CONCEPTUAL STORMWATER MANAGEMENT REPORT FRANKTOWN SUBDIVISION

Project No.: CCO-22-0256

Prepared for:

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1.0 PURPOSE

McIntosh Perry Consulting Engineers Limited (McIntosh Perry) has prepared this Conceptual Stormwater Management Report in support of an application for Draft Plan Approval of the development known as the Franktown Subdivision by Grizzly Homes.

The objective of this stormwater management report is to evaluate the drainage characteristics of the site under existing and proposed conditions and to advance an integrated approach to facilitate the proposed development with no adverse impacts to the receiving drainage systems. The purpose of this report is to provide a conceptual stormwater management design in accordance with the recommendations and guidelines provided by the Ministry of the Environment, Conservation and Parks (MECP) and the Ministry of Northern Development, Mines, Natural Resources and Forestry (MNDMNRF). These guidelines encourage the implementation of Best Management Practices (BMPs) for treating and controlling stormwater runoff.

The servicing constraints, design criteria, municipal standards and project specific quality and quantity control objectives were established based on the previous projects completed in Rideau Valley Conservation Authority (RVCA), Beckwith Township and Lanark County regulatory areas.

During the detailed design stage, further information will be provided regarding the post-development peak flow rates, stormwater management facilities and specifically how the proposed stormwater management strategy will meet quality and quantity control objectives.

2.0 SITE DESCRIPTION

The proposed development is located in the Township of Beckwith. The legal description of the land is Part of Lot 10, Concession 3, Township of Beckwith, County of Lanark. The subject site is bounded by 4th Line Road to the north, vacant land to the east and west and County Road 10 to the south. This site currently encompasses two separate existing local wetlands within the center of the site which do not appear to be connected based on the data and topographic survey information obtained to date. Based on the topography, the wetlands do not appear to have gravity outlets and will continue to pond in post-development conditions. The remainder of the site is comprised of sections of vegetated meadow and forested areas. A copy of the location plan can be found in Appendix A.

The subject property is approximately 27 hectares in area and the owner wishes to develop the subject lands into thirty (30) rural estate lots with lot sizes averaging 1.6 acres accessed via a new street from 4th Line Road ending in a cul-de-sac. The length of proposed road is approximately 1,020 m.

As per the Environmental Impact Statement (EIS) prepared by Gemtec (February 2022), the subject property is comprised of mix forest and shrub with a presence of standing freshwater pond. The site is relatively flat and gentle slopes towards north. Surface water features include a dug pond and surrounding swamps (unevaluated) located in the western centre and southeastern portions of the property. A 15m setback is recommended for mitigating water quality impacts to protect wildlife habitat and to minimize Anthropocene influence.

2.1 SOIL CONDITIONS

It is understood that a Hydrogeological Investigation and Terrain Analysis Report will be prepared by McIntosh Perry for this site. As this conceptual design work is occurring concurrently with their work, for the purposes of this design, the Ontario Ministry of Agricultural, Food and Rural Affairs (OMAFRA) agricultural mapping was used to determine the underlying soil conditions. Based on this information and as shown in Figure 1, the site is comprised of farmington soil, which is classified as having a hydrological soil group 'B' and muck, which is classified as having a hydrological soil group 'D'.

Further investigations from the test pits and groundwater testing will be utilized in the detailed design to optimize the site with regards to construction practices for the dwelling placements, road profiles and ditching profiles.

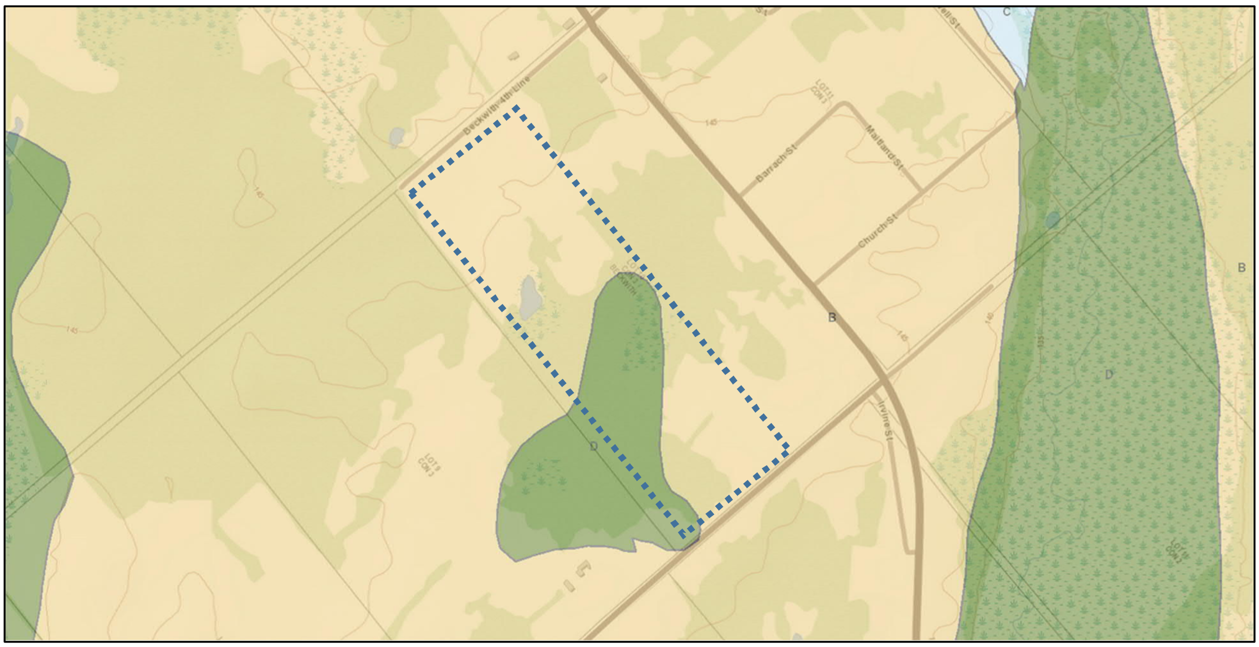


Figure 1 - Hydrologic Soil Groups - AgMaps

3.0 PROPOSED STORMWATER MANAGEMENT

3.1 DESIGN CRITERIA

In Ontario, typically the watershed level management and planning are done using watershed plans, sub watershed plans and/or individual stormwater management plans, in that order. The subject property is not covered by any specific watershed or sub watershed plans and has no existing stormwater controls in place. As such, the subject site will require a site-specific stormwater management plan using the MECP Stormwater Management Planning and Design Manual (March 2003). This methodology promotes water management from an environmentally sustainable perspective. The intent of this stormwater management plan is to provide adequate stormwater treatment for both quantity and quality controls. Stormwater Best Management

Practices (BMPs) will be implemented at the “Lot level”, “Conveyance” and “End of Pipe” locations. To summarize, roof water will be directed to grass surfaces that in turn will be collected in grassed swales or roadside ditches prior to entering the proposed stormwater management facilities. The SWM facilities will consist of stormwater retention areas providing temporary attenuation to meet the necessary quantity control objective. Quality control objectives are expected to be achieved through enhanced grass swales and the implementation of rock flow check dams within the roadside ditches and offtake swales.

The following design criteria is established based on the Stormwater Management Manual, 2003:

- Stormwater quantity controls will be required to regulate the post-development peak flows to pre-development levels for all design storms including the 2, 5, 10, 25, 50 and 100-year storm events.
- Stormwater quality controls will be required to achieve the “Enhanced” level of protection, which corresponds to 80% long term average removal of Total Suspended Solids (TSS) as recommended in the MECP SWMPD Manual, 2003.
- Incorporate LID features (if applicable) in the stormwater management strategy by implementing a “treatment train” approach to supplement the stormwater quality control; and
- Grading should demonstrate that flows to the wetland will not change and incorporate the regulatory setback requirements (i.e.: maintain post to pre).

3.2 METHODOLOGY

Runoff calculations were completed with the aid of a computer modelling program, Visual OTTHYMO (Version 6.0) (VO6). The proposed model was developed as a rural development and therefore employed NASHYD routines for calculating hydrographs. The overland travel time of concentration for each of the drainage areas was derived using the SCS Lag equation:

$$T_c = 60\left(L^{0.8}\,\frac{(S'+25.4)^{0.7}}{4238\,S^{0.33}}\right) \text{ (min)}$$

Where:

L = Flow length (m)

S’ = Potential maximum retention ($S' = \frac{25400}{CN} - 254$)

CN = Curve Number

S = Average watershed land slope (%)

A maximum value of 30m (100ft) was used in calculating the overland sheet flow time of concentration. The remaining overland sheet flow is assumed to form shallow concentrated flows after these conditions and was calculated as such. The velocity for the shallow concentrated flow was calculated using the following formula:

$$V = K(s)^{0.5} \text{ (m/s)}$$

Where: k = constant (referenced from the National Engineering Handbook, Table 15-3)

V = Velocity of water (m/s)

S = Average watershed land slope (%)

The velocity for channelized flow was also calculated using the above equation, substituting k=0.457. For pre-development, shallow concentrated flows were calculated using a k-value of 5.032 as appropriate for woodlands and cultural meadow lands. For post-development, given that it is expected that much of the lots will be left in their natural state, a k-value of 5.032 was used as well. These values were taken from the National Engineering Handbook Table 15-3 (converting the velocity equation from imperial to metric units). The resulting time of concentration was then determined using the velocity method which "assumes the time of concentration is the sum of the travel times for segments along the hydraulically most distant flow path." (National Engineering Handbook, Page 15-6).

The time of concentration was used to estimate the time to peak through the relation that the time to peak occurs at approximately 67% of the time of concentration. The input value for the simulation time step (DT) in VO6 was taken as 5 minutes where the time of concentration was determined to be less than 20 minutes, and 10 minutes where the time of concentration was determined to be greater than 20 minutes. For the 24-hour SCS Type II distribution, where the time of concentration was determined to be greater than 30 minutes, a DT of 15 minutes was assigned.

The following values were used to develop a composite curve number and initial abstraction value.

Table 1: Curve Numbers and Initial Abstraction Values

Land Use	Curve Number	Initial Abstraction (mm)
Impervious	98	2
Meadow	58	8
Cultural Thicket/Forest "B"	55	10
Cultural Thicket/Forest "D"	77	10
Manicured Lawns B	74	5
Wetland	50	10

As described in Section 2.1, and as per the available soils mapping on the Ministry of Ontario's OMAFRA Agmap's website, the existing soils have generally been classified as Class B and D. The areas were delineated using CAD. Reference support files for the above chosen curve numbers have been provided in Appendix B.

The initial abstraction values used for each sub-catchment input in VO6 were taken from the following table (Table 7.5: Initial Abstraction/Depression Storage – Adapted from UNESCO, Manual on Drainage in Urbanized Areas, 1987):

Table 2: Initial Abstraction Reference Table

Ground Cover	Depth (mm)
Woods	10
Meadows	8
Cultivated	7
Lawns	5
Impervious Areas	2

Given the proximity to the City of Ottawa, the design is based on the hyetographs for the City of Ottawa. The SCS Type II distribution (12-hour and 24-hour) and the 4-hour Chicago distribution were all reviewed in preparing the proposed design. The 12-hour SCS Type II distribution was reviewed using a 30-minute time step, while the 24-hour SCS Type II distribution was reviewed with a 1-hour time step. The 4-hour Chicago distribution was reviewed using a 10-minute time step.

It is anticipated that the on-site drainage ditches will be constructed at a minimum of 0.1% for rear yards, 0.3% for side yards and 0.5% for roadside ditches. During the final design process, opportunity to alter the slope of the ditches will be explored considering additional topographic information and final road and lot grading plans. It is expected that all roadside ditches are designed at a minimum depth of 0.85 m.

Driveway culverts will be sized for the 5-year storm while road crossing culverts will be sized for the 10-year storm. Flows during the 100-year storm will be reviewed to confirm they do not overtop the driveways/roads greater than 0.30 m. Driveway culverts are to be a minimum 400 mm diameter with road crossing culverts a minimum 600 mm diameter, consistent with Township standards.

3.3 PRE-DEVELOPMENT DRAINAGE

The pre-development boundary encompasses four (4) drainage areas. Appendix C includes CCO-22-0256-PRE, which illustrates the pre-development drainage areas in the vicinity of the subject lands, noted as A1 through A4 and the supporting pre-development drainage calculations and associated model output results. The external drainage areas, which contribute to the overall site drainage were included in the analyses under pre-development conditions.

3.3.1 4th LINE ROAD – PRE-DEVELOPMENT DRAINAGE AREA A1

Pre-development drainage area A1 is comprised of the northern portion of the subdivision and generally flows north toward 4th Line Road. This drainage area is comprised of a mix of meadow and forested areas. The 12.0-hectare area ranges in elevation from 148 meters near the centre of the site to approximately 142 meters at the northern corner at 4th Line Road. The area has a composite curve number of 56.7, an initial abstraction of 8.9 and an estimated time of concentration of 45 minutes.

3.3.2 LOCAL WETLAND OUTLET – PRE-DEVELOPMENT DRAINAGE AREA A2

Pre-development drainage area A2 encompasses the southwestern central portion of the site and outlets to the existing wetland at the western limits. The drainage area encompasses off site flow from the vacant land to the west. The 10.3-hectare area is relatively flat and ranges in elevation from 148 m in the vacant land to the west to 146 m at the local wetland. The area has a composite curve number of 62.9, an initial abstraction of 10 and an estimated time of concentration of 72 minutes.

3.3.3 LOCAL WETLAND – PRE-DEVELOPMENT DRAINAGE AREA A3

Pre-development drainage area A3 is the eastern most drainage area and outlets to the other local wetland along the eastern property limit. Similar to area A2, offsite flows enter into the wetland, however for A3, they come from the south and east. The 12.1-hectare area is relatively flat and ranges in elevation from 149 m at the vacant land to the southeast to 146 m at the wetland. The area has a composite curve number of 64.6, an initial abstraction of 9.8 and an estimated time of concentration of 18 minutes.

3.3.4 COUNTY ROAD 10 – PRE-DEVELOPMENT DRAINAGE AREA A4

Pre-development drainage area A4 is the southern most drainage area and outlets to the roadside ditch along County Road 10 and through the rear yards of existing residential dwellings. This area is primarily treed with some open meadow areas. The 3.5-hectare area is relatively flat and ranges in elevation from 149 m at the highpoint throughout the site to 147 m at the County Road 10 right-of-way. The area has a composite curve number of 64.7, an initial abstraction of 9.3 and an estimated time of concentration of 21 minutes.

