# Functional Servicing and Stormwater Management Report

## 5782 6th Line East
## Township of Guelph/Eramosa (Ariss)

**GMBP File: 420099-1**
**Revised January 2024**

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**5782 6TH LINE EAST**

**TOWNSHIP OF GUELPH/ERAMOSA (ARISS)**

**REVISED JANUARY 2024**

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# 1.0 INTRODUCTION

In support of approval of the Draft Plan of Subdivision application for the subject property, GM BluePlan Engineering Limited have prepared this Functional Servicing and Stormwater Management Report to document the proposed site servicing and stormwater management design for the site, and to document the updated draft plan (GSP Group, dated November 7, 2023).

The 7.80 ha site is located at 5782 6th Line East in the Township of Guelph / Eramosa (Ariss). The site is bound by agricultural land to the north, 6th Line East to the east, existing residential properties to the south, and the former Canadian Pacific Railway to the west of the site. **Figure 1** illustrates the site location.

# 2.0 EXISTING CONDITIONS

## 2.1 Land Use

The site is currently a vacant agricultural field. The lands to the south of the site have been developed for single family residential housing. The former Canadian Pacific Railway, located to the west of the site, has been developed as a walking trail system (Kissing Bridge Trail).

A portion of the Kurtz Municipal Drain also extended through the site. Improvements and relocation of a portion of the Kurtz Municipal Drain through the subject site was recently completed in 2022.

## 2.2 Topography

The land within the site has an average slope of 1.4% from the perimeter of the site towards the Kurtz Municipal Drain. Runoff generated from the site currently sheetflows overland to Branch ‘A’, ‘C’, ‘E’ and ‘F’ of the Kurtz Municipal Drain.

The existing site features are shown on the Existing Conditions and Removals Plan prepared by GM BluePlan Engineering Limited.

## 2.3 Soils

CMT Engineering Inc. completed a Geotechnical Investigation of the site in 2021. A total of six (6) boreholes were extended to approximately 6.10m below the existing surface to determine the soil properties.

Based on the CMT investigation, the topsoil depth on site ranges from 300 mm to 610 mm with an average depth of 520 mm. A sand and gravel fill were observed at Borehole 6 at an approximate thickness of 1,680 mm. Based on the finding from the Geotechnical report, the sand and gravel fill are likely backfill from a nearby field drain. Subsurface soils are mainly composed of sand and gravel and sandy silt. The sandy silt was observed to the termination depth of all six (6) boreholes.

A copy of the CMT Geotechnical Investigation is included in **Appendix A.**

## 2.4 Groundwater

As part of the Geotechnical Investigation conducted by CMT Engineering Inc in 2021, monitoring wells were installed at all six (6) of the borehole locations. It is noted that the groundwater level measurement of 0.66 metre and 3.18 meter below the existing ground surface. The Geotechnical investigation by the CMT Inc. mentioned that the typically fine-grained sandy silt soils have the potential to create perched groundwater in the overlying soils.

In addition to the Geotechnical Investigation by CMT Engineering Inc in 2021, a field investigation to measure groundwater levels was conducted as a part of the Hydrogeological Study by GM BluePlan Engineering Limited (5782 6th Line Hydrogeological Study, Feb 2023). The Hydrogeological study, based on data collected from June 2021 to February 2023, shown that the seasonal high groundwater levels range from roughly surface to nearly 2 metre below surface. The ground water levels investigated in this study are indicated on design drawing (General Servicing Plan: Drawing No. 3).

The observation of the relatively shallow groundwater in the site requires seepage control during construction. Within The CMT Inc report, it was mentioned that seepage should be handled by conventional construction dewater techniques such as pumping sump pits. And mentioned that the number of pumps could be increased during construction for heavy seepage.

The estimated percolation rate is from 20 min/cm to 30 min/cm for the sandy silty with some clay and trace gravel. It is expected that low volumes of precipitation infiltrate through the sandy silty material on site.

## 3.0 PROPOSED DEVELOPMENT

The proposed development generally consists of single-family estate style residential lots complete with internal road connecting to both 6th Line East and the existing Ariss Glen Drive. **Figure 2** illustrates the proposed Draft Plan of Subdivision.

### 3.1 Site Grading

The preliminary site grading for the proposed residential lots and internal road is shown on the grading plan prepared by GM BluePlan Engineering Limited.

The proposed residential lots have been graded to direct flows to both a rear yard swale and the roadside ditch. The rear yard swale allows a maximum of 0.3 metres surface ponding before runoff overflows to the relocated Branch C of the Kurtz Municipal Drain.

Proposed road (Street ‘A’) elevations are controlled by the current elevation of 6th Line East and Ariss Glen Drive. The proposed road has been graded to direct major storm overland flow to the Kurtz Municipal Drain.

The proposed roadways are proposed to be graded with slopes ranging from 0.5% to 1.4%, while lots are generally proposed to be graded with a minimum grade of 2.0 % as per Township of Guelph/ Eramosa Development Standards.

### 3.2 Street

The proposed road will be constructed with a minimum gradient of 0.5% connecting 6th Line East and Ariss Glen Drive. A rural road cross-section complete with roadside ditches will be provided throughout the development.

The proposed road will have a 20.0 m right of way, with a 6.5 m wide pavement. The details and cross-sections are shown on the drawings designed by GM Blue Plan Engineering Limited (Sections 1, Sections 2, and Notes and Details).

### 3.3 Kurtz Municipal Drain

The project site is within the catchment area of Kurtz Municipal Drain. The Kurtz Municipal Drain was constructed in 1969 to provide a combination of open ditch and closed tile drainage for an approximately 665-ha of land. The Kurtz Municipal Drain is comprised of several branches (Branch A through Brand F) and extends approximately 2.2-km northwest of Ariss Valley Road along 6th Line East to 4th Line East and 8th Line East to Highway 86 at the edge of the existing Ariss Valley Golf and Country Club at the lower limits.

The site at 5782 6th Line East is a major junction of several Branches of the Kurtz Municipal Drain. Portions of Branch ‘A’, ‘C’, ‘E’, and ‘F’ of the Kurtz Municipal Drain are all located within the limits of the subject site.

Based on the hydrologic and hydraulic analysis in Floodplain Analysis Report completed by GM BluePlan Engineering Limited on July 2021, improvements to the Kurtz Municipal Drain were undertaken and completed in 2022 under the Drainage Act. The following is a brief summary of the improvements and relocations completed in 2022 for the Kurtz Municipal Drain:

- Branch ‘C’ – the width of the channel was increased, and the channel re-aligned / relocated to match the previous improvements made to Brand ‘C’ as part of the Ussher’s Creek Subdivision.

- Branch ‘F’ – the width of the channel was increased, and the channel relocated to be on the adjacent lands to the north of the subject site. The previous Branch ‘F’ will be abandoned.

The improvements and relocations to the Kurtz Municipal Drain have been shown on the detailed design drawings prepared by GM BluePlan Engineering Limited.

### 3.4 Water Supply

The subject site does not have a municipal water supply system. As such, water supply to each of the proposed single family estate residential lots will be provided by private individual drilled wells on each lot. An analysis of the local aquifer's ability to supply water at a sufficient rate was completed as part of the Hydrogeological Assessment prepared by GM BluePlan Engineering Limited. Based on the analysis, there is ample supply available to meet the needs of the subdivision.

The preliminary location of each private well, along with the 15m minimum setback, from the septic system is shown on the grading and general servicing plans prepared by GM BluePlan Engineering Limited.

### 3.5 Fire Protection

Fire flow demands for developments were determined in accordance with the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999) and Ontario Building Code (OBC).

An approximate building area of 270 $m^2$ with an assumed 2-storey building height of 6.0m to underside of roof (excluding the basement) was utilized in the calculations. The water supply rate must be provided for a minimum duration of 30 minutes, as per paragraph 3.c of Section A-3.2.5.7 of Appendix A of the Ontario Building Code (2006).

The resulting FUS and OBC fire flow is 50 l/s and the minimum required water supply is 90,000 L. Design calculations for the fire reservoir tanks are provided in **Appendix B**.

Fire supply reservoirs will be provided to ensure adequate protection for the proposed development. To provide adequate water supply for the largest expected home within the subdivision, a storage tank with a capacity of 90,000 litres is required. It is proposed that two 50,000 L tanks be installed in the subdivision. The fire reservoirs will be precast concrete construction and will be designed to meet all the requirements of the Township of Guelph/Eramosa fire department and the Ontario Building Code.

### 3.6 Sanitary Servicing

Sanitary servicing for the proposed development will be provided by a private septic system complete with enhanced tertiary treatment located in the front yard of each lot.

The Hydrogeological Study has been conducted by GM BluePlan Engineering Limited to characterize the hydrogeological setting of the site and to assess the feasibility associated with the use of on-site sewage systems and private water supply wells. The detailed design of each private sewage system will be completed by others as part of the building permit application process and approval.

The proposed location of the private septic system is illustrated in the Servicing Plan prepared by GM BluePlan Engineering Limited.

### 3.7 Storm Servicing

The proposed road will be constructed with a rural cross-section. Stormwater runoff will be conveyed via the roadside ditches and rear-yard swales to the Kurtz Municipal Drain.

Driveway culverts will be a minimum of 450 mm diameter with 450 mm to 600 mm of cover, as per Township standards.

## 4.0 STORMWATER MANAGEMENT DESIGN

The studies, policies and guidelines used to develop the stormwater management plan are as follows:

1) The MOE Stormwater Management Planning and Design Manual, 2003
2) The MTO Drainage Management Manual, 1997
3) The Grand River Conservation Authority Sediment and Erosion Control Guidelines for Urban Construction, 2006
4) Development Standards for the Township of Guelph/Eramosa, 2004

The stormwater management criteria for the proposed development, are as follows:

1. Post-development flow rates for the site must be controlled to pre-development rates for the 5- and 100-year design storm events.
2. Provide enhanced level of quality control, 80% Total Suspended Solids (TSS) removal from all runoff leaving the site.
3. Major storm flows are to be routed overland to an appropriate outlet.

The method used to evaluate and design the stormwater management plan is as follows:

A four-hour duration rainfall event was used to generate the mass rainfall data required for the 25 mm design storm event. A three-hour duration rainfall event was used to generate the mass rainfall data required to model the 5, and 100-year design storms. The Chicago parameters and the total depth of rainfall data required for the 25 mm, 5 and 100-year design storm events are based on City of Guelph requirements and are in **Table 1**.

From the Soil Survey of Wellington County (Report No. 35 of the Ontario Soil Survey), the soils on-site are described as London Loam, with imperfect drainage characteristics. The MTO Drainage Management Manual hydrologic soil classification for London Loam is hydrologic soil group BC. A small strip of the watershed is comprised of Donnybrook Sandy Loam and Parkhill Loam, which have a hydrologic soil group of AB and BC respectively, as a result of the increased sand and reduced silt content.

**Table 1: City of Guelph Chicago Rainfall Distribution Parameters**

| | 1-Year | 5-Year | 100-Year |
|---|---|---|---|
| a = | 367.0 | 1593.0 | 4688.0 |
| b = | 5.0 | 11.000 | 17.000 |
| c = | 0.700 | 0.879 | 0.962 |
| r = | 0.394 | 0.400 | 0.400 |
| Duration (minutes) = | 240.000 | 180.000 | 180.000 |
| Rainfall depth (mm) | 31.211 | 47.240 | 87.263 |

The hydrologic model Visual OTTHYMO was used to create the runoff hydrographs and to route the flows through the storage structures. The SCS infiltration method was utilized in the runoff calculations. The Pre-Development and Post-Development Catchment SCS Numbers (weighted calculations) utilized in the analysis have been provided in **Appendix C and D** respectively.

## 4.1 Pre-Development Conditions

For the pre-development conditions analysis, the site was modelled as two (2) drainage catchments. The pre-development condition drainage catchments are shown on **Figure 3** and described below. The existing conditions Visual OTTHYMO computer modelling is attached in **Appendix C**.

**Catchment 10 (0.988 hectares, 0% impervious)** represents existing farmlands and includes part of the municipal drains (Branch 'C', Branch 'A') in the site. Runoff generated from Catchment 10 sheetflows overland towards the Municipal Drain.

**Catchment 20 (7.800 hectares, 0% impervious)** represents the existing farmlands and includes part of the Municipal Drain (Branch 'F', Branch 'E' and Branch 'A'). Runoff from the catchment flows overland to the Municipal Drain. The boundary of south side of this catchment is matched with proposed municipal right-of-way that includes roadside ditch.

The total flow rate generated from Catchment 10 and 20 represents the allowable flow rate.

Table 2 lists the flow rates and total flow rate discharging from each catchment under pre-development conditions.

**Table 2: Pre-Development Condition Flow Rates**

| | 5-Year | 100-Year |
|---|---|---|
| Catchment 10 | 0.032 $m^3/s$ | 0.108 $m^3/s$ |
| Catchment 20 | 0.378 $m^3/s$ | 1.166 $m^3/s$ |
| **Total Flow Rate** | **0.410 $m^3/s$** | **1.274 $m^3/s$** |

## 4.2 Post-Development Conditions

For post-development analysis purposes, the site was modelled as nine (9) drainage catchments. The post-development drainage catchments are shown on **Figure 4** and described below. The post-development Visual OTTHYMO computer modelling is attached in **Appendix D.**

**Catchment 100 (0.463 hectares, 31% impervious)** includes the proposed municipal right-of-way. Runoff from the catchment is directed to the roadside ditches and flows toward the improved municipal drain Branch 'C'.

**Catchment 200 (1.889 hectares, 13% impervious)** represents the front yard on the east side of the proposed residential lots and the municipal right-of-way. Given the proposed residential lots are designed with a split drainage concept, runoff from the catchment flows via overland to the proposed roadside ditch. The runoff along the roadside ditches is ultimately drained through the improved municipal drain Branch 'C'.

**Catchment 300-301 (2.241 hectares, 5% impervious)** represents backyard of the east side of the proposed residential lots at the improved municipal drain Branch 'C'. Runoff from the catchment flows via overland to the rear yard swale. The runoff from catchment 300 and 301 will be controlled by a rear yard swale with 1,000mm storm pipe storage systems and will be ultimately discharged through the improved municipal drain Branch 'C'.

**Catchment 400 (0.369 hectares, 47% impervious)** includes the proposed municipal right-of-way. Runoff from the catchment is directed to the roadside ditch and will be controlled by a proposed infiltration gallery before discharging to the improved municipal drain Branch 'C'.

**Catchment 500 (1.789 hectares, 17% impervious)** represents the front yard on the west side of the proposed residential lots and the municipal right-of-way. Runoff from the catchment flows overland to the proposed roadside ditch ultimately discharging to the improved municipal drain Branch ‘C’.

**Catchment 600-601 (1.52 hectares, 6% impervious)** represents the backyard of the west side of the proposed residential lots. Runoff from the catchment flows overland to the rear yard swale and will be controlled by a rear yard swale with oversized 1000 mm storm pipe storage systems ultimately discharging to the improved municipal drain Branch ‘C’.

**Catchment 700 (0.49 hectares, 14% impervious)** includes improved municipal drain Branch ‘C’ and **‘**A**’** and the proposed infiltration gallery connected to the west side roadside ditch. Runoff from the catchment will be discharged to the improved Kurtz Municipal Drain.

The post-development conditions flow rates were calculated using Visual OTTHYMO software to route the hydrographs.

Table 3 identifies the post-development uncontrolled flow rates generated from the site.

**Table 3: Post-Development Uncontrolled Flow Rates**

| Catchment | 5-Year | 100-Year |
|---|---|---|
| Catchment 100 | 0.102 $m^3/s$ | 0.216 $m^3/s$ |
| Catchment 200 | 0.117 $m^3/s$ | 0.376 $m^3/s$ |
| Catchment 300 & 301 | 0.121 $m^3/s$ | 0.410 $m^3/s$ |
| Catchment 400 | 0.089 $m^3/s$ | 0.181 $m^3/s$ |
| Catchment 500 | 0.115 $m^3/s$ | 0.368 $m^3/s$ |
| Catchment 600 & 601 | 0.083 $m^3/s$ | 0.280 $m^3/s$ |
| Catchment 700 | 0.047 $m^3/s$ | 0.136 $m^3/s$ |
| **Total Flow Rate** | **0.606 $m^3/s$** | **1.889 $m^3/s$** |

### 4.3 Stormwater Management Overview

In line with current practices and guidelines, the stormwater management approach for the subject site is designed as a “treatment train” to remove sediments and any absorbed contaminants prior to the discharge of runoff from the development to the receiving outlets. The “treatment train” approach will include a combination of lot level, conveyance and end-of-pipe best management practices and is proposed to filter and remove sediments from stormwater runoff prior to discharging to the municipal drain.

The stormwater management system has been designed to control the post-development flow to the pre-development condition flow rates. The stormwater management system consists of subsurface perforated storm pipe storage systems through rear yard swales and roadside ditches.

#### a) Roof Drainage to Ground Surface

The proposed lot grading throughout the development is split drainage with driveways and front yards draining towards the road, and roof and rear yard areas draining towards the rear of the lot.

The roof runoff from most rainfall events will be filtered across the grassed area with some minor filtration to the underlying soils. The runoff from any event large enough to generate flow to the rear yard swale system will be adequately filtered by the grass en-route.

The grading of the lots will be to minimum gradients of 2%, as per the current Township of

Guelph/Eramosa standards.

**b) Detention of Stormwater Runoff**

As mentioned above, the lots are designed as split drainage system and, as such the grading in the rear and front yard areas will direct stormwater runoff towards rear yard swales and roadside ditches respectively.

The rear yard areas have been designed to accommodate runoff from up to 100-year rainfall event. The rear yard swales drainage consists of 1050 mm dia. perforated storm pipe storage systems with an orifice at the outlet. The locations of the orifices and sizes are shown on the servicing plan. Major storm flows exceeding the capacity of the perforated storm pipe storage systems will be overflowed into the improved Kurtz Municipal Drain.

The runoff from the west side roadside ditch will be controlled by the proposed infiltration gallery consisting of 1050 mm diameter perforated storm pipe and clear stone with a 150 mm orifice at the outlet. The proposed infiltration gallery will accommodate runoff from up to 100-year rainfall event.

Orifice controls, located at the downstream outlet of each perforated storm pipe storage system, will provide quantity control prior to discharging to the relocated Kurtz Municipal Drain. The subsurface storm pipe storage systems have been designed with sufficient capacity to attenuate the runoff from the post-development conditions.

## 4.4 Routing

The hydrologic model Visual OTTHYMO was used to properly model the effect of detention volumes. Details of the proposed stormwater volumes, flow rate are found in **Appendix D**.

Table 4 and 8 show the summary of the routing results from catchment 300, 301, 400, 600, and 601 with the available stage/storage/ discharge capacities.

**Table 4: Subsurface 1,000mm Perforated Storm Pipe Storage (Catchment 300 at Lot 13, 14, 15 & 16) - Stage/Storage/Discharge Comparison**

| Control | Available Capacity | | | Actual Capacity Used | | |
|---|---|---|---|---|---|---|
| | Peak Flow $m^3/s$ | Storage Volume $m^3$ | Storage Elevation m | Peak Flow $m^3/s$ | Storage Volume $m^3$ | Storage Elevation m |
| Bottom of Stone | 0.000 | 0.000 | 345.90 | --- | --- | --- |
| Pipe Invert (Orifice 180mm) | 0.0019 | 29.03 | 346.20 | --- | --- | --- |
| 5 Year Storm | --- | --- | --- | 0.033 | 73.0 | 346.48 |
| Pipe Overt | 0.0713 | 197.05 | 347.20 | --- | --- | --- |
| 100 Year Storm | --- | --- | --- | 0.080 | 221.0 | 347.45 |
| Top of Stone | 0.0821 | 226.08 | 347.50 | --- | --- | --- |

**Table 5: Subsurface 1,000mm Perforated Storm Pipe Storage (catchment 301 at Lot 8, 9, 10, 11, & 12) – Stage/Storage/Discharge Comparison**

| Control | Available Capacity | | | Actual Capacity Used | | |
|---|---|---|---|---|---|---|
| | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m |
| Bottom of Stone | 0.000 | 0.000 | 344.50 | --- | --- | --- |
| Pipe Invert (Orifice 190mm) | 0.0036 | 55.91 | 344.80 | --- | --- | --- |
| 5 Year Storm | --- | --- | --- | 0.042 | 154.0 | 345.12 |
| Pipe Overt | 0.0821 | 379.50 | 345.80 | --- | --- | --- |
| 100 Year Storm | --- | --- | --- | 0.094 | 431.0 | 346.08 |
| Top of Stone | 0.095 | 106.99 | 346.10 | --- | --- | --- |

**Table 6: Subsurface Infiltration gallery (catchment 400) –Stage/Storage/Discharge Comparison**

| Control | Available Capacity | | | Actual Capacity Used | | |
|---|---|---|---|---|---|---|
| | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m |
| Bottom of Stone | 0.000 | 0.00 | 344.20 | --- | --- | --- |
| Pipe Invert (Orifice 150mm) | 0.0231 | 24.00 | 344.50 | --- | --- | --- |
| 5 Year Storm | --- | --- | --- | 0.035 | 56.0 | 344.78 |
| Pipe Overt | 0.0531 | 112.00 | 345.40 | --- | --- | --- |
| 100 Year Storm | --- | --- | --- | 0.057 | 126.0 | 345.57 |
| Top of Stone | 0.0599 | 136.00 | 345.70 | --- | --- | --- |

**Table 7: Subsurface 1,000mm Perforated Storm Pipe Storage (catchment 600 at Lot 1, 2, 3, 4, & 5) – Stage/Storage/Discharge Comparison**

| Control | Available Capacity | | | Actual Capacity Used | | |
|---|---|---|---|---|---|---|
| | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m | Peak Flow m³/s | Storage Volume m³ | Storage Elevation m |
| Bottom of Stone | 0.000 | 0.000 | 344.32 | --- | --- | --- |
| Pipe Invert (Orifice 220mm) | 0.0017 | 26.42 | 344.62 | --- | --- | --- |
| 5 Year Storm | --- | --- | --- | 0.040 | 61.0 | 344.87 |
| Pipe Overt | 0.1033 | 179.33 | 345.62 | --- | --- | --- |
| 100 Year Storm | --- | --- | --- | 0.102 | 176.0 | 345.60 |
| Top of Stone | 0.1194 | 205.74 | 345.92 | --- | --- | --- |

**Table 8: Subsurface 1,000mm Perforated Storm Pipe Storage (catchment 601 at Lot 6 & 5) – Stage/Storage/Discharge Comparison**

| Control | Available Capacity | | | Actual Capacity Used | | |
|---|---|---|---|---|---|---|
| | Peak Flow $m^3/s$ | Storage Volume $m^3$ | Storage Elevation m | Peak Flow $m^3/s$ | Storage Volume $m^3$ | Storage Elevation m |
| Bottom of Stone | 0.000 | 0.000 | 344.64 | --- | --- | --- |
| Pipe Invert (Orifice 180mm) | 0.0019 | 29.38 | 344.94 | --- | --- | --- |
| 5 Year Storm | --- | --- | --- | 0.045 | 73.0 | 345.22 |
| Pipe Overt | 0.1037 | 199.40 | 345.94 | --- | --- | --- |
| 100 Year Storm | --- | --- | --- | 0.104 | 200.0 | 345.95 |
| Top of Stone | 0.1198 | 228.77 | 346.24 | --- | --- | --- |

### 4.5 Comparison to Pre-Development Flows

Table 9 identifies the post-development controlled flow rates generated from the site.

**Table 9: Post-Development controlled Flow Rates**

| Catchment | 5-Year | 100-Year |
|---|---|---|
| Catchment 100 (uncontrolled) | 0.102 $m^3/s$ | 0.216 $m^3/s$ |
| Catchment 200 (uncontrolled) | 0.117 $m^3/s$ | 0.376 $m^3/s$ |
| Catchment 300 & 301 (controlled) | 0.042 $m^3/s$ | 0.094 $m^3/s$ |
| Catchment 400 (controlled) | 0.035 $m^3/s$ | 0.057 $m^3/s$ |
| Catchment 500 (uncontrolled) | 0.115 $m^3/s$ | 0.368 $m^3/s$ |
| Catchment 600 & 601 (controlled) | 0.045 $m^3/s$ | 0.104 $m^3/s$ |
| Catchment 700 (uncontrolled) | 0.047 $m^3/s$ | 0.136 $m^3/s$ |
| **Total Flow Rate** | **401 $m^3/s$** | **1.143 $m^3/s$** |

Table 10 summarizes the comparison of pre- and post-development flows from the site.

**Table 10: Comparison of Pre- and Post-Development Flows**

| | 5-Year | 100-Year |
|---|---|---|
| Pre-Development Flow Rate | 0.410 $m^3/s$ | 1.274 $m^3/s$ |
| Post-Development Flow Rate | 0.401 $m^3/s$ | 1.143 $m^3/s$ |

The 5-year post-development flows have been controlled to 0.401 $m^3/s$, which is 98% of the existing condition 5-year design storm flow rate. The 100-year post-development flows have been controlled to 1.143 $m^3/s$, which is 90% of the existing 100-year design storm flow rate.

Therefore, the post-development flow rates discharging from the site during the 5 and 100-year design storm events are less than the pre-development flow rates from the site.

## 4.6 Quality Control

The objective of the post development quality control for the site is to achieve 80% long-term suspended solid (TSS) removal prior to discharging stormwater to the downstream as per the Ministry of the Environment Stormwater Management Planning and Design Manual, dated March 2003.

The proposed rear yard areas being added to the site as a result of the development consist of a building rooftop and grassed rear yard area. It is considered that there are no quality control impacts as a result of the proposed development in that area. As such, the discharge from Catchment 300 to 301 and from Catchment 600 to 601 area is considered “clean”, and further quality control measures have not been proposed for those areas.

The Catchment 400 area represents the municipal right-of-way and the runoff from the catchment is controlled by the proposed infiltration gallery. Based on Table 3.2 of the Ministry of Environment Stormwater Management Planning and Design Manual 2003, an infiltration facility requires quality storage of 28m$^3$/ha at 47% impervious level. As such, the catchment 400 requires quality storage of 10.3 m$^3$ (28m$^3$/ha x 0.369 ha) and the proposed infiltration gallery has a storage volume of 135.90 m$^3$, which meets the water quality criteria required.

The rooftop and landscape area of the Catchment 200 and 500 are 1.75 and 1.55 hectares, respectively. The remaining area of 0.14 and 0.17 hectares, respectively, are impervious and will be treated by grassed swales prior to discharge from the site to the Municipal Drain.

The Catchment 100 area represent the municipal right-of-way and roadside ditches. The Ministry of Environment Stormwater Management Planning and Design Manual 2003 requires that grassed swales designed for water quality enhancement should convey the peak flow from a 4-hour, 25 mm Chicago Storm with a velocity of less than 0.5 m/s.

Based on the flow characteristics for the roadside ditches as provided in Table 11, adequate water quality treatment will be provided in the roadside ditches. The detailed calculation results are shown in **Appendix D**.

**Table 11: Flow Characteristics of Roadside Ditches for 25 mm, 4-hour, Chicago Storm**

| Roadside Ditch Location | Flow Length (m) | Average Flow Slope (%) | Flow Rate (m$^3$/s) | Flow depth (m) | Flow Velocity (m/s) |
|---|---|---|---|---|---|
| Catchment 100 | 460 | 1.00 | 0.037 | 0.156 | 0.50 |
| Catchment 200 | 460 | 1.00 | 0.043 | 0.165 | 0.52 |
| Catchment 500 | 280 | 1.00 | 0.034 | 0.151 | 0.49 |

## 5.0 WATER BALANCE

A water balance analysis has been completed on the subject site using the catchment information.

Based on the Canadian Climate Normals for the Fergus Shand Dam station from 1981 to 2010, the average annual precipitation for the area in which the site is located is estimated to be 945.9 mm.

It has been estimated that the potential annual evapotranspiration for this area is 563.3 mm for pervious surfaces. Therefore, 382.6 mm remains available for infiltration and runoff.

Based on the subsurface soil's information provided by CMT Engineering Inc, the potential infiltration across the site has been estimated as 191.3 mm annually, with the remaining 191.3 mm being runoff.

Based on the annual infiltration rates, as shown on the Monthly Water Balance calculations attached in **Appendix E**, the existing annual average groundwater recharge occurring within the 8.79-hectare site is estimated to be 16,814 $m^3$. Under post-development conditions, the annual natural groundwater recharge occurring on-site is estimated to be 16,511 $m^3$ prior to the addition of the runoff volume infiltrated in the stormwater management facility.

Under existing conditions, the annual average runoff from the site is estimated to be 16,814 $m^3$. As a result of the proposed development the impervious area (rooftop and paved surfaces) of the site increases which causes an increase in runoff volume to 20,275 $m^3$ per year prior to the addition of the runoff volume infiltrated in the stormwater management facility.

As the proposed stormwater management facility, the infiltration galleria has been designed with a total volume of 120.9$m^3$. With the addition of the site runoff volume infiltrated in the proposed stormwater management facility, the comparison between existing conditions and post-development recharge and runoff volumes are summarized in Table 11 below.

**Table 11: Summary of Recharge and Runoff Volume**

| | **Total Estimated Recharge** | **Total Estimate Runoff** |
|---|---|---|
| Existing Conditions | 16,814 $m^3$ | 16,814 $m^3$ |
| Post-Development Conditions | 17,612 $m^3$ | 20,275 $m^3$ |
| Change from Existing Conditions | +5% | +21% |

Therefore, the infiltration targets for the site are being achieved through the infiltration occurring in the stormwater management facility.

## 6.0 SEDIMENT AND EROSION CONTROL PLAN

Primary sediment control will be achieved with the installation of silt fence around the property boundary. The silt fence will eliminate the opportunity for water borne sediments to be transported from the site.

Temporary rock check dams will be installed in rear and side yard swales after the initial grading has been completed to slow the flow rates and promote the settlement of water borne sediments before they reach the silt fences and ponds.

A silt fence will be placed around any outlet structures discharging to the Kurtz Municipal Drain to restrict the movement of sediment.

The grates of any catch basin structures installed on site will also be wrapped in filter cloth. This will be maintained until all building and landscaping has been completed.

