall Station:	Belleville, ONT (MAP)
Peak Storm Flow:	116 L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	51.0%	>90%
FD-4HC	56.0%	>90%
FD-5HC	59.0%	>90%
FD-6HC	62.0%	>90%
FD-8HC	66.0%	>90%
FD-10HC	69.0%	>90%

Model Specification:

Model:	**FD-4HC**
Diameter:	1200 mm
Peak Flow Capacity:	510.00 L/s
Sediment Storage:	0.54 m^3
Oil Storage:	723.00 L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	OK
Inlet Pipe 1 Size:		mm	OK
Inlet Pipe 2 Size:		mm	OK
Inlet Pipe 3 Size:		mm	OK
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	OK!
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Net Annual Removal Model: FD-4HC

Intensity[1]	Fraction of Rainfall[1]	FD-4HC Removal Efficiency[2]	Weighted Net Annual Efficiency
(mm/hr)	(%)	(%)	(%)
0.50	0.4%	70.3%	0.3%
1.00	13.2%	65.3%	8.6%
1.50	14.0%	62.4%	8.7%
2.00	14.0%	60.3%	8.4%
2.50	3.6%	58.7%	2.1%
3.00	2.5%	57.4%	1.5%
3.50	8.4%	56.3%	4.7%
4.00	5.1%	55.3%	2.8%
4.50	1.6%	54.4%	0.9%
5.00	5.1%	53.7%	2.7%
6.00	4.8%	52.4%	2.5%
7.00	4.5%	51.3%	2.3%
8.00	3.5%	50.3%	1.8%
9.00	2.4%	49.5%	1.2%
10.00	2.5%	48.7%	1.2%
20.00	9.7%	43.7%	4.2%
30.00	2.8%	40.8%	1.1%
40.00	0.9%	38.7%	0.4%
50.00	0.4%	37.1%	0.2%
100.00	0.6%	32.1%	0.2%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%

tal Net Annual Removal Efficiency:	**56.0%**
al Annual Runoff Volume Treated:	**>90%**

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes:

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Paste

Treatment Parameters:

Structure ID:	211G	
TSS Goal:	80	% Removal
TSS Particle Size:	ETV	
Area:	0.67	ha
Percent Impervious:	45%	
Rational C value:	0.57	Calc. Cn
Rainfall Station:	Belleville, ONT	MAP
Peak Storm Flow:	173	L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	49.0%	>90%
FD-4HC	53.0%	>90%
FD-5HC	56.0%	>90%
FD-6HC	59.0%	>90%
FD-8HC	63.0%	>90%
FD-10HC	66.0%	>90%

Model Specification:

Model:	**FD-4HC**	
Diameter:	1200	mm
Peak Flow Capacity:	510.00	L/s
Sediment Storage:	0.54	m^3
Oil Storage:	723.00	L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	*OK*
Inlet Pipe 1 Size:		mm	*OK*
Inlet Pipe 2 Size:		mm	*OK*
Inlet Pipe 3 Size:		mm	*OK*
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	*OK!*
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Net Annual Removal Model: FD-4HC

Intensity[1]	Fraction of Rainfall[1]	FD-4HC Removal Efficiency[2]	Weighted Net Annual Efficiency
(mm/hr)	(%)	(%)	(%)
0.50	0.4%	67.4%	0.3%
1.00	13.2%	62.4%	8.3%
1.50	14.0%	59.5%	8.3%
2.00	14.0%	57.4%	8.0%
2.50	3.6%	55.8%	2.0%
3.00	2.5%	54.5%	1.4%
3.50	8.4%	53.4%	4.5%
4.00	5.1%	52.4%	2.7%
4.50	1.6%	51.6%	0.8%
5.00	5.1%	50.8%	2.6%
6.00	4.8%	49.5%	2.4%
7.00	4.5%	48.4%	2.2%
8.00	3.5%	47.4%	1.7%
9.00	2.4%	46.6%	1.1%
10.00	2.5%	45.8%	1.1%
20.00	9.7%	40.8%	3.9%
30.00	2.8%	37.9%	1.1%
40.00	0.9%	35.8%	0.3%
50.00	0.4%	34.2%	0.2%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%
tal Net Annual Removal Efficiency:			53.0%
tal Annual Runoff Volume Treated:			>90%

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes:

Hydro First Defense® - HC

Net Annual Water Quality Worksheet

Hydro International

Rev. 12.5

Project Name:	**Black Bear Ridge**	*Report Date:*	**7/2/2024**
Street:	**Harmony Road**	*City:*	**Belleville**
Province:	**Ontario**	*Country:*	
Designer:	**M. Warner**	*email:*	

Treatment Parameters:

Structure ID:	204	
TSS Goal:	80	% Removal
TSS Particle Size:	ETV	
Area:	14.33	ha
Percent Impervious:	60%	
Rational C value:	0.66	Calc. Cn
Rainfall Station:	Belleville, ONT	MAP
Peak Storm Flow:	2000	L/s

RESULTS SUMMARY

Model	TSS	Volume
FD-3HC	9.0%	55.8%
FD-4HC	20.0%	77.6%
FD-5HC	28.0%	88.2%
FD-6HC	32.0%	>90%
FD-8HC	39.0%	>90%
FD-10HC	43.0%	>90%

Model Specification:

Model:	**FD-10HC**	
Diameter:	3000	mm
Peak Flow Capacity:	1416.00	L/s
Sediment Storage:	3.36	m^3
Oil Storage:	6594.00	L

Installation Configuration:

Placement:	Online		
Outlet Pipe Size:		mm	*OK*
Inlet Pipe 1 Size:		mm	*OK*
Inlet Pipe 2 Size:		mm	*OK*
Inlet Pipe 3 Size:		mm	*OK*
Rim Level:	100.000	m	Calc Invs.
Outlet Pipe Invert:		m	
Invert Pipe 1:		m	*OK!*
Invert Pipe 2:		m	
Invert Pipe 3:		m	

Net Annual Removal Model: FD-10HC

Intensity(1) (mm/hr)	Fraction of Rainfall(1) (%)	FD-10HC Removal Efficiency(2) (%)	Weighted Net Annual Efficiency (%)
0.50	0.4%	57.4%	0.2%
1.00	13.2%	52.4%	6.9%
1.50	14.0%	49.5%	6.9%
2.00	14.0%	47.4%	6.6%
2.50	3.6%	45.8%	1.6%
3.00	2.5%	44.5%	1.1%
3.50	8.4%	43.4%	3.7%
4.00	5.1%	42.4%	2.2%
4.50	1.6%	41.6%	0.7%
5.00	5.1%	40.8%	2.1%
6.00	4.8%	39.5%	1.9%
7.00	4.5%	38.4%	1.7%
8.00	3.5%	37.4%	1.3%
9.00	2.4%	36.6%	0.9%
10.00	2.5%	35.8%	0.9%
20.00	9.7%	30.9%	3.0%
30.00	2.8%	27.9%	0.8%
40.00	0.9%	25.9%	0.2%
50.00	0.4%	24.3%	0.1%
100.00	0.6%	0.0%	0.0%
150.00	0.1%	0.0%	0.0%
200.00	0.0%	0.0%	0.0%

al Net Annual Removal Efficiency:	**43.0%**
al Annual Runoff Volume Treated:	**>90%**

1. Rainfall Data: 1960:2007, HLY03, Belleville, ONT, 6150700 & 6150689.
2. Canada ETV PSD & Test Protocols - ISO14034 Certifed
3. Rainfall adjusted to 5 min peak intensity based on hourly average.

Designer Notes

ADS Treatment Train Sizing

Project Name: Node A
Consulting Engineer: Jewell Engineering
Location: Ottawa, Ontario
Sizing Completed By: Haider Nasrullah **Email:** haider.nasrullah@adspipe.com

Summary of Results	
Isolator Row PLUS TSS Removal:	80.0%
FD-8HC TSS Removal:	20.0%
Combined TSS Removal:	**83.8%**
Total Volume Treated:	**>90%**

Site Details	
Site Area (ha):	17.43
Rational C:	0.438
Particle Size Distribution:	ETV
Rainfall Station:	Ottawa, ONT

Notes: OGS results based on ETV PSD and results from ETV testing protocols.

Individual OGS Results

Model	TSS Removal	Volume Treated
FD-4HC	16.0%	82.0%
FD-5HC	18.0%	>90%
FD-6HC	19.0%	>90%
FD-8HC	20.0%	>90%
FD-10HC	22.0%	>90%

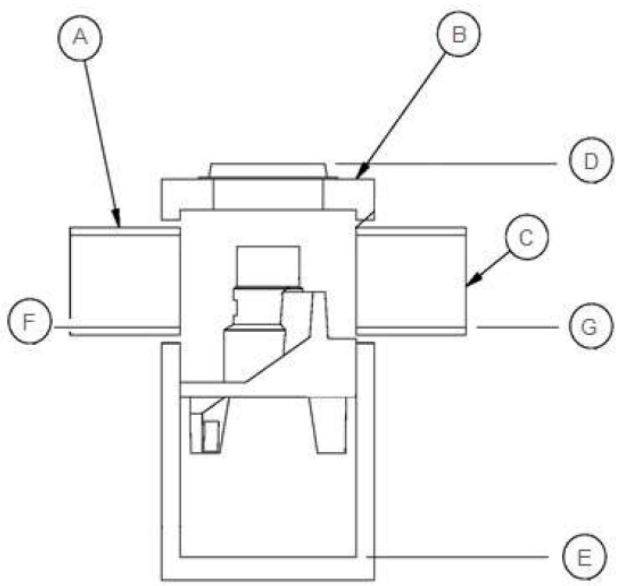
Stormtech Details	
Chamber Model:	MC-7200
No. Chambers in Isolator Row PLUS:	44
Volume Treated by Isolator Row PLUS:	>90%

Notes: Refer to Stormtech drawings for full IR+ configuration.