3.3.5 PRE-DEVELOPMENT SUMMARY

The input parameters and results have been summarized in the following tables, while the full detailed output results can be found in Appendix C.

Table 3: Pre-Development Input Parameters

Catchment ID	Area (ha)	CN[1]	Ia[2] (mm)	Tp[3] (hr)
A1	12.0	56.7	8.9	0.503
A2	10.3	62.9	10.0	0.802
A3	12.1	64.6	9.8	0.200
A4	3.5	64.7	9.3	0.236
Total	37.9			

Notes:
1. CN refers to the average weighted curve number based on the land cover and land use.
2. Ia refers to the initial abstraction
3. Tp refers to time to peak

Table 4: Pre-Development Results (m^3/s)

Catchment	12-hr SCS		24-hr SCS		4-hr Chicago	
	5-Year	100-Year	5-Year	100-Year	5-Year	100-Year
A1	0.157	0.470	0.178	0.508	0.106	0.354
A2	0.114	0.339	0.128	0.364	0.079	0.260
A3	0.386	1.119	0.444	1.229	0.226	0.793
A4	0.101	0.294	0.116	0.321	0.063	0.213

3.4 POST-DEVELOPMENT DRAINAGE

The post-development drainage scheme for the proposed development is comprised of seven drainage areas which either outlet to 4th Line Road, the local wetlands or County Road 10. The development will see the addition of approximately 1,020 m of asphalt roadway with roadside drainage ditches, along with 30 single family homes and associated driveways. The development is also anticipated to include two dry retention areas for stormwater management purposes.

Appendix D includes CC0-22-0256-POST, which illustrates the post-development sub-catchments for the subject lands, noted as B1a, B1b, B2a, B2b, B3a, B3b and B4, supporting drainage calculations and associated model output results.

3.4.1 4th LINE ROAD – POST-DEVELOPMENT DRAINAGE AREAS B1a + B1b

B1a + B1b encompass most of the land contained in pre-development area A1. Post-development drainage area B1a is comprised of the area that will not reach the stormwater management feature and will continue to drain uncontrolled toward 4th Line Road as in existing conditions. B1a is comprised of the rear portions of 4 proposed dwellings and approximately 60m of roadway. The 3.2-hectare area will see runoff overland sheet flow from the center of the site to the north toward 4th Line Road. Area B1a has a composite curve number of 71.8, an initial abstraction of 5.7 and an estimated time of concentration of 22 minutes.

Post-development drainage area B1b encompasses the land which will outlet to the stormwater management facility which will attenuate post-development peak flows to pre-development peak flow rates prior to discharge to the 4th Line Road outlet. B1b will be comprised of 8 dwellings and 6 parts of dwellings and corresponding driveways and approximately 400m of proposed roadway. The 8.2-hectare area will overland sheet flow from the dwellings toward the roadside ditch which will outlet to an offtake swale prior to reaching the stormwater management feature located in the northeast corner of the site (along the rear of lots 1 through 6). Area B1b has a composite curve number of 72.7, an initial abstraction of 5.6 and an estimated time of concentration of 45 minutes.

3.4.2 LOCAL WETLAND OUTLET – POST-DEVELOPMENT DRAINAGE AREAS B2a + B2b

B2a + B2b encompass most of the land contained in pre-development area A2. Post-development drainage area B2a is comprised of the area that will not reach the stormwater management feature and will continue to drain uncontrolled toward the local wetland as in existing conditions. B1a is comprised of a portion of 1 proposed dwelling and its driveway as well as approximately 250m of one half of the roadway. The 3.3-hectare area will see runoff overland sheet flow roadways over a vegetated buffer area and into the wetland. Area B2a has a composite curve number of 54.4, an initial abstraction of 9.4 and an estimated time of concentration of 13 minutes.

Post-development drainage area B2b encompasses the land which will outlet to the stormwater management facility which will attenuate post-development peak flows to pre-development peak flow rates at the local wetland outlet. B2b will be comprised of 5 dwellings and 5 parts of dwellings and corresponding driveways and approximately one half of 500m of proposed roadway. The 9.5-hectare area will overland sheet flow from the dwellings toward the roadside ditch which will outlet to an offtake swale prior to reaching the stormwater management feature located in the western portion of the site (along the rear of lots 21 through 25). Area B1b has a composite curve number of 71.4, an initial abstraction of 7.5 and an estimated time of concentration of 28 minutes.

3.4.3 LOCAL WETLAND – POST-DEVELOPMENT DRAINAGE AREA B3a + B3b

B3a + B3b encompass most of the land contained in pre-development area A3. Post-development drainage area B3a is comprised of the area that will flow uncontrolled directly into the wetland as in existing conditions. B3a is comprised of a portion of 7 proposed dwellings (rear portions only). The 8.7-hectare area will see runoff overland sheet flow from the rear of the dwellings into the wetland. Area B3a has a composite curve number of 61.6, an initial abstraction of 8.0 and an estimated time of concentration of 35 minutes.

Post-development drainage area B3b encompasses the land which will outlet to an enhanced swale to provide quality control prior to outlet to the wetland. Based on the calculations, this area will not require a stormwater management facility as forested areas over HSG D soils will be replaced with fill material and septic beds constructed with imported material. Imported fill material is expected to have better infiltration and percolation rates in comparison to the existing clayey soils. This will reduce the overall curve number for the area and result in not requiring stormwater management. B3b will be comprised of 7 parts of dwellings and corresponding driveways and approximately one half of 500m of proposed roadway. The 2.4-hectare area will overland sheet flow from the dwellings toward the roadside ditch which will outlet to the enhanced swale between lots 11 and 12 then to the wetland. Area B3b has a composite curve number of 77.3, an initial abstraction of 4.6 and an estimated time of concentration of 24 minutes.

3.4.4 COUNTY ROAD 10 – POST-DEVELOPMENT DRAINAGE AREA B4

Post-development drainage area B4 encompasses the land that was contained in pre-development area A4. Site grading has allowed for a reduction in the contributing drainage area to this outlet. Area B4 will be comprised of the rear yards of 5 proposed dwellings. Drainage area B4 measures 2.7 hectares, has a composite curve number of 70.2, an initial abstraction value of 6.6 and an estimated time of concentration of 20 minutes.

3.4.5 POST-DEVELOPMENT SUMMARY

The input parameters and results have been summarized in the following tables, while the full detailed output results can be found in Appendix D.

Table 5: Post-Development Input Parameters.

Catchment ID	Area (ha)	CN[1]	Ia[2] (mm)	Tp[3] (hr)
B1a	3.2	71.8	5.7	0.246
B1b	8.2	72.7	5.6	0.502
B2a	3.3	54.4	9.4	0.142
B2b	9.5	71.4	7.5	0.315
B3a	8.7	61.6	8.0	0.389
B3b	2.4	77.3	4.6	0.270
B4	2.7	70.2	6.6	0.222
Total	37.9			

Notes:
1. CN refers to the average weighted curve number based on the land cover and land use.
2. Ia refers to the initial abstraction
3. Tp refers to time to peak

Table 6: Post-Development Results (m^3/s)

Catchment		12-hr SCS		24-hr SCS		4-hr Chicago	
Existing	Proposed Equivalent	5-Year	100-Year	5-Year	100-Year	5-Year	100-Year
A1	B1a + B1b	0.316	0.806	0.346	0.851	0.227	0.642
A2	B2a + B2b	0.370	1.016	0.413	1.093	0.247	0.766
A3	B3a + B3b	0.277	0.742	0.308	0.794	0.192	0.578
A4	B4	0.110	0.288	0.123	0.311	0.073	0.218

4.0 MAJOR DRAINAGE ROUTES

The proposed roadside ditches and offtake swales will have an important role in site drainage. They will act as the major drainage routes and will be sized to manage the required flow rate. The driveway culverts will be sized for the 5-year storm; however, flows during the 100-year storm will not overtop the driveways greater than 0.30 m. The proposed roadside ditches and side yard offtake swales will act as the major drainage routes and will adhere to the MECP guidelines for enhanced grass swales as much as possible. For example, the swale will be sized accordingly to handle the 25mm storm quality storm event with velocities not to exceed 0.5 m/s. Rock flow check dams will be incorporated to attenuate flows, promote infiltration and allow for particle filtration. Further details will be provided during detailed design. The site will be designed such that the proposed dwelling will not be adversely affected by any 100-year ponding limits, nor by the adjacent wetlands.

5.0 STORMWATER QUANTITY CONTROL

The following is provided as a summary of pre-development peak flow rates in comparison to post-development peak flow rates.

Table 7: Pre- and Post-Development Results

Design Storm (yr)	Peak Flows (m^3/s)								
	12-Hour SCS Type II			24-Hour SCS Type II			4-Hour Chicago		
	Pre.	Post.	Δ	Pre.	Post.	Δ	Pre.	Post.	Δ
4th Line Road – Area A1 / B1a+B1b									
5	0.157	0.316	0.159	0.178	0.346	0.168	0.106	0.227	0.121
100	0.470	0.806	0.336	0.508	0.851	0.343	0.354	0.642	0.288
Local Wetland – Area A2 / B2a + B2b									
5	0.114	0.370	0.256	0.128	0.413	0.285	0.079	0.247	0.168
100	0.339	1.016	0.677	0.364	1.093	0.729	0.260	0.766	0.506
Local Wetland – Area A3 / B3a + B3b									
5	0.386	0.277	-0.109	0.444	0.308	-0.136	0.226	0.192	-0.034
100	1.119	0.742	-0.377	1.229	0.794	-0.435	0.793	0.578	-0.215
County Road 10 – Area A4 / B4									
5	0.101	0.110	0.009	0.116	0.123	0.007	0.063	0.073	0.010
100	0.294	0.288	-0.006	0.321	0.311	-0.010	0.213	0.218	0.005

Evidently from the results, the post-development peak flow rates show an increase compared to pre-development conditions for Areas A1 and A2. Please note that while A4 illustrates a light increase in peak flows, the extremely minor increase is not something that is commercially viable to control. In detailed design, it is anticipated that options will be explored to regrade the site to look to reduce the total area contributing to the County Road however, for conceptual purposes, it is believed that these increases are within a reasonable tolerance.

For Areas A1 and A2, the requirement for stormwater management controls to manage runoff and offer restriction of peak flow rates. The proposed stormwater management design will examine both the 5 and 100-year storm events. The offtake swales to be constructed on-site will be equipped with permanent outlet control devices designed to restrict flows to specified flow rates. It is anticipated that the side and rear yard dry retention areas will have easements associated with the adjacent properties to allow for the temporary storage of water within this dry retention area and to allow for future maintenance.

The relatively wide flat-bottom channels of the swales at an estimated gradient of 0.3% along the side yards and 0.1% along the rear yards ponding areas, will provide ample opportunity for temporary stormwater storage. The ditches and channels will be constructed with 2.5:1 side slope (when excavated in earth) and will be graded such that the yards of the adjacent rural estates lots can be drained properly. The opportunity to employ quality control enhancements such as through rock flow check dams or baffles will be explored to further offer quality control measures through a treatment train approach within the development.

For pre-development area A3 (B3a and B3b), post-development peak flow rates show a reduction to the overall flow, which suggests that no stormwater management controls are necessary.

Detailed sizing of the restrictions will be provided during the detailed design stage however a conceptual estimate of the requirements has been performed in VO6. The estimated storage requirements have been provided in the table below.

Table 8: Storage Requirements

Catchment ID	5-Year Restricted Flow (m^3/s)	5-Year Required Storage (m^3)	100-Year Restricted Flow (m^3/s)	100-Year Required Storage (m^3)
A1 / B1a+B1b	0.048	891	0.091	2262
A2 / B2a+B2b	0.020	1146	0.308	1948

Preliminary, high-level calculations have been completed to approximate the available storage on site. The exact location, geometry and alignment of these dry retention areas will be confirmed during detailed design upon obtaining additional detailed topographic information and in conjunction with the design of the road and roadside ditches and swales. Overall, it is anticipated that sufficient storage can be provided to restrict post-development peak flow rates to pre-development levels.

5.1 POST-DEVELOPMENT PEAK FLOW RATES SUMMARY

Based on the maximum available storage, the following table summarizes the anticipated peak flow rates to the respective outlets. Full supporting calculations for the described storage conditions have been provided in Appendix E. Detailed design calculations for the proposed outlet control structures will be provided during the detailed design stage.

Table 9: Pre- and Post-Development Controlled Results.

Design Storm (yr)	Peak Flows (m^3/s)					
	12-Hour SCS Type II			24-Hour SCS Type II		
	Pre.	Post. (Ctrl)	Δ	Pre.	Post. (Ctrl)	Δ
4th Line Road – Area A1 / B1a+B1b						
5	0.157	0.143	-0.014	0.178	0.158	-0.020
100	0.470	0.354	-0.116	0.508	0.379	-0.129
Local Wetland – Area A2/B2a+B2b						
5	0.114	0.101	-0.013	0.128	0.117	-0.011
100	0.339	0.324	-0.015	0.364	0.348	-0.016

Note: The results for the 4 Hour Chicago storms were not considered in the Post-Development Controlled calculations as the distribution associated with a Chicago Storm would not be expected to be reflective of a large rural estate lot subdivision like the Franktown Subdivision with a total imperviousness of only 5%.

6.0 STORMWATER QUALITY CONTROL

The entire subdivision will employ Best Management Practices (BMPs) wherever possible. The intent of implementing stormwater BMPs throughout the entire development is to ensure that water quality and quantity concerns are addressed at all stages of the development. The stormwater BMPs will be implemented at the lot, conveyance and end of pipe levels.

Lot level BMPs include the directing of roof leaders onto grassed areas, minimizing ground slopes and maintaining as much of the lot as possible in a natural state. Roof leaders will flow to grass areas, which will provide an opportunity for initial filtration of any sediment and provide an opportunity for absorption and ground water recharge. Recent recommendations by a number of Conservation Authorities and the MECP suggest that yard grading as flat as 0.5% be implemented to promote infiltration. The target range for finished ground slopes will be 1% - 5% where possible. This range of slope will still provide an opportunity for the absorption and filtration process.

The conveyance system to be used in the subdivision is natural overland sheet flow and a combination of roadside ditches and side yard offtake swales. All swales and ditches will be constructed at minimal gradient where possible, thus promoting absorption and infiltration, as well as providing some opportunity for particle filtration. The gradient of the system will be enough to ensure the continuous flow of stormwater, minimizing standing water. To aid in achieving the quality control objective, additional measures such as infiltration trenches and permanent rock flow check dams within the ditches and swales will be explored during the detailed design stage. Riprap will be placed at erosion-prone areas and all disturbed areas shall be landscaped as soon as possible.