Inspection and maintenance of all silt fencing, and erosion and sediment control measures will start after installation is complete. These features will be inspected on a weekly basis or after a rainfall event of 13 mm or greater. Maintenance will be carried out, within 48 hours, on any part of the facility found to need repair.

Once construction has been substantially completed, the silt fence will be removed from within the pond, any accumulated sediment will be removed, and the landscaping and planting of the ponds will be completed.

After construction of the complete development, erosion and sediment transport will be minimal.

## 7.0 CONCLUSIONS

In summary, the features of the design for the proposed development are as follows:

1. Sanitary servicing will be provided by lot level private septic system complete with enhanced tertiary treatment.

2. Water servicing will be provided by a private well for each lot which is to be designed and constructed by others.

3. Stormwater convey systems will be designed to convey the 5-year design storm event, while the major overland flows from the site will be directed overland towards the Kurtz Municipal Drain.

4. The perforated storm pipe storage systems are designed to function as a detention storage.

5. The post-development flow rates discharging from the site during the 5 and 100-year design storm are less than the pre-development flow rates from the site.

6. Enhanced level (80% TSS Removal) quality control for the site will be provided via the perforated storm pipe storage systems and grassed roadside ditches.

7. The stormwater management systems meet the current Provincial and Municipal guidelines.

8. The principles of "Stormwater Management Practices", the Ministry of Environment Stormwater Management Planning and Design Manual 2003 have been used in the design of the stormwater management system.

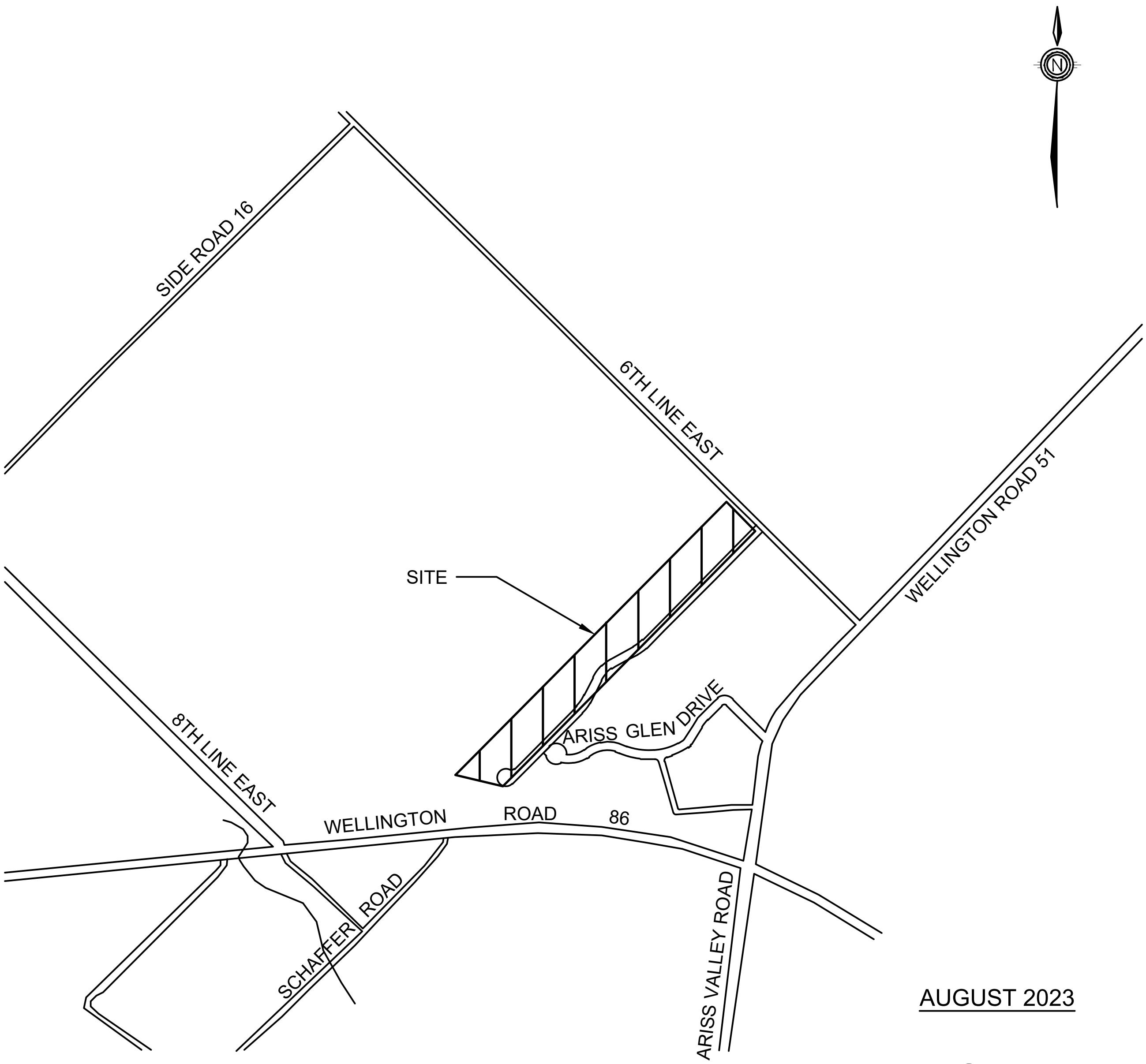
All of which is respectfully submitted.

GM Blue Plan Engineering LIMITED
Per:


Angela Kroetsch, P.Eng.
AK/jl

\\gamsby.local\GMProjects\Kitchener\420-2020\420099-1 6th Line Aris Draft Plan Approval\Design Phase\Reports - SWM, FSR, Design Brief, etc\420099 - Functional Servicing and Stormwater Management Report-Revised_2024-01-30.docx

# 5782 6TH LINE EAST
# TOWNSHIP OF GUELPH/ERAMOSA (ARISS)



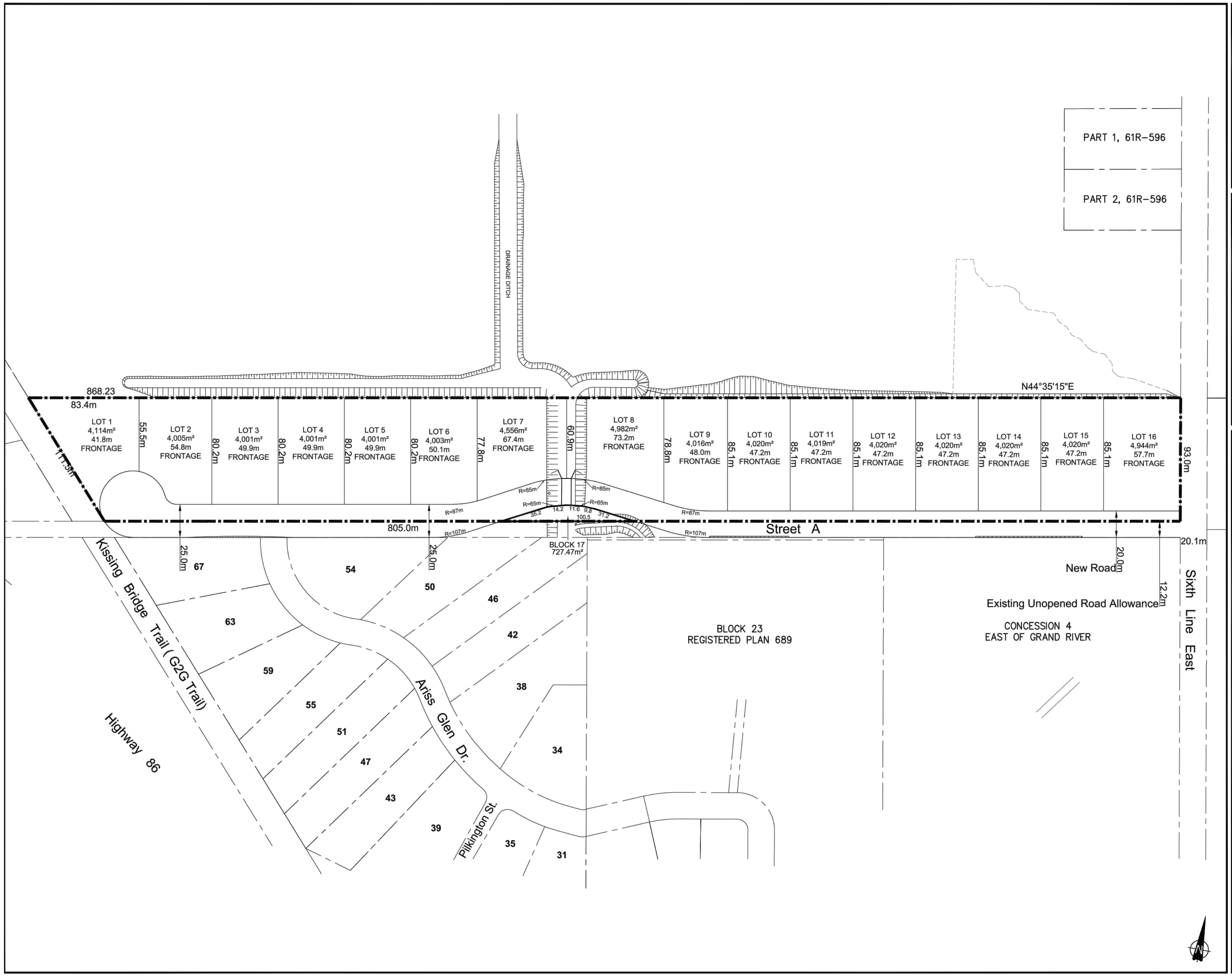

AUGUST 2023

SITE LOCATION MAP
Figure No. 1

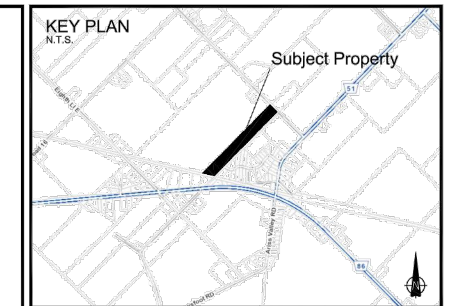
GM BluePlan ENGINEERING

FILE:W:\Kitchener\420-2020\420099 - Will O Homes 6th Line East Ariss\Drawings\420099 SWM.dwg LAYOUT:FIGURE 1
LAST SAVED BY:Sgasior, 1/25/2024 2:04:32 PM PLOTTED BY:Steve Gasior - GM BluePlan 1/25/2024 2:07:10 PM

# 5782 6TH LINE EAST
# TOWNSHIP OF GUELPH/ERAMOSA (ARISS)




KEY PLAN
N.T.S.




# DRAFT PLAN OF SUBDIVISION

Part of Lot 17, Concession 4
East of the Grand River
Geographic Township of Pilkington
Township of Guelph-Eramosa
County of Wellington

Sixth Line East, Ariss

## LAND USE SCHEDULE

| DESCRIPTION | LOTS/BLKS. | UNITS | AREA (ha.) |
|---|---|---|---|
| Single Detached Residential | 1-16 | 16 | 6.67 |
| Open Space | 17 | | 0.07 |
| Roads | | | 1.05 |
| Total | | 16 | 7.79 |

## ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT)

INFORMATION REQUIRED BY CLAUSES a,b,c,d,e,f,g,j and l ARE AS SHOWN ON THE DRAFT PLAN.

h) Municipal water supply
i) Sandy silt trace gravel
k) All sanitary and storm sewers as required

## OWNER'S CERTIFICATE

I AUTHORIZE THE GSP GROUP INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE COUNTY OF OXFORD.

OWNERS SIGNATURE DATE

## SURVEYOR'S CERTIFICATE

I CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE CORRECTLY SHOWN.

SURVEYORS SIGNATURE DATE

GSP group
PLANNING | URBAN DESIGN | LANDSCAPE ARCHITECTURE
gspgroup.ca

REVISIONS
November 7, 2023

| | | |
|---|---|---|
| Date: April 26, 2022 | Drawn By: E.F | Dwg. File Name:dp19274d.dwg |
| Scale: 1:1,250 metric | Project No.: 19274 | |

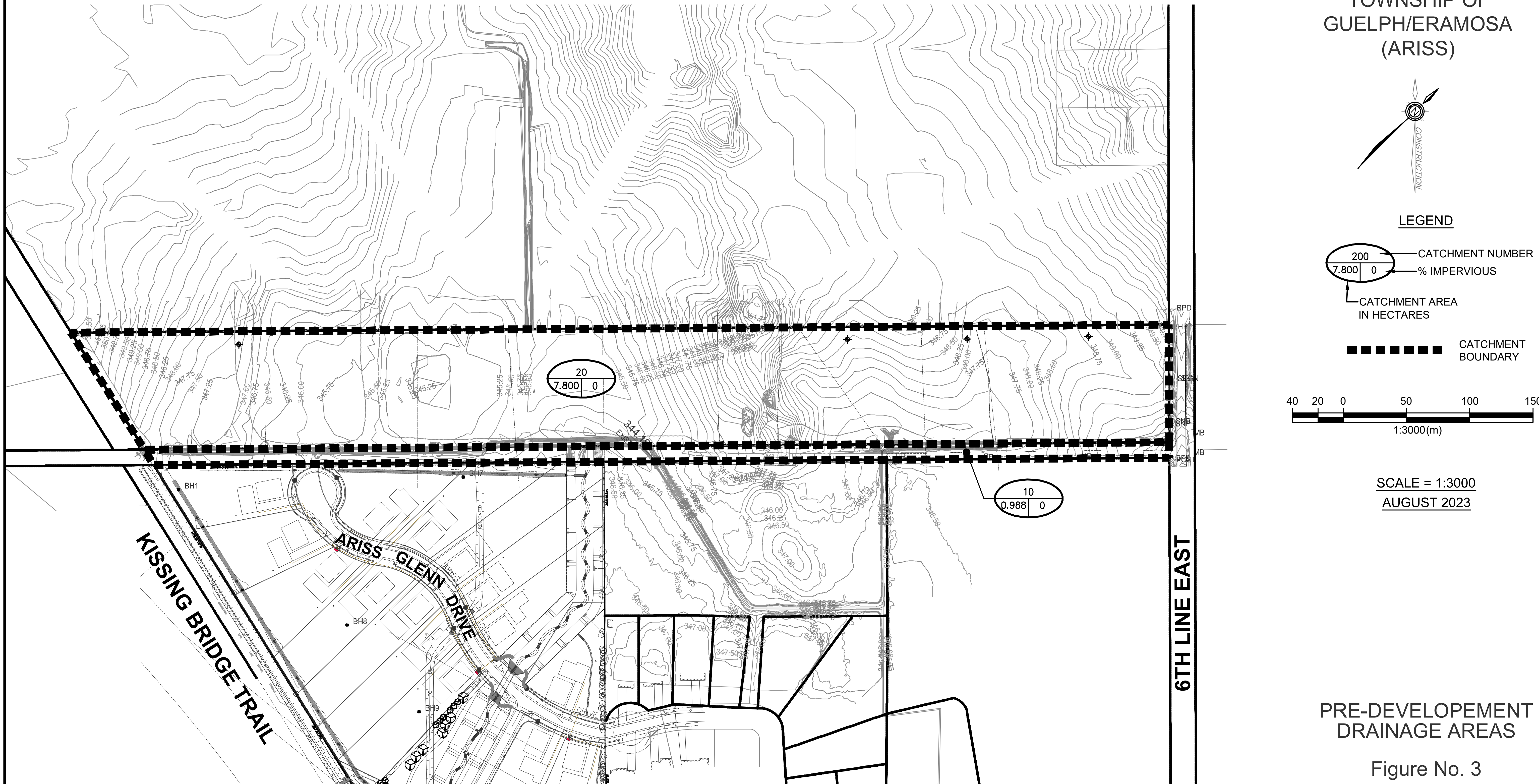
SCALE = N.T.S
JANUARY 2024

PROPOSED DEVELOPMENT

Figure No. 2

GM BluePlan ENGINEERING

FILE:W:\Kitchener\420-2020\420099 - Will O Homes 6th Line East Ariss\Drawings\420099 SWM.dwg LAYOUT:FIGURE 2 PROP DEVELOPMENT
LAST SAVED BY:Sgasior, 1/25/2024 2:04:32 PM PLOTTED BY:Steve Gasior - GM BluePlan 1/25/2024 2:07:13 PM




# 5782 6TH LINE EAST TOWNSHIP OF GUELPH/ERAMOSA (ARISS)

SCALE = 1:3000

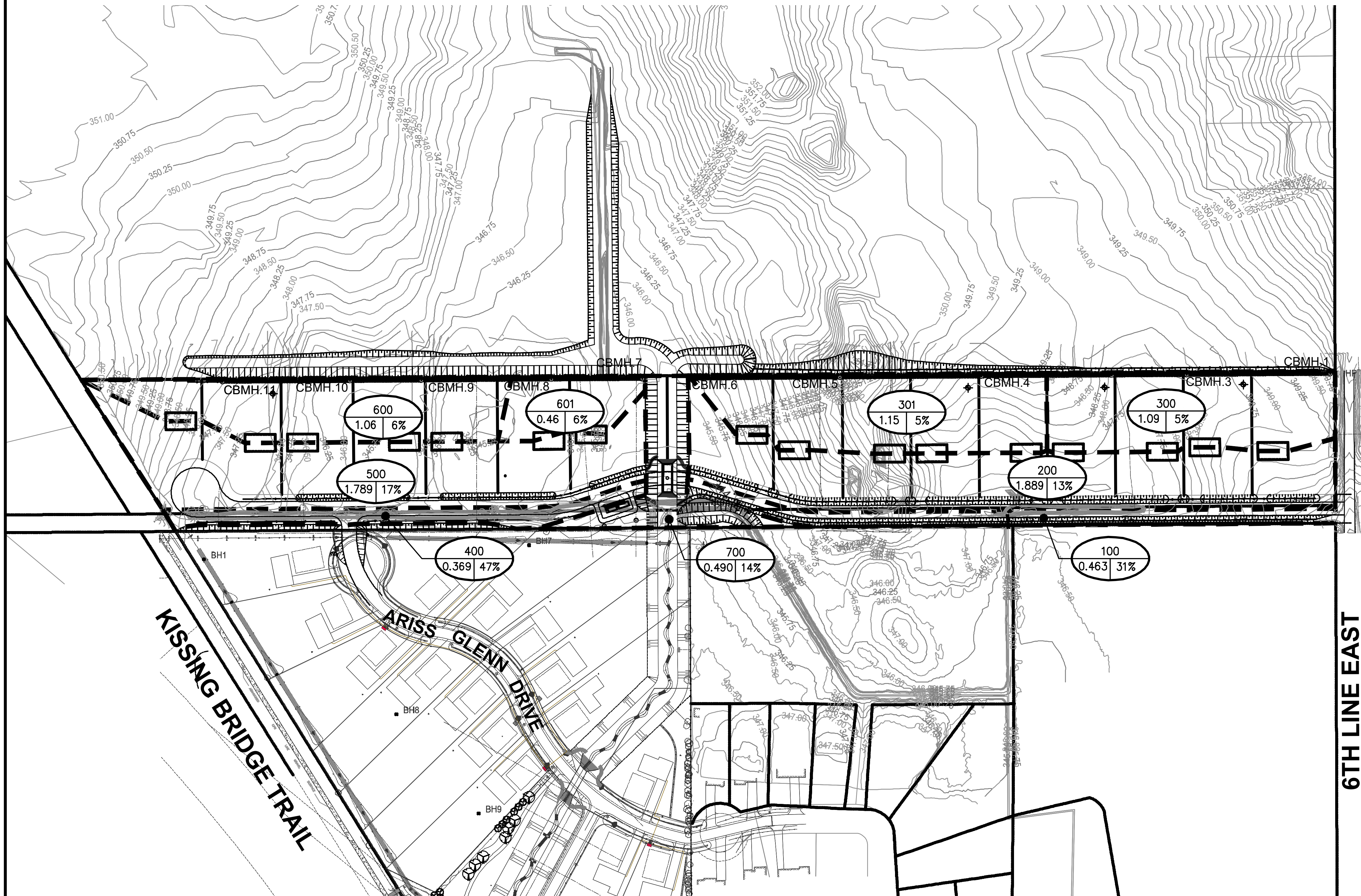
AUGUST 2023

## PRE-DEVELOPEMENT DRAINAGE AREAS

Figure No. 3

GM BluePlan ENGINEERING

FILE:W:\Kitchener\420-2020\420099 - Will O Homes 6th Line East Ariss\Drawings\420099 SWM.dwg LAYOUT:SWM PRE
LAST SAVED BY:Sgasior, 1/25/2024 2:04:32 PM PLOTTED BY:Steve Gasior - GM BluePlan 1/25/2024 2:07:45 PM




# 5782 6TH LINE EAST
# TOWNSHIP OF GUELPH/ERAMOSA (ARISS)

CONSTRUCTION

LEGEND

100 — CATCHMENT NUMBER
1.2472 | 87% — % IMPERVIOUS
CATCHMENT AREA IN HECTARES

CATCHMENT BOUNDARY

40 20 0 50 100 150
1:3000(m)

SCALE = 1:3000

JANUARY 2024

## POST-DEVELOPMENT DRAINAGE AREAS

Figure No. 4

GM BluePlan ENGINEERING

FILE:W:\Kitchener\420-2020\420099 - Will O Homes 6th Line East Ariss\Drawings\420099 SWM.dwg LAYOUT:SWM PROP
LAST SAVED BY:Sgasior, 1/25/2024 2:04:32 PM PLOTTED BY:Steve Gasior - GM BluePlan 1/25/2024 2:08:46 PM

# APPENDIX A

## Geotechnical Investigation

CMT Engineering Inc., 2021

# GEOTECHNICAL INVESTIGATION

**PROPOSED RESIDENTIAL DEVELOPMENT**
**5782 6$^{th}$ LINE EAST**
**ARISS, ONTARIO**

**CMT Project 21-209.R01**

**Prepared for:**

**Will-O Homes**

**June 10, 2021**

*CMT Engineering Inc.*
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
*Tel: 519-699-5775*
*Fax: 519-699-4664*
www.cmtinc.net

June 10, 2021 21-209.R01

Will-O Homes
Box 187
Petersburg, Ontario
N0B 2H0

Attention: Mr. Kevin Smith

Dear Sir:

**Re: Geotechnical Investigation**
**Proposed Residential Development**
**5782 6th Line East**
**Ariss, Ontario**

As requested, CMT Engineering Inc. conducted a geotechnical investigation at the above referenced site, and we are pleased to present the enclosed report.

We trust that this information meets your present requirements, and we thank you for allowing us to undertake this project. Should you have any questions, please do not hesitate to contact our office.

Yours truly,

J Feeney

Jake Feeney B.Eng., EIT.

ks

**TABLE OF CONTENTS**

## *1.0 INTRODUCTION*

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. Kevin Smith of Will-O Homes to conduct a geotechnical investigation for the proposed residential development to be constructed at 5782 6$^{th}$ Line East in Ariss, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will involve the construction of seventeen (17) estate homes, approximately 2,500 ft$^2$ to 3,500 ft$^2$ in size. It is understood that each home is proposed to have roughly one (1) three-car garage, four (4) bedrooms and four (4) to five (5) bathrooms. Private Class IV septic systems and drilled wells are proposed to service the residences.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes. Included in the assessment are the soil classification and groundwater observations, as well as comments and recommendations regarding geotechnical resistance (bearing capacity); serviceability limit states (anticipated settlement); dewatering considerations; site classification for seismic site response; recommendations for site grading, site servicing, excavations and backfilling; recommendations for slab-on-grade construction; pavement design/drainage; soil design properties; and a summary of the laboratory results.

The recommendations provided in this report are solely based on the information obtained from the boreholes advanced on the subject site.

## *2.0 EXISTING SITE CONDITIONS*

The site of the proposed residential development is located on the southwest side of 6$^{th}$ Line East in Ariss. The site is bounded by 6$^{th}$ Line East to the northeast, residential property to the southeast, Kissing Bridge Trail and Wellington Road 86 to the southwest, and agricultural fields to the northwest. The site currently comprises agricultural land. In general, the site topography is undulating slightly throughout the proposed construction area.

## *3.0 FIELD AND LABORATORY PROCEDURES*

The field investigation was conducted on May 13 and 26, 2021 and comprised the advancement of six (6) boreholes (referenced as Boreholes 1 to 6), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. Boreholes 1 to 6 were advanced to depths of approximately 6.10 m (20.00 ft) below the existing ground surface in the area of the proposed development. Prior to the field investigation being carried out, underground service locates were undertaken to ensure that existing utilities would not be damaged, or personnel injured.

Standard penetration testing and sampling was carried out in Boreholes 1 to 6 using a 38 mm inside diameter split spoon sampling equipment and an automatic hammer, in accordance with ASTM D1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel

Sampling of Soils". SPT soil sampling was generally conducted at 0.76 m (2.5 ft) intervals to 3.05 m (10.00 ft) and every 1.52 m (5.00 ft) thereafter, to borehole termination. Macro core (MC5) direct push sampling was typically conducted between the SPT soil samples conducted below 3.05 m (10.00 ft) depth. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations.

Representative soil samples from boreholes at the following depths were submitted to the CMT Inc. laboratory in St. Clements, Ontario for grain size analyses:

- Borehole 1 – depth 2.29 m to 2.90 m (7.50 ft to 9.50 ft)
- Borehole 2 – depth 0.76 m to 1.37 m (2.50 ft to 4.50 ft)
- Borehole 3 – depth 3.05 m to 3.66 m (10.00 ft to 12.00 ft)
- Borehole 4 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft)
- Borehole 5 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft)
- Borehole 6 – depth 3.05 m to 3.66 m (10.00 ft to 12.00 ft)

The borehole logs are provided in Appendix A and the resulting grain size analyses can be found in Appendix B.

Monitoring wells were installed at all six of the borehole locations and comprised 3.05 m (10.00 ft) long slotted screens. The monitoring well screens were backfilled with #2 filter sand and the riser pipes were backfilled with bentonite. The monitoring wells were installed in accordance with the Ontario Water Resources Act, Regulation 903 (O. Reg. 903) by well technicians licensed by the Ministry of the Environment, Conservation and Parks (MECP). The well records are provided in Appendix C.

The ground surface elevations of the boreholes were surveyed by GM BluePlan Engineering Limited prior to the commencement of drilling. The ground surface elevations at the borehole locations ranged from approximately 345.50 m to 350.22 m. The locations of the boreholes are shown on Drawing 2.

## *4.0 SUBSOIL CONDITIONS*

The soils encountered in the boreholes are described briefly below and a more detailed stratigraphic description is provided on the borehole logs in Appendix A. The following paragraphs have been simplified into terms of major soil strata. The soil boundaries indicated have been inferred from non-continuous samples and observations of sampling and drilling resistance and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, the subsurface conditions are anticipated to vary between and beyond the borehole locations.

### ***4.1. Topsoil***

Loose, moist, dark brown, silty, organic topsoil was encountered at the surface of all borehole locations. The thickness of the topsoil was observed to range from about 300 mm to 610 mm (average 520 mm) at the borehole locations, however, the thickness of the topsoil is anticipated to vary throughout the site. Materials noted as topsoil in this report were classified based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out.

### ***4.2. Sand and Gravel Fill***

Brown sand and gravel fill with trace silt was encountered underlying the topsoil at Borehole 6. The sand and gravel fill had an approximate thickness of 1,680 mm. The sand and gravel fill was considered to be compact to dense, with SPT N-values ranging from about 13 to 47 blows per 0.30 m (average 30 blows per 0.30 m). The sand and gravel fill soils are considered to be moist to saturated, with measured moisture contents ranging from about 6.7% to 13.3% (average 10.0%). It should be noted that the sand and gravel fill is likely backfill from a nearby field drain.

### ***4.3. Sand and Gravel***

Brown to reddish brown sand and gravel with trace silt was encountered underlying the sandy silt at Boreholes 2 and 5 and underlying the topsoil at Borehole 4. The sand and gravel was considered to be compact to very dense, with SPT N-values of about 19 blows per 0.30 m. The sand and gravel soils are considered to be moist to saturated, with measured moisture contents ranging from about 6.1% to 16.3% (average 11.2%).

### ***4.4. Sandy Silt***

Grey to brown sandy silt to sand and silt with trace to some clay and trace to no gravel was encountered underlying the topsoil at Boreholes 1, 2, 3 and 5; underlying the sand and gravel at Boreholes 2, 4, and 5; and underlying the sand and gravel fill at Borehole 6. The sandy silt was observed to extend to the termination depth of all six (6) boreholes. Oxidation staining was observed within the sandy silt at Boreholes 3 and 4. The sandy silt was considered to be very loose to very dense, with SPT N-values ranging from 4 to greater than 100 blows per 0.30 m (average 42 blows per 0.30 m). The sandy silt soils are considered to be moist to wet, with measured moisture contents ranging from about 5.5% to 17.6% (average 9.3%).

### *4.5. Groundwater*

Monitoring wells were installed in all boreholes to measure the static groundwater levels. The water levels were measured by CMT Inc. personnel on June 8, 2021.

The measured elevations of water in the monitoring wells, the estimated wet to saturated zones, as well as the ground surface and bottom of borehole elevations, are provided in the following table:

| Borehole No. | Ground Surface Elevation (m) | Measured Elevation of Water in Monitoring Well June 8, 2021 (m) | Estimated Wet to Saturated Zones (m) | Bottom of Borehole Elevation (m) |
|---|---|---|---|---|
| 1 | 349.18 | 347.86 (1.32) | -- | 343.08 |
| 2 | 345.58 | 344.16 (1.42) | 344.97 to 343.90 | 339.48 |
| 3 | 345.50 | 344.09 (1.41) | -- | 339.40 |
| 4 | 350.22 | 347.04 (3.18) | 347.93 to 347.17 | 344.12 |
| 5 | 347.45 | 345.92 (1.53) | 343.18 to 342.88 | 341.35 |
| 6 | 349.04 | 348.38 (0.66) | 347.52 to 346.75 | 342.94 |

It should be noted that the typically fine-grained sandy silt soils have the potential to create perched groundwater in the overlying soils. Groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report.