Isolator Row PLUS must include Flared End Ramp (FLAMP) for proper performance.

Overall System Capacities	
Total Sediment Storage Capacity:	19.07 m³
Oil Storage Capacity:	4,239 L
Max. OGS Pipe Diameter:	1,200 mm
Peak OGS Flow Capacity:	1,415 L/s
Peak Stormtech Inlet Flow Capacity:	311 L/s
Peak IR PLUS Water Quality Flow:	569.8 L/s

OGS Specifications	
Inlet Pipe Diameter (A):	525 mm
Unit Diameter (B):	2,400 mm
Outlet Pipe Diameter (C):	525 mm
Rim Elevation (D):	10.00 m
Bottom of Sump Elevation (E):	#N/A
Inlet Pipe Elevation (F):	8.00 m
Outlet Pipe Elevation (G):	8.00 m



Notes:
Isolator Row PLUS removal efficiency based on verified ETV test report. For dimensions and configuration of Isolator Row PLUS, please see Stormtech drawing package.

Project Name:	Area 1
Consulting Engineer:	Jewell Engineering
Location:	Belleville, Ontario

Net Annual Removal Efficiency Summary

Rainfall Intensity	Fraction of Rainfall	Removal Efficiency		Combined Removal Efficiency	Combined Weighted Removal Efficiency
		FD-8HC	IR PLUS(2)		
mm/hr	%	%	%	%	%
0.50	0.1%	55.8%	81.2%	91.7%	0.1%
1.00	14.1%	50.8%	81.2%	90.7%	12.8%
1.50	14.2%	47.8%	81.2%	90.2%	12.8%
2.00	14.1%	45.8%	81.2%	89.8%	12.7%
2.50	4.2%	0.0%	81.2%	81.2%	3.4%
3.00	1.5%	0.0%	81.2%	81.2%	1.2%
3.50	8.5%	0.0%	81.2%	81.2%	6.9%
4.00	5.4%	0.0%	81.2%	81.2%	4.4%
4.50	1.2%	0.0%	81.2%	81.2%	0.9%
5.00	5.5%	0.0%	81.2%	81.2%	4.5%
6.00	4.3%	0.0%	81.2%	81.2%	3.5%
7.00	4.5%	0.0%	81.2%	81.2%	3.7%
8.00	3.1%	0.0%	81.2%	81.2%	2.5%
9.00	2.3%	0.0%	81.2%	81.2%	1.9%
10.00	2.6%	0.0%	81.2%	81.2%	2.1%
20.00	9.2%	0.0%	81.2%	81.2%	7.5%
30.00	2.6%	0.0%	72.7%	72.7%	1.9%
40.00	1.2%	0.0%	54.5%	54.5%	0.6%
50.00	0.5%	0.0%	43.6%	43.6%	0.2%
100.00	0.7%	0.0%	21.8%	21.8%	0.2%
150.00	0.1%	0.0%	14.5%	14.5%	0.0%
200.00	0.0%	0.0%	10.9%	10.9%	0.0%
		Total Net Annual Removal Efficiency			**83.8%**
		Total Runoff Volume Treated			**>90%**

Notes:

(1) Rainfall Data: 1960:2007, HLY03, Ottawa, ONT, 6105976 & 6105978.

(2) IR PLUS removal based on ETV PSD and ETV protocols.

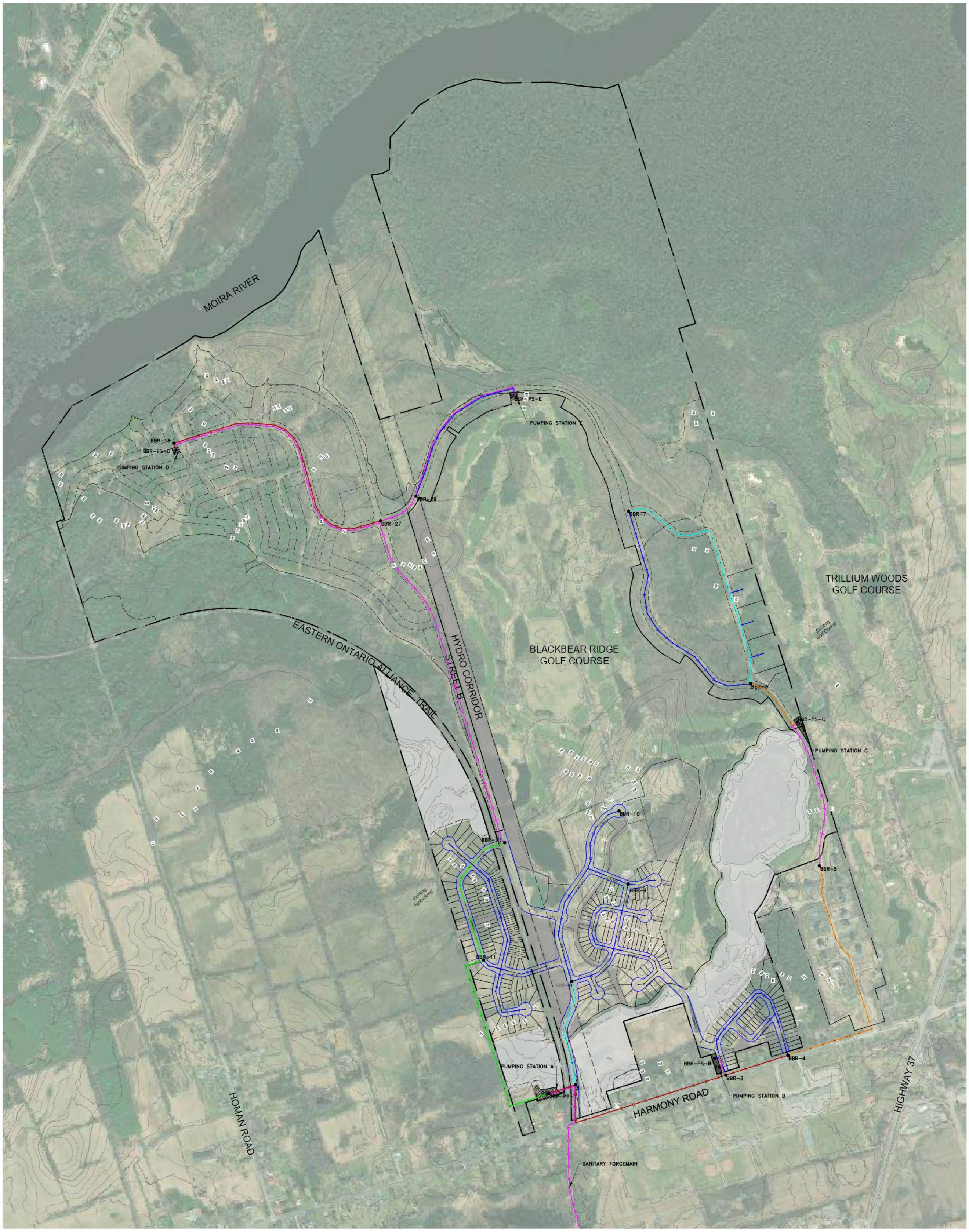
(3) Rainfall adjusted to 5 min peak intensity based on hourly average.

(4) Combined removal efficiencies calculated based on NCDENR Stormwater BMP Manual, Section 3.9.4, where Total Removal Efficiency = 1st BMP Efficiency + 2nd BMP Efficiency - (1st BMP Efficiency x 2nd BMP Efficiency)

APPENDIX B

Grading Plan and Catchment Area Drawings

F:\FTP\PROJECT FILES\1 CIVIL 3D PROJECT FILES\2205260 - SPIRE CAPITAL INVESTMENTS - BLACK BEAR RIDGE\3 - SHEETS\2205260 - SPIRE - BLACK BEAR RIDGE - SAN 01/31/2025



JEWELL ENGINEERING

GENERAL NOTES:

- ALL INFORMATION TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK. ANY DISCREPANCIES ARE TO BE REPORTED TO THE CONSULTANT IMMEDIATELY.
- ALL UTILITY LOCATIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL CONFIRM THE LOCATION ON SITE AND ASSUME ALL LIABILITY FOR DAMAGE TO ALL UTILITIES.
- EXCLUDING THE BENCHMARK AND DESCRIPTION PROVIDED FOR THIS PROJECT, NO OTHER ELEVATIONS ARE TO BE USED AS A REFERENCE ELEVATION FOR ANY PURPOSE.