The proposed dry retention areas will serve as end of pipe control measures. The use of quality control enhancing measures such as baffles will be explored during the detailed design stage to act as an additional measure in the treatment train approach.

Given the significant length of open ditch, relatively low percentage of hard surfaced area, the proposed works to be constructed are believed to achieve an enhanced level of quality treatment (80% TSS removal). Details will be provided during the detailed design stage to further address this.

7.0 WATER BALANCE ANALYSIS

An annual water balance analysis was completed to ensure that the annual infiltration volume will be maintained, since the outflow from the subject property feeds the south central and north wetlands as well as the proposed development will be serviced by well and septic systems. The water balance analyses, and the annual infiltration targets are calculated using C.W. Thornwaite and J.R. Mather Water Balance Method.

The annual climate data normals from the Environment Canada for the Ottawa International Airport Climate Station was used to calculate the total precipitation and surplus due to the climate station’s proximity to the subject development. The annual water balance analysis for the catchment area drainage towards the wetlands was completed under the existing and proposed conditions using the available soil data, topographic and geotechnical data, and the existing/proposed land use and land cover information.

The infiltration factors for the different land use were selected form the tier 1 water budget and water quantity stress assessment prepared by Mississippi-Rideau Source Protection Region, August 2009. The detailed calculations are included in Appendix E.

Table 10: Annual Water Balance- Infiltration Summary

Description	Drainage Area (Ha)	Storage Volume Provided (m³)	Annual Infiltration Rates (m³/year)			
			Pervious Areas	Impervious Areas	LID Features	Total
To Southcentral Swamp (B2a+B2b)						
Existing Conditions	10.30	-	20295	-	-	20295
Proposed Conditions	12.79	-	23495	545	-	24040
Net Difference in Infiltration under proposed conditions (%)						18%
To North Swamp (B3a+B3b)						
Existing Conditions	12.12	-	23851	-	-	23851
Proposed Conditions	11.1	-	21014	342	2428	23783
Net Difference in Infiltration under proposed conditions (%)						0%

Based on the annual water balance analysis, there is a net increase in the total infiltration for the Southcentral swamp due to the increase in the contributing area. As such, no infiltration features will be required for this drainage area to meet the annual infiltration budget for the Southcentral Swamp Outlet. On the contrary, there will be a net decrease in the total infiltration volume for the north swamp, if no mitigation measures are included. As such, an infiltration feature is warranted for this drainage area to meet the annual infiltration budget for the North Swamp outlet. A clear stone infiltration trench is proposed as the mitigation measure to balance the annual infiltration targets. Based on the Environment Canada data for days with precipitation, the infiltration trench must be designed to completely infiltrate a 10 mm storm event to meet the annual infiltration targets.

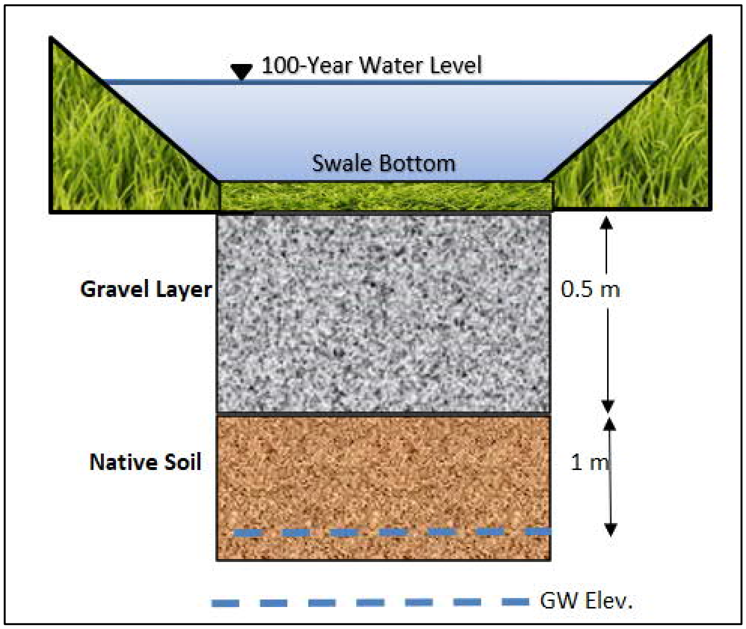
8.0 LOW IMPACT DEVELOPMENT

An infiltration trench is proposed as a mitigation measure to maintain the annual infiltration targets. It also will provide additional water quality benefits asides form the proposed "Enhanced" quality controls measures using Enhanced grass swales.

The available geotechnical and hydrogeological information was reviewed to evaluate the performance of an infiltration feature. Based on the soils information, the infiltration rates for the native soils were assumed to be 4.8mm/hr (including 2.5 factor of safety) which were typical rates for the cohesive soils prevalent in the site. The hydrogeological study confirms that there is at least 1.0m separation from the seasonal groundwater table and an average topsoil depth of 0.75m over bedrock.

Based on the above constraints, an infiltration trench of 0.5m deep filled with 50mm clear stone layer is proposed underneath the enhanced grass swale for the drainage area B3b to meet the annual infiltration targets by completely infiltrating a 10 mm storm event. An in-situ infiltration testing is recommended during detailed design to confirm the observed infiltration rates of the native medium and to establish the in-situ design performance of the proposed infiltration feature. A typical cross section of the proposed infiltration feature is illustrated in Figure 2.

Figure 2 - Infiltration Trench- Typical Section



9.0 PROVINCAL POLICY STATEMENT

The revised Provincial Policy Statement, which came into effect on April 30, 2014, (replacing the PPS issued March 1, 2005) and issued under Section 3 of the Planning Act, notes that Planning authorities shall protect, improve, or restore the quality and quantity of water by:

a) Using the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development.
b) Minimizing potential negative impacts, including cross-jurisdictional and cross-watershed impacts.
c) Identifying water resource systems consisting of ground water features, hydrologic functions, natural heritage features and areas and surface water features including shoreline areas, which are necessary for the ecological and hydrological integrity of the watershed.
d) Maintaining linkages and related functions among ground water features, hydrologic functions, natural heritage features and areas and surface water features including shoreline areas.
e) Implementing necessary restrictions on development and site alteration to:
    a. protect all municipal drinking water supplies and designated vulnerable areas; and
    b. protect, improve or restore vulnerable surface and ground water, sensitive surface water features and sensitive ground water features and their hydrologic functions.
f) Planning for efficient and sustainable use of water resources, through practices for water conservation and sustaining water quality.
g) Ensuring consideration of environmental lake capacity, where applicable; and

h) Ensuring stormwater management practices minimize stormwater volumes and contaminant loads; and maintain or increase the extent of vegetative and pervious surfaces.

The following table summarizes how many of the above noted sub-sections have been met.

Table 11: Provincial Policy Statement

Sub-section	Applicability
b	The development proposed to limit disturbance as much as possible, maintaining much of the land in its natural state. The percent imperviousness is estimated at only 5%, supporting those negative impacts are minimized by maintaining natural features.
d, e	The proposed stormwater management plan provides that post-development drainage patterns will be consistent with pre-development patterns such that natural features existing within the site are not negatively impacted by altered drainage flows.
f	The proposed stormwater management plan will provide an enhanced level of quality control. This will ensure that the proposed development does not have any negative impacts from a quality perspective, and through temporary ponding, etc., to achieve the necessary quality objectives.
g	As the proposed development has a total percent imperviousness of only 5%, sediment loading is not expected to be a large concern. Lot development will be done in such a manner as to limit disturbance to the existing natural features. Impervious areas, such as roads, are anticipated the be the biggest risk for sediment loading and appropriate measures will be implemented immediately surrounding these features to ensure that sediment loading does not impact the surrounding natural features.

10.0 EROSION AND SEDIMENT CONTROL

A site-specific Erosion and Sediment Control Plan will be prepared during the design development stage of the application process, delineating the proposed features to be implemented on-site as temporary and permanent means of managing erosion and sediment control. Following Best Management Practices are recommended to be incorporated into the Erosion and Sediment Control plans.

10.1 TEMPORARY MEASURES

Before construction begins, applicable temporary light silt fence (OPSD 219.110), straw bale and rock flow check dams shall be installed at all natural runoff outlets from the property. It is crucial that these controls be maintained throughout construction and inspection of sediment and erosion control will be facilitated by the Contractor or Contract Administration staff throughout the construction period.

The Contractor, at their discretion or at the instruction of the Township, Conservation Authority or the Contract Administrator shall increase the quantity of sediment and erosion controls on-site to ensure that the site is operating as intended and no additional sediment finds its way offsite or into the adjacent wetlands. Measures shall be inspected weekly and after all rainfall events. Care shall be taken to properly remove sediment from the fences and check dams as required.

Work through winter months shall be closely monitored for erosion along sloped areas. Should erosion be noted, the Contractor shall be alerted and shall take all necessary steps to rectify the situation. Should the Contractor's efforts fail at remediating the eroded areas, the Contractor shall contact the Conservation Authority to review the site conditions and determine the appropriate course of action.

10.2 PERMANENT MEASURES

Rip-rap shall be placed at all locations that have the potential for concentrated flow, particularly at the outflow of all proposed offtake swales and dry retention areas. In addition, rip-rap and geotextile shall be placed at the inlet and outlet of the road crossing culverts. It is crucial that the Contractor ensure that the geotextile is keyed in properly to ensure runoff does not undermine the rip-rapped area. Additional rip-rap is to be placed at erosion prone locations as identified by the Contractor / Contract Administrator / Township or RVCA.

It is expected that the Contractor will promptly ensure that all disturbed areas receive topsoil and seed and that grass be established as soon as possible. Any areas of excess fill shall be removed or levelled as soon as possible and must be located a sufficient distance from the wetlands to ensure that no sediment is washed out into the wetlands. As the vegetation growth along the proposed roadside, offtake swales and within the dry retention areas provides a key component to the control of sediment for the site, it must be properly maintained once established. As the lots are sold it will be up to the landowners to maintain that section of vegetation and ensure that they are not overgrown or impeded by foreign objects.

11.0 SUMMARY

- Runoff will be conveyed via overland sheet flow toward the roadside ditches, offtake swales and dry retention areas which ultimately outlet to 4th Line Road, the local wetlands at the center of the property and County Road 10.
- Preliminary calculations demonstrate that sufficient storage can be provided to restrict post-development peak flow rates to pre-development levels. Roadside ditches, offtake swales and dry retention areas are proposed to convey runoff, while rock flow check dams and outlet control structures will be employed to limit post-development peak flow rates to pre-development levels.
- Best Management Practices will be implemented to provide adequate quality control. Lot level, conveyance and end of pipe measures shall be implemented to ensure that runoff from the site achieves its targeted quality control objective. Additional details will be provided during the detailed design stage.

12.0 RECOMMENDATIONS

Based on the information presented in this report, we recommend that Beckwith Township and the Rideau Valley Conservation Authority approve this Conceptual Stormwater Management Report in support of the proposed Franktown Subdivision development.

Sincerely,
McIntosh Perry Consulting Engineers Ltd.

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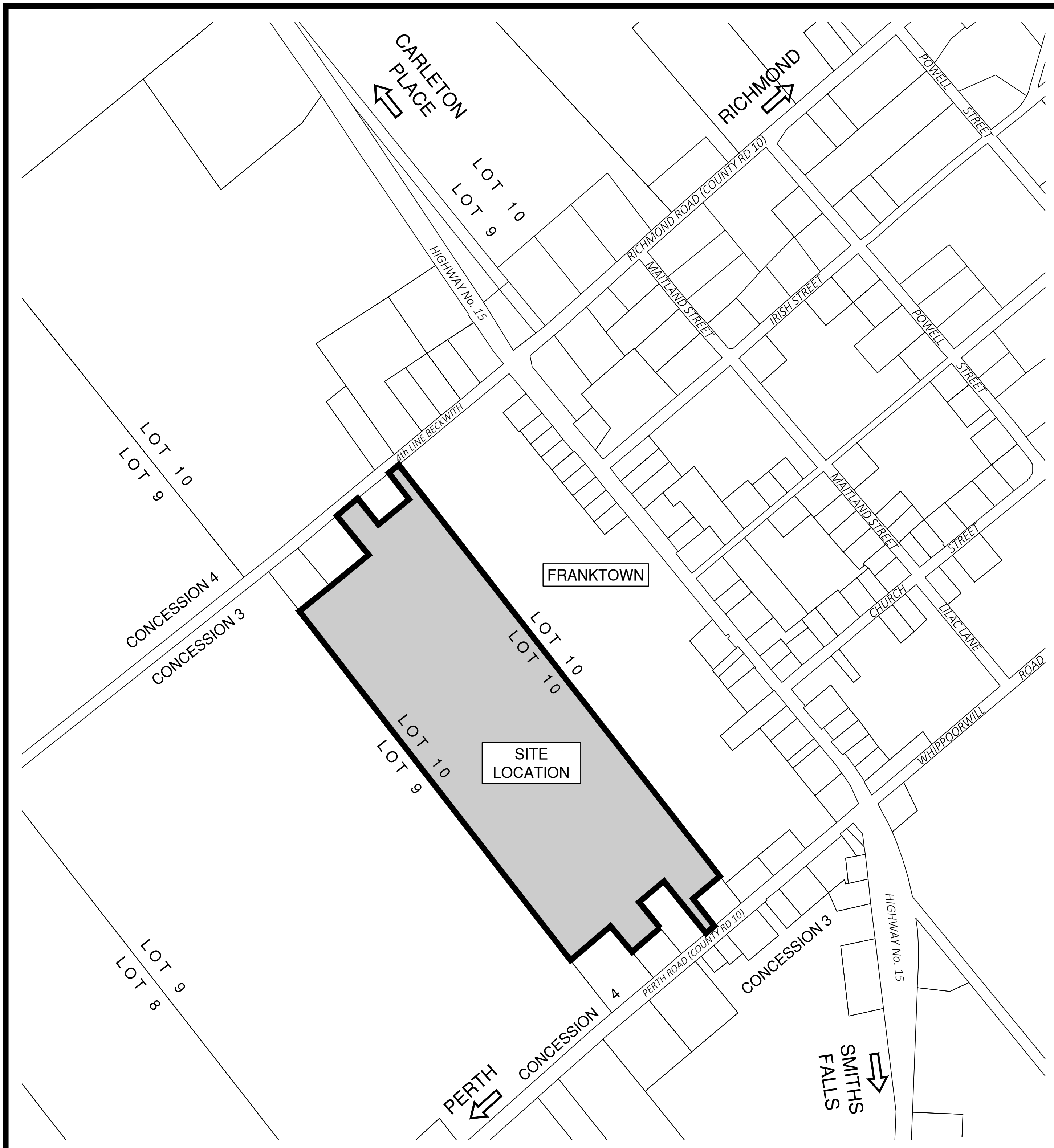
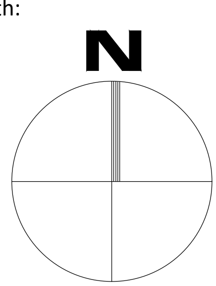
Ref: \\10.1.0.19\perth\mpce jobs\mpce projects\2022\cco\cco-22-0256 - grizzly homes - franktown subdivision review\10 - d&h\cco-22-0256 - franktown subdivision_conceptual swm report.docx