## *5.0 DISCUSSION AND RECOMMENDATIONS*

This section of the report provides CMT Inc.'s interpretation of the factual geotechnical data obtained during the investigation and is intended for the guidance of the owner and design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors bidding on or undertaking the work should make their own independent interpretation of the factual subsurface information provided as it affects their proposed construction means and methods, equipment selection, scheduling, pricing, and the like.

Utilizing the information gathered during the geotechnical investigation and assuming that the borehole information is representative of the subsoil conditions throughout the site, the following comments and recommendations are provided.

### *5.1. Serviceability and Ultimate Limit Pressure*

Based on the information obtained from the boreholes, the following table provides a summary of the estimated geotechnical reaction at the Serviceability Limit State (SLS) and the factored geotechnical resistance at the Ultimate Limit State (ULS) at the various elevations, including soil type:

| MW No. | Ground Surface Elevation (m) | SLS kPa (psf) | ULS kPa (psf) | Estimated Highest Founding Elevations (m) | Depth Below Existing Grade to Founding Elevation (m) | Soil Type |
|---|---|---|---|---|---|---|
| 1 | 349.18 | 75 (1,500) | 115 (2,300) | 348.52 to 347.66 | 0.66 | Sandy Silt |
| | | 150 (3,000) | 225 (4,500) | 347.66 to 343.08 (termination) | 1.52 | |
| 2 | 345.58 | 150 (3,000) | 225 (4,500) | 344.36 to 339.48 (termination) | 1.22 | Sandy Silt/Sand and Gravel |
| 3 | 345.50 | 75 (1,500) | 115 (2,300) | 344.59 to 343.98 | 0.91 | Sandy Silt Clayey Silt |
| | | 150 (3,000) | 225 (4,500) | 343.98 to 339.40 (termination) | 1.52 | |
| 4 | 350.22 | 150 (3,000) | 225 (4,500) | 349.31 to 344.12 (termination) | 0.91 | Sand and Gravel/Sandy Silt |
| 5 | 347.45 | 150 (3,000) | 225 (4,500) | 346.69 to 341.35 (termination) | 0.76 | Sandy Silt/Sand and Gravel |
| 6 | 349.04 | 150 (3,000) | 225 (4,500) | 348.13 to 345.99 | 0.91 | Sand and Gravel Fill/Sandy Silt |
| | | 75 (1,500) | 115 (2,300) | 345.99 to 342.94 (termination) | 3.05 | |

*Highest founding elevations presented above do not take into account groundwater conditions.

Based on the bearing capacities and elevations provided in the table above, soils suitable to support conventional foundations designed with an estimated bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS were typically encountered underlying the topsoil and loose upper soils encountered in the boreholes. Soils suitable to support conventional foundations designed with an estimated bearing capacity of

75 kPa (1,500 psf) at SLS and 115 kPa (2,300 psf) at ULS were typically encountered below the topsoil in the borehole locations. It is recommended that footings be founded at least one (1) footing width (minimum 0.5 m) above the high groundwater table at the site. Depending on the groundwater conditions at the time of construction, it may be necessary to install a granular drainage layer or mud mat to provide a suitable base for the foundations. This will depend on the bearing capacity required for the founding strata. If required, the granular drainage layer must conform to the requirements listed in Section 9.14.4 of the OBC 2012. The founding soils must be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

Should footings be designed to be constructed at elevations higher than the elevations indicated in the table above, then structural fill will be required in order to achieve the design grades for the proposed foundations. The serviceability limit pressure for granular structural fill placed and compacted in accordance with Section 5.4.4 of this report is estimated to be at least 150 kPa (3,000 psf). Alternatively, lean mix concrete fill could be used for this application.

Footings could also be stepped down to bear on approved undisturbed founding soils. Due to the presence of wet to saturated soils on the subject site, it is imperative that the founding soils be assessed at the time of construction by qualified geotechnical personnel in order to confirm their suitability.

Footings founded on soil may be placed at a higher elevation relative to another footing provided that the slope between the outside face of the footings is separated by a minimum slope of 10 horizontal to 7 vertical (10H:7V) with an imaginary line projected from the underside of the footings.

It is recommended that the structural foundation drawings be cross-referenced with site servicing drawings to ensure that service pipes do not conflict with building foundations (including the zone of influence down and away from the footings).

With respect to the Serviceability Limit State (SLS), the total and differential footing settlements are not expected to exceed the generally acceptable limits of 25 mm (1") and 19 mm (3/4") respectively.

All exterior footings must be provided with a minimum of 1.2 m of soil cover or equivalent thermal insulation in order to provide protection against frost action.

CMT Inc. would be pleased to review design drawings when they become available and provide further recommendations with respect to bearing and foundation elevations.

### 5.2. Seismic Site Classification

The site classification for seismic response in Table 4.1.8.4 of the 2012 Ontario Building Code relates to the average properties of the upper 30.0 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 6.10 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class D (stiff soils) for structures founded on the native soils or structural fill at the recommended founding elevations provided in Section 5.1 of this report. The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

### 5.3. Soil Design Parameters

The following table provides estimated soil design parameters for imported granular fill, as well as the existing native soils encountered on-site. It should be noted that earth pressure coefficients (Ka, Kp, Ko) provided are for flat ground surface conditions and will differ for areas with slopes or embankments.

The estimated soil design parameters can be utilized for the design of perimeter shoring, foundations and retaining walls, as required.

| Soil Type | Soil Density ($kg/m^3$) | Friction Angle (Degree) | Coefficient of Active Pressure ($K_a$) | Coefficient of Passive Pressure ($K_p$) | Coefficient of At-Rest Pressure ($K_o$) | Coefficient of Friction (μ) | Cohesion (Undrained) (kPa) |
|---|---|---|---|---|---|---|---|
| Imported Granular 'A'/ Granular 'B' (OPSS 1010) | 2,100 | 34° | 0.28 | 3.54 | 0.44 | 0.45 | 0 |
| Sandy Silt | 1,750 | 30° | 0.33 | 3.00 | 0.50 | 0.38 | 0 |
| Sand and Gravel | 1,900 | 34 ° | 0.28 | 3.54 | 0.44 | 0.45 | 0 |

### 5.4. Site Preparation

The site preparation for the proposed residential development is anticipated to include the removal of topsoil and vegetation, the subexcavation of any unsuitable fill and any native soils deemed not capable of supporting the design bearing capacity, removal or relocation of any existing services, followed by the placement of structural fill (as required) and site grading to achieve proposed grades.

### 5.4.1. Topsoil Stripping/Vegetation Removal

All topsoil must be removed from within the proposed building and roadway envelopes to expose approved competent subgrade soils. The topsoil may be used in landscaped areas where some settlement can be tolerated; otherwise it should be properly disposed of off-site.

All vegetation and trees (including tree root structures as well as any loose soils that are typically associated with root structures) must be removed from within the proposed building and roadway envelopes to expose approved competent subgrade soils.

The volume of topsoil removed during the stripping process can be influenced by the equipment utilized for the stripping process as well as the moisture conditions at the time of stripping.

### 5.4.2. Removal/Relocation of Existing Buried Piping

It should be noted that a hickenbottom was noted in the area of Boreholes 5 and 6. Any existing underground services (if present) that may be located within the proposed building envelopes must be removed/relocated. If left in place, the location of existing services must be reviewed to ensure that they do not conflict with proposed foundation locations. This includes any existing field tiles or subdrains that may be present. Any piping that is left in place that is no longer active must be completely sealed with watertight mechanical covers, concrete or grout at termination points to prevent the migration of soils into pipe voids, which may result in potential settlement. All existing trench backfill material associated with any underground services must be subexcavated and the subsequent excavation must be backfilled with approved soils placed in accordance with Section 5.4.4 of this report.

### 5.4.3. Fill Removal

Any existing fill (including any existing trench backfill), as well as any native soils that have inadequate bearing capacity or has been disturbed by demolition/construction processes and are considered to be unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building envelopes, exterior entranceways, perimeter sidewalks and perimeter concrete slab areas to expose approved competent subgrade soils. It would also be sound construction practice to subexcavate all existing unsuitable fill from the paved driveway areas; however, this may not be cost-effective. At a minimum, thorough inspection will be required at the time of construction to assess the existing fill to ensure there is no buried topsoil or other deleterious materials within the subgrade soils. Remedial action may also be required to further consolidate any existing fill or loose/soft native soils if it is decided to leave them in place. If any existing fill is left in place, provisions for the alterations to the design of the pavement structure should be included in the tender documents. Review of the subgrade and potential changes to the design of the pavement structure, as required, will be addressed at the time of construction.

Prior to reusing excavated material on-site as potential bulk fill, thorough field inspection and approval by qualified geotechnical personnel would be required to ensure that existing fill materials are not comprised of organics, topsoil or other deleterious materials.

#### *5.4.4. Site Grading*

Following removal of the topsoil and vegetation, as well as the subexcavation of any fill or native soils deemed unsuitable of supporting the design bearing capacity, the exposed subgrade soils must be proof-rolled, and any soft or unstable areas must be subexcavated and replaced with approved fill materials.

Any fill materials required to achieve the design grades should be placed according to the following procedures:

- Prior to placement of any structural fill or bulk fill, the subgrade for the proposed buildings and roadway must be prepared large enough to accommodate a 1:1 slope commencing a distance of 1.0 m beyond the outside edge of the proposed foundation and pavement edge (where feasible) to the approved competent founding soils;

- Soils approved for use as structural fill must be placed in loose lifts not exceeding 0.3 m (12") in depth for granular soils (recommended fill material) and 0.2 m (8") in depth for silts and clays (not recommended for this application), or the capacity of the compactor (whichever is less);

- Granular fill materials (OPSS 1010 Type III Granular 'B' recommended for this application) can be compacted utilizing adequate heavy vibratory smooth drum or padfoot compaction equipment;

- Fine-grained silt and clay soils (not recommended) must be compacted utilizing adequate heavy padfoot vibratory compaction equipment;

- Approved fill materials must be at suitable moisture contents to achieve the specified compaction. Soil moisture will also be dependent on weather conditions at the time of construction. Granular soils may require the addition of water in order to achieve the specified compaction;

- Approved structural fill materials that will support structures (including foundations, interior slab-on-grades, sidewalks and large expansive exterior slabs) must be compacted to 100% standard Proctor maximum dry density (SPMDD);

- Approved bulk fill (foundation wall backfill, bulk fill under slab-on-grades that will not support footings or heavy point loading) must be compacted to a minimum 98% SPMDD. It would be expected that the native soils would be suitable for use as bulk fill; however, depending on the time of year and weather conditions when construction takes place, soils excavated at depth may require air-drying in order to achieve the specified density; and

- Granular 'B' subbase and Granular 'A' base materials for the paved parking areas must be compacted to 100% SPMDD.

Any wet to saturated soils encountered during the excavation will require significant air-drying along with working of the soils in order to achieve the specified compaction. Utilizing the existing soils during site grading may be more achievable if work is completed during the generally drier summer months. It should be noted, however, that due to the nature of some of the soils, during hot dry weather, the addition of water might be required in order to achieve the specified compaction. Reuse of excavated soils on-site will be subject to approval from qualified geotechnical personnel.

### *5.5.* ***Foundation Subgrade Preparation***

The native soils encountered in the boreholes are sensitive to change in moisture content and can become loose/soft if the soils are subjected to additional water or precipitation, as well as severe drying conditions. The native subgrade soils could also be easily disturbed if traveled on during construction. Once they become disturbed, they are no longer considered adequate for the support of shallow foundations.

To ensure and protect the integrity of the founding soils during construction operations, the following is recommended:

- Should the native soils at the design founding elevation in the proposed building envelopes comprise wet or saturated soils, then a granular drainage layer, constructed in accordance with Section 9.14.4 of the current Ontario Building

Code (OBC) may be required. Alternatively, a lean mix concrete mud mat may be poured overlying the subgrade soils to provide a stable base;

- During construction, the subgrade should be sloped/ditched to a sump (as required) located outside the building footprint (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavation. It is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparation commence in dry conditions;

- Construction equipment travel and foot traffic on the founding soils should be minimized;

- If construction is to be undertaken during subzero weather conditions, the founding native soils and any potential fill materials must be maintained above freezing;

- Prior to placing concrete for the footings, the footing area must be cleaned of all disturbed or caved materials;

- The foundation formwork and concrete should be installed as soon as practical following the excavation, inspection and approval of the founding soils. The longer that the excavated soils remain open to weather conditions and groundwater seepage, the greater the potential for construction problems to occur;

- If it is expected that the founding soils will be left open to exposure for an extended period of time, it is recommended that a 75 mm concrete mud slab be poured in order to protect the structural integrity of the founding soils.

All foundation excavations must be reviewed by qualified personnel to confirm the suitability of the founding fill soils prior to foundation placement.

### *5.6. Slab-on-Grade/Modulus of Subgrade Reaction*

Prior to the placement of the granular base for any slab-on-grades, the subgrade soils must be proof-rolled. Any soft or weak zones, as well as the unsuitable fill in the subgrade, should be subexcavated and backfilled with approved fill materials (see Sections 5.4.4 and 5.10 of this report).

The following table provides the estimated modulus of subgrade reaction (k) for imported granular fill, as well as the native soils encountered on-site:

| Soil Type | Estimated Modulus of Subgrade Reaction (k) |
|---|---|
| Imported Sand and Gravel (OPSS 1010) | 81,000 kN/m$^3$ (300 lb/in$^3$) |
| Sandy Silt | 33,955 kN/m$^3$ (125 lb/in$^3$) |
| Sand and Gravel | 68,000 kN/m$^3$ (250 lb/in$^3$) |

In dry conditions, floor slabs can be founded on a minimum thickness of 150 mm (6") of Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. It should be noted that wet to saturated soil conditions were encountered in the boreholes. As such, if wet to saturated soils are encountered during the excavation, it would be recommended that 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) should be used as a base for the floor slabs instead of Granular 'A'. Utilizing clear crushed stone for the slab-on-grade base can assist in providing a moisture barrier by reducing the potential for capillary rise of moisture from the subgrade soils. Compactive effort is required to consolidate the clear stone. The 19 mm clear crushed stone should meet the physical property and gradation requirements of OPSS 1004.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks and accessibility ramps) be constructed with a Granular 'B' subbase (450 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to promote rapid drainage and reduce the effects of frost heaving. This is particularly critical at barrier-free access points. Alternatively, structural frost slabs could be designed and constructed, or sufficient thermal insulation could be provided, at all door entrances and areas of barrier-free access.

## *5.7.* ***Excavations***

All excavations must be carried out in accordance with Ontario Regulation 213/91 (Reg 213/91) of the Occupational Health and Safety Act and Regulations for Construction Projects.

**Type 2 Soils** - In general, the native sandy silt soils encountered in the boreholes in a drained state (not saturated), would be classified as Type 2 soils under Reg 213/91. The Type 2 soils must be sloped from within 1.2 m of the bottom of the excavation having a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 3 or 4 soils that are exposed in the excavation must be treated accordingly as Type 3 or 4 soils (see below). All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 3 Soils** - In general, any existing fill materials (backfill of existing foundations and services) as well as the sand and gravel soils in a drained state (not saturated), would be classified as Type 3 soils under Reg 213/91. The Type 3 soils must be sloped from the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 4 soils that are exposed in the excavation must be treated accordingly as Type 4 soils (see below). All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 4 Soils** - In general, any wet to saturated soils would be classified as Type 4 soils under Reg 213/91. Type 4 soils must be sloped from the bottom of the excavation at a minimum gradient of 3 horizontal to 1 vertical.

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized. When using a temporary trench support system consisting of trench boxes to reduce the lateral extent of the excavations, it should be noted that the support system is intended primarily to protect workers as opposed to controlling lateral soil movement. Any voids between the excavation walls and the support system should be immediately filled to reduce the potential for loss of ground and to provide support to existing adjacent utilities and structures, and it is recommended that the excavation be carried out in short sections, with the support system installed immediately upon excavation completion.

### *5.8. Construction Dewatering Considerations*

It should be noted that the groundwater was measured to be relatively shallow throughout the borehole locations. Groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume. As such, provisions for site dewatering should be part of the site development and construction process.

Seepage control requirements during construction will depend upon the area of work on the site, the depth of the excavations, the time of year, the amount of precipitation and the control of surface water. As required, seepage should generally be adequately controlled using conventional construction dewatering techniques such as pumping from sump pits. However, if heavy seepage occurs (particularly in the saturated soil deposits), it may be necessary to increase the number of pumps during construction.

Dewatering should be performed in accordance with OPSS 517, and the control of water must be in accordance with OPSS 518. It is the responsibility of the contractor to propose a suitable dewatering system based on the groundwater elevation at the time of construction. Collected water should discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures must be installed at the discharge point of the dewatering system to avoid any potential adverse impacts on the environment.

## *5.9. Service Pipe Bedding*

The native soils encountered in the geotechnical investigation are generally considered suitable for indirect support of the site service pipes, however there is the potential for a high groundwater table to be encountered. Should instability due to saturated soil conditions be encountered, it may be necessary to increase the thickness of the granular base and utilize 19 mm clear stone to create an adequate supporting base for the service pipes and/or manholes. Additionally, it may be necessary to place granular bedding/backfill immediately upon placing the pipe to prevent the pipe from floating in wet conditions. Pipe embedment, cover and backfill for both flexible and rigid pipes should be in accordance with all current and applicable OPSD, OPSS and OBC standards and guidelines and as follows:

**Flexible Pipes** – The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.031. The trench excavations should be symmetrical with respect to the centre-line of the pipe. The granular material placed under the haunches of the pipe must be compacted to 100% SPMDD prior to the continued placement and compaction of the embedment material. The homogeneous granular material used for embedment should be placed and compacted uniformly around the pipe. Should wet conditions be encountered at the base of the trench, then the pipe bedding should consist of 19 mm clear stone (meeting OPS Specifications) wrapped completely in a geotextile fabric such as Terrafix 270 or equivalent.

**Rigid Pipes** - In general, the pipe installation recommendations for rigid pipes are the same as those for flexible pipes, except that the minimum bedding depth below a rigid pipe should be $0.15D$ (where $D$ is the pipe diameter). In no case should this dimension be less than 150 mm or greater than 300 mm.

Any service pipes that are not provided with sufficient frost coverage must be protected with the necessary equivalent thermal insulation. The general contractor is responsible to protect existing and new service piping from damage by heavy equipment.

## *5.10. Perimeter Building Drainage, Foundation Wall Backfill and Trench Backfill*

In order to assist in maintaining a dry building with respect to surface water seepage, it is recommended that exterior grades around the building be sloped down and away at a 2% gradient or more, for a distance of at least 1.5 m. Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from the building foundation and/or beyond sidewalks to a drainage swale or appropriate storm drainage system.

In order to reduce the effects of surficial frost heave in areas that will be hard surfaced, it is recommended that the exterior foundation backfill consist of free-draining granular material such as approved on-site sand or sand and gravel or imported Granular 'B' Type I or Type III (OPSS 1010), with a maximum aggregate size not exceeding 100 mm, and that it extend a minimum lateral distance of 600 mm out from the foundation walls and/or beyond perimeter sidewalks and entranceway slabs. It is critical that particles greater than 100 mm in diameter are not in contact with the foundation wall to prevent point loading and overstressing. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. Where only one side of a foundation wall will be backfilled, and the height of the wall is such that lateral support is required, or where the concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. In situations where both sides of the wall are backfilled, the backfill should be placed in equal lifts, not exceeding 200 mm differential on each side during backfill operations and the backfill should be compacted to a minimum of 98% SPMDD.

Foundations constructed within or below the zone of wet to saturated soils noted in the boreholes may be subject to flooding in the event of a power failure or equipment malfunction. Therefore, it would be recommended that foundations be constructed above the wet to saturated zones. If this is not feasible, it is recommended that good quality sump pumps be utilized and that, at a minimum, the systems be equipped with a battery backup (in the event of a power outage) preferably with a separate functioning sump pump(s). Each residence should have its own sump pit and pump(s). Groundwater elevations (perched and regional water tables) are dependent on weather and seasonal conditions and should be expected to fluctuate. The construction of foundations, slabs-on-grade, and deep structures such as sump pits within or below zones of saturation will require design of site-specific waterproofing and dewatering systems constructed in accordance with the 2012 OBC.

If the proposed dwellings are to have basements, an exterior perimeter drainage system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone and wrapped in a geotextile filter fabric such as Terrafix 270R (or equivalent), must be installed at an elevation that is below the proposed basement slab-on-grade elevation and provided with positive drainage into a sump pit or pits. The portion of the piping that connects the exterior drainage system into the sump pit must comprise solid piping to prevent exterior water from being introduced into the interior subslab stone. It may be prudent to install perforated drainage pipe in the interior basement as well to provide an outlet for any water that may collect in the subslab stone. It is also recommended that a capped cleanout port(s) be extended up to the ground surface elevation to provide future access (if required). The rainwater leaders must not be connected to the perimeter drainage system.

The native soils, as well as approved fill materials (non-organic) are generally considered suitable for reuse as trench backfill and bulk fill in the driveway areas; however, any wet soils encountered may require air-drying in order to achieve the specified compaction. Air-drying cannot typically be achieved during winter construction; therefore, depending on the time of year that construction takes place, it may be more feasible to utilize an imported granular fill for this project.

Backfilling operations should be carried out with the following minimum requirements:

- Adequate heavy smooth drum or padfoot vibratory compaction equipment should be used for the compaction and to break down any large blocky pieces of soil;
- Loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for silt soils or the capacity of the compactor (whichever is less);
- The soils must be at suitable moisture contents to achieve compaction to a minimum 98% SPMDD in non-structural bulk fill areas. Service trenches excavated within the zone of influence of footings for structures must be compacted to a minimum of 100% SPMDD;
- It is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure that compaction requirements are achieved;
- Service trench backfill materials may consist of approved excavated soils with no particles greater than 100 mm and no topsoil or other deleterious materials;
- If construction operations are undertaken in the winter, strict consideration should be given to the condition of the backfill material to make certain that frozen material is not used.

### *5.11. Pavement Design/Drainage*

The existing topsoil, vegetation, and any soils containing organics or other deleterious material must be stripped/subexcavated from within the roadway area. It is recommended to either subexcavate any existing loose subgrade materials or provide further consolidation with vibratory compaction equipment in order to prepare a proper, stable subgrade. Prior to placement of the new granular base, the subgrade soils must be proof-rolled, and any soft or unstable areas should be subexcavated and replaced with suitable drier materials. The subgrade should be graded smooth (free of depressions) and properly crowned to ensure positive drainage, with a minimum grade of 3% toward the drainage outlet or curb line. When service pipes are installed, pipe bedding and backfilling should be undertaken as indicated in Sections 5.9 and 5.10 of this report.

Rapid drainage of the pavement structure is critical to ensure long-term performance. The requirement for subdrains will be dependent on the composition of the prepared roadway and driveway subgrade soils. It is expected that the subgrade soils will generally be comprised of frost-susceptible soils. As such, it is recommended to install subdrains, provided gravity drainage to a suitable outlet can be provided. It is recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent). Installation of rigid subdrains allows for better grade control and less potential for damage during installation; however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. Positive drainage through grade control of subdrains is critical, as improperly installed subdrains can turn drainage systems into reservoirs, which can fuel frost action. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed along the edge of the roadway pavement to prevent water from entering the subbase. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subgrade must be prepared with positive drainage to the subdrains and the subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet.

The native subgrade soils are sensitive to change in moisture content and can become loose or soft if the soils are subject to inclement weather and seepage or severe drying. Furthermore, the subgrade soils could be easily disturbed if traveled on during construction. As such, where this material will be exposed, it is recommended that the granular subbase be placed immediately upon completion of the subgrade preparation to protect the integrity of the subgrade soils.

Should wet to saturated conditions be encountered during construction, site assessments may be required to determine what options can be undertaken to construct a modified pavement base. These options may include subexcavation of wet soils and increasing the thickness of the granular base, the use of reinforcing geotextiles, or a combination of both.

It is expected that the roadway will be subject to mostly light traffic (personal vehicles) as well as some heavy traffic (delivery trucks, maintenance and emergency vehicles).

Based on the anticipated loading, the following pavement design is provided:

| Material | Recommended Thickness For New Pavement | |
|---|---|---|
| | **Light Duty** | **Heavy Duty** |
| Asphaltic Concrete | HL3 - 40 mm (1.5")<br>HL4 or HL8 - 50 mm (2.0") | HL3 - 40 mm (1.5")<br>HL4 or HL8 - 60 mm (2.5") |
| Granular 'A' Base (OPSS 1010) | 150 mm (6.0") | 150 mm (6.0") |
| Granular 'B' Subbase (OPSS 1010) | 400 mm (16.0") | 450 mm (18.0") |

Frost tapers must be constructed at any changes from light traffic to heavy traffic areas. If heavy traffic routes are not delineated by barriers or if it is anticipated that heavy equipment (loader and dump trucks) will be utilized for snow removal, it would be recommended that the heavy traffic pavement structure be utilized throughout.

Construction joints in the surface asphalt must be offset a minimum of 150 mm to 300 mm (6" to 12") from construction joints in the binder asphalt so that longitudinal joints do not coincide.

Where new asphalt is joined into existing asphalt, it is recommended that the existing asphalt be sawcut in a straight line prior to being milled to a depth of 40 mm and a width of 150 mm as per OPSD 509.010. It is recommended that a tackcoat in conformance with OPSS 308 be applied to the edge and surface of all milled asphalt prior to placement of new asphalt.

The granular base and subbase materials must conform to the physical property and gradation requirements of OPSS 1010 and must be compacted to 100% SPMDD. Asphaltic concrete should be supplied, placed and compacted to a minimum 92.0% Marshall maximum relative density, in accordance with OPSS 1150 and OPSS 310.

The pavement should be designed to ensure that water will not pond on the pavement surface. If the surface asphalt is not placed within a reasonable time following placement of the binder asphalt, it is recommended that the catch basin lids are set at a lower elevation or apertures provided to allow surface water to drain into the catch basins and not accumulate around the catch basins. The strength of the pavement structure relies on all of the components to be in place in order to provide the design strength; therefore, it is strongly recommended that the surface asphalt be placed shortly after placement of the binder asphalt so as to avoid undue stress on the binder asphalt by not having the complete pavement structure in place.

It should be noted that, currently, asphalt mixes tend to be more flexible and, as such, there is a tendency for damage to occur from vehicles turning their steering wheels or applying excessive brake pressure. The damage can occur from both passenger vehicles as well as large vehicles. The condition is further intensified during hot weather. In high traffic areas, it is recommended that rigid Portland cement pavement be considered.

### *5.12. Infiltration*

The following information is based on the grain size analyses that were undertaken on soil samples obtained from Borehole 1 (depth 2.29 m to 2.90 m or 7.50 ft to 9.50 ft), Borehole 3 (depth 3.05 m to 3.66 m or 10.00 ft to 12.00 ft) and Borehole 6 (depth 3.05 m to 3.66 m or 10.00 ft to 12.00 ft).

The sample from Borehole 1 comprised sandy silt with some clay and trace gravel (ML) and the estimated coefficient of permeability (k) of this sample is 1.22 x $10^{-6}$ cm/sec.

The sample from Borehole 3 comprised sandy silt with some clay and trace gravel (ML) and the estimated coefficient of permeability (k) of this sample is 2.44 x $10^{-6}$ cm/sec.

The sample from Borehole 6 comprised sand and silt with some clay and trace gravel (SM) and the estimated coefficient of permeability (k) of this sample is 4.08 x $10^{-6}$ cm/sec.

A detailed stratigraphic description of the soils encountered for each borehole is provided in the borehole logs (Appendix A). The grain size analyses can be found in Appendix B of this report.

### *5.13. Percolation Rate (T-time) Determination*

It is understood that new septic systems are to be designed at a later date. The following is a summary of the percolation rate (T-time) determinations by CMT Inc.

The sample from Borehole 2 (depth 0.76 m to 1.37 m or 2.50 ft to 4.50 ft) was determined to be sand and silt with trace clay and can be classified as SM using the Unified Soil Classification System. The corresponding estimated soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 20 min/cm.

The sample from Borehole 4 (depth 1.52 m to 2.13 m or 5.00 ft to 7.00 ft) was determined to be sandy silt with some clay and gravel and can be classified as ML using the Unified Soil Classification System. The corresponding soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 25 min/cm.

The sample from Borehole 5 (depth 1.52 m to 2.13 m or 5.00 ft to 7.00 ft) was determined to be sandy silt with some clay and trace gravel and can be classified as ML using the Unified Soil Classification System. The corresponding soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 30 min/cm.

It should be noted that these test results are based on single samples obtained during the investigation and do not constitute as guarantees for the entire site. Additional test samples should be obtained and tested if there is a variation observed at any time.

A detailed stratigraphic description of the soils encountered for each borehole is provided in the borehole logs (Appendix A). The grain size analyses can be found in Appendix B of this report.

### *5.14. <u>Excess Soil Management</u>*

#### *5.14.1. <u>Chemical Testing was NOT Undertaken</u>*

Generally, if surplus soils are to be exported off-site, it will be necessary to undertake chemical analysis of the soils. Chemical analysis was not undertaken as part of this geotechnical investigation. Should chemical analysis tests be required, the required tests vary and will be dependent on the disposal site utilized by the general contractor.

Most commonly, the soils are tested for the following:

- F1-F4, VOC's, BTEX as per O. Reg. 153/04 as amended by R511
- SVOC as per O. Reg. 153/04 as amended by R511
- Metals/Inorganics as per O. Reg. 153/04 amended by R511

#### *5.14.2. <u>TCLP Requirement</u>*

If soils are transported to a landfill facility, additional chemical testing in accordance with Ontario Regulation 347, Schedule 4, as amended to Ontario Regulation 558/00, dated March 2001, Toxicity Characteristic Leaching Procedure (TCLP) will be required.

When transporting soils off-site, the following is recommended:

- All chemical analyses and environmental assessment reports must be fully disclosed to the receiving site owners/authorities, whom must agree to receive the material;

- An environmental consultant must confirm the land use at the receiving site is compatible to receive the material;

- An environmental consultant must monitor the transportation and placement of the materials to ensure that the material is placed appropriately at the pre-approved site;

- The excess materials may not be transported to a site that has previously had a Record of Site Condition (RSC) filed, unless the material meets the criteria outlined in the RSC.