METRIC NOTE:

- ALL DIMENSIONS SHOWN ARE IN METRES OR MILLIMETRES, UNLESS OTHERWISE NOTED.

GEOMETRIC NOTE:

- ALL SURVEY DATA SHOWN ON THIS DRAWING WAS RECORDED USING REAL-TIME KINETIC (RTK) GPS OBSERVATIONS IN REFERENCE TO UTM 18 NORTH COORDINATE SYSTEM.
- ALL ELEVATIONS ARE IN REFERENCE TO LOCAL DATUM NAD83 - GEODETIC MODEL HT2_0, UNLESS DESCRIBED OTHERWISE.
- LIDAR CGVD 2013

^^ DRAWINGS ARE NOT TO BE SCALED ^^

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- 200mmø SANITARY MAIN
- 250mmø SANITARY MAIN
- 300mmø SANITARY MAIN
- 375mmø SANITARY MAIN
- 450mmø SANITARY TRUNK
- SANITARY FORCE MAIN
- PUMPING STATION
- ENVIRONMENTAL CONSTRAINTS
- 100 YEAR FLOOD LIMIT

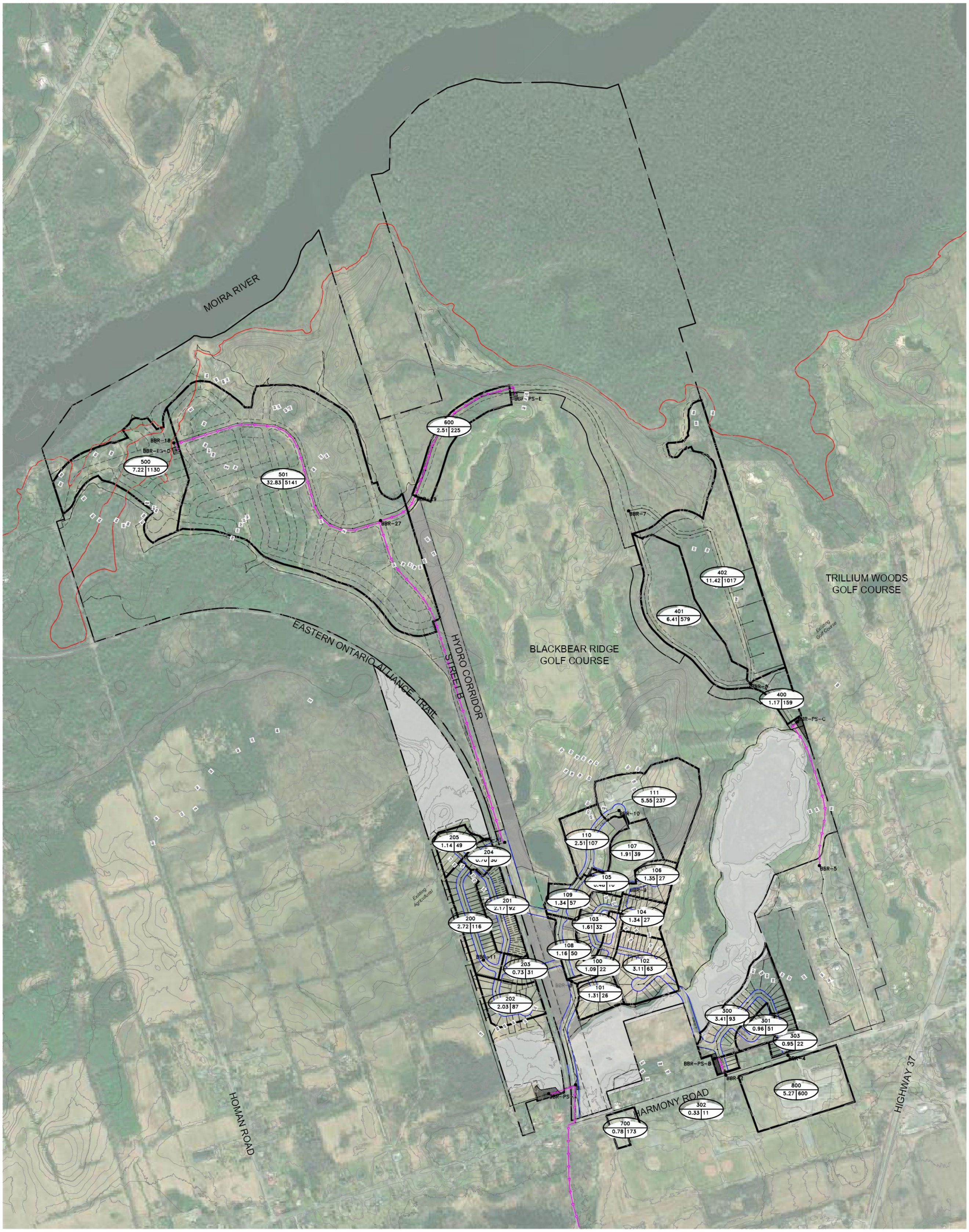
N W E S

LICENSED PROFESSIONAL ENGINEER B. C. KEENE PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PRELIMINARY SANITARY PLAN

DRAWN BY: DFM/AG	PROJECT NO: 2205260
DESIGNED BY: DFM/AG	DATE: January 2025
CHECKED BY: BK	CONTRACT NO:
APPROVED BY: BK	
SCALE: HORIZONTAL - VERTICAL -	1:5000
	DRAWING NO: SAN-1



GENERAL NOTES:

- ALL INFORMATION TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK. ANY DISCREPANCIES ARE TO BE REPORTED TO THE CONSULTANT IMMEDIATELY.
- ALL UTILITY LOCATIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL CONFIRM THE LOCATION ON SITE AND ASSUME ALL LIABILITY FOR DAMAGE TO ALL UTILITIES.
- EXCLUDING THE BENCHMARK AND DESCRIPTION PROVIDED FOR THIS PROJECT, NO OTHER ELEVATIONS ARE TO BE USED AS A REFERENCE ELEVATION FOR ANY PURPOSE.

METRIC NOTE:

- ALL DIMENSIONS SHOWN ARE IN METRES OR MILLIMETRES, UNLESS OTHERWISE NOTED.

GEOMETRIC NOTE:

- ALL SURVEY DATA SHOWN ON THIS DRAWING WAS RECORDED USING REAL-TIME KINETIC (RTK) GPS OBSERVATIONS IN REFERENCE TO UTM 18 NORTH COORDINATE SYSTEM.
- ALL ELEVATIONS ARE IN REFERENCE TO LOCAL DATUM NAD83 - GEODETIC MODEL HT2_0, UNLESS DESCRIBED OTHERWISE.
- LIDAR CGVD 2013

** DRAWINGS ARE NOT TO BE SCALED **

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- 700 — CATCHMENT AREA ID NUMBER / AREA IN HECTARES (ha) / POPULATION
- ENVIRONMENTAL CONSTRAINTS
- SANITARY FORCE MAIN
- 100 YEAR FLOOD LIMIT

N / W / E / S

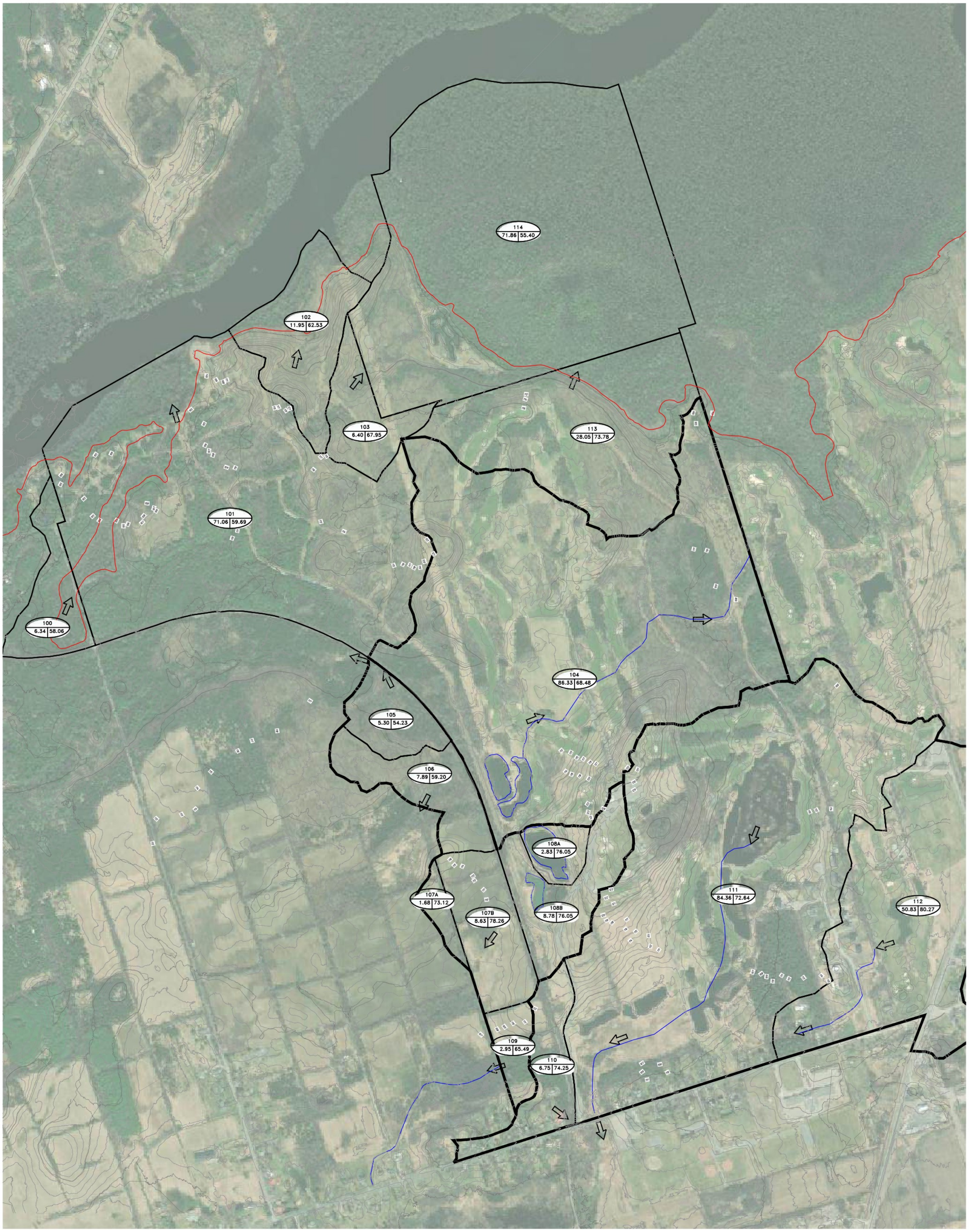
LICENSED PROFESSIONAL ENGINEER — B. C. KEENE — Jan. 31/25 — PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PRELIMINARY
SANITARY CATCHMENT AREA PLAN