CONCEPTUAL STORMWATER MANAGEMENT REPORT
FRANKTOWN SUBDIVISION

APPENDIX A – LOCATION PLAN



North:	McINTOSH PERRY 3240 Drummond Cons 5A, R.R. #7, Perth, ON K7H 3C9 Tel: 613-267-6524 Fax: 613-267-7992 www.mcintoshperry.com		Client: GRIZZLY HOMES P.O. BOX 422, RR#7 ASHTON, ONTARIO, K0A 1B0			
			Project: FRANKTOWN SUBDIVISION			
			Title: LOCATION PLAN			
	Drawn by: SH	Scale: N.T.S.				Drawing Number:
	Checked By:	Date: DEC.10.2021				LOC
	Project Number:	CCO-22-0256	No.	Revision / Issue	Date	



FILENAME: U:\Perth\MPCE JOBS\MPCE Projects\2022\CCO\CCO-22-0256 - Grizzly Homes - Franktown Subdivision Review\12 - Dwgs\JS.dwg
LAST SAVED: Wednesday, March 09, 2022 LAST SAVED BY: r.rajachockalingam
LAST PLOTTED: Wednesday, March 16, 2022 CTB FILE USED: ----

CONCEPTUAL STORMWATER MANAGEMENT REPORT
FRANKTOWN SUBDIVISION

APPENDIX B – REFERENCE SUPPORT FILES

Design Coefficients

Land Use	Curve Number	Initial Abstraction (mm)
Pre-Development		
Impervious	98	2
Meadow - HSG B	58	8
Cultural Thicket/Forest - HSG B	55	10
Cultural Thicket/Forest - HSG D	77	10
Wetland	50	10
Post-Development		
Impervious	98	2
Manicured Lawns B	74	5
Cultural Thicket/Forest - HSG B	55	10
Cultural Thicket/Forest - HSG D	77	10
Meadow - HSG B	58	8
Wetland	50	10

*Class B Soils

CONCEPTUAL STORMWATER MANAGEMENT REPORT
FRANKTOWN SUBDIVISION

APPENDIX C – PRE-DEVELOPMENT DRAINAGE PLAN, MODEL & CALCULATIONS

TEST WELLS :

TEST WELL LOCATIONS SHOWN ARE APPROXIMATE ONLY AND SHALL BE VERIFIED PRIOR TO DETAILED DESIGN.

ANY TEST WELLS THAT DO NOT MEET OBC REQUIREMENTS SHALL BE ABANDONED IN ACCORDANCE WITH O.REG 903

LEGEND

AREA I.D. — A1 | 5.00 ha — AREA SIZE (HECTARES)

50.00 — CURVE NUMBER

DIRECTION OF SURFACE DRAINAGE

No.	Revision/Issue	Date
0	ISSUED FOR REVIEW	AUG.25.2022

McINTOSH PERRY
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Scale: 1:1500

Client:
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ASHTON, ONTARIO, K0A 1B0

Project:
FRANKTOWN SUBDIVISION
BECKWITH TOWNSHIP

Drawing Title:
PRE-DEVELOPMENT DRAINAGE PLAN

Date: MAR.30.2022
Project Number: CCO-22-0256
Drawing Number: PRE

Check and verify all dimensions before proceeding with the work

Do not scale drawings

CCO-22-0256 - FRANKTOWN SUBDIVISION - PRE-DEVELOPMENT DRAINAGE AREA INFORMATION

Land Use Breakdown

Catchment ID	Area (m^2)	Impervious (m^2)	Meadow (m^2) - HSG B	Cultural Thicket/ Forest (m^2) - HSG B	Cultural Thicket/ Forest (m^2) - HSG D	Wetland (m^2)	CN	Ia (mm)	% Imperviousness	Outlet
A1	119800	0	68103	51697	0	0	56.7	8.9	0.0%	4th Line
A2	103000	0	0	38609	42251	22140	62.9	10.0	0.0%	Local Wetland
A3	121200	0	12877	36191	55226	16906	64.6	9.8	0.0%	Local Wetland
A4	35300	0	12620	8863	13817	0	64.7	9.3	0.0%	Concession Road 10
Total	379300	0	93600	135360	111294	39046				

Time of Concentration

Catchment ID	Total Overland Flow Distance (m)	**Slope of Land (%)**	Sheet Flow Distance (m)	Sheet Flow Tc (min)	Shallow Concentrated Flow Distance (m)	Shallow Concentrated Flow Velocity (m/s)	Shallow Concentrated Tc (min)	Ditch Length (m)	Ditch Slope (%)	Ditch Velocity (m/s)	Ditch Tc (min)	Total Tc (min)
A1	432	1.39	30	8	402	0.18	37	0.0	0	0.00	0	45
A2	415	0.48	30	12	385	0.11	60	0.0	0	0.00	0	72
A3	150	1.33	30	7	120	0.18	11	0.0	0	0.00	0	18
A4	130	0.77	30	9	100	0.13	12	0.0	0	0.00	0	21

Hydrologic Model Parameters

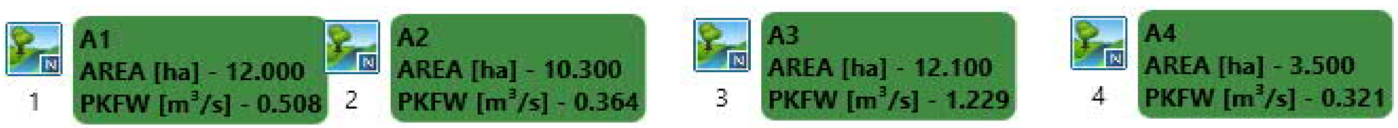
Catchment ID	Area (ha)	CN	Ia (mm)	tc (min)	tp (hr)	Outlet
A1	12.0	56.7	8.9	45	0.503	4th Line
A2	10.3	62.9	10.0	72	0.802	Local Wetland
A3	12.1	64.6	9.8	18	0.200	Local Wetland
A4	3.5	64.7	9.3	21	0.236	Concession Road 10
Total	37.9					

CCO-22-0256 - FRANKTOWN SUBDIVISION - PRE-DEVELOPMENT HYDROLOGICAL RESULTS

	12-hr SCS		24-hr SCS		4-hr Chicago		Max	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
A1	0.157	0.470	0.178	0.508	0.106	0.354	0.178	0.508
A2	0.114	0.339	0.128	0.364	0.079	0.260	0.128	0.364
A3	0.386	1.119	0.444	1.229	0.226	0.793	0.444	1.229
A4	0.101	0.294	0.116	0.321	0.063	0.213	0.116	0.321

	Outlet
A1	4th Line
A2	Local Wetland
A3	Local Wetland
A4	Concession Road 10

VO3 Model Pre-development Conditions



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        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
Developed and Distributed by Civica Infrastructure
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DATE: 03-16-2022                             TIME: 10:08:12

USER:



COMMENTS: ____________________________________________________________

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  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************

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| CHICAGO STORM    |    IDF curve parameters: A=1735.688
| Ptotal= 76.00 mm |                          B=   6.014
--------------------                          C=   0.820
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.33

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    4.39 |  1.17   40.65 |  2.17   11.06 |  3.17    5.28
```



```
                 0.33    5.07 |  1.33  178.56 |  2.33    9.29 |  3.33    4.88
                 0.50    6.05 |  1.50   54.05 |  2.50    8.02 |  3.50    4.54
                 0.67    7.54 |  1.67   27.32 |  2.67    7.08 |  3.67    4.25
                 0.83   10.16 |  1.83   18.24 |  2.83    6.35 |  3.83    3.99
                 1.00   15.97 |  2.00   13.74 |  3.00    5.76 |  4.00    3.77


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| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=  12.00   Curve Number   (CN)= 56.7
|ID= 1 DT= 5.0 min |   Ia      (mm)=   8.90   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.50

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    4.39 | 1.083   40.65 | 2.083   11.06 |  3.08    5.28
                0.167    4.39 | 1.167   40.65 | 2.167   11.06 |  3.17    5.28
                0.250    5.07 | 1.250  178.56 | 2.250    9.29 |  3.25    4.88
                0.333    5.07 | 1.333  178.56 | 2.333    9.29 |  3.33    4.88
                0.417    6.05 | 1.417   54.05 | 2.417    8.02 |  3.42    4.54
                0.500    6.05 | 1.500   54.05 | 2.500    8.02 |  3.50    4.54
                0.583    7.54 | 1.583   27.32 | 2.583    7.08 |  3.58    4.25
                0.667    7.54 | 1.667   27.32 | 2.667    7.08 |  3.67    4.25
                0.750   10.16 | 1.750   18.24 | 2.750    6.35 |  3.75    3.99
                0.833   10.16 | 1.833   18.24 | 2.833    6.35 |  3.83    3.99
                0.917   15.97 | 1.917   13.74 | 2.917    5.76 |  3.92    3.77
                1.000   15.97 | 2.000   13.74 | 3.000    5.76 |  4.00    3.77

     Unit Hyd Qpeak  (cms)=   0.911

     PEAK FLOW       (cms)=   0.354 (i)
     TIME TO PEAK    (hrs)=   1.917
     RUNOFF VOLUME    (mm)=  17.244
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.227

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

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--------------------
| CALIB              |
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     Unit Hyd Qpeak  (cms)=   0.491

     PEAK FLOW       (cms)=   0.260 (i)
     TIME TO PEAK    (hrs)=   2.333
     RUNOFF VOLUME    (mm)=  20.183
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.266

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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--------------------
| CALIB             |
| NASHYD   (  0003)|   Area    (ha)=  12.10   Curve Number   (CN)= 64.6
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     Unit Hyd Qpeak  (cms)=   2.311

     PEAK FLOW       (cms)=   0.793 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  21.296
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.280

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

-----------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0004)|   Area    (ha)=   3.50   Curve Number   (CN)= 64.7
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.30   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.24

     Unit Hyd Qpeak  (cms)=   0.566

     PEAK FLOW       (cms)=   0.213 (i)
     TIME TO PEAK    (hrs)=   1.583
     RUNOFF VOLUME    (mm)=  21.650
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.285

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

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 FINISH
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CONCEPTUAL STORMWATER MANAGEMENT REPORT
FRANKTOWN SUBDIVISION

APPENDIX D – POST-DEVELOPMENT DRAINAGE PLAN, MODEL & CALCULATIONS

TEST WELLS :

TEST WELL LOCATIONS SHOWN ARE APPROXIMATE ONLY AND SHALL BE VERIFIED PRIOR TO DETAILED DESIGN.

ANY TEST WELLS THAT DO NOT MEET OBC REQUIREMENTS SHALL BE ABANDONED IN ACCORDANCE WITH O.REG 903

LEGEND

AREA I.D. — B1 5.00 ha — AREA SIZE (HECTARES)

50.00 — CURVE NUMBER

DIRECTION OF SURFACE DRAINAGE

CONCEPTUAL STORMWATER MANAGEMENT SWALE

No.	Revision/Issue	Date
0	ISSUED FOR REVIEW	AUG.25.2022

McINTOSH PERRY
3240 Drummond Cons 5A, R.R. #7, Perth, ON K7H 3C9
Tel: 613-267-6524 Fax: 613-267-7992
www.mcintoshperry.com

Designed by: JS
Drawn by: SH
Checked By: JS
Scale: 1:1500

Client: GRIZZLY HOMES
P.O. BOX 422, RR#7
ASHTON, ONTARIO, K0A 1B0

Project: FRANKTOWN SUBDIVISION
BECKWITH TOWNSHIP

Drawing Title: POST-DEVELOPMENT DRAINAGE PLAN

Date: MAR.30.2022
Project Number: CCO-22-0256
Drawing Number: POST

Check and verify all dimensions before proceeding with the work

Do not scale drawings

CCO-22-0256 - FRANKTOWN SUBDIVISION - POST-DEVELOPMENT DRAINAGE AREA INFORMATION

Land Use Breakdown

Catchment ID	Area (m^2)	Impervious (m^2)	Meadow (m^2) - HSG B	Cultural Thicket/ Forest (m^2) - HSG B	Cultural Thicket/ Forest (m^2) - HSG D	Manicured Lawns (m^2)	Wetlands	CN	Ia (mm)	% Imperviousness	Controlled/ Uncontrolled
B1a	32020	1060	0	4972	0	25988	0	71.8	5.7	3%	Uncontrolled
B1b	81680	7142	0	14755	0	59783	0	72.7	5.6	9%	Controlled
B2a	32700	1161	0	7231	0	2168	22140	54.4	9.4	4%	Uncontrolled
B2b	95200	5250	0	23641	26634	39675	0	71.4	7.5	6%	Uncontrolled
B3a	86800	700	0	36191	0	33003	16906	61.6	8.0	1%	Uncontrolled
B3b	24200	3320	0	0	0	20880	0	77.3	4.6	14%	Controlled
B4	26700	500	3000	4000	3300	15900	0	70.2	6.6	2%	Uncontrolled
Sub-Total	379300	19133	3000	90790	29934	197397	39046			5%	