It should be noted that landfill sites will generally only accept laboratory test results that have been completed within 30 days of exporting. Therefore, it is recommended that provisions for chemical analysis be included in the tender documents. It should also be noted that the laboratory testing generally takes five (5) working days to process with a regular turnaround time.

### *5.15.* ***Radon***

According to information provided by Health Canada, radon is a radioactive gas that is naturally formed through the breakdown of uranium in soil, rock and water. When radon escapes the earth in the outdoors, it mixes with fresh air, resulting in concentrations that are too low to be of concern. However, when radon enters an enclosed space, such as a building, high concentration of radon can accumulate and become a health concern. Health Canada indicates that most buildings and homes have some level of radon in them. Unfortunately, it is not possible to predict before construction whether or not a new building will have high radon levels as radon can only be detected by radon measurement devices, which would be installed in a building, post construction. Section 9.13.4.1 Soil Gas Control of the current 2012 Ontario Building Code (OBC) states that *"Where methane or radon gases are known to be a problem, construction shall comply with the requirements for soil gas control in MMAH Supplementary Standard SB-9, Requirements for Soil Gas Control".*

## *6.0 SITE INSPECTION*

Qualified geotechnical personnel should supervise excavation inspections as well as compaction testing for structural filling, site grading and site servicing. This will ensure that footings are founded in the proper strata and that proper material and techniques are used and the specified compaction is achieved. CMT Engineering Inc. would be pleased to review the design drawings and provide an inspection and testing program for the construction of the proposed development.

## *7.0 LIMITATIONS OF THE INVESTIGATION*

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete, or if the proposed construction should differ from that mentioned in this report.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments are based on the results obtained at the test locations only. It is therefore assumed that these results are representative of the subsoil conditions across the site. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

It should be noted that this report specifically addresses geotechnical aspects of the project and does not include any investigations or assessments relating to potential subsurface contamination. As such, there should be no assumptions or conclusions derived from this report with respect to potential soil or water contamination. Soil or water contamination is generally caused by the presence of xenobiotic (human-made) chemicals or other alteration processes in the natural soil and groundwater environment. If necessary, the investigation, assessment and rehabilitation of soil and water contaminants should be undertaken by qualified environmental specialists.

The samples obtained during the geotechnical investigation will be stored for a period of three months, after which time they will be disposed of unless alternative arrangements are made.

This report is intended solely for the client named. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the reliability of such third parties. The factual data, interpretation, and recommendations in this report pertain to a specific project as described in this report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, deviates from the assumptions stated herein, CMT Inc. should be given an opportunity to confirm that the recommendations are still valid. The subject geotechnical exploration and this report address only the geotechnical aspects of the proposed project; potential environmental impacts or related issues are beyond the defined scope of this work and have not been addressed.

We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

Prepared by:

Jake Feeney B.Eng., EIT.

ks

LICENSED PROFESSIONAL ENGINEER
2021/06/14
N. J. CHORTOS
100210851
PROVINCE OF ONTARIO

Reviewed by:

Nathan Chortos, P.Eng.
Senior Geotechnical Engineer


NOTES:

Base map provided by Google.

| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

REVISIONS


CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

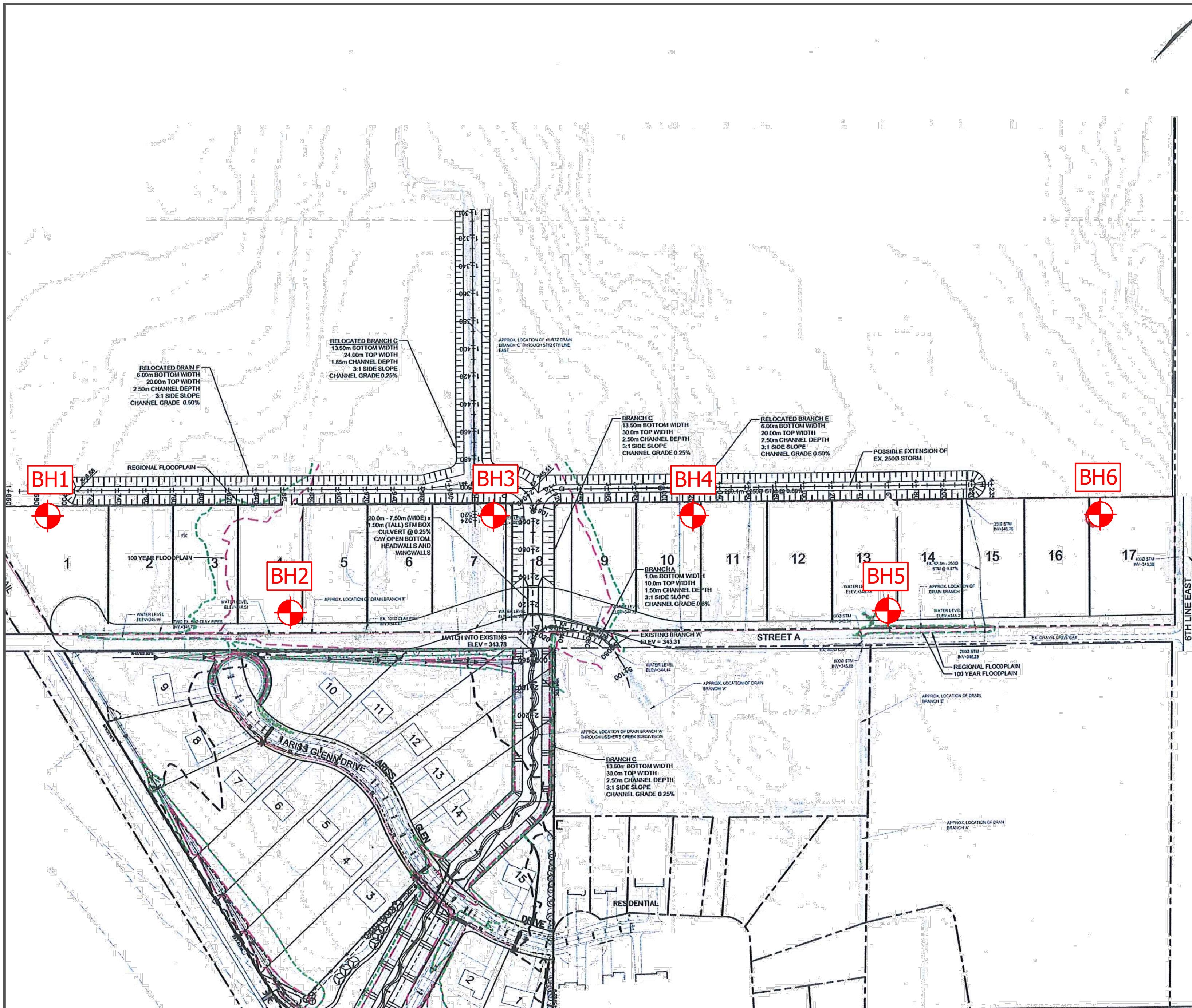

PROJECT:

PROPOSED DEVELOPMENT
5782 6th Line East
Ariss, Ontario

DRAWING TITLE:

SITE LOCATION MAP

| PROJECT NO.: | DATE: |
|---|---|
| 21-209 | June 7, 2021 |
| SCALE: N.T.S. | DRAWING NO. 1 |




NOTES:

Base map provided by GM BluePlan Engineering

Legend

CMT Borehole with Monitoring Well

| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |
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| | | |

REVISIONS

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PROJECT:

PROPOSED DEVELOPMENT
5782 6th Line East
Ariss, Ontario

DRAWING TITLE:

AERIAL VIEW SHOWING
BOREHOLE LOCATIONS

| PROJECT NO.: | DATE: |
|---|---|
| 21-209 | June 7, 2021 |
| SCALE: | DRAWING NO. |
| N.T.S. | 2 |

# APPENDIX A

# BOREHOLE LOGS

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

# BOREHOLE NUMBER 1



**PROJECT:** Proposed Development
**PROJECT ADDRESS:** 5782 6th Line East
**PROJECT NUMBER:** 21-209
**PROJECT LOCATION:** Ariss, Ontario
**DRILLING DATE:** 21-5-13
**GROUND ELEVATION:** 349.18 m
**DRILLING CONTRACTOR:** CMT Drilling Inc.
**LOGGED BY:** J. Feeney
**DRILLING EQUIPMENT:** Geoprobe 7822DT
**SAMPLING METHOD:** SPT

| MATERIAL DESCRIPTION | Depth, Elevation (m) |
|---|---|
| **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (380 mm) | 0.00, 349.18 |
| **Sandy Silt:** Very loose, grey-brown sandy silt, some clay, trace gravel, moist | 0.38, 348.80 |
| becoming loose | 0.76, 348.42 |
| becoming compact, brown | 1.52, 347.66 |
| becoming dense | 2.29, 346.89 |
| becoming very dense, sand and silt | 3.05, 346.13 |
| becoming grey | 4.57, 344.61 |

| SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | POCKET PEN. (kPa) | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|
| SPT 1 | 49 | 1-1-1-1 (2) | 2 | | 17.2 |
| SPT 2 | 100 | 2-2-7-5 (9) | 9 | | 12.3 |
| SPT 3 | 100 | 5-7-13-13 (20) | 20 | | 10.4 |
| SPT 4 | 100 | 9-17-23-33 (40) | 40 | | 8.6 |
| SPT 5 | 100 | 35-50-50-50 (100) | >> | 350 | 11.6 |
| MC5 6 | 100 | | | 350 | 7.8 |
| SPT 7 | 100 | 20-20-30-50 (50) | 50 | 350 | 7.2 |
| MC5 8 | 100 | | | 250 | 7.8 |

SPT N VALUE: 10 20 30 40
POCKET PEN. (kPa): 90 180 270 360
MOISTURE CONTENT (%): 12 24 36 48

DEPTH (m): 1 2 3 4 5 6

WELL DIAGRAM
Bentonite Seal
Water Level: 347.86 m (1.32 mbgs)
38mm Riser
#2 Sand Pack
38mm Slotted Screen

Bottom of borehole at 6.10 m, Elevation 343.08 m.

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
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# BOREHOLE NUMBER 2



**PROJECT:** Proposed Development

**PROJECT ADDRESS:** 5782 6th Line East

**PROJECT NUMBER:** 21-209

**PROJECT LOCATION:** Ariss, Ontario

**DRILLING DATE:** 21-5-13

**GROUND ELEVATION:** 345.58 m

**DRILLING CONTRACTOR:** CMT Drilling Inc.

**LOGGED BY:** J. Feeney

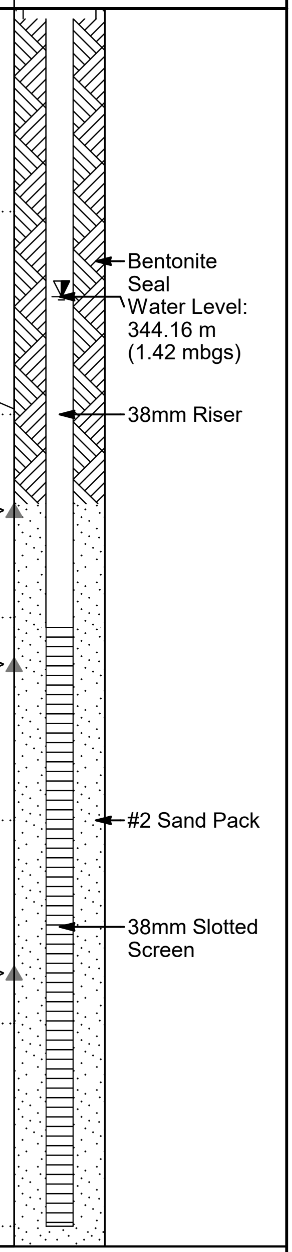
**DRILLING EQUIPMENT:** Geoprobe 7822DT

**SAMPLING METHOD:** SPT

| MATERIAL DESCRIPTION | Depth, Elevation (m) |
|---|---|
| **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm) | 0.00, 345.58 |
| **Sandy Silt:** Loose, brown sand and silt, trace clay, wet | 0.61, 344.97 |
| **Sand and Gravel:** Compact, reddish brown sand and gravel, trace silt, wet | 1.22, 344.36 |
| **Sandy Silt:** Compact, brown sand and silt, trace clay and gravel, moist | 1.68, 343.90 |
| becoming very dense and sandy with some clay | 2.29, 343.29 |
| becoming grey | 3.66, 341.92 |

| SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | MOISTURE CONTENT (%) |
|---|---|---|---|---|
| SPT 1 | 49 | 0-1-2-2 (3) | 3 | 16.8 |
| SPT 2 | 100 | 1-2-2-21 (4) | 4 | 17.6 |
| SPT 3 | 100 | 4-11-12-8 (23) | 23 | 12.1 |
| SPT 4 | 100 | 50-50-50-50 (100) | >> | 6.1 |
| SPT 5 | 100 | 47-50-50-50 (100) | >> | 5.5 |
| MC5 6 | 100 | | | 6.4 |
| SPT 7 | 49 | 42-50-50-50 (100) | >> | 5.9 |
| MC5 8 | 100 | | | 6.5 |

WELL DIAGRAM




Bottom of borehole at 6.10 m, Elevation 339.48 m.

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
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Fax: 519-699-4664

# BOREHOLE NUMBER 3



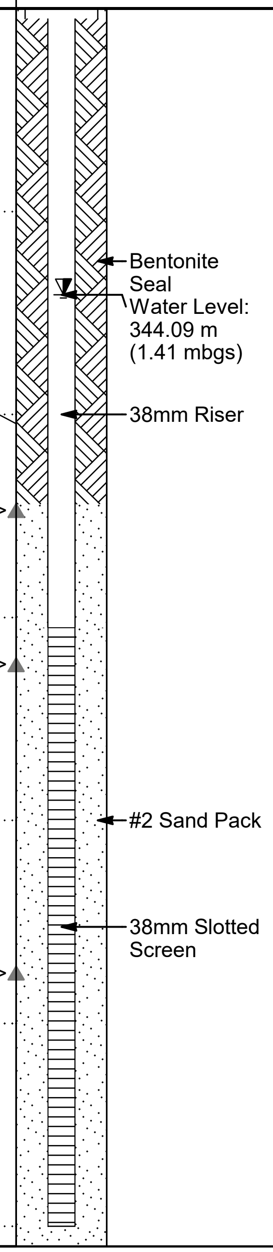
**PROJECT:** Proposed Development
**PROJECT ADDRESS:** 5782 6th Line East
**PROJECT LOCATION:** Ariss, Ontario
**GROUND ELEVATION:** 345.50 m
**LOGGED BY:** J. Feeney
**SAMPLING METHOD:** SPT

**PROJECT NUMBER:** 21-209
**DRILLING DATE:** 21-5-13
**DRILLING CONTRACTOR:** CMT Drilling Inc.
**DRILLING EQUIPMENT:** Geoprobe 7822DT

| MATERIAL DESCRIPTION | Depth, Elevation (m) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | POCKET PEN. (kPa) | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|---|---|
| **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm) | 0.00, 345.50 | SPT 1 | 49 | 1-1-2-3 (3) | 3 | | 19.1 |
| **Sandy Silt:** Loose, brown sandy silt, some clay, trace gravel, moist | 0.61, 344.89 | SPT 2 | 100 | 2-2-6-8 (8) | 8 | | 9.3 |
| becoming compact<br>Oxidation staining observed | 1.52, 343.98 | SPT 3 | 100 | 9-11-11-11 (22) | 22 | 300 | 9.9 |
| becoming very dense | 2.29, 343.21 | SPT 4 | 100 | 13-48-37-50 (85) | >> | 250 | 6.7 |
| becoming grey | 3.05, 342.45 | SPT 5 | 100 | 32-50-50-50 (100) | >> | 200 | 6.9 |
| | | MC5 6 | 100 | | | | 6.3 |
| | | SPT 7 | 100 | 50-50-50-50 (100) | >> | | |
| | | MC5 8 | 100 | | | | |

Bottom of borehole at 6.10 m, Elevation 339.40 m.

WELL DIAGRAM




BOREHOLE LOG WITH WELL2 21-209.GPJ CMT_TEMPLATE_2020-05-15.GDT 21-6-9

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

# BOREHOLE NUMBER 4



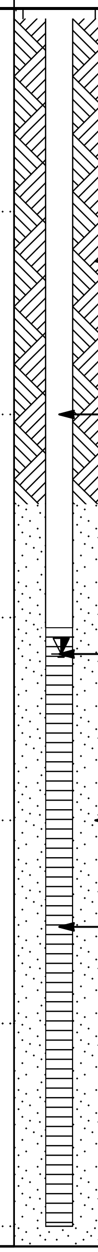
**PROJECT:** Proposed Development
**PROJECT ADDRESS:** 5782 6th Line East
**PROJECT LOCATION:** Ariss, Ontario
**PROJECT NUMBER:** 21-209
**DRILLING DATE:** 21-5-13
**GROUND ELEVATION:** 350.22 m
**DRILLING CONTRACTOR:** CMT Drilling Inc.
**LOGGED BY:** J. Feeney
**DRILLING EQUIPMENT:** Geoprobe 7822DT
**SAMPLING METHOD:** SPT

| MATERIAL DESCRIPTION | Depth, Elevation (m) |
|---|---|
| **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm) | 0.00, 350.22 |
| **Sand and Gravel:** Compact, brown sand and gravel, trace silt, moist | 0.61, 349.61 |
| **Sandy Silt:** Compact, brown sandy silt, some clay and gravel, moist | 1.52, 348.70 |
| becoming grey and wet<br>Oxidation staining observed | 2.29, 347.93 |
| becoming moist | 3.05, 347.17 |

Bottom of borehole at 6.10 m, Elevation 344.12 m.

| SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | POCKET PEN. (kPa) | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|
| SPT 1 | 49 | 0-1-1-3 (2) | 2 | | 15.3 |
| SPT 2 | 49 | 11-8-11-11 (19) | 19 | | 6.1 |
| SPT 3 | 100 | 3-5-7-8 (12) | 12 | | 8.9 |
| SPT 4 | 100 | 4-7-8-11 (15) | 15 | | 8.8 |
| SPT 5 | 100 | 5-8-7-14 (15) | 15 | 250 | 9.4 |
| MC5 6 | 100 | | | 150 | 8.5 |
| SPT 7 | 100 | 9-13-15-18 (28) | 28 | 100 | 8.6 |
| MC5 8 | 100 | | | 200 | 8 |

WELL DIAGRAM



CMT Engineering Inc.
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Fax: 519-699-4664

# BOREHOLE NUMBER 5



**PROJECT:** Proposed Development

**PROJECT ADDRESS:** 5782 6th Line East

**PROJECT NUMBER:** 21-209

**PROJECT LOCATION:** Ariss, Ontario

**DRILLING DATE:** 21-5-26

**GROUND ELEVATION:** 347.45 m

**DRILLING CONTRACTOR:** CMT Drilling Inc.

**LOGGED BY:** J. Feeney

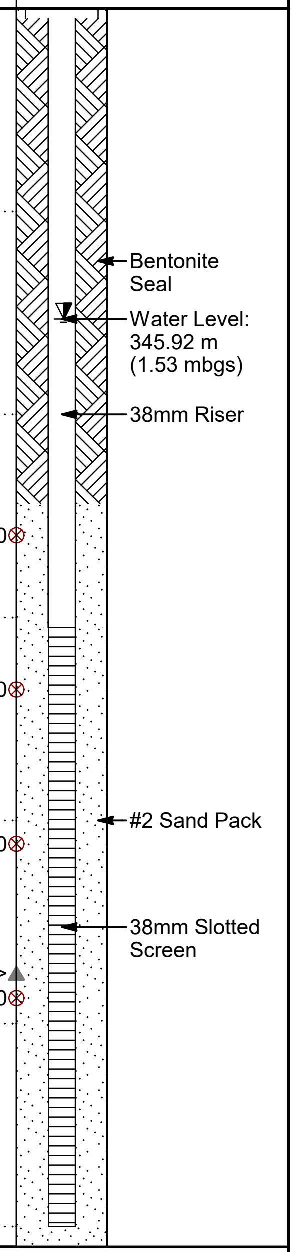
**DRILLING EQUIPMENT:** Geoprobe 7822DT

**SAMPLING METHOD:** SPT

| DEPTH (m) | MATERIAL DESCRIPTION | Depth, Elevation (m) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | POCKET PEN. (kPa) | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|---|---|---|
| | **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (300 mm) | 0.00, 347.45 | SPT 1 | 49 | 2-2-2-3 (4) | 4 | | 23 |
| | **Sandy Silt:** Loose, brown sand and silt, trace clay and gravel, moist | 0.30, 347.15 | | | | | | |
| 1 | becoming dense | 0.76, 346.69 | SPT 2 | 49 | 8-14-18-12 (32) | 32 | | 13.1 |
| 2 | becoming compact and sandy with some clay | 1.52, 345.93 | SPT 3 | 100 | 12-10-9-14 (19) | 19 | 250 | 9 |
| 3 | becoming dense and grey | 2.29, 345.16 | SPT 4 | 100 | 7-14-18-18 (32) | 32 | 450 | 9.9 |
| | | | SPT 5 | 100 | 12-17-16-42 (33) | 33 | 450 | 8.5 |
| 4 | | | MC5 6 | 100 | | | 450 | 16.3 |
| | **Sand and Gravel:** Very dense, brown sand and gravel, trace silt, saturated | 4.27, 343.18 | | | | | | |
| 5 | **Sandy Silt:** Very dense, brown sand and silt, trace clay and gravel, moist | 4.57, 342.88 | SPT 7 | 100 | 17-27-37-50 (64) | >> | 450 | 12.9 |
| | becoming grey and sandy with some clay | 5.03, 342.42 | | | | | | 7.4 |
| 6 | | | MC5 8 | 100 | | | 300 | 12.1 |

Bottom of borehole at 6.10 m, Elevation 341.35 m.

WELL DIAGRAM



# BOREHOLE NUMBER 6



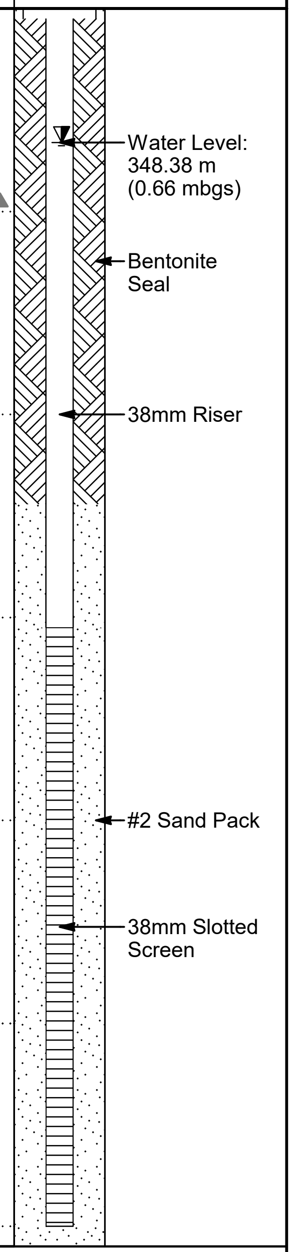
CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

**PROJECT:** Proposed Development
**PROJECT ADDRESS:** 5782 6th Line East
**PROJECT LOCATION:** Ariss, Ontario
**PROJECT NUMBER:** 21-209
**DRILLING DATE:** 21-5-26
**GROUND ELEVATION:** 349.04 m
**DRILLING CONTRACTOR:** CMT Drilling Inc.
**LOGGED BY:** J. Feeney
**DRILLING EQUIPMENT:** Geoprobe 7822DT
**SAMPLING METHOD:** SPT

| MATERIAL DESCRIPTION | Depth, Elevation (m) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | SPT N VALUE | POCKET PEN. (kPa) | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|---|---|
| **Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm) | 0.00, 349.04 | SPT 1 | 49 | 1-2-4-5 (6) | 6 | | 19 |
| **Sand and Gravel Fill:** Dense, brown sand and gravel fill, trace silt, moist (1,680 mm) | 0.61, 348.43 | SPT 2 | 74 | 15-24-23-15 (47) | 47 | | 6.7 |
| becoming compact and saturated | 1.52, 347.52 | SPT 3 | 16 | 9-6-7-6 (13) | 13 | | 13.3 |
| **Sandy Silt:** Compact, brown sand and silt, some clay, trace gravel, moist | 2.29, 346.75 | SPT 4 | 100 | 4-7-9-8 (16) | 16 | | 10.7 |
| becoming loose | 3.05, 345.99 | SPT 5 | 100 | 2-2-5-6 (7) | 7 | | 9.7 |
| | | MC5 6 | 100 | | | 50 | 10.8 |
| | | SPT 7 | 100 | 4-4-5-6 (9) | 9 | 50 | 11.5 |
| | | MC5 8 | 100 | | | 50 | 10.6 |

Bottom of borehole at 6.10 m, Elevation 342.94 m.

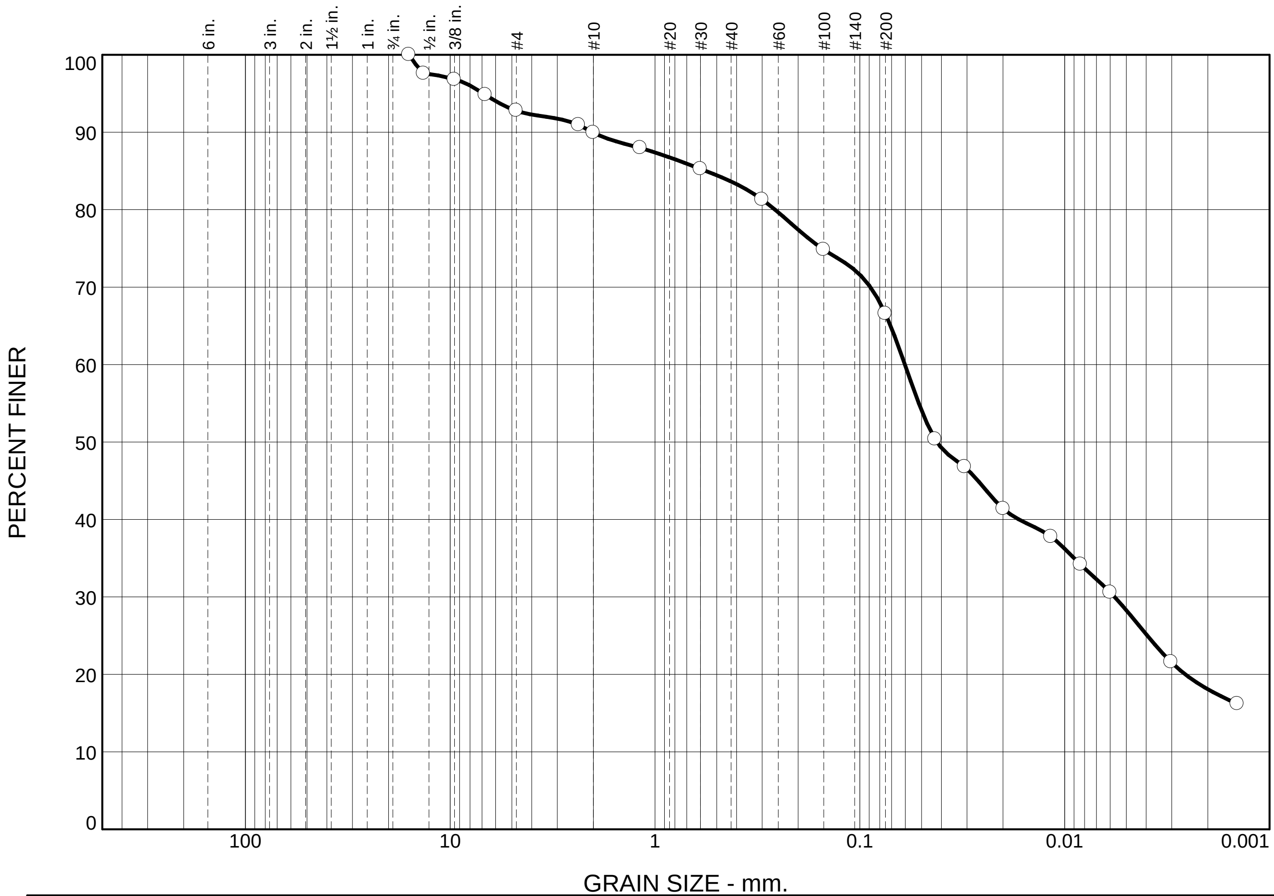
WELL DIAGRAM



# APPENDIX B

# GRAIN SIZE ANALYSES

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 7.2 | 2.9 | 6.3 | 17.0 | 48.5 | 18.1 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
|---|---|---|---|---|---|
| ○ | BH1 | 4 | 2.29-2.90m | sandy silt, some clay, trace gravel | ML |
| | | | | Estimated Coefficient of Permeability; k = 1.22 x $10^{-6}$ cm/sec | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