DRAWN BY: DFM/AG	PROJECT NO: 2205260
DESIGNED BY: DFM/AG	DATE: January 2025
CHECKED BY: BK	CONTRACT NO:
APPROVED BY: BK	
SCALE: HORIZONTAL -	1:5000
VERTICAL -	

DRAWING NO: SAN-2



JEWELL
ENGINEERING

GENERAL NOTES:

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METRIC NOTE:

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GEOMETRIC NOTE:

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- LIDAR CGVD 2013

** DRAWINGS ARE NOT TO BE SCALED **

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

EXISTING OVERLAND FLOW ROUTE

110
6.75 | 74.25
CATCHMENT ID NUMBER
AREA(ha) AND CURVE NUMBER

100 YEAR FLOOD LIMIT

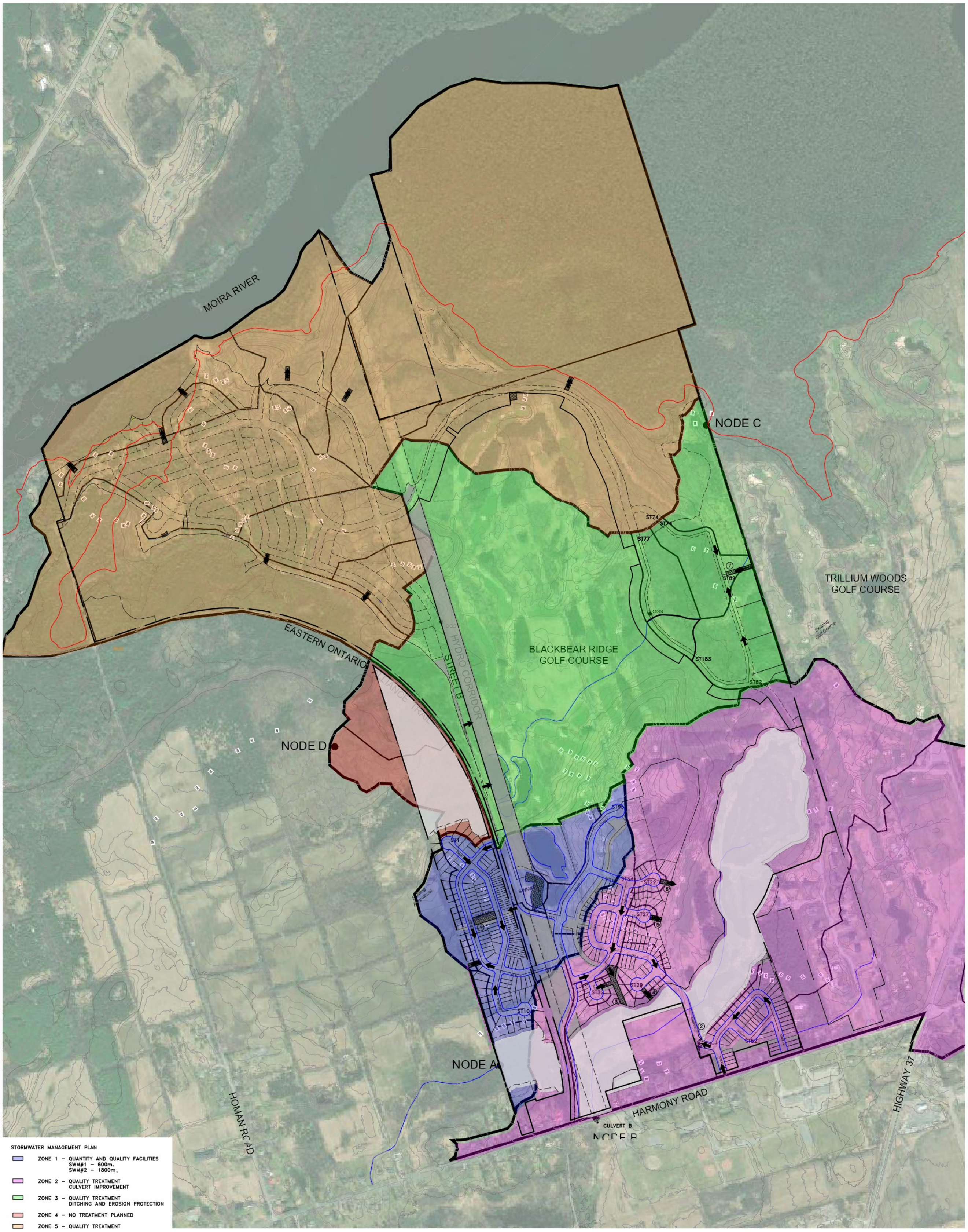
N
W E
S

LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
Jan. 31/25
PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

EXISTING STORM CATCHMENT AREA PLAN

DRAWN BY: DFM/AG	PROJECT NO: 2205260
DESIGNED BY: DFM/AG	DATE: January 2025
CHECKED BY: BK	CONTRACT NO:
APPROVED BY: BK	
SCALE: HORIZONTAL - VERTICAL -	1:5000
	DRAWING NO: STM-1



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- LIDAR CGVD 2013

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REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- SWM FEATURE
- PROPOSED OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- ENVIRONMENTAL CONSTRAINTS
- DITCHING
- 100 YEAR FLOOD LIMIT
- ① STORM OUTLET ID