Time of Concentration

Catchment ID	Total Overland Flow Distance (m)	**Slope of Land (%)**	Sheet Flow Distance (m)	Sheet Flow Tc (min)	Shallow Concentrated Flow Distance (m)	Shallow Concentrated Flow Velocity (m/s)	Shallow Concentrated Tc (min)	Ditch Length (m)	Ditch Slope (%)	Ditch Velocity (m/s)	Ditch Tc (min)	Total Tc (min)
B1a	50	1.00	30	6	20	0.15	2	262.0	0.5	0.32	14	22
B1b	50	1.00	30	6	20	0.15	2	400.0	0.5	0.32	21	45
	-	-	-	-	-	-	-	240.0	0.3	0.25	16	
B2a	56	1.00	30	10	26	0.15	3					13
B2b	48	1.00	30	6	18	0.15	2	385.0	0.5	0.32	20	28
B3a	244	0.82	30	9	214	0.14	26					35
B3b	35	1.00	30	5	5	0.15	1	353.0	0.5	0.32	18	24
B4	130	0.77	30	8	100	0.13	12					20

Hydrologic Model Parameters

Catchment ID	Area (ha)	CN	Ia (mm)	tc (min)	tp (hr)	Outlet
B1a	3.2	71.8	5.7	22	0.246	Unrestricted to 4th Line
B1b	8.2	72.7	5.6	45	0.502	Restricted to 4th Line
B2a	3.3	54.4	9.4	13	0.142	Unrestricted to the Local Wetland
B2b	9.5	71.4	7.5	28	0.315	Restricted to the Local Wetland
B3a	8.7	61.6	8.0	35	0.389	Unrestricted to the Local Wetland
B3b	2.4	77.3	4.6	24	0.270	Restricted to the Local Wetland
B4	2.7	70.2	6.6	20	0.222	Unrestricted to Concession Road 10
Total	37.9					

3240 Drummond Concession 5A, R.R.7 Perth, Ontario K7H 3C9 Tel.: 613.267.6524 Fax: 613.267.7992
info@mcintoshperry.com www.mcintoshperry.com

CCO-22-0256 - FRANKTOWN SUBDIVISION - POST-DEVELOPMENT HYDROLOGICAL RESULTS

	12-hr SCS		24-hr SCS		4-hr Chicago		Max	
	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
B1a +B1b	0.316	0.806	0.346	0.851	0.227	0.642	0.346	0.851
B2a + B2b	0.370	1.016	0.413	1.093	0.247	0.766	0.413	1.093
B3a + B3b	0.277	0.742	0.308	0.794	0.192	0.578	0.308	0.794
B4	0.110	0.288	0.123	0.311	0.073	0.218	0.123	0.311

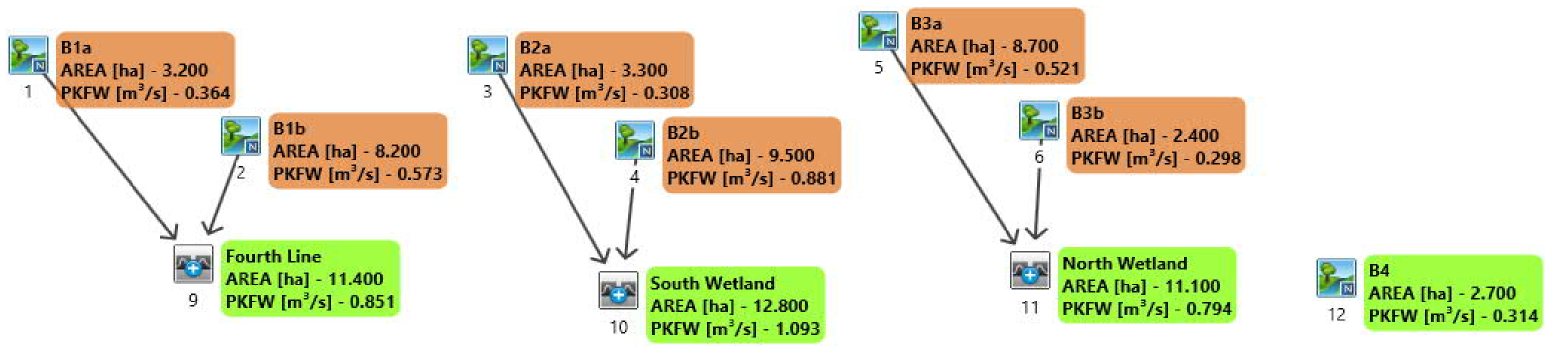
		Outlet
A1	B1a +B1b	4th Line
A2	B2a + B2b	Local Wetland
A3	B3a + B3b	Local Wetland
A4	B4	Concession Road 10

MCINTOSH PERRY

CCO-22-0256 - FRANKTOWN SUBDIVISION - PRE & POST HYDROLOGICAL RESULTS SUMMARY

Peak Flows (m^3/s)												
Design Storm (yr)	12 Hour				24 Hour				4 Hour			
	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ	% Change
Area A1 / B1a + B1b - 4th Line Road												
5	0.157	0.316	0.159	101%	0.178	0.346	0.168	94%	0.106	0.227	0.121	114%
100	0.470	0.806	0.336	71%	0.508	0.851	0.343	68%	0.354	0.642	0.288	81%
Area A2 / B2a + B2b - Local Wetland												
5	0.114	0.370	0.256	225%	0.128	0.413	0.285	223%	0.079	0.247	0.168	213%
100	0.339	1.016	0.677	200%	0.364	1.093	0.729	200%	0.260	0.766	0.506	195%
A3 / B3a + B3b- Local Wetland												
5	0.386	0.277	-0.109	-28%	0.444	0.308	-0.136	-31%	0.226	0.192	-0.034	-15%
100	1.119	0.742	-0.377	-34%	1.229	0.794	-0.435	-35%	0.793	0.578	-0.215	-27%
A4 / B4 - Concession Road 10												
5	0.101	0.110	0.009	9%	0.116	0.123	0.007	6%	0.063	0.073	0.010	16%
100	0.294	0.288	-0.006	-2%	0.321	0.311	-0.010	-3%	0.213	0.218	0.005	2%

VO3 Model Post-development Conditions (Uncontrolled)



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

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```

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***** D E T A I L E D   O U T P U T *****

```
  Input   filename: C:\Program Files (x86)\Visual OTTHYMO
  5.0\VO2\voin.dat
  Output  filename:
  C:\Users\r.rajachockalingam\AppData\Local\Civica\VH5\aff97419-8891-4c36-895b-5719548e9076\fc59
  4964-8644-4fd7-a2ca-e1e228
  Summary filename:
  C:\Users\r.rajachockalingam\AppData\Local\Civica\VH5\aff97419-8891-4c36-895b-5719548e9076\fc59
  4964-8644-4fd7-a2ca-e1e228

DATE: 03-16-2022                            TIME: 10:14:21

USER:


COMMENTS: ____________________________________________________________

-------------------------------------------------------------------------------------------------
-----------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\r.rajachockalingam\AppD
|                  |              ata\Local\Temp\
|                  |              f3a22907-a29a-48ed-83df-6f5e660e64e8\ce206e66
| Ptotal=106.74 mm |    Comments: 100yr 24hr 15min SCS
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	' TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	0.00	6.50	1.92	12.75	15.37	19.00	1.92
0.50	1.17	6.75	1.92	13.00	7.90	19.25	1.92
0.75	1.17	7.00	1.92	13.25	7.90	19.50	1.92
1.00	1.17	7.25	1.92	13.50	5.76	19.75	1.92
1.25	1.17	7.50	2.35	13.75	5.76	20.00	1.92
1.50	1.17	7.75	2.35	14.00	4.48	20.25	1.92
1.75	1.17	8.00	2.35	14.25	4.48	20.50	1.28
2.00	1.17	8.25	2.35	14.50	3.20	20.75	1.28
2.25	1.17	8.50	2.78	14.75	3.20	21.00	1.28
2.50	1.39	8.75	2.78	15.00	3.20	21.25	1.28
2.75	1.39	9.00	2.99	15.25	3.20	21.50	1.28
3.00	1.39	9.25	2.99	15.50	3.20	21.75	1.28
3.25	1.39	9.50	3.42	15.75	3.20	22.00	1.28
3.50	1.39	9.75	3.42	16.00	3.20	22.25	1.28
3.75	1.39	10.00	3.84	16.25	3.20	22.50	1.28
4.00	1.39	10.25	3.84	16.50	1.92	22.75	1.28
4.25	1.39	10.50	4.91	16.75	1.92	23.00	1.28
4.50	1.71	10.75	4.91	17.00	1.92	23.25	1.28
4.75	1.71	11.00	6.62	17.25	1.92	23.50	1.28
5.00	1.71	11.25	6.62	17.50	1.92	23.75	1.28
5.25	1.71	11.50	10.25	17.75	1.92	24.00	1.28
5.50	1.71	11.75	10.25	18.00	1.92	24.25	1.28
5.75	1.71	12.00	31.60	18.25	1.92		
6.00	1.71	12.25	130.65	18.50	1.92		
6.25	1.71	12.50	15.37	18.75	1.92		


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

--------------------
| CALIB            |
| NASHYD   (  0012)|   Area    (ha)=   2.70   Curve Number   (CN)= 70.2
|ID= 1 DT= 5.0 min |   Ia      (mm)=   6.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.22

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	' TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	6.167	1.71	12.250	130.65	18.33	1.92
0.167	0.00	6.250	1.71	12.333	15.39	18.42	1.92
0.250	0.00	6.333	1.92	12.417	15.37	18.50	1.92
0.333	1.17	6.417	1.92	12.500	15.37	18.58	1.92
0.417	1.17	6.500	1.92	12.583	15.37	18.67	1.92
0.500	1.17	6.583	1.92	12.667	15.37	18.75	1.92
0.583	1.17	6.667	1.92	12.750	15.37	18.83	1.92
0.667	1.17	6.750	1.92	12.833	7.90	18.92	1.92
0.750	1.17	6.833	1.92	12.917	7.90	19.00	1.92
0.833	1.17	6.917	1.92	13.000	7.90	19.08	1.92
0.917	1.17	7.000	1.92	13.083	7.90	19.17	1.92
1.000	1.17	7.083	1.92	13.167	7.90	19.25	1.92
1.083	1.17	7.167	1.92	13.250	7.90	19.33	1.92
1.167	1.17	7.250	1.92	13.333	5.76	19.42	1.92
1.250	1.17	7.333	2.35	13.417	5.76	19.50	1.92
1.333	1.17	7.417	2.35	13.500	5.76	19.58	1.92
1.417	1.17	7.500	2.35	13.583	5.76	19.67	1.92
1.500	1.17	7.583	2.35	13.667	5.76	19.75	1.92
1.583	1.17	7.667	2.35	13.750	5.76	19.83	1.92
1.667	1.17	7.750	2.35	13.833	4.48	19.92	1.92
1.750	1.17	7.833	2.35	13.917	4.48	20.00	1.92
1.833	1.17	7.917	2.35	14.000	4.48	20.08	1.92
1.917	1.17	8.000	2.35	14.083	4.48	20.17	1.92

```
            2.000    1.17 | 8.083    2.35 |14.167    4.48 | 20.25    1.92
            2.083    1.17 | 8.167    2.35 |14.250    4.48 | 20.33    1.28
            2.167    1.17 | 8.250    2.35 |14.333    3.20 | 20.42    1.28
            2.250    1.17 | 8.333    2.78 |14.417    3.20 | 20.50    1.28
            2.333    1.39 | 8.417    2.78 |14.500    3.20 | 20.58    1.28
            2.417    1.39 | 8.500    2.78 |14.583    3.20 | 20.67    1.28
            2.500    1.39 | 8.583    2.78 |14.667    3.20 | 20.75    1.28
            2.583    1.39 | 8.667    2.78 |14.750    3.20 | 20.83    1.28
            2.667    1.39 | 8.750    2.78 |14.833    3.20 | 20.92    1.28
            2.750    1.39 | 8.833    2.99 |14.917    3.20 | 21.00    1.28
            2.833    1.39 | 8.917    2.99 |15.000    3.20 | 21.08    1.28
            2.917    1.39 | 9.000    2.99 |15.083    3.20 | 21.17    1.28
            3.000    1.39 | 9.083    2.99 |15.167    3.20 | 21.25    1.28
            3.083    1.39 | 9.167    2.99 |15.250    3.20 | 21.33    1.28
            3.167    1.39 | 9.250    2.99 |15.333    3.20 | 21.42    1.28
            3.250    1.39 | 9.333    3.42 |15.417    3.20 | 21.50    1.28
            3.333    1.39 | 9.417    3.42 |15.500    3.20 | 21.58    1.28
            3.417    1.39 | 9.500    3.42 |15.583    3.20 | 21.67    1.28
            3.500    1.39 | 9.583    3.42 |15.667    3.20 | 21.75    1.28
            3.583    1.39 | 9.667    3.42 |15.750    3.20 | 21.83    1.28
            3.667    1.39 | 9.750    3.42 |15.833    3.20 | 21.92    1.28
            3.750    1.39 | 9.833    3.84 |15.917    3.20 | 22.00    1.28
            3.833    1.39 | 9.917    3.84 |16.000    3.20 | 22.08    1.28
            3.917    1.39 |10.000    3.84 |16.083    3.20 | 22.17    1.28
            4.000    1.39 |10.083    3.84 |16.167    3.20 | 22.25    1.28
            4.083    1.39 |10.167    3.84 |16.250    3.20 | 22.33    1.28
            4.167    1.39 |10.250    3.84 |16.333    1.92 | 22.42    1.28
            4.250    1.39 |10.333    4.91 |16.417    1.92 | 22.50    1.28
            4.333    1.71 |10.417    4.91 |16.500    1.92 | 22.58    1.28
            4.417    1.71 |10.500    4.91 |16.583    1.92 | 22.67    1.28
            4.500    1.71 |10.583    4.91 |16.667    1.92 | 22.75    1.28
            4.583    1.71 |10.667    4.91 |16.750    1.92 | 22.83    1.28
            4.667    1.71 |10.750    4.91 |16.833    1.92 | 22.92    1.28
            4.750    1.71 |10.833    6.62 |16.917    1.92 | 23.00    1.28
            4.833    1.71 |10.917    6.62 |17.000    1.92 | 23.08    1.28
            4.917    1.71 |11.000    6.62 |17.083    1.92 | 23.17    1.28
            5.000    1.71 |11.083    6.62 |17.167    1.92 | 23.25    1.28
            5.083    1.71 |11.167    6.62 |17.250    1.92 | 23.33    1.28
            5.167    1.71 |11.250    6.62 |17.333    1.92 | 23.42    1.28
            5.250    1.71 |11.333   10.25 |17.417    1.92 | 23.50    1.28
            5.333    1.71 |11.417   10.25 |17.500    1.92 | 23.58    1.28
            5.417    1.71 |11.500   10.25 |17.583    1.92 | 23.67    1.28
            5.500    1.71 |11.583   10.25 |17.667    1.92 | 23.75    1.28
            5.583    1.71 |11.667   10.25 |17.750    1.92 | 23.83    1.28
            5.667    1.71 |11.750   10.25 |17.833    1.92 | 23.92    1.28
            5.750    1.71 |11.833   31.59 |17.917    1.92 | 24.00    1.28
            5.833    1.71 |11.917   31.60 |18.000    1.92 | 24.08    1.28
            5.917    1.71 |12.000   31.60 |18.083    1.92 | 24.17    1.28
            6.000    1.71 |12.083  130.64 |18.167    1.92 | 24.25    1.28
            6.083    1.71 |12.167  130.65 |18.250    1.92 |