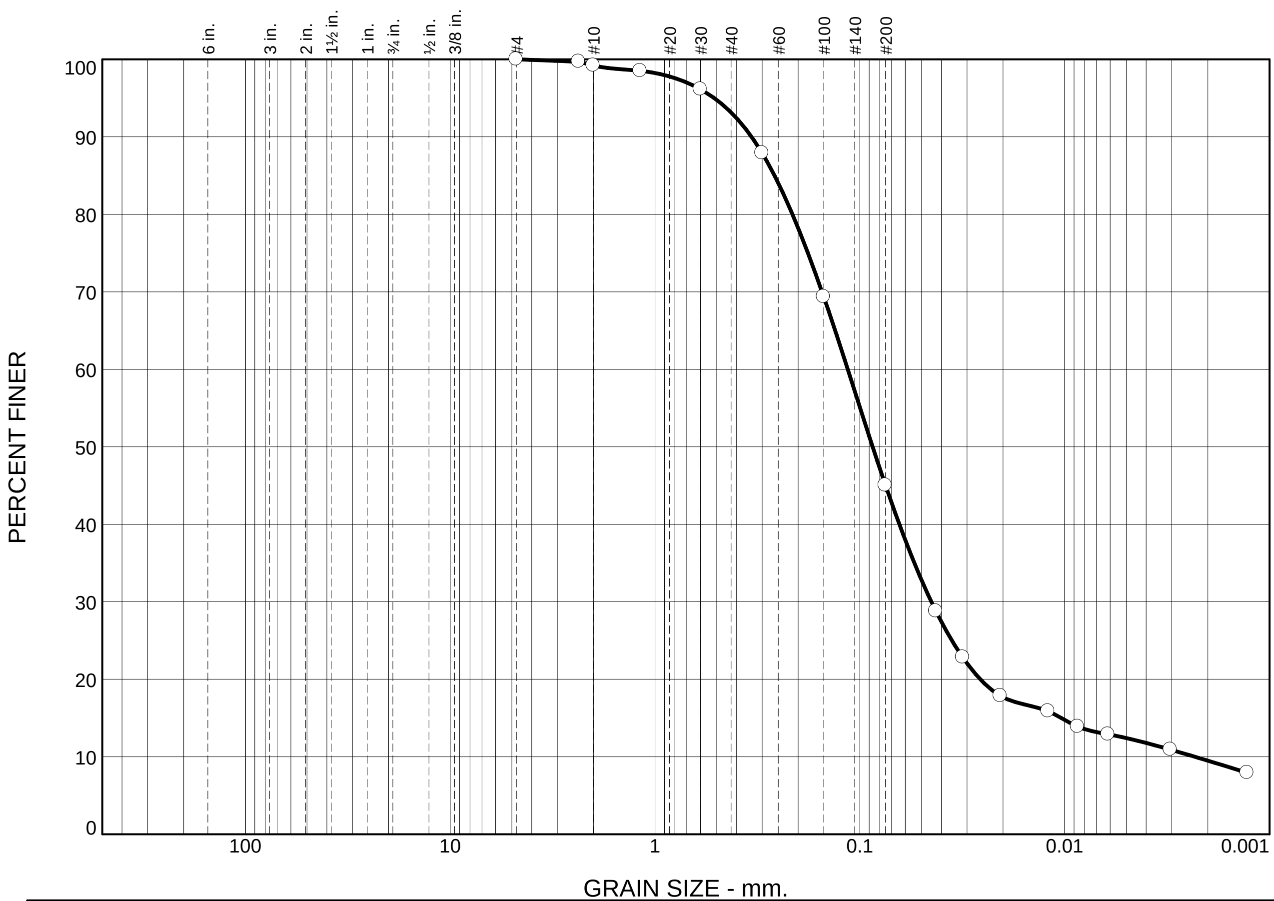
**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 1

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.8 | 6.1 | 48.1 | 35.5 | 9.5 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

| SOIL DATA | | | | | |
|---|---|---|---|---|---|
| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
| ○ | BH2 | 2 | 0.76-1.37m | sand and silt, trace clay | SM |
| | | | | Estimated Percolation Rate; T = 20 min/cm | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

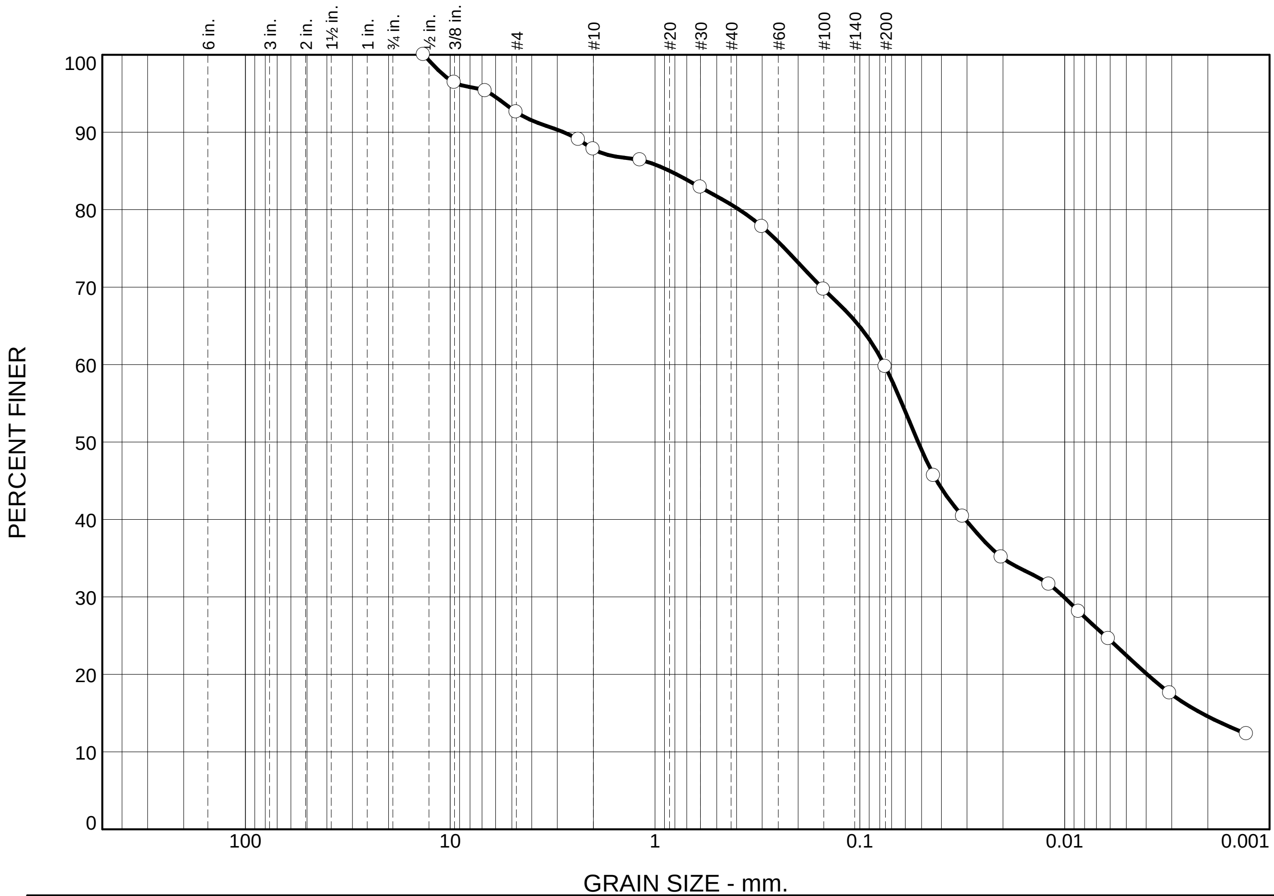
**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 2

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 7.4 | 4.8 | 7.1 | 21.0 | 45.1 | 14.6 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
|---|---|---|---|---|---|
| ○ | BH3 | 5 | 3.05-3.66m | sandy silt, some clay, trace gravel | ML |
| | | | | Estimated Coefficient of Permeability; $k = 2.44 \times 10^{-6}$ cm/sec | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

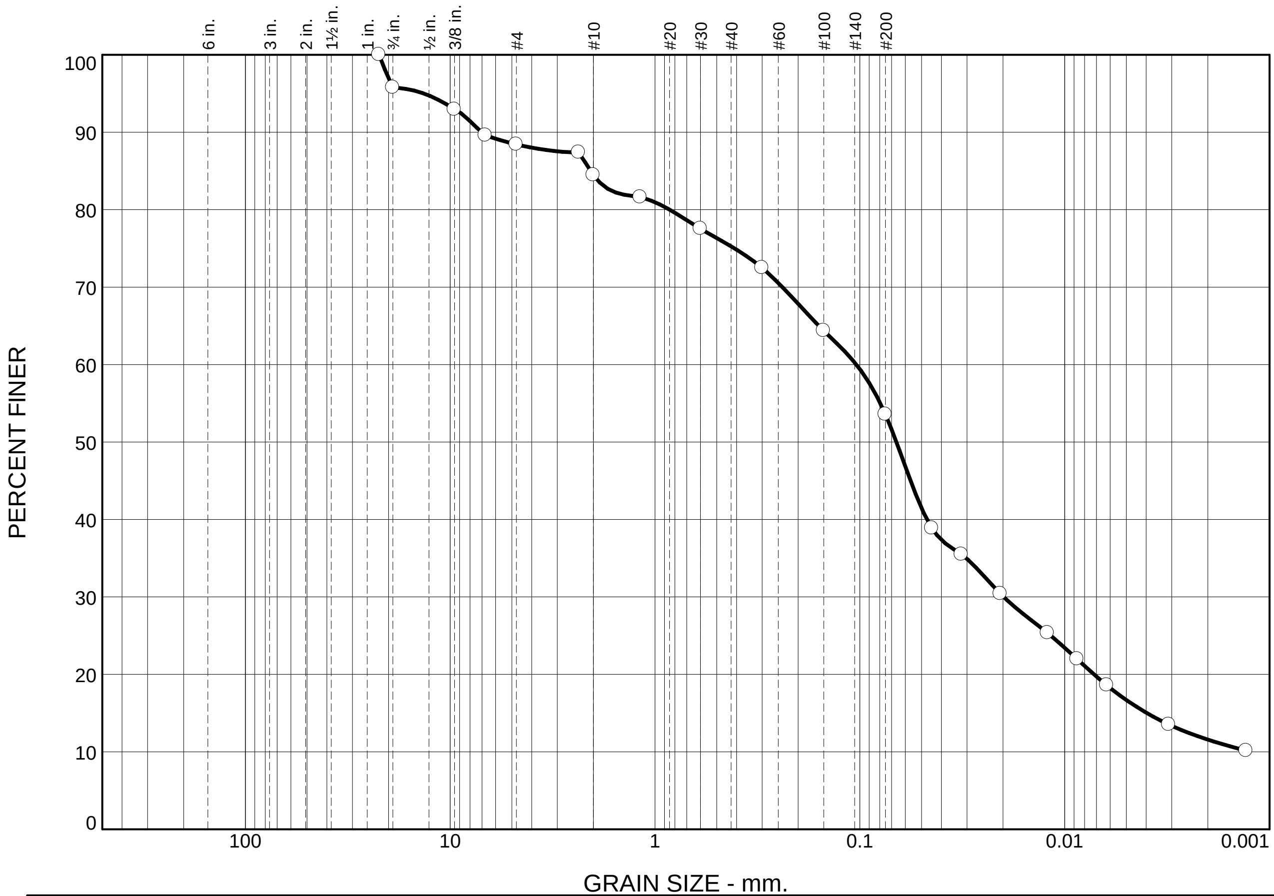
**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 3

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 4.2 | 7.4 | 3.9 | 9.2 | 21.7 | 42.0 | 11.6 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
|---|---|---|---|---|---|
| ○ | BH4 | 3 | 1.52-2.13m | sandy silt, some clay, and gravel | ML |
| | | | | Estimated Percolation Rate; T = 25min/cm | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

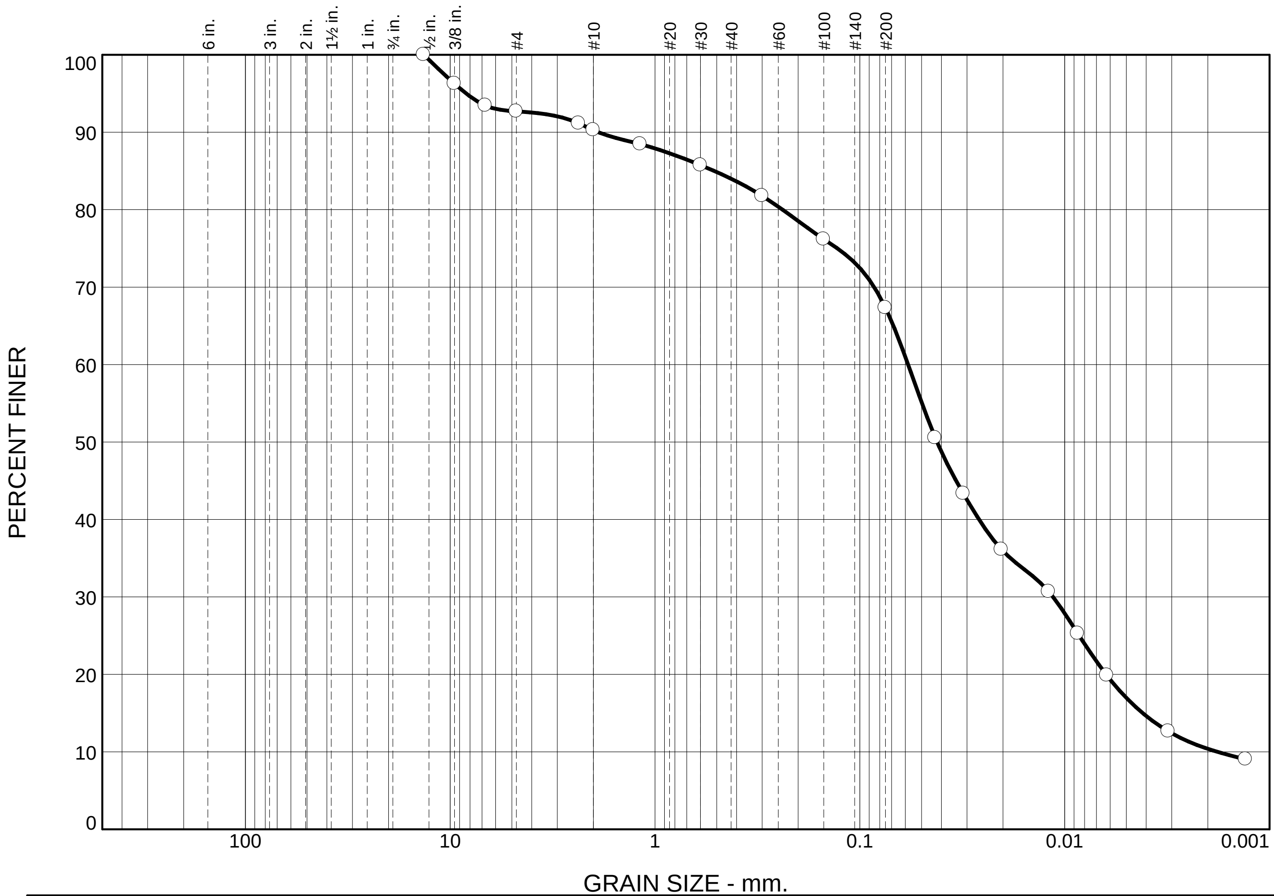
**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 4

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 7.3 | 2.4 | 6.3 | 16.7 | 56.9 | 10.4 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
|---|---|---|---|---|---|
| ○ | BH5 | 3 | 1.52-2.13m | sandy silt, some clay, trace gravel | ML |
| | | | | Estimated Percolation Rate; T = 30 min/cm | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

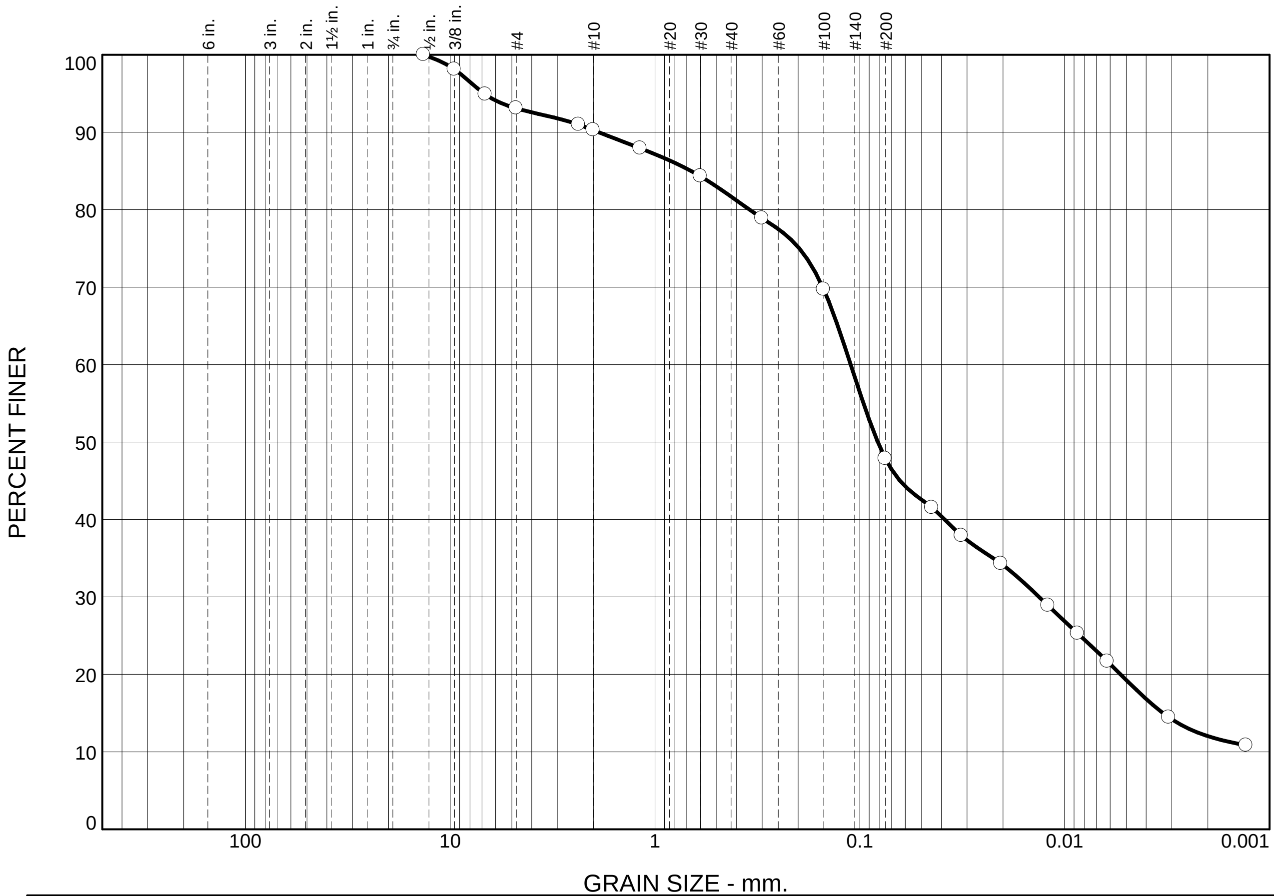
**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 5

# Particle Size Distribution Report




| | % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 6.9 | 2.8 | 8.6 | 33.9 | 35.8 | 12.0 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## SOIL DATA

| SYMBOL | SOURCE | SAMPLE NO. | DEPTH (ft.) | Material Description | USCS |
|---|---|---|---|---|---|
| ○ | BH6 | 5 | 3.05-3.66m | sand and silt, some clay, trace gravel | SM |
| | | | | Estimated Coefficient of Permeability; k = 4.08 x $10^{-6}$ cm/sec | |
| | | | | Sampled by JF of CMT Engineering Inc., May 13, 2021 | |
| | | | | Tested by JM of CMT Engineering Inc., May 28, 2021 | |
| | | | | | |

**CMT Engineering Inc.**

**St. Clements, ON**

**Client:** Will-O Homes

**Project:** 5782 6th Line East
Ariss, Ontario

**Project No.:** 21-209 **Figure** 6

# APPENDIX C

# WELL LOG RECORDS

# APPENDIX B

## Fire Reservoir Sizing Calculations

# FIRE UNDERWRITERS SURVEY CALCULATIONS

Project No: 420099-1
Designed By: JL
Checked By: AK

Date: 6/22/2023

## 5782 6TH LINE EAST

## TOWNSHIP OF GUELPH/ERAMOSA

Parameters from Water Supply for Public Fire Protection, Fire Underwriters Survey (1999)

| **Type of Construction** | | **Fire Hazard** | | **Sprinklers** | | **Proximity to closest structure (m)** | |
|---|---|---|---|---|---|---|---|
| | | | | | | 0 to 3 | 25% |
| Wood | 1.5 | Non-Combustible | -0.25 | No | 0 | 3 to 10 | 20% |
| Ordinary | 1.0 | Limited Combustibility | -0.15 | System | -30% | 10 to 20 | 15% |
| Non-Combustible | 0.8 | Combustible | 0 | Standard Water Supply | -40% | 20 to 30 | 10% |
| Fire-Resistive | 0.6 | Free Burning | 0.15 | Fully Supervised | -50% | 30 to 40 | 5% |
| | | Rapid Burning | 0.25 | | | None | 0% |
| | | | | | | Fire Wall | 10% |

| Unit No. | Main Floor Area (m2) | Second Floor Area (m2) | Gross Floor Area (m2) | Construction Coefficient | NFF 220*C*(A)**0.5 | Rounded NFF (to nearest 1000L/min) | Occupancy Factor | NFF adjusted for occupancy | Sprinkler Adjustment | Sprinkler Credit | Exposure Coefficient N | S | E | W | Total (max 0.75) | Exposure Flow Debit | RFF (liter/min) | Rounded RFF (to nearest 1000L/min) | Required Fire Flow (L/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Building Area | 270 | 270 | 540 | 0.8 | 4090 | 4000 | 0 | 4000 | -0.4 | -1600 | 0 | 0 | 0 | 0.025 | 0.025 | 100 | 2500 | 3000 | 50 |
| | Minimum Required Water Supply = | | | 90,000.00 | litres | | | | | | | | | | | | | | |

Project No: 420099-1
Designed By: JL
Checked By: AK

# ONTARIO BUILDING CODE FIRE DEMANDCALCULATIONS

## 5782 6$^{TH}$ LINE EAST
## TOWNSHIP OF GUELPH/ERAMOSA

Date: 6/22/2023

Parameters from Water Supply for Public Fire Protection, Fire Underwriters Survey (1999)

**Spatial Coefficient (s)**

| | |
|---|---|
| 1 m to 5 m | 0.50 |
| 6 m | 0.40 |
| 8 m | 0.20 |
| >10 m | 0.00 |

Stot = 1.0 + (S1 + S2+ S3 + S4)

Building Height = 6 m

Minimum required water supply = 30 minute

Required Minimum Water Supply Flow Rate, L/min

| | |
|---|---|
| One-storey buildign with building area not exceeding 600 m$^2$ | 1800 |
| if Q ≤ 10800 L | 2700 |
| if Q > 10800 L and ≤ 135000 L | 3600 |
| if Q > 13500 L and ≤ 162000 L | 4500 |
| if Q > 16200 L and ≤ 190000 L | 5400 |
| if Q > 19000 L and ≤ 2700000 L | 6300 |
| if Q > 270000 L | 9000 |

| Unit No. | Average Floor Area (m2) | Total building volume(V) (m3) | water supply Coefficient (K) | Q (K) x (V) | Exposure Coefficient N | S | E | W | Total (max 2.0) | Q (litres) | RFF (liter/min) | Rounded RFF (to nearest 1000L/min) | Required Fire Flow (L/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Building Area | 270 | 1,620 | 23 | 37260 | 0 | 0 | 0 | 0.2 | 1.2 | 44712 | 2700 | 3000 | 50 |
| | Minimum Required Water Supply = | | 90,000.00 | litres | | | | | | | | | |

# APPENDIX C

## Pre-Development Conditions Stormwater Management Analysis

Pre-Development SCS Numbers (weighted calculations)
Pre-Development Condition Modelling results

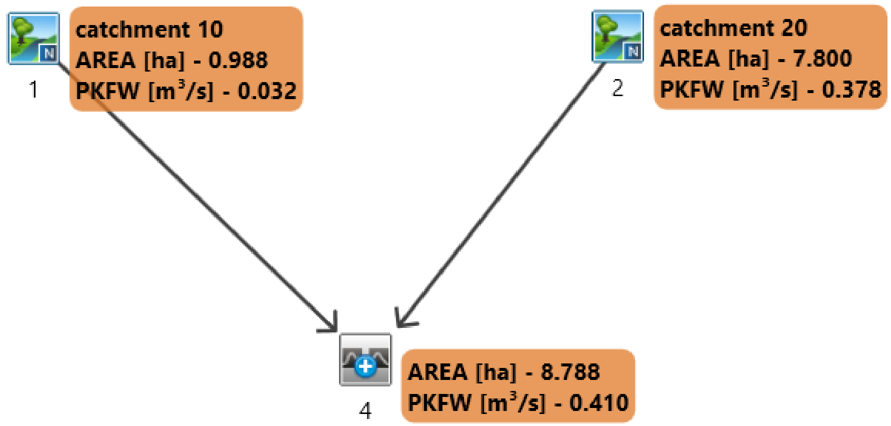
**Pre Development Catchment SCS Numbers**
**5782 6TH LINE EAST**
**Project: 420099**
**22-Jun-23**

| CATCHMENT | Area (ha.) | SOILGROUP | Landuse | SCS CURVE NO. |
|---|---|---|---|---|
| 20 | 1.102 | BC | Wooded/wetlands | 66.50 |
| | 6.615 | BC | Crop land | 74.50 |
| | 0.084 | AB | Wooded/wetlands | 48.00 |
| **Total** | 7.800 | | | 74.00 |

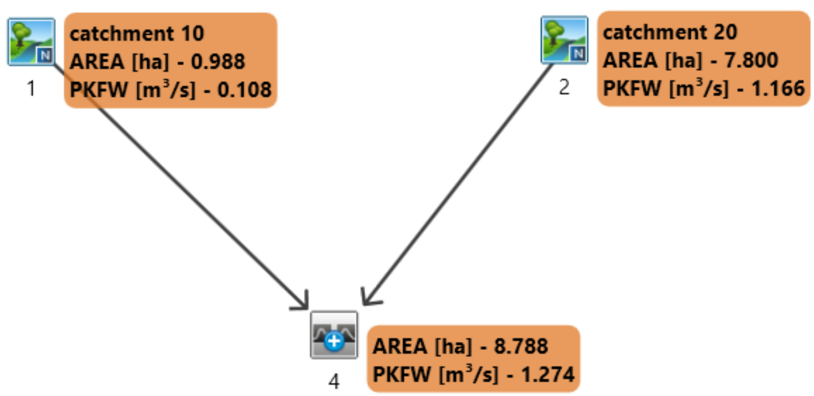
| CATCHMENT | Area (ha.) | SOILGROUP | Landuse | SCS CURVE NO. |
|---|---|---|---|---|
| 10 | 0.415 | BC | Wooded/wetlands | 66.50 |
| | 0.053 | BC | Pasture | 74.00 |
| | 0.521 | AB | Pasture | 59.00 |
| **Total** | 0.988 | | | 63.00 |

| SCS CURVE PARAMETERS | A | AB | B | C | BC |
|---|---|---|---|---|---|
| Cultivated land with no conservation treatment | 62.00 | 66.50 | 71.00 | 78.00 | 74.50 |
| Pasture & other umimproved land | 49.00 | 59.00 | 69.00 | 79.00 | 74.00 |
| Wooded and wetlands (fair) | 36.00 | 48.00 | 60.00 | 73.00 | 66.50 |

**Pre-Development Conditions (5-year)**




**Pre-Development Conditions (100-year)**



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

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2007)
       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 *****


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095d4af-8577-438c-9f70-6620268bae19\
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095d4af-8577-438c-9f70-6620268bae19\


DATE: 06/22/2023                           TIME: 08:59:35

USER:



COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 5yr-3hr 10min Chicago         **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1593.000
| Ptotal= 47.25 mm |                          B=  11.000
--------------------                          C=   0.879
```

```
                    used in:   INTENSITY =  A / (t + B)^C

                    Duration of storm  =  3.00 hrs
                    Storm time step    = 10.00 min
                    Time to peak ratio =  0.38

             TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
              hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.00    3.21 |  0.83   32.44 |  1.67    8.62 |  2.50    3.39
             0.17    3.97 |  1.00  109.68 |  1.83    6.65 |  2.67    3.02
             0.33    5.20 |  1.17   39.67 |  2.00    5.38 |  2.83    2.72
             0.50    7.43 |  1.33   19.15 |  2.17    4.51 |
             0.67   12.54 |  1.50   12.05 |  2.33    3.88 |


--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=   0.99   Curve Number   (CN)= 63.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17

     Unit Hyd Qpeak  (cms)=   0.222

     PEAK FLOW       (cms)=   0.032 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=   8.896
     TOTAL RAINFALL   (mm)=  47.252
     RUNOFF COEFFICIENT   =   0.188

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0002)|   Area    (ha)=   7.80   Curve Number   (CN)= 74.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17

     Unit Hyd Qpeak  (cms)=   1.752

     PEAK FLOW       (cms)=   0.378 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  12.951
     TOTAL RAINFALL   (mm)=  47.252
     RUNOFF COEFFICIENT   =   0.274