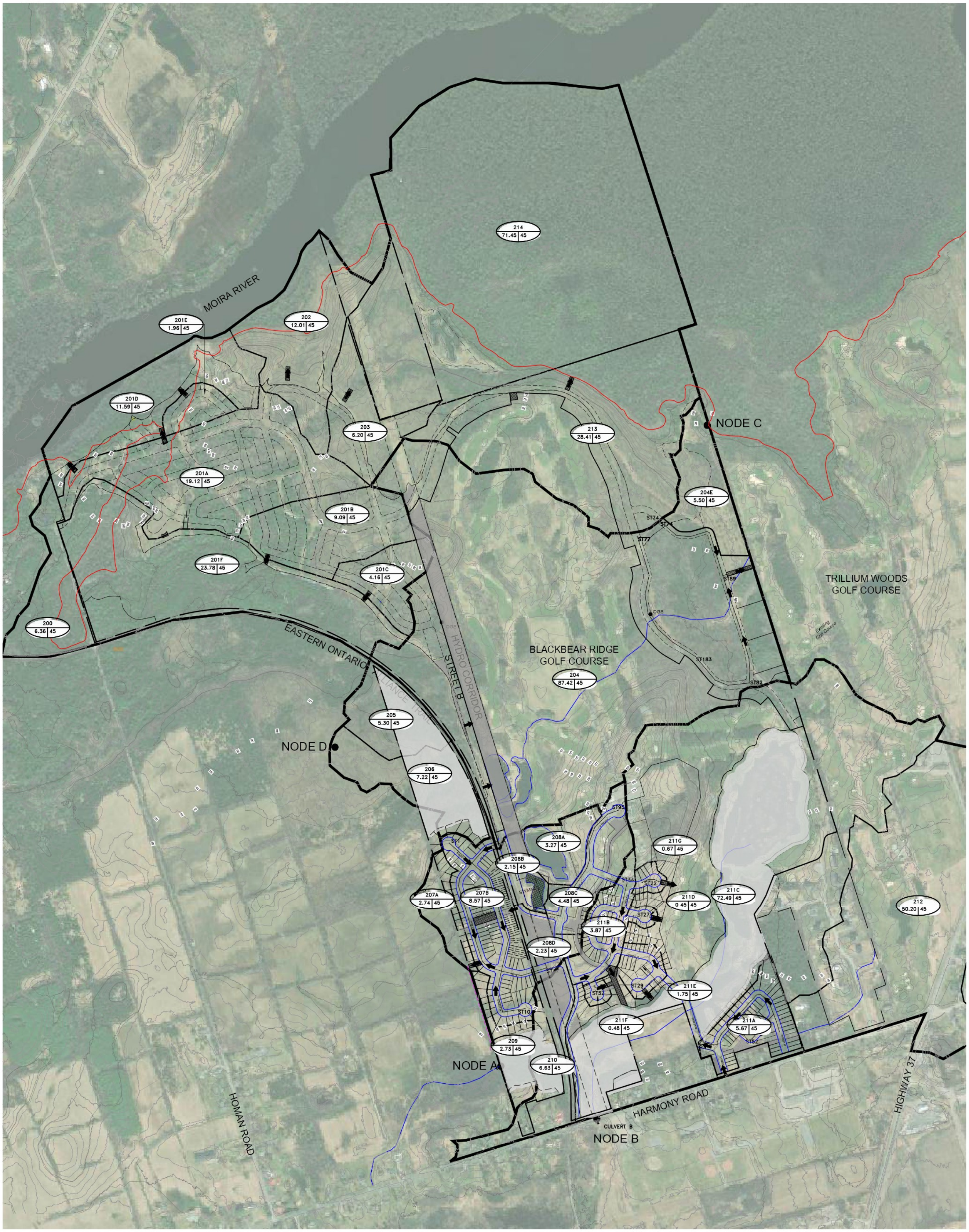
N E S W

LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PROPOSED STORMWATER MASTER PLAN

DRAWN BY: DFM/AG	PROJECT NO: 2205260
DESIGNED BY: DFM/AG	DATE: January 2025
CHECKED BY: BK	CONTRACT NO:
APPROVED BY: BK	
SCALE: HORIZONTAL - VERTICAL -	1:5000
	DRAWING NO: STM-2



JEWELL
ENGINEERING

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- LIDAR CGVD 2013

* * DRAWINGS ARE NOT TO BE SCALED * *

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- SWM FEATURE
- PROPOSED OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- ENVIRONMENTAL CONSTRAINTS
- DITCHING
- 100 YEAR FLOOD LIMIT
- 211F / 0.48 | 45 — CATCHMENT AREA ID, AREA(ha) & IMPERVIOUSNESS

N W E S

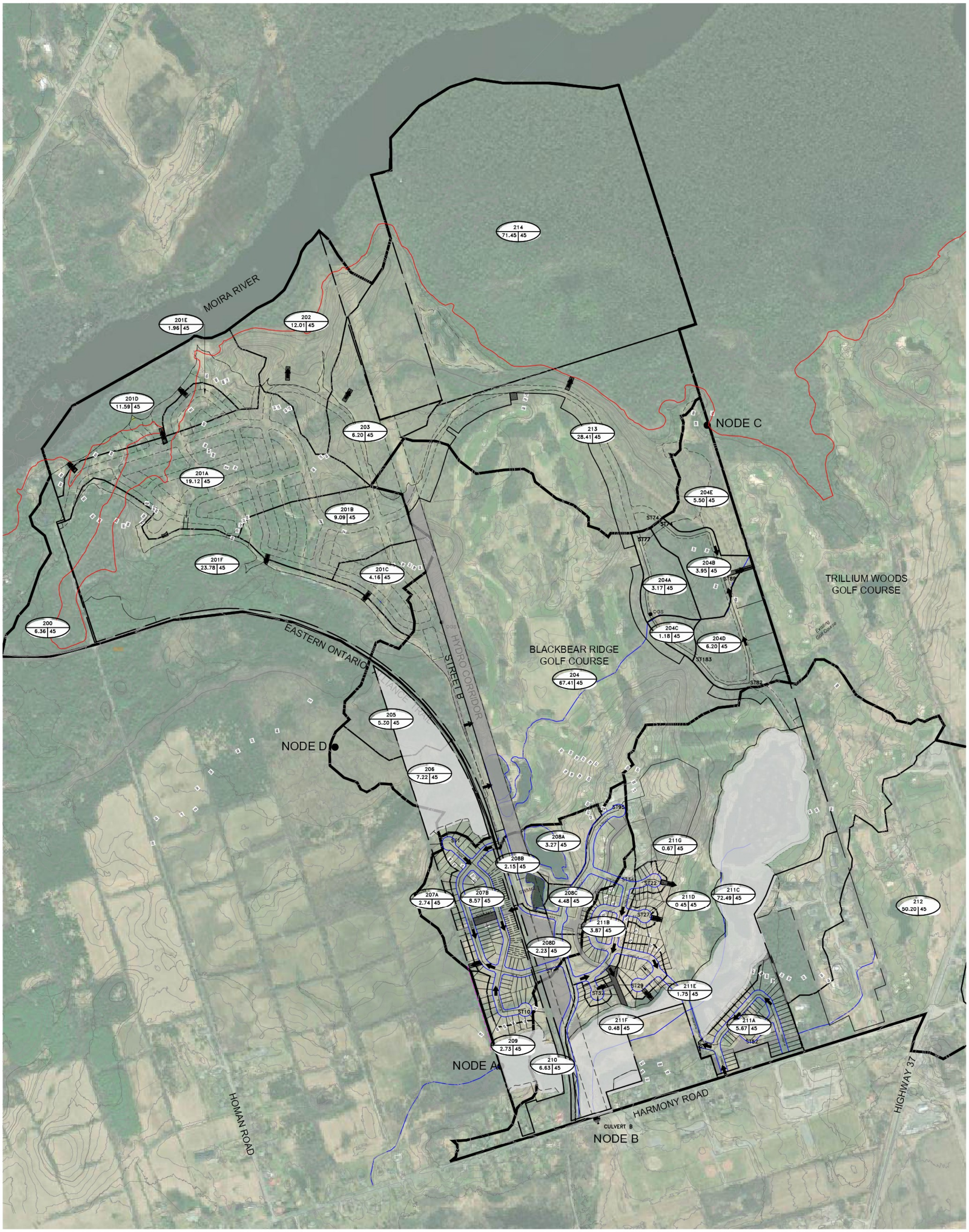
LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
Jan. 31/25
PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PROPOSED STORMWATER
CATCHMENT AREA PLAN

DRAWN BY: DFM/AG
PROJECT NO: 2205260
DESIGNED BY: DFM/AG
DATE: January 2025
CHECKED BY: BK
CONTRACT NO:
APPROVED BY: BK
SCALE:
HORIZONTAL - 1:5000
VERTICAL -

DRAWING NO:
STM-3



JEWELL ENGINEERING

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- LIDAR CGVD 2013

** DRAWINGS ARE NOT TO BE SCALED **

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- SWM FEATURE
- PROPOSED OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- ENVIRONMENTAL CONSTRAINTS
- DITCHING
- 100 YEAR FLOOD LIMIT
- 211F / 0.48 | 45 — CATCHMENT AREA ID, AREA(ha) & IMPERVIOUSNESS