     Unit Hyd Qpeak  (cms)=   0.465

     PEAK FLOW       (cms)=   0.314 (i)
     TIME TO PEAK    (hrs)=  12.333
     RUNOFF VOLUME    (mm)=  48.159
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.451
```



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

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   3.20   Curve Number   (CN)= 71.8
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.70   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.497

     PEAK FLOW       (cms)=   0.364 (i)
     TIME TO PEAK    (hrs)=  12.333
     RUNOFF VOLUME    (mm)=  50.799
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.476

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

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0002)|   Area    (ha)=   8.20   Curve Number   (CN)= 72.7
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.50

     Unit Hyd Qpeak  (cms)=   0.624

     PEAK FLOW       (cms)=   0.573 (i)
     TIME TO PEAK    (hrs)=  12.667
     RUNOFF VOLUME    (mm)=  52.049
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.488

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

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

--------------------
| ADD HYD  (  0009)|
|  1 +  2 =  3     |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     3.20   0.364    12.33    50.80
      + ID2= 2 (  0002):     8.20   0.573    12.67    52.05
        ===================================================
        ID = 3 (  0009):    11.40   0.851    12.50    51.70

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0003)|   Area    (ha)=   3.30   Curve Number   (CN)= 54.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.40   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.14

     Unit Hyd Qpeak  (cms)=   0.888

     PEAK FLOW       (cms)=   0.308 (i)
```

```
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  30.323
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.284

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0004)|   Area    (ha)=   9.50   Curve Number   (CN)= 71.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.31

     Unit Hyd Qpeak  (cms)=   1.152

     PEAK FLOW       (cms)=   0.881 (i)
     TIME TO PEAK    (hrs)=  12.417
     RUNOFF VOLUME    (mm)=  48.987
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.459

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

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

--------------------
| ADD HYD  (  0010)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0003):     3.30   0.308    12.25    30.32
      + ID2= 2 (  0004):     9.50   0.881    12.42    48.99
        ====================================================
        ID = 3 (  0010):    12.80   1.093    12.33    44.17

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0005)|   Area    (ha)=   8.70   Curve Number   (CN)= 61.6
|ID= 1 DT= 5.0 min |   Ia      (mm)=   8.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.39

     Unit Hyd Qpeak  (cms)=   0.854

     PEAK FLOW       (cms)=   0.521 (i)
     TIME TO PEAK    (hrs)=  12.500
     RUNOFF VOLUME    (mm)=  37.919
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.355

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0006)|   Area    (ha)=   2.40   Curve Number   (CN)= 77.3
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.60   # of Linear Res.(N)= 3.00
```



```
--------------------   U.H. Tp(hrs)=   0.27

     Unit Hyd Qpeak  (cms)=   0.340

     PEAK FLOW       (cms)=   0.298 (i)
     TIME TO PEAK    (hrs)=  12.417
     RUNOFF VOLUME    (mm)=  58.996
     TOTAL RAINFALL   (mm)= 106.740
     RUNOFF COEFFICIENT   =   0.553

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

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

--------------------
| ADD HYD  (  0011)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0005):     8.70   0.521    12.50    37.92
      + ID2= 2 (  0006):     2.40   0.298    12.42    59.00
        ====================================================
        ID = 3 (  0011):    11.10   0.794    12.42    42.48

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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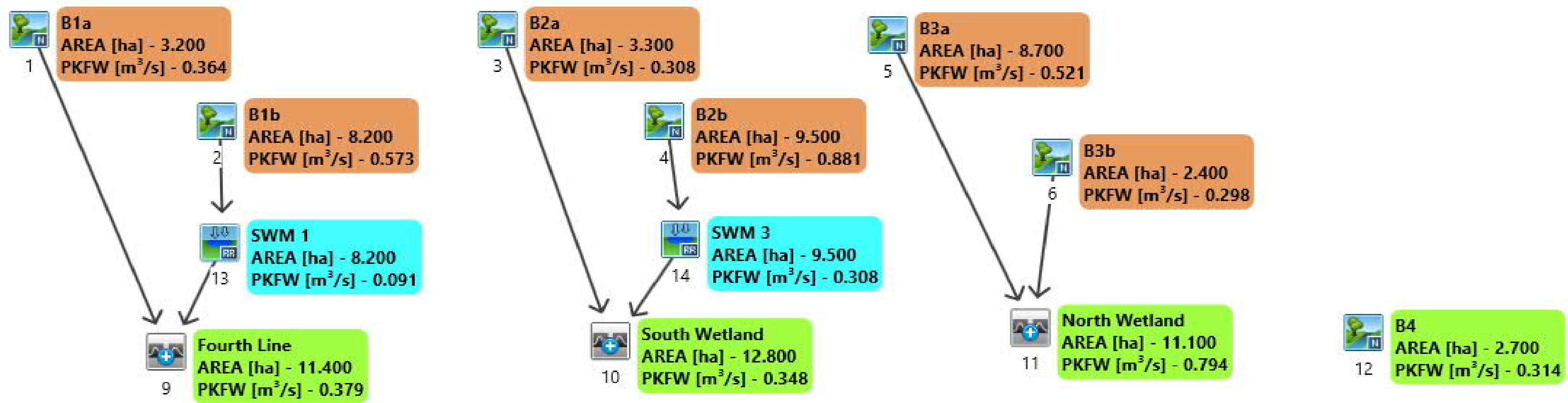
CCO-22-0256 - FRANKTOWN SUBDIVISION - PRE & POST HYDROLOGICAL RESULTS SUMMARY - CONTROLLED

Peak Flows (m^3/s)												
Design Storm (yr)	12 Hour				24 Hour				4 Hour			
	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ	% Change	Pre.	Post.	Δ	% Change
Area A1 / B1a + B1b - 4th Line Road												
5	0.157	0.143	-0.014	-9%	0.178	0.158	-0.020	-11%	0.106	0.098	-0.008	-8%
100	0.470	0.354	-0.116	-25%	0.508	0.379	-0.129	-25%	0.354	0.279	-0.075	-21%
Area A2 / B2a + B2b - Local Wetland												
5	0.114	0.101	-0.013	-11%	0.128	0.117	-0.011	-9%	0.079	0.058	-0.021	-27%
100	0.339	0.324	-0.015	-4%	0.364	0.348	-0.016	-4%	0.260	0.217	-0.043	-17%
A3 / B3a + B3b- Local Wetland												
5	0.386	0.277	-0.109	-28%	0.444	0.308	-0.136	-31%	0.226	0.192	-0.034	-15%
100	1.119	0.742	-0.377	-34%	1.229	0.794	-0.435	-35%	0.793	0.578	-0.215	-27%
A4 / B4 - Concession Road 10												
5	0.101	0.110	0.009	9%	0.116	0.123	0.007	6%	0.063	0.073	0.010	16%
100	0.294	0.288	-0.006	-2%	0.321	0.311	-0.010	-3%	0.213	0.218	0.005	2%

VO3 Model Post-development Conditions (Controlled)



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

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
```



```
                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO
  5.0\VO2\voin.dat
  Output  filename:
  C:\Users\r.rajachockalingam\AppData\Local\Civica\VH5\aff97419-8891-4c36-895b-5719548e9076\f021
  7438-5f47-4f07-b5bf-f62ee9
  Summary filename:
  C:\Users\r.rajachockalingam\AppData\Local\Civica\VH5\aff97419-8891-4c36-895b-5719548e9076\f021
  7438-5f47-4f07-b5bf-f62ee9


DATE: 03-16-2022                             TIME: 10:18:49

USER:



COMMENTS: ____________________________________________________________


----------------------------------------------------------------------------------------------
-----------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1735.688
| Ptotal= 76.00 mm |                          B=   6.014
--------------------                          C=   0.820
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.33

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    4.39 |  1.17   40.65 |  2.17   11.06 |  3.17    5.28
```



```
                 0.33    5.07 |  1.33  178.56 |  2.33    9.29 |  3.33    4.88
                 0.50    6.05 |  1.50   54.05 |  2.50    8.02 |  3.50    4.54
                 0.67    7.54 |  1.67   27.32 |  2.67    7.08 |  3.67    4.25
                 0.83   10.16 |  1.83   18.24 |  2.83    6.35 |  3.83    3.99
                 1.00   15.97 |  2.00   13.74 |  3.00    5.76 |  4.00    3.77


----------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0012)|   Area    (ha)=   2.70   Curve Number   (CN)= 70.2
|ID= 1 DT= 5.0 min |   Ia      (mm)=   6.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.22

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    4.39 | 1.083   40.65 | 2.083   11.06 |  3.08    5.28
                0.167    4.39 | 1.167   40.65 | 2.167   11.06 |  3.17    5.28
                0.250    5.07 | 1.250  178.56 | 2.250    9.29 |  3.25    4.88
                0.333    5.07 | 1.333  178.56 | 2.333    9.29 |  3.33    4.88
                0.417    6.05 | 1.417   54.05 | 2.417    8.02 |  3.42    4.54
                0.500    6.05 | 1.500   54.05 | 2.500    8.02 |  3.50    4.54
                0.583    7.54 | 1.583   27.32 | 2.583    7.08 |  3.58    4.25
                0.667    7.54 | 1.667   27.32 | 2.667    7.08 |  3.67    4.25
                0.750   10.16 | 1.750   18.24 | 2.750    6.35 |  3.75    3.99
                0.833   10.16 | 1.833   18.24 | 2.833    6.35 |  3.83    3.99
                0.917   15.97 | 1.917   13.74 | 2.917    5.76 |  3.92    3.77
                1.000   15.97 | 2.000   13.74 | 3.000    5.76 |  4.00    3.77

     Unit Hyd Qpeak  (cms)=   0.465

     PEAK FLOW       (cms)=   0.221 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  27.142
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.357

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

----------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   3.20   Curve Number   (CN)= 71.8
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.70   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.497

     PEAK FLOW       (cms)=   0.268 (i)
     TIME TO PEAK    (hrs)=   1.583
     RUNOFF VOLUME    (mm)=  29.035
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.382

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

```
-----------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0002)|   Area    (ha)=   8.20   Curve Number   (CN)= 72.7
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.50

     Unit Hyd Qpeak  (cms)=   0.624

     PEAK FLOW       (cms)=   0.444 (i)
     TIME TO PEAK    (hrs)=   1.917
     RUNOFF VOLUME    (mm)=  29.894
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.393

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

-----------------------------------------------------------------------------
--------------------
| RESERVOIR(  0013)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |  0.0800      0.1713
                          0.0100     0.0117   |  0.0960      0.2530
                          0.0150     0.0504   |  0.1090      0.3491
                          0.0600     0.1037   |  0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0002)      8.200      0.444      1.92      29.89
   OUTFLOW: ID= 1 (  0013)      8.200      0.080      3.92      29.86

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 18.04
                   TIME SHIFT OF PEAK FLOW         (min)=120.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1715

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

--------------------
| ADD HYD  (  0009)|
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     3.20   0.268     1.58    29.04
      + ID2= 2 (  0013):     8.20   0.080     3.92    29.86
        ==================================================
        ID = 3 (  0009):    11.40   0.279     1.58    29.63

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-----------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0003)|   Area    (ha)=   3.30   Curve Number   (CN)= 54.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.40   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.14

     Unit Hyd Qpeak  (cms)=   0.888
```



```
     PEAK FLOW       (cms)=   0.185 (i)
     TIME TO PEAK    (hrs)=   1.417
     RUNOFF VOLUME    (mm)=  15.756
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.207

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

-----------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0004)|   Area    (ha)=   9.50   Curve Number   (CN)= 71.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.31

     Unit Hyd Qpeak  (cms)=   1.152

     PEAK FLOW       (cms)=   0.639 (i)
     TIME TO PEAK    (hrs)=   1.667
     RUNOFF VOLUME    (mm)=  27.553
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.363

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

-----------------------------------------------------------------------------
--------------------
| RESERVOIR(  0014)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |  0.0210      0.1242
                          0.0100     0.0117   |  0.2840      0.1805
                          0.0150     0.0398   |  0.3950      0.2461
                          0.0180     0.0773   |  0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      9.500      0.639      1.67      27.55
   OUTFLOW: ID= 1 (  0014)      9.500      0.188      2.58      27.52

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 29.43
                   TIME SHIFT OF PEAK FLOW         (min)= 55.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1600

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

--------------------
| ADD HYD  (  0010)|
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0014):     9.50   0.188     2.58    27.52
      + ID2= 2 (  0003):     3.30   0.185     1.42    15.76
        ==================================================
        ID = 3 (  0010):    12.80   0.217     2.50    24.49