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

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

```
--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):      0.99   0.032     1.33     8.90
      + ID2= 2 (  0002):      7.80   0.378     1.33    12.95
        ====================================================
        ID = 3 (  0004):      8.79   0.410     1.33    12.50

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

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

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2007)
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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
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```



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DATE: 06/22/2023                           TIME: 08:59:35

USER:



COMMENTS: ____________________________________________________________


------------------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 100yr-3hr 10min Chicago       **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=4688.000
| Ptotal= 87.06 mm |                          B=  17.000
--------------------                          C=   0.962
```

```
                    used in:   INTENSITY =  A / (t + B)^C

                    Duration of storm  =  3.00 hrs
                    Storm time step    = 10.00 min
                    Time to peak ratio =  0.38

             TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
              hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.00    4.42 |  0.83   66.23 |  1.67   15.63 |  2.50    4.76
             0.17    5.87 |  1.00  196.54 |  1.83   11.36 |  2.67    4.07
             0.33    8.33 |  1.17   81.01 |  2.00    8.71 |  2.83    3.53
             0.50   13.04 |  1.33   38.79 |  2.17    6.93 |
             0.67   24.27 |  1.50   23.19 |  2.33    5.68 |


-------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0001)|   Area    (ha)=   0.99   Curve Number   (CN)= 63.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17

     Unit Hyd Qpeak  (cms)=   0.222

     PEAK FLOW       (cms)=   0.108 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  27.778
     TOTAL RAINFALL   (mm)=  87.057
     RUNOFF COEFFICIENT   =   0.319

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

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0002)|   Area    (ha)=   7.80   Curve Number   (CN)= 74.0
|ID= 1 DT=10.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17

     Unit Hyd Qpeak  (cms)=   1.752

     PEAK FLOW       (cms)=   1.166 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  37.497
     TOTAL RAINFALL   (mm)=  87.057
     RUNOFF COEFFICIENT   =   0.431

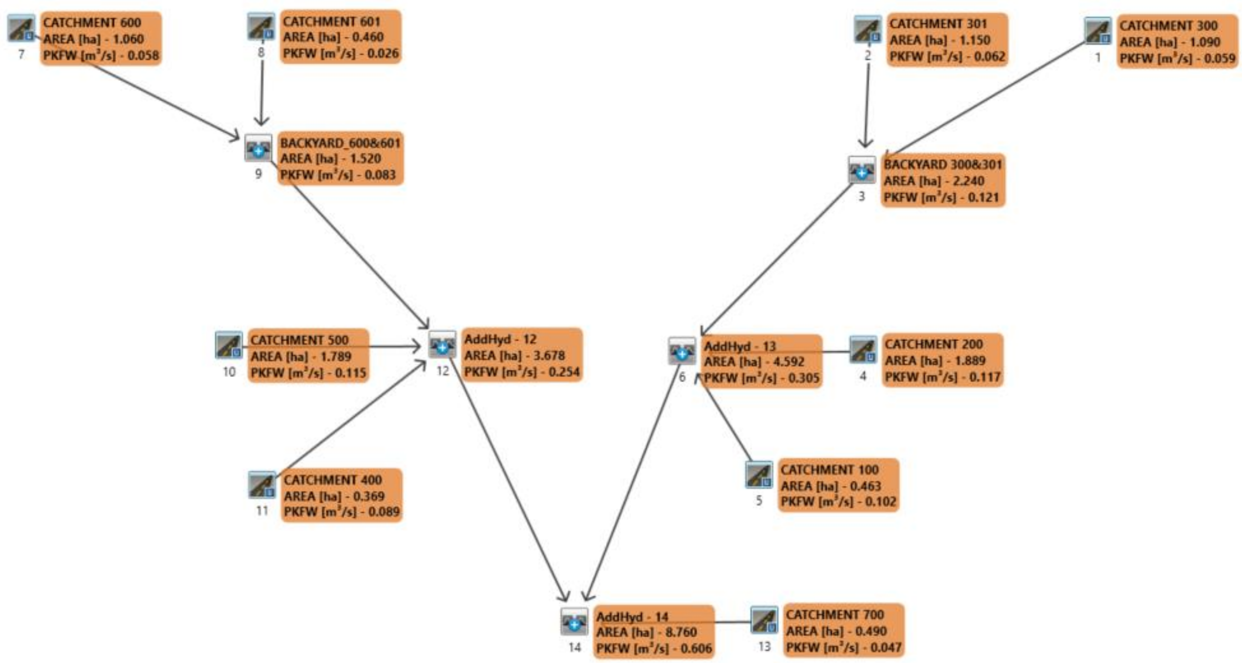
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

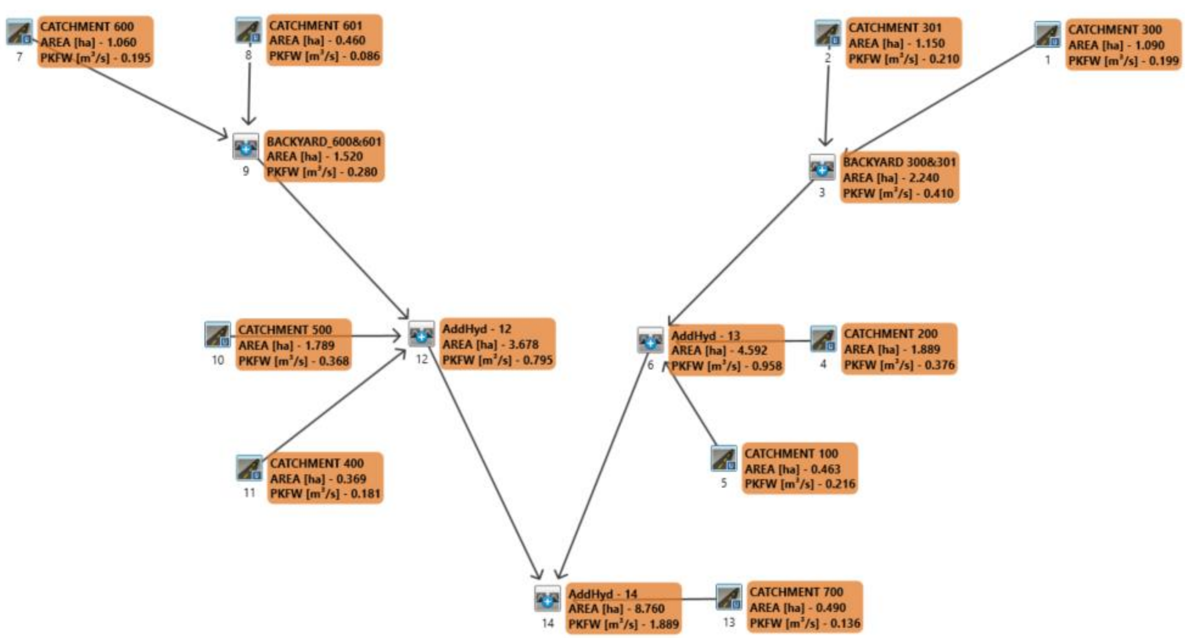
```
--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.99   0.108     1.33    27.78
      + ID2= 2 (  0002):     7.80   1.166     1.33    37.50
        =====================================================
        ID = 3 (  0004):     8.79   1.274     1.33    36.40

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

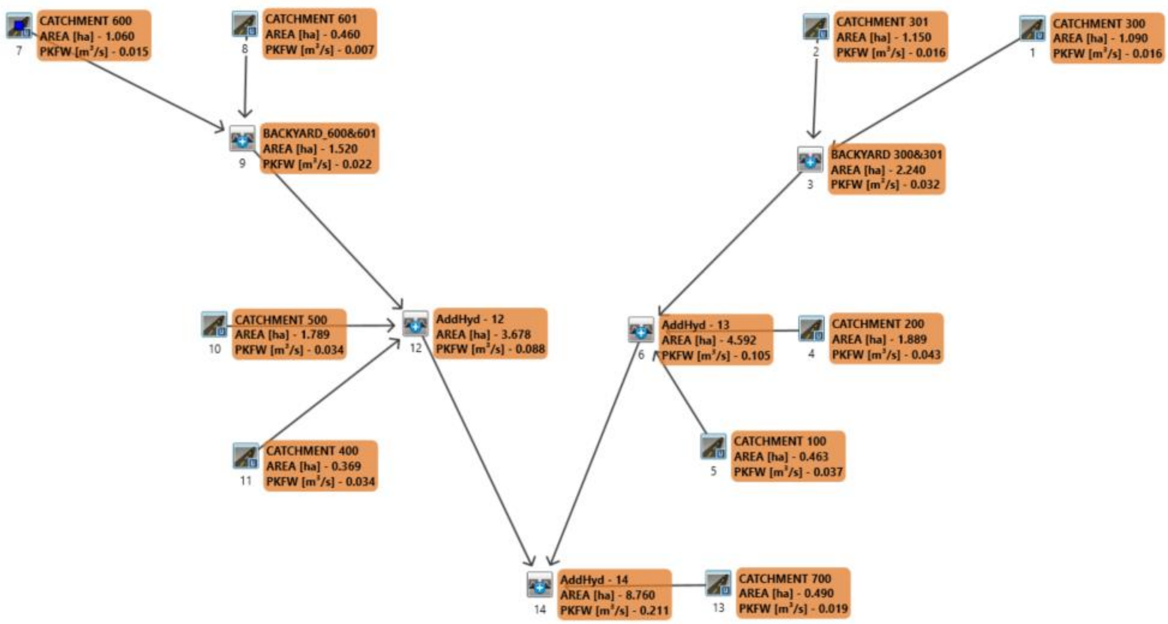
**Post-Development Conditions (5-year uncontrolled)**




**Post-Development Conditions (100-year uncontrolled)**



## Post-Development Conditions (24mm 4hour uncontrolled)



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

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       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 *****

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DATE: 01/26/2024                           TIME: 01:24:02

USER:


COMMENTS: ____________________________________________________________

----------------------------------------------------------------------------------------------------------
  ************************************************
  ** SIMULATION : 5yr-3hr 10min Chicago         **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1593.000
| Ptotal= 47.25 mm |                          B=  11.000
--------------------                          C=   0.879
```

```
              used in:   INTENSITY =  A / (t + B)^C

              Duration of storm  =  3.00 hrs
              Storm time step    = 10.00 min
              Time to peak ratio =  0.38

        TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
         hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
        0.00    3.21 |  0.83   32.44 |  1.67    8.62 |  2.50    3.39
        0.17    3.97 |  1.00  109.68 |  1.83    6.65 |  2.67    3.02
        0.33    5.20 |  1.17   39.67 |  2.00    5.38 |  2.83    2.72
        0.50    7.43 |  1.33   19.15 |  2.17    4.51 |
        0.67   12.54 |  1.50   12.05 |  2.33    3.88 |


-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0013)|   Area    (ha)=   0.49
|ID= 1 DT= 5.0 min |   Total Imp(%)=  28.00   Dir. Conn.(%)=  20.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.35
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      57.15        40.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
       0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
       0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
       0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
       0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
       0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
       0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
       0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
       0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        52.90
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.76 (ii)   10.86 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.09
                                                           *TOTALS*
```

```
     PEAK FLOW       (cms)=       0.03          0.03          0.047 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.33           1.17
     RUNOFF VOLUME    (mm)=      46.25         20.94          25.99
     TOTAL RAINFALL   (mm)=      47.25         47.25          47.25
     RUNOFF COEFFICIENT   =       0.98          0.44           0.55

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0002)|   Area    (ha)=   1.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06          1.09
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      87.56         40.00
     Mannings n           =      0.013         0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
               0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
               0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
               0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
               0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
               0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
               0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
               0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
               0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68         27.73
                over (min)        5.00         15.00
     Storage Coeff.  (min)=       2.27 (ii)   14.06 (ii)
     Unit Hyd. Tpeak (min)=       5.00         15.00
     Unit Hyd. peak  (cms)=       0.30          0.08
```

```
                                                                 *TOTALS*
     PEAK FLOW       (cms)=       0.02          0.06            0.062 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.33             1.33
     RUNOFF VOLUME    (mm)=      46.25         15.24            16.79
     TOTAL RAINFALL   (mm)=      47.25         47.25            47.25
     RUNOFF COEFFICIENT   =       0.98          0.32             0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
             YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0001)|   Area    (ha)=   1.09
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05          1.04
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      85.24         40.00
     Mannings n           =      0.013         0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68         27.73
                over (min)        5.00         15.00
     Storage Coeff.  (min)=       2.24 (ii)    14.03 (ii)
     Unit Hyd. Tpeak (min)=       5.00         15.00
```

```
     Unit Hyd. peak  (cms)=       0.30         0.08
                                                                *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.05               0.059 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33                1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24               16.79
     TOTAL RAINFALL   (mm)=      47.25        47.25               47.25
     RUNOFF COEFFICIENT   =       0.98         0.32                0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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


--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     1.09   0.059     1.33    16.79
      + ID2= 2 (  0002):     1.15   0.062     1.33    16.79
        ====================================================
        ID = 3 (  0003):     2.24   0.121     1.33    16.79

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.32
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.56         5.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
```

```
            0.167    3.21 | 0.917   32.44 | 1.667   12.05 |   2.42    3.88
            0.250    3.97 | 1.000   32.44 | 1.750    8.62 |   2.50    3.88
            0.333    3.97 | 1.083  109.68 | 1.833    8.62 |   2.58    3.39
            0.417    5.20 | 1.167  109.68 | 1.917    6.65 |   2.67    3.39
            0.500    5.20 | 1.250   39.67 | 2.000    6.65 |   2.75    3.02
            0.583    7.43 | 1.333   39.67 | 2.083    5.38 |   2.83    3.02
            0.667    7.43 | 1.417   19.15 | 2.167    5.38 |   2.92    2.72
            0.750   12.54 | 1.500   19.15 | 2.250    4.51 |   3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        78.76
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.73 (ii)    4.66 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.32         0.22
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.07           0.102 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17            1.17
     RUNOFF VOLUME    (mm)=      46.25        29.89           33.97
     TOTAL RAINFALL   (mm)=      47.25        47.25           47.25
     RUNOFF COEFFICIENT   =       0.98         0.63            0.72

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0004)|   Area    (ha)=   1.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  13.00   Dir. Conn.(%)=  13.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         1.64
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     112.22        40.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |   2.33    4.51
            0.167    3.21 | 0.917   32.44 | 1.667   12.05 |   2.42    3.88
```

```
              0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
              0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
              0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
              0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
              0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
              0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
              0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        29.09
               over (min)         5.00        15.00
     Storage Coeff.  (min)=       2.64 (ii)   14.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.08
                                                             *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.09            0.117 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33             1.17
     RUNOFF VOLUME    (mm)=      46.25        15.93            19.87
     TOTAL RAINFALL   (mm)=      47.25        47.25            47.25
     RUNOFF COEFFICIENT   =       0.98         0.34             0.42

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  74.8    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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


--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0003):     2.24   0.121     1.33    16.79
      + ID2= 2 (  0004):     1.89   0.117     1.17    19.87
        =====================================================
        ID = 3 (  0006):     4.13   0.236     1.33    18.19

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


--------------------
| ADD HYD  (  0006)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0006):     4.13   0.236     1.33    18.19
      + ID2= 2 (  0005):     0.46   0.102     1.17    33.97
```

```
      ====================================================
      ID = 1 (  0006):     4.59   0.305     1.17    19.79

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0010)|   Area    (ha)=   1.79
|ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  10.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
   Surface Area     (ha)=       0.30         1.48
   Dep. Storage     (mm)=       1.00         1.50
   Average Slope     (%)=       1.00         2.00
   Length            (m)=     109.21        40.00
   Mannings n          =      0.013        0.250

       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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
             0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
             0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
             0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
             0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
             0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
             0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
             0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
             0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

   Max.Eff.Inten.(mm/hr)=     109.68        34.07
              over (min)        5.00        15.00
   Storage Coeff.  (min)=       2.60 (ii)   13.45 (ii)
   Unit Hyd. Tpeak (min)=       5.00        15.00
   Unit Hyd. peak  (cms)=       0.29         0.08
                                                          *TOTALS*
   PEAK FLOW       (cms)=       0.05         0.09          0.115 (iii)
   TIME TO PEAK    (hrs)=       1.17         1.33           1.33
   RUNOFF VOLUME    (mm)=      46.25        17.09          20.00
   TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
   RUNOFF COEFFICIENT   =       0.98         0.36           0.42

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
        CN*  =  75.2    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0007)|   Area    (ha)=   1.06
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.00
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      84.06        40.00
     Mannings n          =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                 0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                 0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                 0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                 0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                 0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                 0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                 0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                 0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        27.73
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.22 (ii)   14.01 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.30         0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.05          0.058 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33           1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24          17.10
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.32           0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0008)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.03         0.43
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.38        40.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
               0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
               0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
               0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
               0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
               0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
               0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
               0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
               0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        27.73
                over (min)       5.00        15.00
     Storage Coeff.  (min)=       1.73 (ii)   13.52 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.02          0.026 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33           1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24          17.09
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.32           0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD  (  0009)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0007):      1.06   0.058     1.33    17.10
      + ID2= 2 (  0008):      0.46   0.026     1.33    17.09
        ====================================================
        ID = 3 (  0009):      1.52   0.083     1.33    17.09

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0011)|   Area    (ha)=   0.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  30.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17          0.20
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      49.60          5.00
     Mannings n          =      0.013         0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        103.77
                over (min)        5.00          5.00
```

```
     Storage Coeff.  (min)=       1.62 (ii)    4.07 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.32         0.24
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.06          0.089 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17           1.17
     RUNOFF VOLUME    (mm)=      46.25        32.08          36.32
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.68           0.77

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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


--------------------
| ADD HYD  (  0012)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     1.79   0.115     1.33    20.00
      + ID2= 2 (  0011):     0.37   0.089     1.17    36.32
        ====================================================
        ID = 3 (  0012):     2.16   0.190     1.17    22.79

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


--------------------
| ADD HYD  (  0012)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0012):     2.16   0.190     1.17    22.79
      + ID2= 2 (  0009):     1.52   0.083     1.33    17.09
        ====================================================
        ID = 1 (  0012):     3.68   0.254     1.17    20.44

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


--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):     3.68   0.254     1.17    20.44
      + ID2= 2 (  0013):     0.49   0.047     1.17    25.99
```

```
        ====================================================
        ID = 3 (  0014):     4.17   0.300     1.17    21.09

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

--------------------
| ADD HYD  (  0014)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0014):     4.17   0.300     1.17    21.09
      + ID2= 2 (  0006):     4.59   0.305     1.17    19.79
        ====================================================
        ID = 1 (  0014):     8.76   0.606     1.17    20.41

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

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

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===============================================================================================
=======================

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2015)
       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 6.2\VO2\voin.dat

  Output  filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\3
a012428-2a1e-4b6b-b2f8-892d23b32abb\
  Summary filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\3
a012428-2a1e-4b6b-b2f8-892d23b32abb\


DATE: 01/26/2024                           TIME: 01:24:01

USER:


COMMENTS: ____________________________________________________________


-----------------------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 100yr-3hr 10min Chicago       **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=4688.000
| Ptotal= 87.06 mm |                          B=  17.000
--------------------                          C=   0.962
```

```
                  used in:   INTENSITY =  A / (t + B)^C

                  Duration of storm  =  3.00 hrs
                  Storm time step    = 10.00 min
                  Time to peak ratio =  0.38

           TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
            hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
           0.00    4.42 |  0.83   66.23 |  1.67   15.63 |  2.50    4.76
           0.17    5.87 |  1.00  196.54 |  1.83   11.36 |  2.67    4.07
           0.33    8.33 |  1.17   81.01 |  2.00    8.71 |  2.83    3.53
           0.50   13.04 |  1.33   38.79 |  2.17    6.93 |
           0.67   24.27 |  1.50   23.19 |  2.33    5.68 |


------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0013)|   Area    (ha)=   0.49
|ID= 1 DT= 5.0 min |   Total Imp(%)=  28.00   Dir. Conn.(%)=  20.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14          0.35
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      57.15         40.00
     Mannings n           =      0.013         0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
          0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
          0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
          0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
          0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
          0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
          0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
          0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
          0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       135.11
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.39 (ii)    7.65 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.13
                                                                *TOTALS*
```

```
     PEAK FLOW       (cms)=       0.05          0.10          0.136 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.25           1.17
     RUNOFF VOLUME    (mm)=      86.06         52.31          59.06
     TOTAL RAINFALL   (mm)=      87.06         87.06          87.06
     RUNOFF COEFFICIENT   =       0.99          0.60           0.68

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*   =  80.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0002)|   Area    (ha)=   1.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06          1.09
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      87.56         40.00
     Mannings n          =      0.013         0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
               0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
               0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
               0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
               0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
               0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
               0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
               0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
               0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54         92.31
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.80 (ii)     9.09 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.32          0.12
```

```
                                                                  *TOTALS*
     PEAK FLOW       (cms)=       0.03          0.20          0.210 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.25           1.25
     RUNOFF VOLUME    (mm)=      86.06         41.32          43.56
     TOTAL RAINFALL   (mm)=      87.06         87.06          87.06
     RUNOFF COEFFICIENT   =       0.99          0.47           0.50

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0001)|   Area    (ha)=   1.09
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05          1.04
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      85.24         40.00
     Mannings n           =      0.013         0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54         92.31
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.77 (ii)     9.06 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
```

```
     Unit Hyd. peak  (cms)=       0.32         0.12
                                                                    *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.19          0.199 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25           1.25
     RUNOFF VOLUME    (mm)=      86.06        41.32          43.56
     TOTAL RAINFALL   (mm)=      87.06        87.06          87.06
     RUNOFF COEFFICIENT   =       0.99         0.47           0.50

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     1.09   0.199     1.25    43.56
      + ID2= 2 (  0002):     1.15   0.210     1.25    43.56
        ====================================================
        ID = 3 (  0003):     2.24   0.410     1.25    43.56

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.32
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.56         5.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
```

```
              0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
              0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
              0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
              0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
              0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
              0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
              0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
              0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       174.89
               over (min)        5.00         5.00
     Storage Coeff.  (min)=      1.37 (ii)    3.69 (ii)
     Unit Hyd. Tpeak (min)=      5.00         5.00
     Unit Hyd. peak  (cms)=      0.33         0.25
                                                         *TOTALS*
     PEAK FLOW       (cms)=      0.06         0.15         0.216 (iii)
     TIME TO PEAK    (hrs)=      1.17         1.17          1.17
     RUNOFF VOLUME    (mm)=     86.06        66.61         71.46
     TOTAL RAINFALL   (mm)=     87.06        87.06         87.06
     RUNOFF COEFFICIENT   =      0.99         0.77          0.82

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0004)|   Area    (ha)=   1.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  13.00   Dir. Conn.(%)=  13.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      0.25         1.64
     Dep. Storage     (mm)=      1.00         1.50
     Average Slope     (%)=      1.00         2.00
     Length            (m)=    112.22        40.00
     Mannings n           =     0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
              0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
```

```
              0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
              0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
              0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
              0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
              0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
              0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
              0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        96.03
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.09 (ii)    9.26 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.31         0.12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.30          0.376 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25           1.17
     RUNOFF VOLUME    (mm)=      86.06        42.75          48.38
     TOTAL RAINFALL   (mm)=      87.06        87.06          87.06
     RUNOFF COEFFICIENT   =       0.99         0.49           0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  74.8    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0003):     2.24   0.410     1.25    43.56
      + ID2= 2 (  0004):     1.89   0.376     1.17    48.38
        ====================================================
        ID = 3 (  0006):     4.13   0.776     1.25    45.76

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


--------------------
| ADD HYD  (  0006)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0006):     4.13   0.776     1.25    45.76
      + ID2= 2 (  0005):     0.46   0.216     1.17    71.46
```

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    ====================================================
    ID = 1 (  0006):     4.59   0.958     1.17    48.35

 NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0010)|   Area    (ha)=   1.79
|ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  10.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.30         1.48
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     109.21        40.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                 0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                 0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                 0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                 0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                 0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                 0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                 0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                 0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       110.65
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.06 (ii)    8.83 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.31         0.12
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.10         0.32           0.368 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25            1.25
     RUNOFF VOLUME    (mm)=      86.06        45.05           49.15
     TOTAL RAINFALL   (mm)=      87.06        87.06           87.06
     RUNOFF COEFFICIENT   =       0.99         0.52            0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
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```
       CN*  =  75.2    Ia = Dep. Storage  (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
      THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0007)|   Area    (ha)=   1.06
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.00
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      84.06        40.00
     Mannings n          =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        92.31
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.76 (ii)    9.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.18         0.195 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25          1.25
     RUNOFF VOLUME    (mm)=      86.06        41.32         44.00
     TOTAL RAINFALL   (mm)=      87.06        87.06         87.06
     RUNOFF COEFFICIENT   =       0.99         0.47          0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.
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       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0008)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.03         0.43
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.38        40.00
     Mannings n          =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
               0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
               0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
               0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
               0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
               0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
               0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
               0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
               0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        92.31
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.37 (ii)    8.65 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.12
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.08            0.086 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25             1.25
     RUNOFF VOLUME    (mm)=      86.06        41.32            44.00
     TOTAL RAINFALL   (mm)=      87.06        87.06            87.06
     RUNOFF COEFFICIENT   =       0.99         0.47             0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.
```

```
      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  73.5    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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


--------------------
| ADD HYD  (  0009)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0007):      1.06   0.195     1.25    44.00
      + ID2= 2 (  0008):      0.46   0.086     1.25    44.00
        ====================================================
        ID = 3 (  0009):      1.52   0.280     1.25    44.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0011)|   Area    (ha)=   0.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  30.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.20
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      49.60         5.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
               0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
               0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
               0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
               0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
               0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
               0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
               0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
               0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       222.38
               over (min)         5.00         5.00
```

```
     Storage Coeff.  (min)=       1.28 (ii)    3.22 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.33         0.27
                                                         *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.12         0.181 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17          1.17
     RUNOFF VOLUME    (mm)=      86.06        69.57         74.52
     TOTAL RAINFALL   (mm)=      87.06        87.06         87.06
     RUNOFF COEFFICIENT   =       0.99         0.80          0.86

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD  (  0012)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     1.79   0.368     1.25    49.15
      + ID2= 2 (  0011):     0.37   0.181     1.17    74.52
        =====================================================
        ID = 3 (  0012):     2.16   0.539     1.17    53.49

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

--------------------
| ADD HYD  (  0012)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0012):     2.16   0.539     1.17    53.49
      + ID2= 2 (  0009):     1.52   0.280     1.25    44.00
        =====================================================
        ID = 1 (  0012):     3.68   0.795     1.17    49.57

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

--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):     3.68   0.795     1.17    49.57
      + ID2= 2 (  0013):     0.49   0.136     1.17    59.06
```