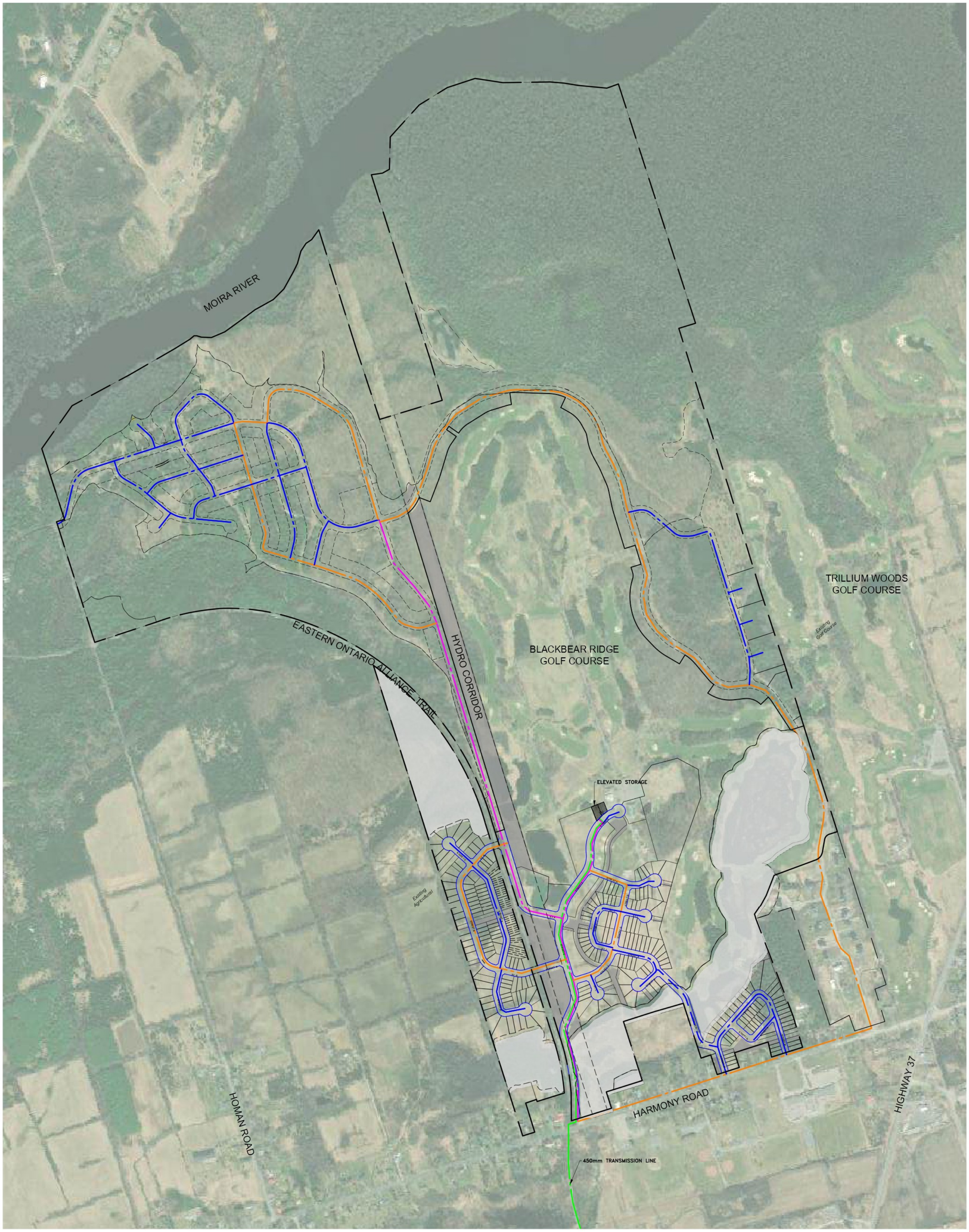
N E S W

LICENSED PROFESSIONAL ENGINEER B. C. KEENE Jan 31/25 PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PROPOSED STORMWATER CATCHMENT AREA PLAN

DRAWN BY: DFM/AG
PROJECT NO: 2205260
DESIGNED BY: DFM/AG
DATE: January 2025
CHECKED BY: BK
CONTRACT NO:
APPROVED BY: BK
SCALE: HORIZONTAL - 1:5000
VERTICAL -
DRAWING NO: STM-4



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- LIDAR CGVD 2013

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REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- 200mm⌀ WATERMAIN
- 300mm⌀ WATERMAIN
- 400mm⌀ WATERMAIN
- 450mm⌀ WATERMAIN
- W ELEVATED STORAGE
- ENVIRONMENTAL CONSTRAINTS

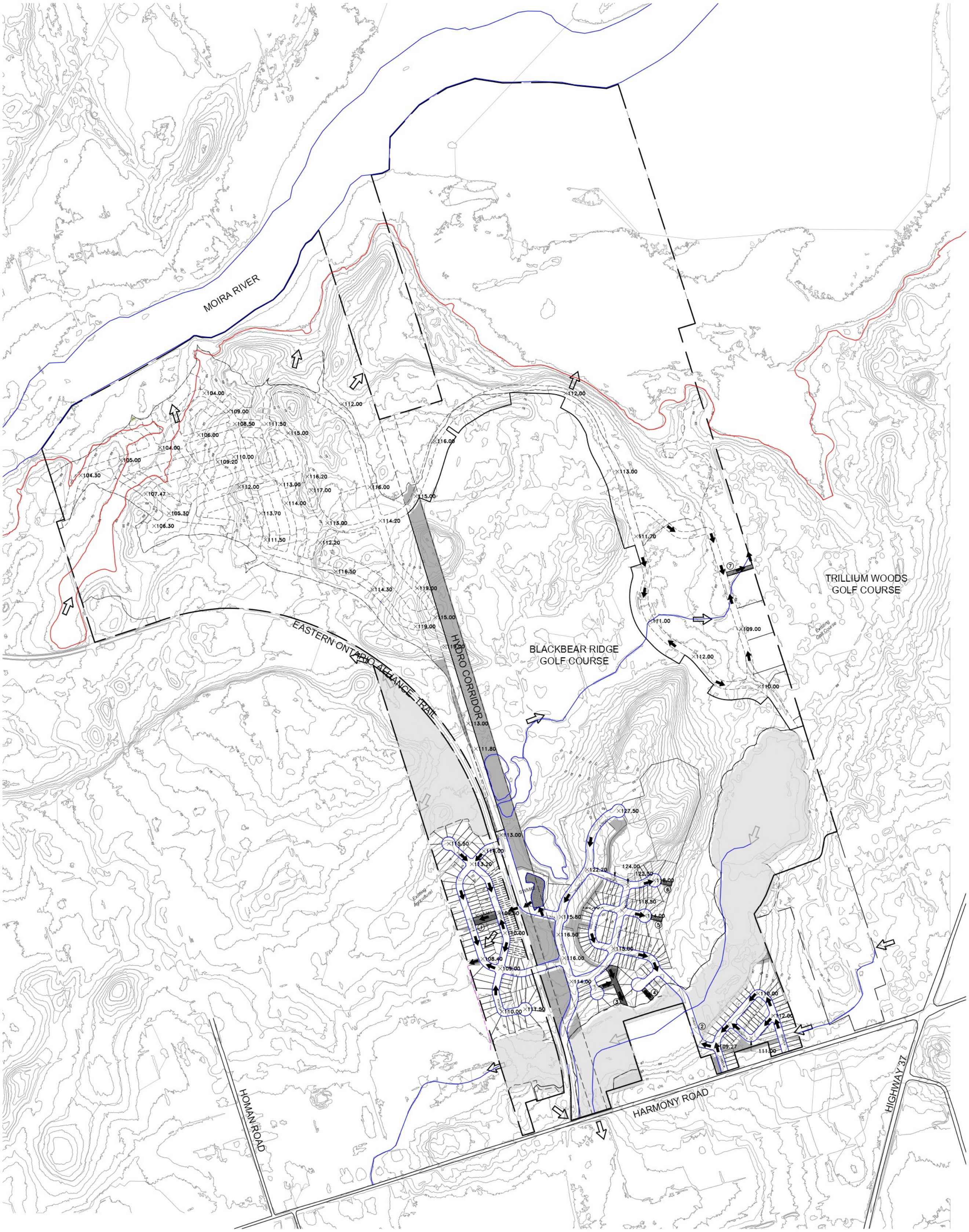
N E S W

LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PRELIMINARY WATER SERVICING PLAN

DRAWN BY: DFM/AG
PROJECT NO: 2205260
DESIGNED BY: DFM/AG
DATE: February 2025
CHECKED BY: BK
CONTRACT NO:
APPROVED BY: BK
SCALE:
HORIZONTAL - 1:5000
VERTICAL -
DRAWING NO: WTR-1



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- LIDAR CGVD 2013

^^ DRAWINGS ARE NOT TO BE SCALED ^^

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND

- SWM FEATURE
- PROPOSED OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- ENVIRONMENTAL CONSTRAINTS
- DITCHING
- 100 YEAR FLOOD LIMIT
- ① STORM OUTLET ID

N E S W

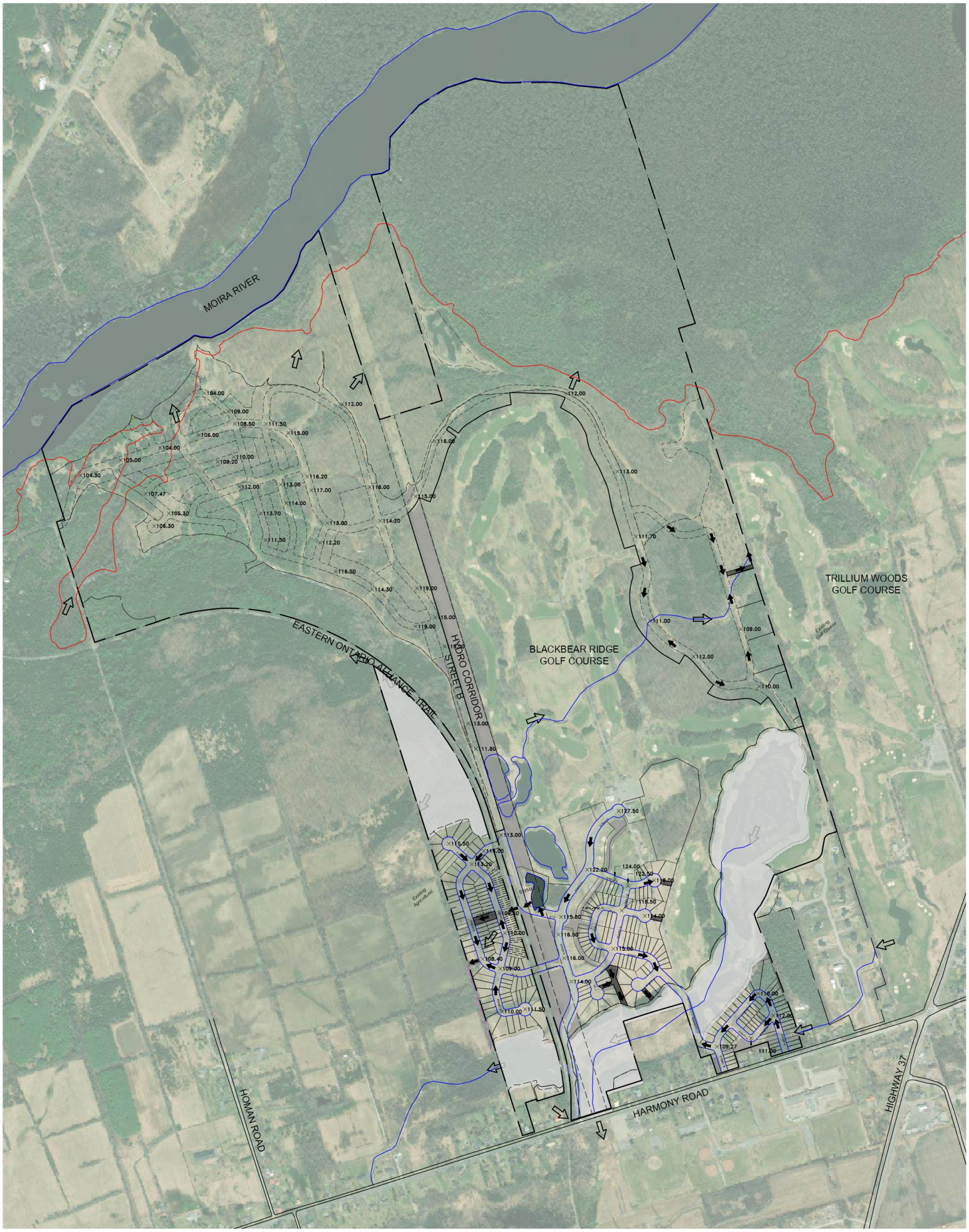
LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
Jan. 31/25
PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