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

```
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0005)|   Area    (ha)=   8.70   Curve Number   (CN)= 61.6
|ID= 1 DT= 5.0 min |   Ia      (mm)=   8.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.39

     Unit Hyd Qpeak  (cms)=   0.854

     PEAK FLOW       (cms)=   0.366 (i)
     TIME TO PEAK    (hrs)=   1.750
     RUNOFF VOLUME    (mm)=  20.426
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.269

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

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0006)|   Area    (ha)=   2.40   Curve Number   (CN)= 77.3
|ID= 1 DT= 5.0 min |   Ia      (mm)=   4.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.27

     Unit Hyd Qpeak  (cms)=   0.340

     PEAK FLOW       (cms)=   0.235 (i)
     TIME TO PEAK    (hrs)=   1.583
     RUNOFF VOLUME    (mm)=  34.898
     TOTAL RAINFALL   (mm)=  75.999
     RUNOFF COEFFICIENT   =   0.459

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

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

--------------------
| ADD HYD  (  0011)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0005):     8.70   0.366     1.75    20.43
      + ID2= 2 (  0006):     2.40   0.235     1.58    34.90
        ====================================================
        ID = 3 (  0011):    11.10   0.578     1.67    23.56

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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CONCEPTUAL STORMWATER MANAGEMENT REPORT
FRANKTOWN SUBDIVISION

APPENDIX E-WATER BALANCE ANALYSIS

CCO-22-0256 - FRANKTOWN SUBDIVISION - Water Balance Information - Monthly Review

The site exhibits five primary types of pervious land use / soil combinations:

	Values from Thornthwaite-Mather Table 10				Table 10 Values Applied to Site Conditions		
Pre-development / Post-development	Soil Type	Available Water (mm)	Root Zone (m)	Applicable Soil Moisture Rentention Table	Available Average Soil Depth (m)	Soil Moisture Retention Table Given Soil Depth (mm)	Values to use (mm)
Meadow overtopping sandy soils (class B soils)	Sandy Loam	150	1	150	0.75	113	100
Meadow overtopping sandy soils (class D soils)	Clay	250	1	250	0.75	188	150
Forest overtopping sandy soils (class B soils)	Sandy Loam	150	2	300	0.75	225	200
Forest overtopping sandy soils (class D soils)	Clay	250	1.6	400	0.75	300	250

Summary of data below:

Soil Moisture Storage	Surplus
75	398
100	391
125	387
150	384
200	380
250	377
350	373
400	371

Soil Moisture Storage Data - From Ottawa Station Climate Normals

75mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		217	0	0	0	0	11	0	11	228
February	-8.1	0	0	54	54		271	0	0	0	0	5	0	5	276
March	-2.3	0	0	64	64		336	0	0	0	0	2	0	2	338
April	6.3	1.4	32	75	43		75	0	32	0	43	22	26	48	166
May	13.3	4.4	79	80	2		75	0	79	0	2	12	117	129	206
June	18.5	7.2	112	93	-19	-19	57	-18	111	1	0	6	59	65	122
July	21	8.8	133	92	-41	-60	33	-24	116	17	0	3	29	32	65
August	19.8	8.0	114	86	-29	-88	22	-11	97	18	0	2	15	17	39
September	15	5.3	73	90	17		39	17	73	0	0	1	7	8	47
October	8	2.0	34	86	52		75	36	34	0	17	9	4	13	105
November	1.5	0.2	5	82	77		75	0	5	0	77	43	2	45	197
December	-6.2	0	0	76	76		151	0	0	0	0	22	1	23	174
		37.4	580	944				0	545	35	138	138	260	398	

Monthly T and P from Environment Canada

Table 25 - 75mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

100mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		241	0	0	0	0	11	0	11	252
February	-8.1	0	0	54	54		296	0	0	0	0	5	0	5	301
March	-2.3	0	0	64	64		360	0	0	0	0	2	0	2	362
April	6.3	1.4	32	75	43		100	0	32	0	43	22	26	48	191
May	13.3	4.4	79	80	2		100	0	79	0	2	12	117	129	231
June	18.5	7.2	112	93	-19	-19	82	-18	111	1	0	6	59	65	147
July	21	8.8	133	92	-41	-60	54	-28	120	13	0	3	29	32	86
August	19.8	8.0	114	86	-29	-88	40	-14	100	15	0	2	15	17	57
September	15	5.3	73	90	17		57	17	73	0	0	1	7	8	65
October	8	2.0	34	86	52		100	43	34	0	10	5	4	9	119
November	1.5	0.2	5	82	77		100	0	5	0	77	41	2	43	220
December	-6.2	0	0	76	76		176	0	0	0	0	21	1	22	198
		37.4	580	944				0	552	28	131	131	260	391	

Monthly T and P from Environment Canada   Table 26 - 100mm soil moisture retention in Thornthwaite [1957]
Heat Index (I)
a: 37.4

125mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		267	0	0	0	0	10	0	10	277
February	-8.1	0	0	54	54		321	0	0	0	0	5	0	5	326
March	-2.3	0	0	64	64		386	0	0	0	0	2	0	2	388
April	6.3	1.4	32	75	43		125	0	32	0	43	23	26	49	217
May	13.3	4.4	79	80	2		125	0	79	0	2	12	117	129	256
June	18.5	7.2	112	93	-19	-19	106	-19	112	0	0	6	59	65	171
July	21	8.8	133	92	-41	-60	76	-30	122	11	0	3	29	32	108
August	19.8	8.0	114	86	-29	-88	61	-15	101	14	0	2	15	17	78
September	15	5.3	73	90	17		78	17	73	0	0	1	7	8	86
October	8	2.0	34	86	52		125	47	34	0	6	3	4	7	138
November	1.5	0.2	5	82	77		125	0	5	0	77	40	2	42	244
December	-6.2	0	0	76	76		201	0	0	0	0	20	1	21	222
		37.4	580	944				0	556	24	127	127	260	387	

Monthly T from Environment Canada   Table 27 - 100mm soil moisture retention in Thornthwaite [1957]
Heat Index (I) 37.4
a: 1.06

150mm														
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		292	0	0	0	0	10	0	10	302
February	-8.1	0	0	54	54		346	0	0	0	0	5	0	5	351
March	-2.3	0	0	64	64		411	0	0	0	0	2	0	2	413
April	6.3	1.4	32	75	43		150	0	32	0	43	23	26	49	242
May	13.3	4.4	79	80	2		150	0	79	0	2	12	117	129	281
June	18.5	7.2	112	93	-19	-19	132	-18	111	1	0	6	59	65	197
July	21	8.8	133	92	-41	-60	100	-32	124	9	0	3	29	32	132
August	19.8	8.0	114	86	-29	-88	83	-17	103	12	0	2	15	17	100
September	15	5.3	73	90	17		100	17	73	0	0	1	7	8	108
October	8	2.0	34	86	52		150	50	34	0	3	2	4	6	159
November	1.5	0.2	5	82	77		150	0	5	0	77	39	2	41	268
December	-6.2	0	0	76	76		226	0	0	0	0	19	1	20	246
		37.4	580	944				0	559	21	124	124	260	384	

Monthly T from Environment Canada

Table 28 - 150mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

200mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		341	0	0	0	0	10	0	10	351
February	-8.1	0	0	54	54		396	0	0	0	0	5	0	5	401
March	-2.3	0	0	64	64		460	0	0	0	0	2	0	2	462
April	6.3	1.4	32	75	43		200	0	32	0	43	22	26	48	291
May	13.3	4.4	79	80	2		200	0	79	0	2	12	117	129	331
June	18.5	7.2	112	93	-19	-19	182	-18	111	1	0	6	59	65	247
July	21	8.8	133	92	-41	-60	148	-34	126	7	0	3	29	32	180
August	19.8	8.0	114	86	-29	-88	128	-20	106	9	0	2	15	17	145
September	15	5.3	73	90	17		145	17	73	0	0	1	7	8	153
October	8	2.0	34	86	52		198	52	34	0	0	0	4	4	202
November	1.5	0.2	5	82	77		200	2	5	0	75	38	2	40	315
December	-6.2	0	0	76	76		276	0	0	0	0	19	1	20	296
		37.4	580	944				0	564	16	120	120	260	380	

Monthly T from Environment Canada

Table 29 - 200mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

250mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		392	0	0	0	0	9	0	9	401
February	-8.1	0	0	54	54		446	0	0	0	0	5	0	5	451
March	-2.3	0	0	64	64		511	0	0	0	0	2	0	2	513
April	6.3	1.4	32	75	43		250	0	32	0	43	23	26	49	342
May	13.3	4.4	79	80	2		250	0	79	0	2	12	117	129	381
June	18.5	7.2	112	93	-19	-19	231	-19	112	0	0	6	59	65	296
July	21	8.8	133	92	-41	-60	196	-35	127	6	0	3	29	32	228
August	19.8	8.0	114	86	-29	-88	175	-21	107	8	0	2	15	17	192
September	15	5.3	73	90	17		192	17	73	0	0	1	7	8	200
October	8	2.0	34	86	52		245	52	34	0	0	0	4	4	249
November	1.5	0.2	5	82	77		250	5	5	0	72	36	2	38	360
December	-6.2	0	0	76	76		326	0	0	0	0	18	1	19	345
		37.4	580	944				0	567	13	117	117	260	377	

Monthly T from Environment Canada

Table 30 - 250mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

350mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		492	0	0	0	0	9	0	9	501
February	-8.1	0	0	54	54		546	0	0	0	0	4	0	4	550
March	-2.3	0	0	64	64		611	0	0	0	0	2	0	2	613
April	6.3	1.4	32	75	43		350	0	32	0	43	23	26	49	442
May	13.3	4.4	79	80	2		350	0	79	0	2	12	117	129	481
June	18.5	7.2	112	93	-19	-19	331	-19	112	0	0	6	59	65	396
July	21	8.8	133	92	-41	-60	294	-37	129	4	0	3	29	32	326
August	19.8	8.0	114	86	-29	-88	271	-23	109	6	0	2	15	17	288
September	15	5.3	73	90	17		288	17	73	0	0	1	7	8	296
October	8	2.0	34	86	52		341	52	34	0	0	0	4	4	345
November	1.5	0.2	5	82	77		350	9	5	0	68	34	2	36	454
December	-6.2	0	0	76	76		426	0	0	0	0	17	1	18	444
		37.4	580	944				0	571	9	113	113	260	373	

Monthly T from Environment Canada

Table 32 - 350mm soil moisture retention in Thornthwaite [1957]

Heat Index (I) 37.4

a: 1.06

400mm															
Month	Temperature	Heat Index	PET	P = Total Precipitation	ΔP = P-PET	Acc Pot WL	ST= Storage	ΔS = Soil Moisture Storage	AET	Soil Moisture Deficit (D)	Soil Moisture Surplus (S)	Water Runoff RO	Snow Melt Runoff	Total Runoff	Total Moisture Detention
January	-10.3	0	0	65	65		542	0	0	0	0	8	0	8	550
February	-8.1	0	0	54	54		596	0	0	0	0	4	0	4	600
March	-2.3	0	0	64	64		661	0	0	0	0	2	0	2	663
April	6.3	1.4	32	75	43		400	0	32	0	43	23	26	49	492
May	13.3	4.4	79	80	2		400	0	79	0	2	12	117	129	531
June	18.5	7.2	112	93	-19	-19	381	-19	112	0	0	6	59	65	446
July	21	8.8	133	92	-41	-60	344	-37	129	4	0	3	29	32	376
August	19.8	8.0	114	86	-29	-88	320	-24	110	5	0	2	15	17	337
September	15	5.3	73	90	17		337	17	73	0	0	1	7	8	345
October	8	2.0	34	86	52		390	52	34	0	0	0	4	4	394
November	1.5	0.2	5	82	77		400	10	5	0	66	33	2	35	501
December	-6.2	0	0	76	76		476	0	0	0	0	17	1	18	494
		37.4	580	944				0	572	8	111	111	260	371	

Monthly T from Environment Canada

Table 33 - 450mm soil moisture retention in Thornthwaite [1957]

Heat Index (I)	37.4
a:	1.06

Water Budget - Pre - Development
Water Balance / Water Budget Assessment

	Development Lands to Southcentral Swamp (A2)							Development Lands to North Swamp (A3)						
	Forest		Meadow					Forest		Meadow				
	D	B	D	B				D	B	D	B			
	Clay (250)	Sandy Loam (200)	Clay (150)	Sandy Loam (100)	Gravel	Asphalt	Total	Silt/Clay Loam (250)	Sandy Loam (200)	Silt/Clay Loam (150)	Sandy Loam (100)	Gravel	Asphalt	Total
Area (m^2)	42251	38609	22140	0	-	-	103000	55226	36191	16906	12877	-	-	121200
Pervious Area (m^2)	42251	38609	22140	0	-	-	103000	55226	36191	16906	12877	-	-	121200
Impervious Area (m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Infiltration Factors														
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	-	-		0.172	0.172	0.172	0.172	-	-	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	-	-		0.15	0.2	0.15	0.2	-	-	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	-	-		0.2	0.2	0.1	0.1	-	-	
MOE infiltration Factor	0.522	0.572	0.422	0.472	-	-		0.522	0.572	0.422	0.472	-	-	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	-	-		0.522	0.572	0.422	0.472	-	-	
Run-off Coefficient	0.478	0.428	0.578	0.528	-	-		0.478	0.428	0.578	0.528	-	-	
Runoff from Impervious Surfaces*	0	0	0	0	-	-		0	0	0	0	-	-	
Inputs (per Unit Area)														
Precipitation (mm/year)	944	944	944	944	-	-	944	944	944	944	944	-	-	944
Run-on (mm/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Other Inputs (mm/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Inputs (mm/year)	944	944	944	944	-	-	944	944	944	944	944	-	-	944
Outputs (per Unit Area)														
Precipitation Surplus (mm/year)	377	380	384	391	-	-	380	377	380	384	391	-	-	380
Net Surplus (mm/year)	377	380	384	391	-	-	380	377	380	384	391	-	-	380
Evapotranspiration (mm/year)	567	564	560	553	-	-	564	567	564	560	553	-	-	564
Infiltration (mm/year)	197	217	162	185	-	-	197	197	217	162	185	-	-	197
Rooftop Infiltration (mm/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Infiltration (mm/year)	197	217	162	185	-	-	197	197	217	162	185	-	-	197
Runoff Pervious Areas	180	163	222	206	-	-	771	180	163	222	206	-	-	771
Runoff Impervious Areas	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Runoff (mm/year)	180	163	222	206	-	-	183	180	163	222	206	-	-	184
Total Outputs (mm/year)	944	944	944	944	-	-	944	944	944	944	944	-	-	944
Difference (Inputs - Outputs)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Inputs (Volume)														
Precipitation (m^3/year)	39885	36447	20900	0	-	-	97232	52133	34164	15959	12156	-	-	114413
Run-on (m^3/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Other Inputs m^3/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Inputs (m^3/year)	39885	36447	20900	0	-	-	97232	52133	34164	15959	12156	-	-	114413
Outputs (Volume)														
Precipitation Surplus (m^3/year)	15929	14671	8502	0	-	-	39102	20820	13753	6492	5035	-	-	46100