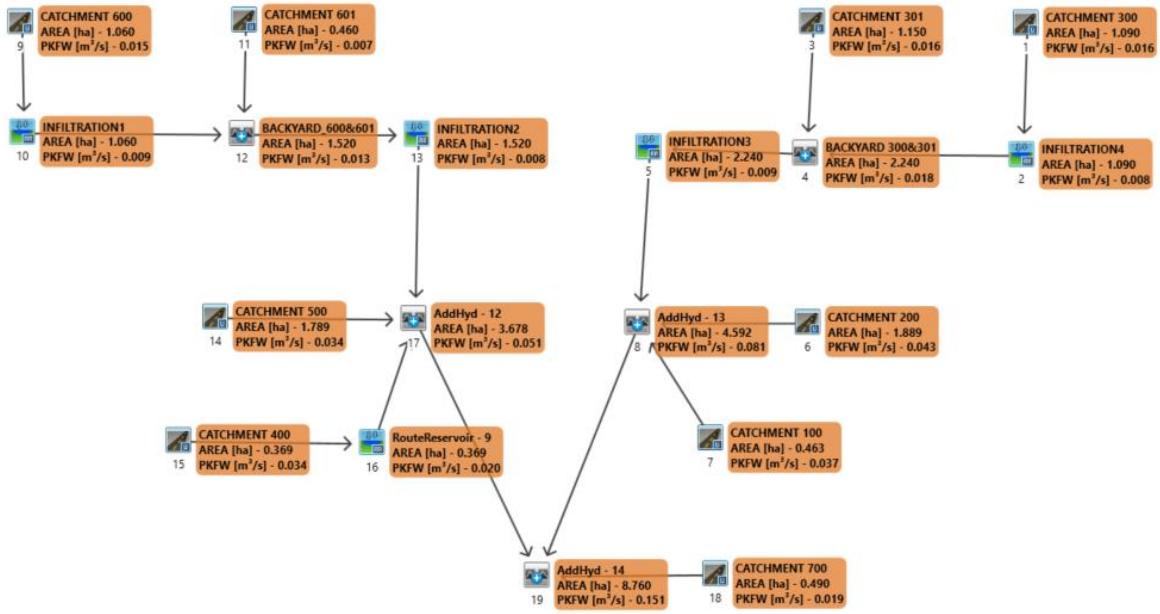
```
        ====================================================
        ID = 3 (  0014):     4.17   0.931     1.17    50.68

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

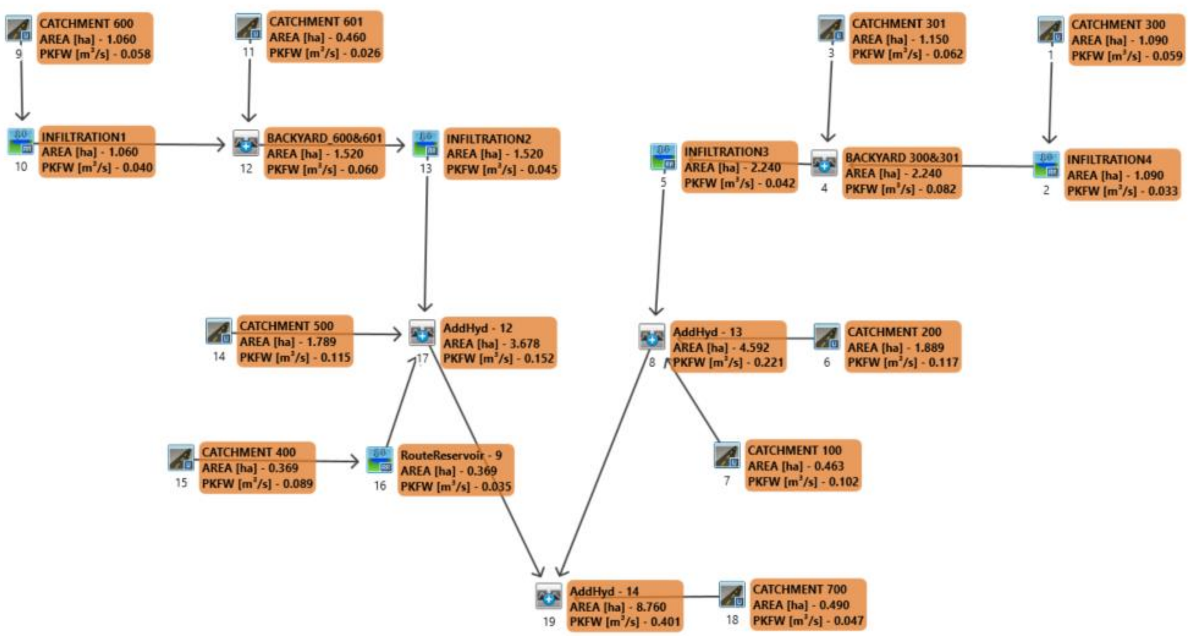
--------------------
| ADD HYD  (  0014)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0014):     4.17   0.931     1.17    50.68
      + ID2= 2 (  0006):     4.59   0.958     1.17    48.35
        ====================================================
        ID = 1 (  0014):     8.76   1.889     1.17    49.46

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

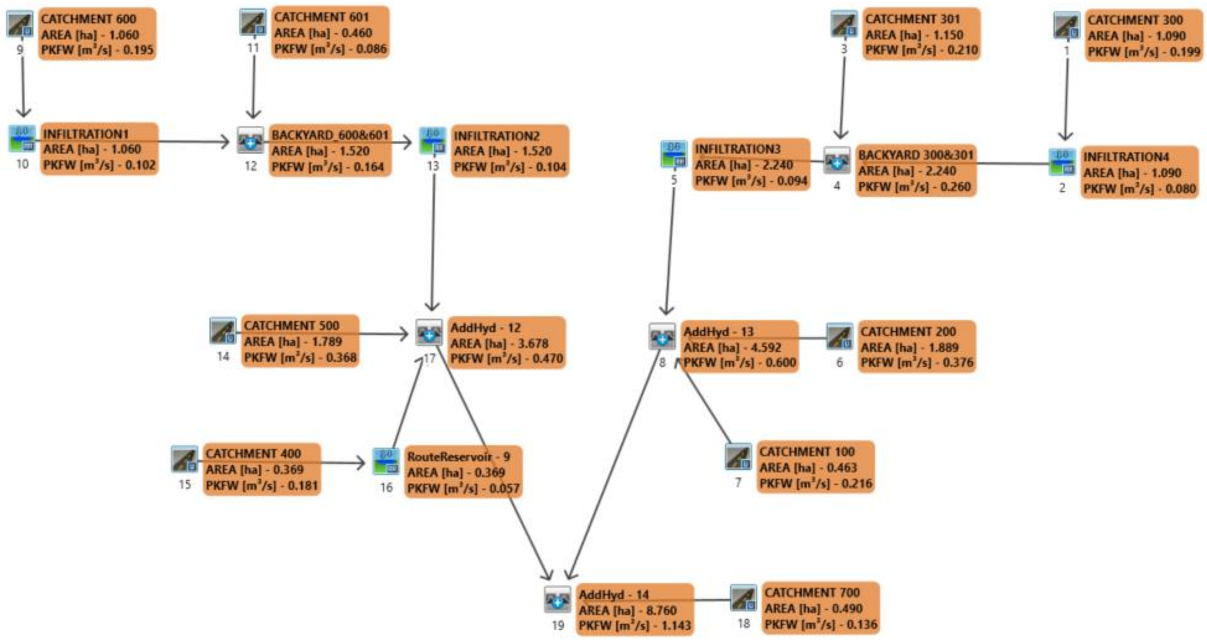
## Post-Development Conditions (24mm 4hour controlled)




## Post-Development Conditions (5-year controlled)



**Post-Development Conditions (100-year controlled)**



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

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2015)
       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 6.2\VO2\voin.dat

  Output  filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\6
118e436-e359-4e69-ba0d-1d73654ab066\
  Summary filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\6
118e436-e359-4e69-ba0d-1d73654ab066\


DATE: 01/26/2024                           TIME: 01:25:57

USER:



COMMENTS: ____________________________________________________________


-----------------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 1yr_4hr 10min Chicago         **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 367.000
| Ptotal= 31.20 mm |                          B=   5.000
--------------------                          C=   0.700
```

```
                 used in:   INTENSITY =  A / (t + B)^C

                 Duration of storm  =  4.00 hrs
                 Storm time step    = 10.00 min
                 Time to peak ratio =  0.38

          TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
           hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
          0.00    2.73 |  1.00    8.29 |  2.00    6.47 |  3.00    3.26
          0.17    3.02 |  1.17   16.48 |  2.17    5.46 |  3.17    3.04
          0.33    3.39 |  1.33   55.13 |  2.33    4.76 |  3.33    2.85
          0.50    3.90 |  1.50   19.39 |  2.50    4.24 |  3.50    2.69
          0.67    4.65 |  1.67   11.11 |  2.67    3.84 |  3.67    2.55
          0.83    5.87 |  1.83    8.08 |  2.83    3.52 |  3.83    2.42


-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0011)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.03          0.43
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      55.38         40.00
     Mannings n          =      0.013         0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
         0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
         0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
         0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
         0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
         0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
         0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
         0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
         0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
         0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
         0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
         1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=      55.13          8.46
                over (min)        5.00         25.00
```

```
     Storage Coeff.  (min)=       2.27 (ii)   21.23 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.30         0.05
                                                        *TOTALS*
     PEAK FLOW       (cms)=       0.00         0.01       0.007 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.83        1.83
     RUNOFF VOLUME    (mm)=      30.20         7.27        8.62
     TOTAL RAINFALL   (mm)=      31.20        31.20       31.20
     RUNOFF COEFFICIENT   =       0.97         0.23        0.28

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
             CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0009)|   Area    (ha)=   1.06
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.00
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      84.06        40.00
     Mannings n           =      0.013        0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
               0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
               0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
               0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
               0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
               0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
               0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
               0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
               0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
               0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
               0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
```

```
            1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=      55.13         8.46
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       2.92 (ii)   21.88 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.28         0.05
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.01           0.015 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.83            1.83
     RUNOFF VOLUME    (mm)=      30.20         7.27            8.63
     TOTAL RAINFALL   (mm)=      31.20        31.20           31.20
     RUNOFF COEFFICIENT   =       0.97         0.23            0.28

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
             CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0010)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0769     0.0120
                          0.0014     0.0009   |   0.0842     0.0136
                          0.0015     0.0018   |   0.0910     0.0152
                          0.0017     0.0026   |   0.0974     0.0165
                          0.0018     0.0039   |   0.1033     0.0179
                          0.0338     0.0054   |   0.1089     0.0188
                          0.0484     0.0069   |   0.1143     0.0197
                          0.0594     0.0086   |   0.1194     0.0206
                          0.0687     0.0103   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)      1.060      0.015      1.83       8.63
   OUTFLOW: ID= 1 (  0010)      1.060      0.009      2.50       8.49

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 58.83
                   TIME SHIFT OF PEAK FLOW        (min)= 40.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0042

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

```
--------------------
| ADD HYD  (  0012)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):      1.06   0.009     2.50     8.49
      + ID2= 2 (  0011):      0.46   0.007     1.83     8.62
        ===================================================
        ID = 3 (  0012):      1.52   0.013     2.42     8.53

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0013)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0772      0.0133
                          0.0015     0.0010   |   0.0846      0.0152
                          0.0017     0.0020   |   0.0914      0.0169
                          0.0019     0.0029   |   0.0977      0.0184
                          0.0020     0.0043   |   0.1037      0.0199
                          0.0340     0.0060   |   0.1093      0.0209
                          0.0486     0.0077   |   0.1147      0.0219
                          0.0597     0.0096   |   0.1198      0.0229
                          0.0690     0.0114   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0012)      1.520      0.013      2.42       8.53
   OUTFLOW: ID= 1 (  0013)      1.520      0.008      3.17       8.43

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 63.22
                   TIME SHIFT OF PEAK FLOW         (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0046

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0015)|   Area    (ha)=   0.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.20
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      49.60         5.00
     Mannings n          =      0.013        0.250

         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 | 2.73 | 1.083 | 8.29 | 2.083 | 6.47 | 3.08 | 3.26 |
| 0.167 | 2.73 | 1.167 | 8.29 | 2.167 | 6.47 | 3.17 | 3.26 |
| 0.250 | 3.02 | 1.250 | 16.48 | 2.250 | 5.46 | 3.25 | 3.04 |
| 0.333 | 3.02 | 1.333 | 16.48 | 2.333 | 5.46 | 3.33 | 3.04 |
| 0.417 | 3.39 | 1.417 | 55.13 | 2.417 | 4.76 | 3.42 | 2.85 |
| 0.500 | 3.39 | 1.500 | 55.13 | 2.500 | 4.76 | 3.50 | 2.85 |
| 0.583 | 3.90 | 1.583 | 19.39 | 2.583 | 4.24 | 3.58 | 2.69 |
| 0.667 | 3.90 | 1.667 | 19.39 | 2.667 | 4.24 | 3.67 | 2.69 |
| 0.750 | 4.65 | 1.750 | 11.11 | 2.750 | 3.84 | 3.75 | 2.55 |
| 0.833 | 4.65 | 1.833 | 11.11 | 2.833 | 3.84 | 3.83 | 2.55 |
| 0.917 | 5.87 | 1.917 | 8.08 | 2.917 | 3.52 | 3.92 | 2.42 |
| 1.000 | 5.87 | 2.000 | 8.08 | 3.000 | 3.52 | 4.00 | 2.42 |

| | | | |
|---|---|---|---|
| Max.Eff.Inten.(mm/hr)= | 55.13 | 42.66 | |
| over (min) | 5.00 | 10.00 | |
| Storage Coeff. (min)= | 2.13 (ii) | 5.36 (ii) | |
| Unit Hyd. Tpeak (min)= | 5.00 | 10.00 | |
| Unit Hyd. peak (cms)= | 0.31 | 0.16 | |
| | | | *TOTALS* |
| PEAK FLOW (cms)= | 0.02 | 0.02 | 0.034 (iii) |
| TIME TO PEAK (hrs)= | 1.50 | 1.58 | 1.50 |
| RUNOFF VOLUME (mm)= | 30.20 | 17.98 | 21.64 |
| TOTAL RAINFALL (mm)= | 31.20 | 31.20 | 31.20 |
| RUNOFF COEFFICIENT = | 0.97 | 0.58 | 0.69 |

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

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 90.5 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

---

```
--------------------
| RESERVOIR(  0016)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |
--------------------
```

| OUTFLOW (cms) | STORAGE (ha.m.) | OUTFLOW (cms) | STORAGE (ha.m.) |
|---|---|---|---|
| **** WARNING : FIRST OUTFLOW IS NOT ZERO. | | | |
| 0.0010 | 0.0000 | 0.0425 | 0.0073 |
| 0.0010 | 0.0008 | 0.0454 | 0.0083 |
| 0.0166 | 0.0016 | 0.0481 | 0.0093 |
| 0.0231 | 0.0024 | 0.0507 | 0.0103 |
| 0.0281 | 0.0033 | 0.0531 | 0.0112 |

```
                              0.0323      0.0043   |   0.0555      0.0120
                              0.0361      0.0053   |   0.0577      0.0128
                              0.0394      0.0063   |   0.0599      0.0136

                                    AREA     QPEAK     TPEAK       R.V.
                                    (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0015)        0.369      0.034      1.50      21.64
   OUTFLOW: ID= 1 (  0016)        0.369      0.020      1.67      21.65

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 58.93
                  TIME SHIFT OF PEAK FLOW         (min)= 10.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0020

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0014)|   Area    (ha)=   1.79
|ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  10.00
--------------------
                                  IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        0.30          1.48
     Dep. Storage     (mm)=        1.00          1.50
     Average Slope     (%)=        1.00          2.00
     Length            (m)=      109.21         40.00
     Mannings n          =        0.013         0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
                 0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
                 0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
                 0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
                 0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
                 0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
                 0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
                 0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
                 0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
                 0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
                 0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
                 1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=       55.13         10.58
                over (min)         5.00         25.00
     Storage Coeff.  (min)=        3.42 (ii)    20.75 (ii)
     Unit Hyd. Tpeak (min)=        5.00         25.00
     Unit Hyd. peak  (cms)=        0.26          0.05
```

```
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.03          0.03          0.034 (iii)
     TIME TO PEAK    (hrs)=       1.50          1.83           1.50
     RUNOFF VOLUME    (mm)=      30.20          8.30          10.48
     TOTAL RAINFALL   (mm)=      31.20         31.20          31.20
     RUNOFF COEFFICIENT   =       0.97          0.27           0.34

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
             YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.2    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0017)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):     1.52   0.008     3.17     8.43
      + ID2= 2 (  0014):     1.79   0.034     1.50    10.48
        ====================================================
        ID = 3 (  0017):     3.31   0.035     1.50     9.54

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


--------------------
| ADD HYD  (  0017)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0017):     3.31   0.035     1.50     9.54
      + ID2= 2 (  0016):     0.37   0.020     1.67    21.65
        ====================================================
        ID = 1 (  0017):     3.68   0.051     1.50    10.75

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.49
|ID= 1 DT= 5.0 min |   Total Imp(%)=  28.00   Dir. Conn.(%)=  20.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14          0.35
     Dep. Storage     (mm)=       1.00          1.50
```

```
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      57.15        40.00
     Mannings n          =      0.013        0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
               0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
               0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
               0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
               0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
               0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
               0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
               0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
               0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
               0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
               0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
               1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=      55.13        15.62
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       2.32 (ii)   17.15 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.30         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.01          0.019 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.75           1.50
     RUNOFF VOLUME    (mm)=      30.20        10.54          14.45
     TOTAL RAINFALL   (mm)=      31.20        31.20          31.20
     RUNOFF COEFFICIENT   =       0.97         0.34           0.46

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0007)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
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--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        0.14         0.32
     Dep. Storage     (mm)=        1.00         1.50
     Average Slope     (%)=        1.00         2.00
     Length            (m)=       55.56         5.00
     Mannings n           =       0.013        0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
               0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
               0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
               0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
               0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
               0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
               0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
               0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
               0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
               0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
               0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
               1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=       55.13        31.32
                over (min)         5.00        10.00
     Storage Coeff.  (min)=        2.28 (ii)    6.14 (ii)
     Unit Hyd. Tpeak (min)=        5.00        10.00
     Unit Hyd. peak  (cms)=        0.30         0.15
                                                             *TOTALS*
     PEAK FLOW       (cms)=        0.02         0.02           0.037 (iii)
     TIME TO PEAK    (hrs)=        1.50         1.58            1.50
     RUNOFF VOLUME    (mm)=       30.20        16.36           19.81
     TOTAL RAINFALL   (mm)=       31.20        31.20           31.20
     RUNOFF COEFFICIENT   =        0.97         0.52            0.64

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
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| STANDHYD (  0001)|   Area    (ha)=   1.09
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         1.04
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      85.24        40.00
     Mannings n          =      0.013        0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
                0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
                0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
                0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
                0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
                0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
                0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
                0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
                0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
                0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
                0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
                1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=      55.13         8.46
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       2.95 (ii)   21.90 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.28         0.05
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.01         0.016 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.83          1.83
     RUNOFF VOLUME    (mm)=      30.20         7.27          8.41
     TOTAL RAINFALL   (mm)=      31.20        31.20         31.20
     RUNOFF COEFFICIENT   =       0.97         0.23          0.27

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
```

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-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0002)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0536     0.0132
                          0.0015     0.0010   |   0.0585     0.0150
                          0.0017     0.0019   |   0.0630     0.0167
                          0.0019     0.0029   |   0.0673     0.0182
                          0.0020     0.0042   |   0.0713     0.0197
                          0.0257     0.0059   |   0.0751     0.0207
                          0.0349     0.0076   |   0.0787     0.0216
                          0.0421     0.0094   |   0.0822     0.0226
                          0.0482     0.0113   |   0.0000     0.0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      1.090      0.016      1.83        8.41
   OUTFLOW: ID= 1 (  0002)      1.090      0.008      2.75        8.26

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 48.56
                  TIME SHIFT OF PEAK FLOW         (min)= 55.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0046

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0003)|   Area    (ha)=   1.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.09
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      87.56        40.00
     Mannings n          =      0.013        0.250

         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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
                0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
                0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
                0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
                0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
```

```
                0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
                0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
                0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
                0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
                0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
                0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
                1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

     Max.Eff.Inten.(mm/hr)=      55.13         8.46
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       2.99 (ii)   21.95 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.28         0.05
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.01          0.016 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.83           1.83
     RUNOFF VOLUME    (mm)=      30.20         7.27           8.41
     TOTAL RAINFALL   (mm)=      31.20        31.20          31.20
     RUNOFF COEFFICIENT   =       0.97         0.23           0.27

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0002):     1.09   0.008     2.75     8.26
      + ID2= 2 (  0003):     1.15   0.016     1.83     8.41
        ====================================================
        ID = 3 (  0004):     2.24   0.018     1.83     8.34

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0617      0.0253
                          0.0029     0.0019   |   0.0674      0.0289
```

```
                                 0.0032     0.0037   |   0.0726     0.0321
                                 0.0036     0.0056   |   0.0775     0.0350
                                 0.0039     0.0082   |   0.0821     0.0380
                                 0.0299     0.0113   |   0.0865     0.0398
                                 0.0404     0.0147   |   0.0906     0.0417
                                 0.0486     0.0182   |   0.0946     0.0435
                                 0.0555     0.0218   |   0.0000     0.0000

                                      AREA     QPEAK     TPEAK      R.V.
                                      (ha)     (cms)     (hrs)      (mm)
  INFLOW : ID= 2 (  0004)      2.240      0.018      1.83       8.34
  OUTFLOW: ID= 1 (  0005)      2.240      0.009      3.83       8.27

                PEAK   FLOW   REDUCTION [Qout/Qin](%)= 48.12
                TIME SHIFT OF PEAK FLOW        (min)=120.00
                MAXIMUM  STORAGE   USED      (ha.m.)=  0.0088

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--------------------
| CALIB              |
| STANDHYD (  0006)|   Area    (ha)=   1.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  13.00   Dir. Conn.(%)=  13.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area     (ha)=        0.25          1.64
    Dep. Storage     (mm)=        1.00          1.50
    Average Slope     (%)=        1.00          2.00
    Length            (m)=      112.22         40.00
    Mannings n           =       0.013         0.250

        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    2.73 | 1.083    8.29 | 2.083    6.47 |  3.08    3.26
              0.167    2.73 | 1.167    8.29 | 2.167    6.47 |  3.17    3.26
              0.250    3.02 | 1.250   16.48 | 2.250    5.46 |  3.25    3.04
              0.333    3.02 | 1.333   16.48 | 2.333    5.46 |  3.33    3.04
              0.417    3.39 | 1.417   55.13 | 2.417    4.76 |  3.42    2.85
              0.500    3.39 | 1.500   55.13 | 2.500    4.76 |  3.50    2.85
              0.583    3.90 | 1.583   19.39 | 2.583    4.24 |  3.58    2.69
              0.667    3.90 | 1.667   19.39 | 2.667    4.24 |  3.67    2.69
              0.750    4.65 | 1.750   11.11 | 2.750    3.84 |  3.75    2.55
              0.833    4.65 | 1.833   11.11 | 2.833    3.84 |  3.83    2.55
              0.917    5.87 | 1.917    8.08 | 2.917    3.52 |  3.92    2.42
              1.000    5.87 | 2.000    8.08 | 3.000    3.52 |  4.00    2.42

    Max.Eff.Inten.(mm/hr)=       55.13          8.93
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                over (min)        5.00        25.00
     Storage Coeff.  (min)=       3.47 (ii)   22.03 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.26         0.05
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.02         0.043 (iii)
     TIME TO PEAK    (hrs)=       1.50         1.83          1.50
     RUNOFF VOLUME    (mm)=      30.20         7.64         10.57
     TOTAL RAINFALL   (mm)=      31.20        31.20         31.20
     RUNOFF COEFFICIENT   =       0.97         0.25          0.34

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.8    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0008)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0005):     2.24   0.009     3.83     8.27
      + ID2= 2 (  0006):     1.89   0.043     1.50    10.57
        ====================================================
        ID = 3 (  0008):     4.13   0.045     1.50     9.32

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

--------------------
| ADD HYD  (  0008)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0008):     4.13   0.045     1.50     9.32
      + ID2= 2 (  0007):     0.46   0.037     1.50    19.81
        ====================================================
        ID = 1 (  0008):     4.59   0.081     1.50    10.38

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

--------------------
| ADD HYD  (  0019)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0017):     3.68   0.051     1.50    10.75
      + ID2= 2 (  0018):     0.49   0.019     1.50    14.45
        ====================================================
        ID = 3 (  0019):     4.17   0.069     1.50    11.19

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

--------------------
| ADD HYD  (  0019)|
|   3 +  2 =  1    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0019):     4.17   0.069     1.50    11.19
      + ID2= 2 (  0008):     4.59   0.081     1.50    10.38
        ====================================================
        ID = 1 (  0019):     8.76   0.151     1.50    10.76

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

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

       V    V   I    SSSSS  U   U    A    L             (v 6.2.2015)
       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 6.2\VO2\voin.dat

  Output  filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\3
26003c3-6c15-43be-adc7-c9b77375e756\
  Summary filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\3
26003c3-6c15-43be-adc7-c9b77375e756\


DATE: 01/26/2024                           TIME: 01:25:56

USER:



COMMENTS: ____________________________________________________________


-----------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 5yr-3hr 10min Chicago         **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1593.000
| Ptotal= 47.25 mm |                          B=  11.000
--------------------                          C=   0.879
```

```
                     used in:   INTENSITY =  A / (t + B)^C

                     Duration of storm  =  3.00 hrs
                     Storm time step    = 10.00 min
                     Time to peak ratio =  0.38

              TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
               hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
              0.00    3.21 |  0.83   32.44 |  1.67    8.62 |  2.50    3.39
              0.17    3.97 |  1.00  109.68 |  1.83    6.65 |  2.67    3.02
              0.33    5.20 |  1.17   39.67 |  2.00    5.38 |  2.83    2.72
              0.50    7.43 |  1.33   19.15 |  2.17    4.51 |
              0.67   12.54 |  1.50   12.05 |  2.33    3.88 |


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0011)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        0.03         0.43
     Dep. Storage     (mm)=        1.00         1.50
     Average Slope     (%)=        1.00         2.00
     Length            (m)=       55.38        40.00
     Mannings n          =       0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
             0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
             0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
             0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
             0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
             0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
             0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
             0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
             0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        27.73
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.73 (ii)   13.52 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                           *TOTALS*
```

```
     PEAK FLOW       (cms)=       0.01         0.02          0.026 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33           1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24          17.09
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.32           0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0009)|   Area    (ha)=   1.06
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.00
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      84.06        40.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        27.73
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.22 (ii)   14.01 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.30         0.08
```

```
                                                                  *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.05          0.058 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33           1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24          17.10
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.32           0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0010)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0769      0.0120
                          0.0014     0.0009   |   0.0842      0.0136
                          0.0015     0.0018   |   0.0910      0.0152
                          0.0017     0.0026   |   0.0974      0.0165
                          0.0018     0.0039   |   0.1033      0.0179
                          0.0338     0.0054   |   0.1089      0.0188
                          0.0484     0.0069   |   0.1143      0.0197
                          0.0594     0.0086   |   0.1194      0.0206
                          0.0687     0.0103   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)      1.060      0.058      1.33      17.10
   OUTFLOW: ID= 1 (  0010)      1.060      0.040      1.58      16.95

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 69.83
                   TIME SHIFT OF PEAK FLOW        (min)= 15.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0061

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

--------------------
| ADD HYD  (  0012)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     1.06   0.040     1.58    16.95
      + ID2= 2 (  0011):     0.46   0.026     1.33    17.09
```

```
        ====================================================
        ID = 3 (  0012):     1.52   0.060     1.50    16.99

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0013)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0772      0.0133
                          0.0015     0.0010   |   0.0846      0.0152
                          0.0017     0.0020   |   0.0914      0.0169
                          0.0019     0.0029   |   0.0977      0.0184
                          0.0020     0.0043   |   0.1037      0.0199
                          0.0340     0.0060   |   0.1093      0.0209
                          0.0486     0.0077   |   0.1147      0.0219
                          0.0597     0.0096   |   0.1198      0.0229
                          0.0690     0.0114   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0012)      1.520      0.060      1.50      16.99
   OUTFLOW: ID= 1 (  0013)      1.520      0.045      1.83      16.89

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 75.01
                  TIME SHIFT OF PEAK FLOW         (min)= 20.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0073

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0015)|   Area    (ha)=   0.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.20
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      49.60         5.00
     Mannings n          =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
```

```
              0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
              0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
              0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
              0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
              0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
              0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
              0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68       103.77
               over (min)         5.00         5.00
     Storage Coeff.  (min)=       1.62 (ii)    4.07 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.32         0.24
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.06           0.089 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17            1.17
     RUNOFF VOLUME    (mm)=      46.25        32.08           36.32
     TOTAL RAINFALL   (mm)=      47.25        47.25           47.25
     RUNOFF COEFFICIENT   =       0.98         0.68            0.77

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0016)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
     **** WARNING : FIRST OUTFLOW IS NOT ZERO.
                          0.0010     0.0000   |   0.0425      0.0073
                          0.0010     0.0008   |   0.0454      0.0083
                          0.0166     0.0016   |   0.0481      0.0093
                          0.0231     0.0024   |   0.0507      0.0103
                          0.0281     0.0033   |   0.0531      0.0112
                          0.0323     0.0043   |   0.0555      0.0120
                          0.0361     0.0053   |   0.0577      0.0128
                          0.0394     0.0063   |   0.0599      0.0136

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0015)      0.369     0.089      1.17      36.32
   OUTFLOW: ID= 1 (  0016)      0.369     0.035      1.33      36.34

                       PEAK   FLOW   REDUCTION [Qout/Qin](%)= 39.54
```

```
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0051

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0014)|   Area    (ha)=   1.79
|ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  10.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        0.30         1.48
     Dep. Storage     (mm)=        1.00         1.50
     Average Slope     (%)=        1.00         2.00
     Length            (m)=      109.21        40.00
     Mannings n          =       0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        34.07
                over (min)        5.00        15.00
     Storage Coeff.  (min)=        2.60 (ii)   13.45 (ii)
     Unit Hyd. Tpeak (min)=        5.00        15.00
     Unit Hyd. peak  (cms)=        0.29         0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=        0.05         0.09          0.115 (iii)
     TIME TO PEAK    (hrs)=        1.17         1.33           1.33
     RUNOFF VOLUME    (mm)=       46.25        17.09          20.00
     TOTAL RAINFALL   (mm)=       47.25        47.25          47.25
     RUNOFF COEFFICIENT   =        0.98         0.36           0.42