PRELIMINARY GRADING PLAN

DRAWN BY: DFM/AG
PROJECT NO: 2205260
DESIGNED BY: DFM/AG
DATE: January 2025
CHECKED BY: BK
CONTRACT NO:
APPROVED BY: BK
SCALE:
HORIZONTAL - 1:5000
VERTICAL -
DRAWING NO: PG-1

JEWELL
ENGINEERING



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LEGEND

- SWM FEATURE
- PROPOSED OVERLAND FLOW ROUTE
- EXISTING OVERLAND FLOW ROUTE
- ENVIRONMENTAL CONSTRAINTS
- DITCHING
- 100 YEAR FLOOD LIMIT
- ① STORM OUTLET ID

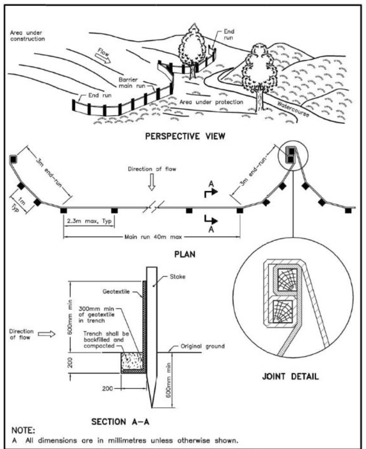
N W E S

LICENSED PROFESSIONAL ENGINEER B. C. KEENE PROVINCE OF ONTARIO

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

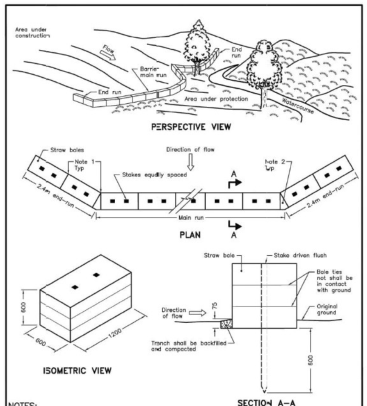
PRELIMINARY GRADING PLAN

DRAWN BY: DFM/AG
PROJECT NO: 2205260
DESIGNED BY: DFM/AG
DATE: January 2025
CHECKED BY: BK
CONTRACT NO:
APPROVED BY: BK
SCALE: HORIZONTAL - 1:5000 VERTICAL -
DRAWING NO: PG-2



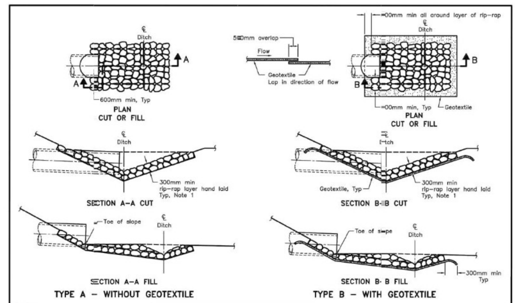
NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
LIGHT-DUTY SILT FENCE BARRIER		OPSD 219.110



NOTES:
1 Straw bales shall be butted tightly against adjoining bales to prevent sediment flow through barrier.
2 Caulk and compact gaps with loose straw.
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
LIGHT-DUTY STRAW BALE BARRIER		OPSD 219.100



NOTES:
1 The thickness of the rip-rap layer shall be at least 1.5 times the rip-rap mean diameter.
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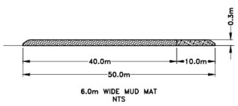
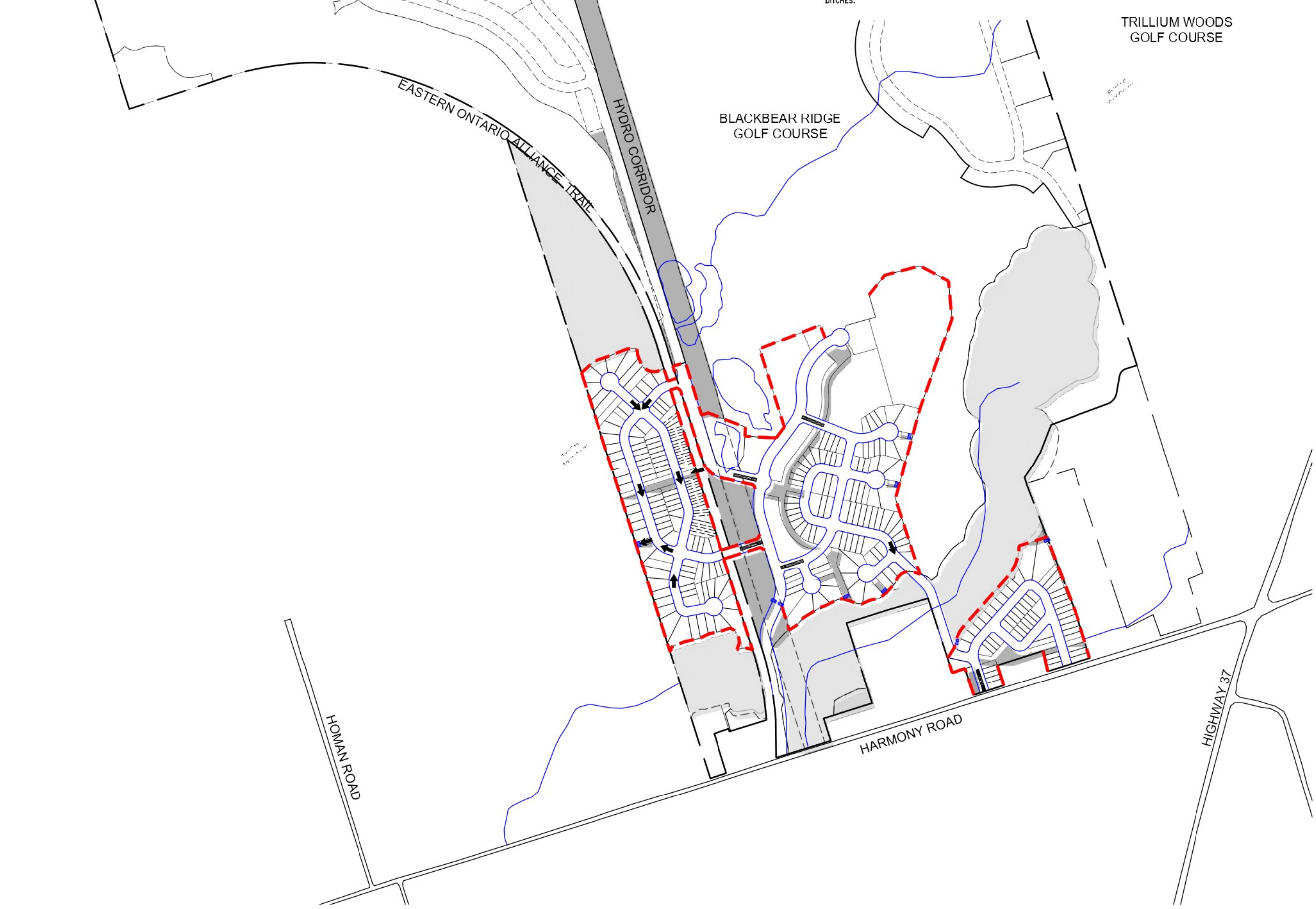
ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2013	Rev 2
GENERAL RIP-RAP LAYOUT FOR SEWER AND CULVERT OUTLETS		OPSD 810.010

EROSION AND SEDIMENT CONTROL NOTES:

1. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES, TO PROVIDE THE PROTECTION OF THE AREA DRAINAGE SYSTEM AND THE RECEIVING WATERCOURSE DURING CONSTRUCTION ACTIVITIES. THIS INCLUDES LIMITING THE AMOUNT OF EXPOSED SOIL, AND INSTALLING SILT FENCES AND OTHER SEDIMENT TRAPS.
2. THE SITE GRADING CONTRACTOR IS RESPONSIBLE FOR ENSURING SEDIMENT AND EROSION CONTROL STRUCTURES ARE INSTALLED AS SHOWN. CARE SHALL BE TAKEN AT THE REMOVAL STAGE TO ENSURE THAT ANY SILT THAT HAS ACCUMULATED IS PROPERLY HANDLES AND DISPOSED OF.
3. FOR STRAW BALE FLOW CHECK USE OPSD 219.100. FOR SILT FENCE BARRIER, USE OPSD 219.110.
4. THE OWNER AGREES TO PREPARE AND IMPLEMENT AN EROSION AND SEDIMENT CONTROL PLAN TO THE SATISFACTION OF THE QUINTE CONSERVATION, APPROPRIATE TO THE SITE CONDITIONS, PRIOR TO UNDERTAKING ANY SITE ALTERATIONS (EXCAVATING, FILLING, GRADING, REMOVAL OF VEGETATION, ECT.) AND DURING ALL PHASES OF SITE PREPARATION AND CONSTRUCTION.
5. SEDIMENT AND EROSION CONTROL MEASURES SHALL BE IN PLACE PRIOR BEFORE ANY EXCAVATION OR CONSTRUCTION WORKS COMMENCE. ALL APPROVED SEDIMENT/EROSION CONTROL MEASURERS ARE TO BE MONITORED REGULARLY AND MAINTAINED AS NECESSARY, TO ENSURE GOOD WORKING ORDER AND REMAIN IN PLACE UNTIL LANDSCAPING HAS BEEN ESTABLISHED. IN THE EVENT THAT THE EROSION AND SEDIMENTATION CONTROL MEASURERS ARE DEEMED NOT BE TO PERFORMING ADEQUATELY, THE CONTRACTOR SHALL UNDERTAKE ADDITIONAL MEASURES AS APPROPRIATE TO THE SITUATION TO THE SATISFACTION OF THE QUINTE CONSERVATION, PROJECT MANAGER AND/OR MUNICIPAL STAFF.
6. SEDIMENT AND EROSION CONTROL MEASURES WILL BE PAID AS PER OPSS 805.10:
   - 50% FOR INITIAL CONSTRUCTION
   - 30% FOR MAINTENANCE
   - 20% FOR REMOVAL
7. THE CUT AREA IS BE RESEEDED AND/OR STABILIZED UPON COMPLETION OF THE WORKS TO ENSURE THAT THERE IS NO CONVEYANCE OF SEDIMENT OFF SITE INTO THE LOCAL DITCHES.
8. ANY CHANGES IN THE PROPOSED CONSTRUCTION WORKS, INCLUDING CHANGES BY THE CONTRACTOR OR PROJECT MANAGER, MUST BE REVIEWED AND APPROVED BY THE QUINTE CONSERVATION PRIOR TO IMPLEMENTATION.
9. THE OWNER IS ULTIMATELY RESPONSIBLE (CONTRACTOR RESPONSIBLE AS WELL) FOR FAILURE TO COMPLY WITH ANY AND/OR ALL OF THESE CONDITIONS AND MUST TAKE ALL PRECAUTIONS TO ENSURE TO SEDIMENT RUNOFF FROM THE WORK SITE INTO THE SURFACE WATERS DURING AND AFTER THE CONSTRUCTION PERIOD. FAILURE TO COMPLY WITH THE APPROVAL AND/OR CONDITIONS MAY RESULT IN APPROVAL BEING REVOKED AND IN THE INITIATION OF LEGAL ACTION TO REMEDY THE MATTER TO THE CONSERVATION AUTHORITY'S SATISFACTION.
10. ALL PROPOSED AND EXISTING REAR YARD CATCH BASINS TO BE FITTED WITH SEDIMENT TRAPS BEFORE CONSTRUCTION BEGINS AND ARE TO BE MAINTAINED THROUGHOUT CONSTRUCTION, AND REMOVED AFTER CONSTRUCTION IS COMPLETE.
11. EXISTING ROAD CATCH BASINS DOWNSTREAM FROM CONSTRUCTION TO BE FITTED WITH SEDIMENT TRAPS BEFORE CONSTRUCTION BEGINS AND ARE TO BE MAINTAINED THROUGHOUT CONSTRUCTION, AND REMOVED AFTER CONSTRUCTION IS COMPLETE.
12. A 6.0m WIDE MUD MAT IS TO BE PLACED AT ALL CONSTRUCTION ACCESS LOCATIONS PRIOR TO CONSTRUCTION AND IS TO BE MAINTAINED THROUGHOUT CONSTRUCTION AND REMOVED UPON THE COMPLETION OF CONSTRUCTION. IF A MUDMAT IS NOT PLACED AT A CONSTRUCTION ACCESS, EXIT FROM THAT CONSTRUCTION ACCESS IS PROHIBITED. ALL TRACKING OF SITE MATERIAL MUST BE CLEANED UP IMMEDIATELY FROM PAVED STREETS.





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- LIDAR CGVD 2013

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REVISIONS

NO.	DATE	DESCRIPTION	BY
1	31/01/25	FIRST SUBMISSION	DFM

LEGEND
- LIGHT DUTY SILT FENCE
- STRAW BALE FLOW CHECK DAM
- ENVIRONMENTAL CONSTRAINTS
- MUDMAT LOCATION

N E S W

LICENSED PROFESSIONAL ENGINEER B. C. KEENE Jan. 31/25 PROVINCE OF ONTARIO

JEWELL ENGINEERING

BLACK BEAR RIDGE GP INC.
BLACK BEAR RIDGE VILLAGE

EROSION & SEDIMENT CONTROL PLAN

DRAWN BY: DFM/AG	PROJECT NO: 2205260
DESIGNED BY: DFM/AG	DATE: January 2025
CHECKED BY: BK	CONTRACT NO:
APPROVED BY: BK	
SCALE: HORIZONTAL - 1:5000	VERTICAL -
DRAWING NO: ERC-1	

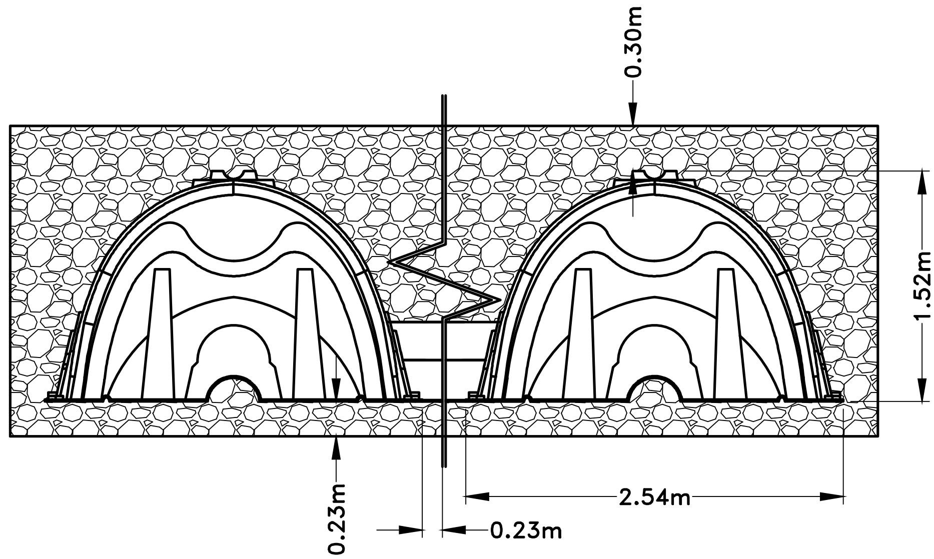

FIGURE 1 – UNDERGROUND
STORMWATER STORAGE DETAIL

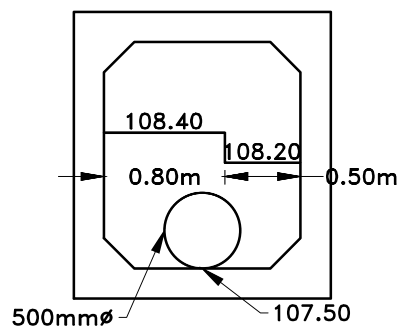

FIGURE 2 – UNDERGROUND
STORMWATER WEIR DETAIL

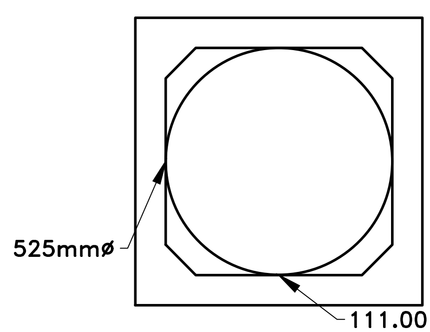

FIGURE 3 – POND 1 DETAIL