Net Surplus (m^3/year)	15929	14671	8502	0	-	-	39102	20820	13753	6492	5035	-	-	46100
Evapotranspiration (m^3/year)	23956	21775	12398	0	-	-	58130	31313	20412	9467	7121	-	-	68313
Infiltration (m^3/year)	8315	8392	3588	0	-	-	20295	10868	7866	2740	2376	-	-	23851
Rooftop infiltration (m^3/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Infiltration (m^3/year)	8315	8392	3588	0	-	-	20295	10868	7866	2740	2376	-	-	23851
Runoff Pervious Areas (m^3/year)	7614	6279	4914	0	-	-	18807	9952	5886	3752	2658	-	-	22249
Runoff Impervious Areas (m^3/year)	0	0	0	0	-	-	0	0	0	0	0	-	-	0
Total Runoff (m^3/year)	7614	6279	4914	0	-	-	18807	9952	5886	3752	2658	-	-	22249
Total Outputs (m^3/year)	39885	36447	20900	0	-	-	97232	52133	34164	15959	12156	-	-	114413
Difference (Inputs - Outputs)	0	0	0	0	-	-	0	0	0	0	0	-	-	0

Water Budget - Post - Development
Water Balance / Water Budget Assessment

Development Lands to Southcentral Swamp (B2a+B2b)

	Forest		Pasture					
	D	B	D	B				
	Clay (250)	Sandy Loam (200)	Clay (150)	Sandy Loam (100)	Sand (75)	Gravel	Asphalt	Total
Area (m^2)	26634	30872	22140	41843	0	0	6411	127900
Pervious Area (m^2)	26634	30872	22140	41843	0	-	-	121489
Impervious Area (m^2)	-	-	-	-	-	0	6411	6411
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	384	384	391	391	398	398	850	411
Net Surplus (mm/year)	384	384	391	391	398	398	850	411
Evapotranspiration (mm/year)	560	560	553	553	546	546	94	533
Infiltration (mm/year)	200	220	165	185	227	88	85	188
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	200	220	165	185	227	88	85	188
Runoff Pervious Areas	184	164	226	206	171	0	0	951
Runoff Impervious Areas	0	0	0	0	0	310	765	1075
Total Runoff (mm/year)	184	164	226	206	171	310	765	223
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Outputs (Volume)								
Precipitation Surplus (m^3/year)	10227	11855	8657	16361	0	0	5447	52546
Net Surplus (m^3/year)	10227	11855	8657	16361	0	0	5447	52546
Evapotranspiration (m^3/year)	14915	17288	12243	23139	0	0	605	68191
Infiltration (m^3/year)	5339	6781	3653	7722	0	0	545	24040
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	5339	6781	3653	7722	0	0	545	24040
Runoff Pervious Areas (m^3/year)	4889	5074	5004	8638	0	0	0	23605
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	4902	4902
Total Runoff (m^3/year)	4889	5074	5004	8638	0	0	4902	28507
Total Outputs (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

Development Lands to North Swamp (B3a+b3b)

	Forest		Pasture					
	D	B	D	B				
	Clay (250)	Sandy Loam (200)	Clay (150)	Sandy Loam (100)	Sand (75)	Gravel	Asphalt	Total
Area (m^2)	0	36191	0	70789	0	0	4020	111000
Pervious Area (m^2)	0	36191	0	70789	0	-	-	106980
Impervious Area (m^2)	-	-	-	-	-	0	4020	4020
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.3	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.52	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.48	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	384	384	391	391	398	398	850	405
Net Surplus (mm/year)	384	384	391	391	398	398	850	405
Evapotranspiration (mm/year)	560	560	553	553	546	546	94	539
Infiltration (mm/year)	200	220	165	185	207	88	85	192
Rooftop and Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	200	220	165	185	207	88	85	192
Runoff Pervious Areas	184	164	226	206	191	0	0	971
Runoff Impervious Areas	0	0	0	0	0	310	765	1075
Total Runoff (mm/year)	184	164	226	206	191	310	765	213
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	34164	0	66825	0	0	3795	104784
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	34164	0	66825	0	0	3795	104784
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	13897	0	27678	0	0	3415	44991
Net Surplus (m^3/year)	0	13897	0	27678	0	0	3415	44991
Evapotranspiration (m^3/year)	0	20267	0	39146	0	0	379	59793
Infiltration (m^3/year)	0	7949	0	13064	0	0	342	21355
Rooftop and Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	0	7949	0	13064	0	0		21355
Runoff Pervious Areas (m^3/year)	0	5948	0	14614	0	0	0	20562
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	3074	3074
Total Runoff (m^3/year)	0	5948	0	14614	0	0	3074	23636
Total Outputs (m^3/year)	0	34164	0	66825	0	0	3453	104784
Difference (Inputs - Outputs)	0	0	0	0	0	0	-342	0

Water Budget - Post - Development - With Mitigation
Water Balance / Water Budget Assessment

	Development Lands to Southcentral Swamp (B2a+B2b)							
	Forest		Pasture					
	D	B	D	B				
	Clay (250)	Sandy Loam (200)	Clay (150)	Sandy Loam (100)	Sand (75)	Gravel	Asphalt	Total
Area (m^2)	26634	30872	22140	41843	0	0	6411	127900
Pervious Area (m^2)	26634	30872	22140	41843	0	-	-	121489
Impervious Area (m^2)	-	-	-	-	-	0	6411	6411
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	384	384	391	391	398	398	850	411
Net Surplus (mm/year)	384	384	391	391	398	398	850	411
Evapotranspiration (mm/year)	560	560	553	553	546	546	94	533
Infiltration (mm/year)	200	220	165	185	227	88	85	188
Trench Infiltration (mm/year)	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	200	220	165	185	227	88	85	188
Runoff Pervious Areas	184	164	226	206	171	0	0	951
Runoff Impervious Areas	0	0	0	0	0	310	765	1075
Total Runoff (mm/year)	184	164	226	206	171	310	765	223
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Outputs (Volume)								
Precipitation Surplus (m^3/year)	10227	11855	8657	16361	0	0	5447	52546
Net Surplus (m^3/year)	10227	11855	8657	16361	0	0	5447	52546
Evapotranspiration (m^3/year)	14915	17288	12243	23139	0	0	605	68191
Infiltration (m^3/year)	5339	6781	3653	7722	0	0	545	24040
Trench Infiltration (m^3/year)	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	5339	6781	3653	7722	0	0	545	24040
Runoff Pervious Areas (m^3/year)	4889	5074	5004	8638	0	0	0	23605
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	4902	4902
Total Runoff (m^3/year)	4889	5074	5004	8638	0	0	4902	28507
Total Outputs (m^3/year)	25142	29143	20900	39500	0	0	6052	120738
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

	Development Lands to North Swamp (B3a+b3b)							
	Forest		Pasture					
	D	B	D	B				
	Clay (250)	Sandy Loam (200)	Clay (150)	Sandy Loam (100)	Sand (75)	Gravel	Asphalt	Total
Area (m^2)	0	36191	0	70789	0	0	4020	111000
Pervious Area (m^2)	0	36191	0	70789	0	-	-	106980
Impervious Area (m^2)	-	-	-	-	-	0	4020	4020
Infiltration Factors								
Topographic Infiltration Factor	0.172	0.172	0.172	0.172	0.12	0.12	0	
Soil Infiltration Factor	0.15	0.2	0.15	0.2	0.35	0.05	0	
Land Cover Infiltration Factor	0.2	0.2	0.1	0.1	0.1	0.05	0	
MOE infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0.1	
Actual Infiltration Factor	0.522	0.572	0.422	0.472	0.57	0.22	0	
Run-off Coefficient	0.478	0.428	0.578	0.528	0.43	0.78	0.9	
Runoff from Impervious Surfaces*	0	0	0	0	0	0.78	0.9	
Inputs (per Unit Area)								
Precipitation (mm/year)	944	944	944	944	944	944	944	944
Run-on (mm/year)	0	0	0	0	0	0	0	0
Other Inputs (mm/year)	0	0	0	0	0	0	0	0
Total Inputs (mm/year)	944	944	944	944	944	944	944	944
Outputs (per Unit Area)								
Precipitation Surplus (mm/year)	384	384	391	391	398	398	850	405
Net Surplus (mm/year)	384	384	391	391	398	398	850	405
Evapotranspiration (mm/year)	560	560	553	553	546	546	94	539
Infiltration (mm/year)	200	220	165	185	227	88	85	192
Trench Infiltration (mm/year)	0	0	0	0	0	0	604	22
Total Infiltration (mm/year)	200	220	165	185	227	88	689	214
Runoff Pervious Areas	184	164	226	206	171	0	0	951
Runoff Impervious Areas	0	0	0	0	0	310	161	471
Total Runoff (mm/year)	184	164	226	206	171	310	161	191
Total Outputs (mm/year)	944	944	944	944	944	944	944	944
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0
Inputs (Volume)								
Precipitation (m^3/year)	0	34164	0	66825	0	0	3795	104784
Run-on (m^3/year)	0	0	0	0	0	0	0	0
Other Inputs m^3/year)	0	0	0	0	0	0	0	0
Total Inputs (m^3/year)	0	34164	0	66825	0	0	3795	104784
Outputs (Volume)								
Precipitation Surplus (m^3/year)	0	13897	0	27678	0	0	3415	44991
Net Surplus (m^3/year)	0	13897	0	27678	0	0	3415	44991
Evapotranspiration (m^3/year)	0	20267	0	39146	0	0	379	59793
Infiltration (m^3/year)	0	7949	0	13064	0	0	342	21355
Trench Infiltration (m^3/year)	0	0	0	0	0	0	2428	2428
Total Infiltration (m^3/year)	0	7949	0	13064	0	0	2770	23783
Runoff Pervious Areas (m^3/year)	0	5948	0	14614	0	0	0	20562
Runoff Impervious Areas (m^3/year)	0	0	0	0	0	0	646	646
Total Runoff (m^3/year)	0	5948	0	14614	0	0	646	21208
Total Outputs (m^3/year)	0	34164	0	66825	0	0	3795	104784
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0

Water Budget Summary
Water Balance / Water Budget Assessment

Development Lands to Southcentral Swamp Pre = Post					
Characteristic	Pre-Development	Post-Development	Change (Pre- to Post)	Post-Development with Mitigation	Change (Pre- to Post-with Mitigation
Inputs (Volumes)					
Precipitation (m^3/year)	97232	120738	24%	120738	24%
Run-on (m^3/year)	0	0	0%	0	0%
Other Inputs m^3/year)	0	0	0%	0	0%
Total Inputs (m^3/year)	97232	120738	24%	120738	24%
Outputs (Volumes)					
Precipitation Surplus (m^3/year)	39102	52546	34%	52546	34%
Net Surplus (m^3/year)	39102	52546	34%	52546	34%
Evapotranspiration (m^3/year)	58130	68191	17%	68191	17%
Infiltration (m^3/year)	20295	24040	18%	24040	18%
Rooftop infiltration (m^3/year)	0	0	0%	0	0%
Total Infiltration (m^3/year)	20295	24040	18%	24040	18%
Runoff Pervious Areas (m^3/year)	18807	23605	26%	23605	26%
Runoff Impervious Areas (m^3/year)	0	4902	0%	4902	0%
Total Runoff (m^3/year)	18807	28507	52%	28507	52%
Total Outputs (m^3/year)	97232	120738	24%	120738	24%

Development Lands to North Swamp Pre = Post					
Characteristic	Pre-Development	Post-Development	Change (Pre- to Post)	Post-Development with Mitigation	Change (Pre- to Post-with Mitigation
Inputs (Volumes)					
Precipitation (m^3/year)	114413	104784	-8%	104784	-8%
Run-on (m^3/year)	0	0	0%	0	0%
Other Inputs m^3/year)	0	0	0%	0	0%
Total Inputs (m^3/year)	114413	104784	-8%	104784	-8%
Outputs (Volumes)					
Precipitation Surplus (m^3/year)	46100	44991	-2%	44991	-2%
Net Surplus (m^3/year)	46100	44991	-2%	44991	-2%
Evapotranspiration (m^3/year)	68313	59793	-12%	59793	-12%
Infiltration (m^3/year)	23851	21355	-10%	21355	-10%
Rooftop infiltration (m^3/year)	0	0	0%	2428	0%
Total Infiltration (m^3/year)	23851	21355	-10%	23783	0%
Runoff Pervious Areas (m^3/year)	22249	20562	-8%	20562	-8%
Runoff Impervious Areas (m^3/year)	0	3074	0%	646	0%
Total Runoff (m^3/year)	22249	23636	6%	21208	-5%
Total Outputs (m^3/year)	114413	104784	-8%	104784	-8%

Mitigation Requirements
Water Balance / Water Budget Assessment

Data Input	
944	mm of precipitation per year avg.
118.4	days with precipitation per year avg.
25	mm design rainfall event

1981 to 2010 Canadian Climate Normals station data

Days with Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
>= 0.2 mm	4.4	3.9	6.7	10.9	13.4	13.2	11.9	11	12.3	13.7	11	6	118.4	A
>= 5 mm	1.6	1.2	2.1	4	4.9	5.8	5.4	4.8	5.1	5	4.2	2.3	46.5	A
>= 10 mm	0.87	0.57	1	2	2.7	2.9	3.1	2.8	3.2	2.7	2.1	1.2	25.2	A
>= 25 mm	0.13	0.07	0.10	0.33	0.47	0.73	0.77	0.67	0.60	0.47	0.43	0.13	4.9	A

Environment Canada	Days exceeding rainfall noted	Days per section	Minimum volume of rain (mm)
0.2 mm	118.4	71.9	14
5 mm	46.5	21.3	107
10 mm	25.2	20.3	203
25 mm	4.9	4.9	123
	Total	118.4	446

*Example - Days per section over 5mm = 46.5 - 25.2 = 21.3 days (which are more than 5 mm but, less than 10 mm).
21.3 days x 5 mm = 107 mm

	Development Lands to North Swamp (B3a+B3b)
Area of Asphalt (m^2)	24200
Composite Runoff Coefficient	0.31
Volume of Runoff in 10 mm Event (m^3) to be infiltrated	75
Volume of Infiltration Trench Required (m^3) - Vol / void space (0.4) - Assuming no outflow	188
Depth under Ditch (m)	0.5
Width under Ditch (m)	1.00
Length of Infiltration Trench required to meet Volume Required (m)	430

Volume of Infiltration Trench Proposed (m^3)	215
Volume of outflow (m^3/hr)	2.58
After 4hour	10.32
Delta of Volume Required to Store	65
Volume of Infiltration Trench Required (m^3) - Vol / void space (0.4) - With outflow	162
Mitigation Provided (m^3/year)	2428
Annual Volume to be infiltrated by designing for 10 mm Event (m^3/year)	2431

(Assumed 15mm/hr infiltration with 2.5 F.S)

By installing trenches sized for the 10 mm event, the annual volume to be infiltrated will exceed that of the mitigation required by the water balance mitigation.