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  75.2    Ia = Dep. Storage  (Above)
```

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

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

--------------------
| ADD HYD  (  0017)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):     1.52   0.045     1.83    16.89
      + ID2= 2 (  0014):     1.79   0.115     1.33    20.00
        ====================================================
        ID = 3 (  0017):     3.31   0.118     1.50    18.57

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

--------------------
| ADD HYD  (  0017)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0017):     3.31   0.118     1.50    18.57
      + ID2= 2 (  0016):     0.37   0.035     1.33    36.34
        ====================================================
        ID = 1 (  0017):     3.68   0.152     1.33    20.35

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.49
|ID= 1 DT= 5.0 min |   Total Imp(%)=  28.00   Dir. Conn.(%)=  20.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.35
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      57.15        40.00
     Mannings n          =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
               0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
               0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
```

```
              0.333    3.97 | 1.083  109.68 | 1.833    8.62 |   2.58    3.39
              0.417    5.20 | 1.167  109.68 | 1.917    6.65 |   2.67    3.39
              0.500    5.20 | 1.250   39.67 | 2.000    6.65 |   2.75    3.02
              0.583    7.43 | 1.333   39.67 | 2.083    5.38 |   2.83    3.02
              0.667    7.43 | 1.417   19.15 | 2.167    5.38 |   2.92    2.72
              0.750   12.54 | 1.500   19.15 | 2.250    4.51 |   3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        52.90
               over (min)         5.00        15.00
     Storage Coeff.  (min)=       1.76 (ii)   10.86 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.09
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.03          0.047 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33           1.17
     RUNOFF VOLUME    (mm)=      46.25        20.94          25.99
     TOTAL RAINFALL   (mm)=      47.25        47.25          47.25
     RUNOFF COEFFICIENT   =       0.98         0.44           0.55

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0007)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.32
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.56         5.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |   2.33    4.51
              0.167    3.21 | 0.917   32.44 | 1.667   12.05 |   2.42    3.88
```

```
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        78.76
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.73 (ii)    4.66 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.32         0.22
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.07           0.102 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17            1.17
     RUNOFF VOLUME    (mm)=      46.25        29.89           33.97
     TOTAL RAINFALL   (mm)=      47.25        47.25           47.25
     RUNOFF COEFFICIENT   =       0.98         0.63            0.72

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0001)|   Area    (ha)=   1.09
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         1.04
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      85.24        40.00
     Mannings n           =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
```

```
                0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        27.73
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.24 (ii)   14.03 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.30         0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.05           0.059 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33            1.33
     RUNOFF VOLUME    (mm)=      46.25        15.24           16.79
     TOTAL RAINFALL   (mm)=      47.25        47.25           47.25
     RUNOFF COEFFICIENT   =       0.98         0.32            0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0002)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)    |   (cms)     (ha.m.)
                          0.0000     0.0000    |   0.0536      0.0132
                          0.0015     0.0010    |   0.0585      0.0150
                          0.0017     0.0019    |   0.0630      0.0167
                          0.0019     0.0029    |   0.0673      0.0182
                          0.0020     0.0042    |   0.0713      0.0197
                          0.0257     0.0059    |   0.0751      0.0207
                          0.0349     0.0076    |   0.0787      0.0216
                          0.0421     0.0094    |   0.0822      0.0226
                          0.0482     0.0113    |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      1.090      0.059      1.33      16.79
   OUTFLOW: ID= 1 (  0002)      1.090      0.033      1.75      16.64
```

```
                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 56.08
                  TIME SHIFT OF PEAK FLOW        (min)= 25.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0073

 --------------------------------------------------------------------------------
 --------------------
 | CALIB            |
 | STANDHYD (  0003)|   Area    (ha)=   1.15
 |ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
 --------------------
                             IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       0.06         1.09
      Dep. Storage     (mm)=       1.00         1.50
      Average Slope     (%)=       1.00         2.00
      Length            (m)=      87.56        40.00
      Mannings n          =      0.013        0.250

          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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                 0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                 0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                 0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                 0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                 0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                 0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                 0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                 0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

      Max.Eff.Inten.(mm/hr)=     109.68        27.73
                 over (min)       5.00        15.00
      Storage Coeff.  (min)=       2.27 (ii)   14.06 (ii)
      Unit Hyd. Tpeak (min)=       5.00        15.00
      Unit Hyd. peak  (cms)=       0.30         0.08
                                                             *TOTALS*
      PEAK FLOW       (cms)=       0.02         0.06           0.062 (iii)
      TIME TO PEAK    (hrs)=       1.17         1.33            1.33
      RUNOFF VOLUME    (mm)=      46.25        15.24           16.79
      TOTAL RAINFALL   (mm)=      47.25        47.25           47.25
      RUNOFF COEFFICIENT   =       0.98         0.32            0.36

 ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
 ***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
               YOU SHOULD CONSIDER SPLITTING THE AREA.

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
          CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0002):     1.09   0.033     1.75    16.64
      + ID2= 2 (  0003):     1.15   0.062     1.33    16.79
        =====================================================
        ID = 3 (  0004):     2.24   0.082     1.42    16.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0617      0.0253
                          0.0029     0.0019   |   0.0674      0.0289
                          0.0032     0.0037   |   0.0726      0.0321
                          0.0036     0.0056   |   0.0775      0.0350
                          0.0039     0.0082   |   0.0821      0.0380
                          0.0299     0.0113   |   0.0865      0.0398
                          0.0404     0.0147   |   0.0906      0.0417
                          0.0486     0.0182   |   0.0946      0.0435
                          0.0555     0.0218   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      2.240      0.082      1.42      16.72
   OUTFLOW: ID= 1 (  0005)      2.240      0.042      2.17      16.65

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 51.08
                   TIME SHIFT OF PEAK FLOW         (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0154

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0006)|   Area    (ha)=   1.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  13.00   Dir. Conn.(%)=  13.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         1.64
```

```
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     112.22        40.00
     Mannings n          =      0.013        0.250

         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    3.21 | 0.833   12.54 | 1.583   12.05 |  2.33    4.51
                 0.167    3.21 | 0.917   32.44 | 1.667   12.05 |  2.42    3.88
                 0.250    3.97 | 1.000   32.44 | 1.750    8.62 |  2.50    3.88
                 0.333    3.97 | 1.083  109.68 | 1.833    8.62 |  2.58    3.39
                 0.417    5.20 | 1.167  109.68 | 1.917    6.65 |  2.67    3.39
                 0.500    5.20 | 1.250   39.67 | 2.000    6.65 |  2.75    3.02
                 0.583    7.43 | 1.333   39.67 | 2.083    5.38 |  2.83    3.02
                 0.667    7.43 | 1.417   19.15 | 2.167    5.38 |  2.92    2.72
                 0.750   12.54 | 1.500   19.15 | 2.250    4.51 |  3.00    2.72

     Max.Eff.Inten.(mm/hr)=     109.68        29.09
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.64 (ii)   14.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.09         0.117 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.33          1.17
     RUNOFF VOLUME    (mm)=      46.25        15.93         19.87
     TOTAL RAINFALL   (mm)=      47.25        47.25         47.25
     RUNOFF COEFFICIENT   =       0.98         0.34          0.42

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
               YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
             CN*  =  74.8    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD  (  0008)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0005):     2.24   0.042     2.17    16.65
```

```
      + ID2= 2 (  0006):     1.89   0.117     1.17    19.87
        ====================================================
        ID = 3 (  0008):     4.13   0.120     1.17    18.12

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

--------------------
| ADD HYD  (  0008)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0008):     4.13   0.120     1.17    18.12
      + ID2= 2 (  0007):     0.46   0.102     1.17    33.97
        ====================================================
        ID = 1 (  0008):     4.59   0.221     1.17    19.72

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

--------------------
| ADD HYD  (  0019)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0017):     3.68   0.152     1.33    20.35
      + ID2= 2 (  0018):     0.49   0.047     1.17    25.99
        ====================================================
        ID = 3 (  0019):     4.17   0.195     1.33    21.02

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

--------------------
| ADD HYD  (  0019)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0019):     4.17   0.195     1.33    21.02
      + ID2= 2 (  0008):     4.59   0.221     1.17    19.72
        ====================================================
        ID = 1 (  0019):     8.76   0.401     1.17    20.34

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

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

       V    V   I    SSSSS  U   U    A    L             (v 6.2.2015)
       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 6.2\VO2\voin.dat

  Output  filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\d
63d498b-34e9-4c2b-bccd-f7bea1f77cc4\
  Summary filename:
C:\Users\jangsoo.lee\AppData\Local\Civica\VH5\72fe312b-9676-436f-b6d3-c40a805b884b\d
63d498b-34e9-4c2b-bccd-f7bea1f77cc4\


DATE: 01/26/2024                           TIME: 01:25:58

USER:



COMMENTS: ____________________________________________________________


------------------------------------------------------------------------------------------
-----------------------
  ************************************************
  ** SIMULATION : 100yr-3hr 10min Chicago       **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=4688.000
| Ptotal= 87.06 mm |                          B=  17.000
--------------------                          C=   0.962
```

```
                used in:   INTENSITY =  A / (t + B)^C

                Duration of storm  =  3.00 hrs
                Storm time step    = 10.00 min
                Time to peak ratio =  0.38

             TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
              hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
             0.00    4.42 |  0.83   66.23 |  1.67   15.63 |  2.50    4.76
             0.17    5.87 |  1.00  196.54 |  1.83   11.36 |  2.67    4.07
             0.33    8.33 |  1.17   81.01 |  2.00    8.71 |  2.83    3.53
             0.50   13.04 |  1.33   38.79 |  2.17    6.93 |
             0.67   24.27 |  1.50   23.19 |  2.33    5.68 |


-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0011)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.03         0.43
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.38        40.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
            0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
            0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
            0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
            0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
            0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
            0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
            0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
            0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        92.31
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.37 (ii)    8.65 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.12
                                                          *TOTALS*
```

```
     PEAK FLOW       (cms)=       0.02          0.08          0.086 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.25           1.25
     RUNOFF VOLUME    (mm)=      86.06         41.32          44.00
     TOTAL RAINFALL   (mm)=      87.06         87.06          87.06
     RUNOFF COEFFICIENT   =       0.99          0.47           0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0009)|   Area    (ha)=   1.06
|ID= 1 DT= 5.0 min |   Total Imp(%)=   6.00   Dir. Conn.(%)=   6.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06          1.00
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      84.06         40.00
     Mannings n          =      0.013         0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54         92.31
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.76 (ii)     9.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.32          0.12
```

```
                                                                   *TOTALS*
     PEAK FLOW       (cms)=       0.03          0.18          0.195 (iii)
     TIME TO PEAK    (hrs)=       1.17          1.25           1.25
     RUNOFF VOLUME    (mm)=      86.06         41.32          44.00
     TOTAL RAINFALL   (mm)=      87.06         87.06          87.06
     RUNOFF COEFFICIENT   =       0.99          0.47           0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0010)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0769      0.0120
                          0.0014     0.0009   |   0.0842      0.0136
                          0.0015     0.0018   |   0.0910      0.0152
                          0.0017     0.0026   |   0.0974      0.0165
                          0.0018     0.0039   |   0.1033      0.0179
                          0.0338     0.0054   |   0.1089      0.0188
                          0.0484     0.0069   |   0.1143      0.0197
                          0.0594     0.0086   |   0.1194      0.0206
                          0.0687     0.0103   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)      1.060      0.195      1.25      44.00
   OUTFLOW: ID= 1 (  0010)      1.060      0.102      1.58      43.86

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 52.16
                   TIME SHIFT OF PEAK FLOW        (min)= 20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0176

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

--------------------
| ADD HYD  (  0012)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     1.06   0.102     1.58    43.86
      + ID2= 2 (  0011):     0.46   0.086     1.25    44.00
```

```
     ====================================================
     ID = 3 (  0012):     1.52   0.164     1.33    43.90

  NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0013)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0772     0.0133
                          0.0015     0.0010   |   0.0846     0.0152
                          0.0017     0.0020   |   0.0914     0.0169
                          0.0019     0.0029   |   0.0977     0.0184
                          0.0020     0.0043   |   0.1037     0.0199
                          0.0340     0.0060   |   0.1093     0.0209
                          0.0486     0.0077   |   0.1147     0.0219
                          0.0597     0.0096   |   0.1198     0.0229
                          0.0690     0.0114   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0012)      1.520      0.164      1.33      43.90
   OUTFLOW: ID= 1 (  0013)      1.520      0.104      1.92      43.80

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 63.50
                  TIME SHIFT OF PEAK FLOW         (min)= 35.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0200

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0015)|   Area    (ha)=   0.37
|ID= 1 DT= 5.0 min |   Total Imp(%)=  47.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.17         0.20
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      49.60         5.00
     Mannings n          =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
```

```
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       222.38
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.28 (ii)    3.22 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.33         0.27
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.12         0.181 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17          1.17
     RUNOFF VOLUME    (mm)=      86.06        69.57         74.52
     TOTAL RAINFALL   (mm)=      87.06        87.06         87.06
     RUNOFF COEFFICIENT   =       0.99         0.80          0.86

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0016)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
     **** WARNING : FIRST OUTFLOW IS NOT ZERO.
                          0.0010     0.0000   |   0.0425      0.0073
                          0.0010     0.0008   |   0.0454      0.0083
                          0.0166     0.0016   |   0.0481      0.0093
                          0.0231     0.0024   |   0.0507      0.0103
                          0.0281     0.0033   |   0.0531      0.0112
                          0.0323     0.0043   |   0.0555      0.0120
                          0.0361     0.0053   |   0.0577      0.0128
                          0.0394     0.0063   |   0.0599      0.0136

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0015)      0.369      0.181      1.17      74.52
   OUTFLOW: ID= 1 (  0016)      0.369      0.057      1.42      74.55

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 31.28
```

```
                  TIME SHIFT OF PEAK FLOW         (min)= 15.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0126

 -------------------------------------------------------------------------------
 --------------------
 | CALIB              |
 | STANDHYD (  0014)|   Area    (ha)=   1.79
 |ID= 1 DT= 5.0 min |   Total Imp(%)=  17.00   Dir. Conn.(%)=  10.00
 --------------------
                             IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       0.30          1.48
      Dep. Storage     (mm)=       1.00          1.50
      Average Slope     (%)=       1.00          2.00
      Length            (m)=     109.21         40.00
      Mannings n          =      0.013         0.250

          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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                  0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                  0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                  0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                  0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                  0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                  0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                  0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                  0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

      Max.Eff.Inten.(mm/hr)=     196.54       110.65
                 over (min)       5.00        10.00
      Storage Coeff.  (min)=       2.06 (ii)    8.83 (ii)
      Unit Hyd. Tpeak (min)=       5.00        10.00
      Unit Hyd. peak  (cms)=       0.31         0.12
                                                              *TOTALS*
      PEAK FLOW       (cms)=       0.10         0.32           0.368 (iii)
      TIME TO PEAK    (hrs)=       1.17         1.25            1.25
      RUNOFF VOLUME    (mm)=      86.06        45.05           49.15
      TOTAL RAINFALL   (mm)=      87.06        87.06           87.06
      RUNOFF COEFFICIENT   =       0.99         0.52            0.56

 ***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
 ***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
                YOU SHOULD CONSIDER SPLITTING THE AREA.

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
             CN*  =  75.2    Ia = Dep. Storage  (Above)
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     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0017)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):     1.52   0.104     1.92    43.80
      + ID2= 2 (  0014):     1.79   0.368     1.25    49.15
        ====================================================
        ID = 3 (  0017):     3.31   0.417     1.25    46.69

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

--------------------
| ADD HYD  (  0017)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0017):     3.31   0.417     1.25    46.69
      + ID2= 2 (  0016):     0.37   0.057     1.42    74.55
        ====================================================
        ID = 1 (  0017):     3.68   0.470     1.25    49.49

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.49
|ID= 1 DT= 5.0 min |   Total Imp(%)=  28.00   Dir. Conn.(%)=  20.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14          0.35
     Dep. Storage     (mm)=       1.00          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      57.15         40.00
     Mannings n          =      0.013         0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                        0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                        0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
```

```
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       135.11
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.39 (ii)    7.65 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.13
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.05         0.10             0.136 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25              1.17
     RUNOFF VOLUME    (mm)=      86.06        52.31             59.06
     TOTAL RAINFALL   (mm)=      87.06        87.06             87.06
     RUNOFF COEFFICIENT   =       0.99         0.60              0.68

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  80.7    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0007)|   Area    (ha)=   0.46
|ID= 1 DT= 5.0 min |   Total Imp(%)=  31.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.32
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      55.56         5.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
```

```
             0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
             0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
             0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
             0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
             0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
             0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
             0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54       174.89
                over (min)        5.00         5.00
     Storage Coeff.  (min)=       1.37 (ii)    3.69 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=       0.33         0.25
                                                         *TOTALS*
     PEAK FLOW       (cms)=       0.06         0.15        0.216 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.17         1.17
     RUNOFF VOLUME    (mm)=      86.06        66.61        71.46
     TOTAL RAINFALL   (mm)=      87.06        87.06        87.06
     RUNOFF COEFFICIENT   =       0.99         0.77         0.82

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  90.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0001)|   Area    (ha)=   1.09
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         1.04
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      85.24        40.00
     Mannings n           =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
             0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
             0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
```

```
               0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
               0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
               0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
               0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
               0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
               0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        92.31
               over (min)         5.00        10.00
     Storage Coeff.  (min)=       1.77 (ii)    9.06 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.12
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.19             0.199 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25              1.25
     RUNOFF VOLUME    (mm)=      86.06        41.32             43.56
     TOTAL RAINFALL   (mm)=      87.06        87.06             87.06
     RUNOFF COEFFICIENT   =       0.99         0.47              0.50

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  73.5    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0002)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)    |   (cms)     (ha.m.)
                          0.0000     0.0000    |   0.0536      0.0132
                          0.0015     0.0010    |   0.0585      0.0150
                          0.0017     0.0019    |   0.0630      0.0167
                          0.0019     0.0029    |   0.0673      0.0182
                          0.0020     0.0042    |   0.0713      0.0197
                          0.0257     0.0059    |   0.0751      0.0207
                          0.0349     0.0076    |   0.0787      0.0216
                          0.0421     0.0094    |   0.0822      0.0226
                          0.0482     0.0113    |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      1.090      0.199      1.25      43.56
   OUTFLOW: ID= 1 (  0002)      1.090      0.080      1.67      43.41
```

```
                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 40.14
                   TIME SHIFT OF PEAK FLOW        (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0221

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0003)|   Area    (ha)=   1.15
|ID= 1 DT= 5.0 min |   Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.06         1.09
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      87.56        40.00
     Mannings n          =      0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        92.31
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.80 (ii)    9.09 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.20          0.210 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25           1.25
     RUNOFF VOLUME    (mm)=      86.06        41.32          43.56
     TOTAL RAINFALL   (mm)=      87.06        87.06          87.06
     RUNOFF COEFFICIENT   =       0.99         0.47           0.50

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
         CN*  =  73.5    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD  (  0004)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0002):     1.09   0.080     1.67    43.41
      + ID2= 2 (  0003):     1.15   0.210     1.25    43.56
        ====================================================
        ID = 3 (  0004):     2.24   0.260     1.25    43.49

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0005)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0617      0.0253
                          0.0029     0.0019   |   0.0674      0.0289
                          0.0032     0.0037   |   0.0726      0.0321
                          0.0036     0.0056   |   0.0775      0.0350
                          0.0039     0.0082   |   0.0821      0.0380
                          0.0299     0.0113   |   0.0865      0.0398
                          0.0404     0.0147   |   0.0906      0.0417
                          0.0486     0.0182   |   0.0946      0.0435
                          0.0555     0.0218   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0004)      2.240      0.260      1.25      43.49
   OUTFLOW: ID= 1 (  0005)      2.240      0.094      2.17      43.42

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 36.06
                   TIME SHIFT OF PEAK FLOW         (min)= 55.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0431

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0006)|   Area    (ha)=   1.89
|ID= 1 DT= 5.0 min |   Total Imp(%)=  13.00   Dir. Conn.(%)=  13.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.25         1.64
```

```
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     112.22        40.00
     Mannings n          =       0.013        0.250

         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    4.42 | 0.833   24.27 | 1.583   23.19 |  2.33    6.93
                0.167    4.42 | 0.917   66.23 | 1.667   23.19 |  2.42    5.68
                0.250    5.87 | 1.000   66.23 | 1.750   15.63 |  2.50    5.68
                0.333    5.87 | 1.083  196.54 | 1.833   15.63 |  2.58    4.76
                0.417    8.33 | 1.167  196.54 | 1.917   11.36 |  2.67    4.76
                0.500    8.33 | 1.250   81.01 | 2.000   11.36 |  2.75    4.07
                0.583   13.04 | 1.333   81.01 | 2.083    8.71 |  2.83    4.07
                0.667   13.04 | 1.417   38.79 | 2.167    8.71 |  2.92    3.53
                0.750   24.27 | 1.500   38.79 | 2.250    6.93 |  3.00    3.53

     Max.Eff.Inten.(mm/hr)=     196.54        96.03
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.09 (ii)    9.26 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.31         0.12
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.13         0.30           0.376 (iii)
     TIME TO PEAK    (hrs)=       1.17         1.25            1.17
     RUNOFF VOLUME    (mm)=      86.06        42.75           48.38
     TOTAL RAINFALL   (mm)=      87.06        87.06           87.06
     RUNOFF COEFFICIENT   =       0.99         0.49            0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  74.8    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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


--------------------
| ADD HYD  (  0008)|
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0005):     2.24   0.094     2.17    43.42
```

```
      + ID2= 2 (  0006):     1.89   0.376     1.17    48.38
        ====================================================
        ID = 3 (  0008):     4.13   0.408     1.25    45.69

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

--------------------
| ADD HYD  (  0008)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0008):     4.13   0.408     1.25    45.69
      + ID2= 2 (  0007):     0.46   0.216     1.17    71.46
        ====================================================
        ID = 1 (  0008):     4.59   0.600     1.17    48.29

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

--------------------
| ADD HYD  (  0019)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0017):     3.68   0.470     1.25    49.49
      + ID2= 2 (  0018):     0.49   0.136     1.17    59.06
        ====================================================
        ID = 3 (  0019):     4.17   0.591     1.25    50.61

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

--------------------
| ADD HYD  (  0019)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0019):     4.17   0.591     1.25    50.61
      + ID2= 2 (  0008):     4.59   0.600     1.17    48.29
        ====================================================
        ID = 1 (  0019):     8.76   1.143     1.17    49.39

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

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

# APPENDIX D

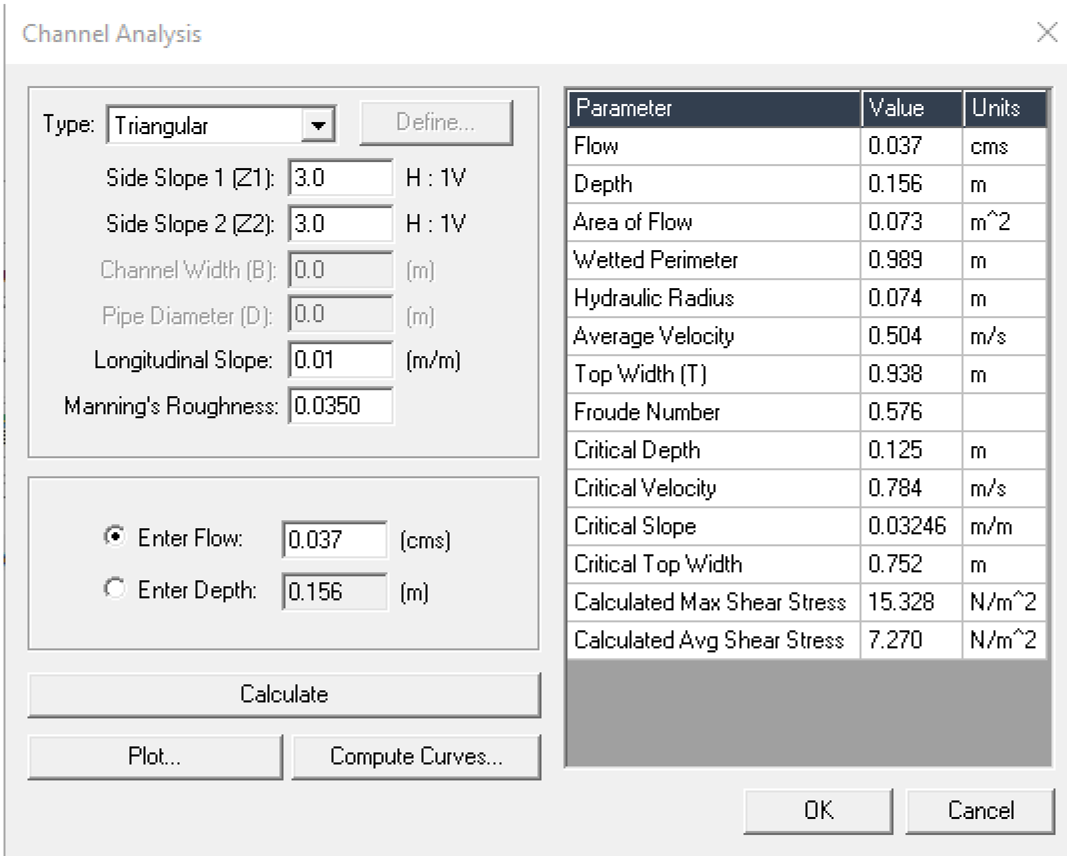
## Post-Development Conditions Stormwater Management Analysis

Post-Development SCS Numbers (weighted calculations)
Stage-Storage-Discharge Tables
Post-Development Condition Modelling results
Roadside Ditch flow velocity calculation

**FLOW VELOCITY CACULATION**

DITCH AT CATCHMENT 100

(FROM FHWA HYDRAULIC TOOLBOX 5.2)



Channel Analysis

Type: Triangular

Define...

Side Slope 1 (Z1): 3.0 H : 1V

Side Slope 2 (Z2): 3.0 H : 1V

Channel Width (B): 0.0 (m)

Pipe Diameter (D): 0.0 (m)

Longitudinal Slope: 0.01 (m/m)

Manning's Roughness: 0.0350

Enter Flow: 0.037 (cms)

Enter Depth: 0.156 (m)

Calculate

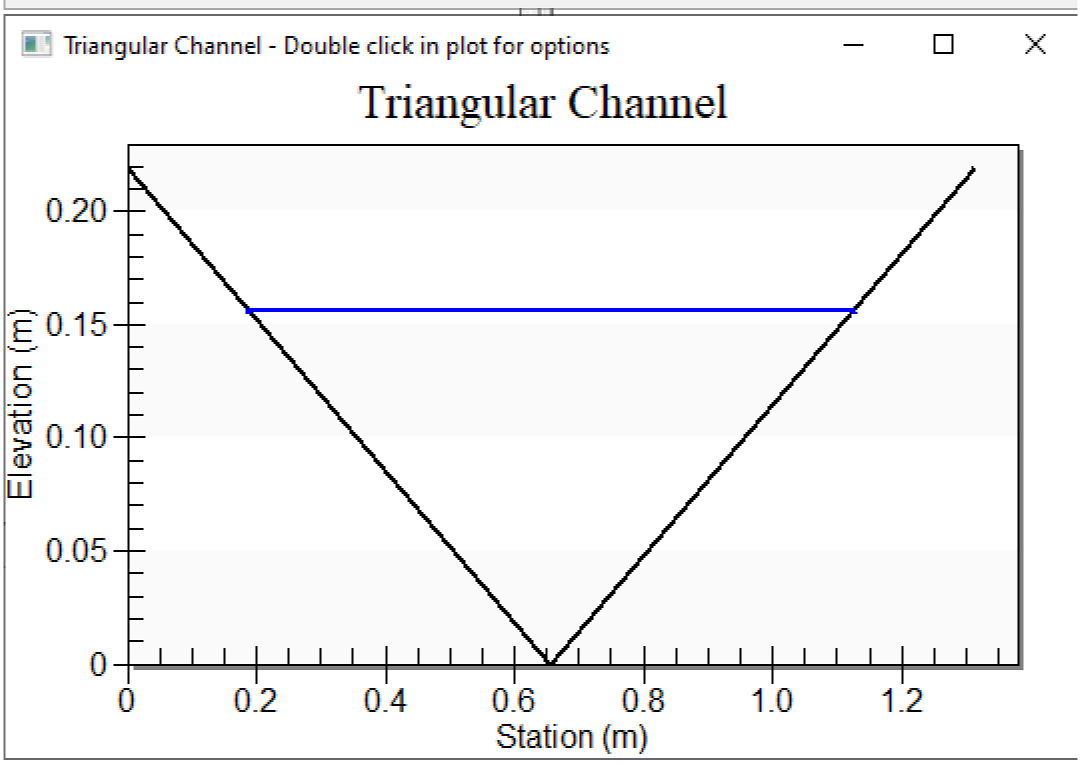
Plot...

Compute Curves...

| Parameter | Value | Units |
|---|---|---|
| Flow | 0.037 | cms |
| Depth | 0.156 | m |
| Area of Flow | 0.073 | m^2 |
| Wetted Perimeter | 0.989 | m |
| Hydraulic Radius | 0.074 | m |
| Average Velocity | 0.504 | m/s |
| Top Width (T) | 0.938 | m |
| Froude Number | 0.576 | |
| Critical Depth | 0.125 | m |
| Critical Velocity | 0.784 | m/s |
| Critical Slope | 0.03246 | m/m |
| Critical Top Width | 0.752 | m |
| Calculated Max Shear Stress | 15.328 | N/m^2 |
| Calculated Avg Shear Stress | 7.270 | N/m^2 |

OK

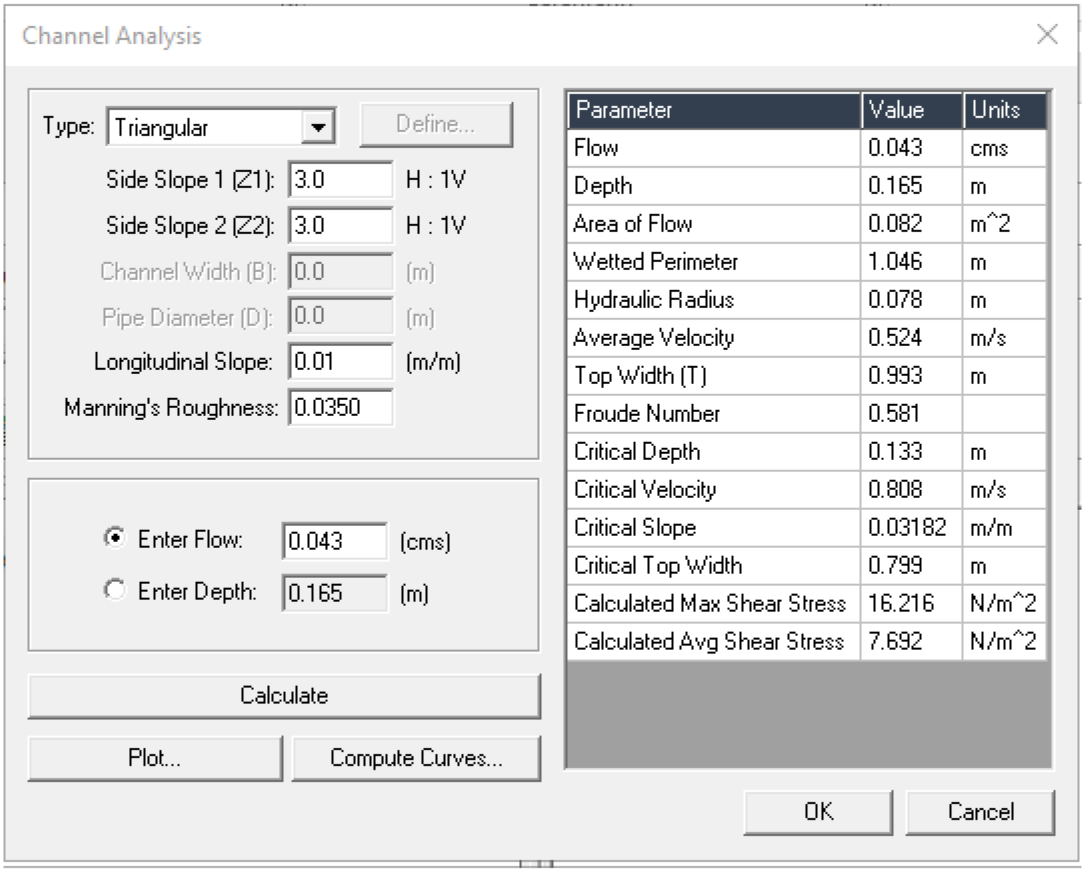
Cancel

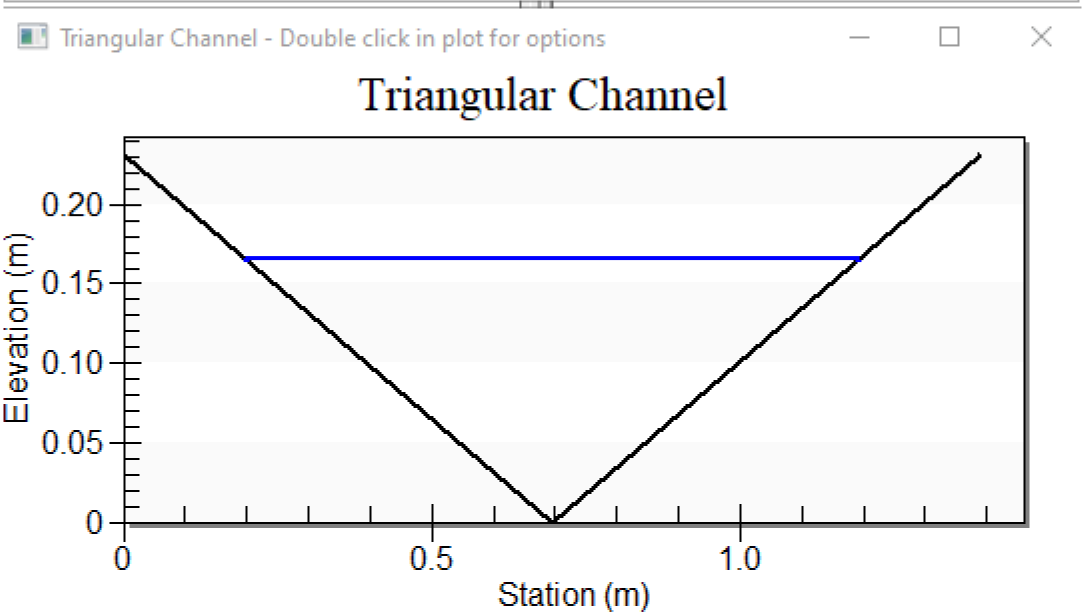


**FLOW VELOCITY CACULATION**

DITCH AT CATCHMENT 200

(FROM FHWA HYDRAULIC TOOLBOX 5.2)

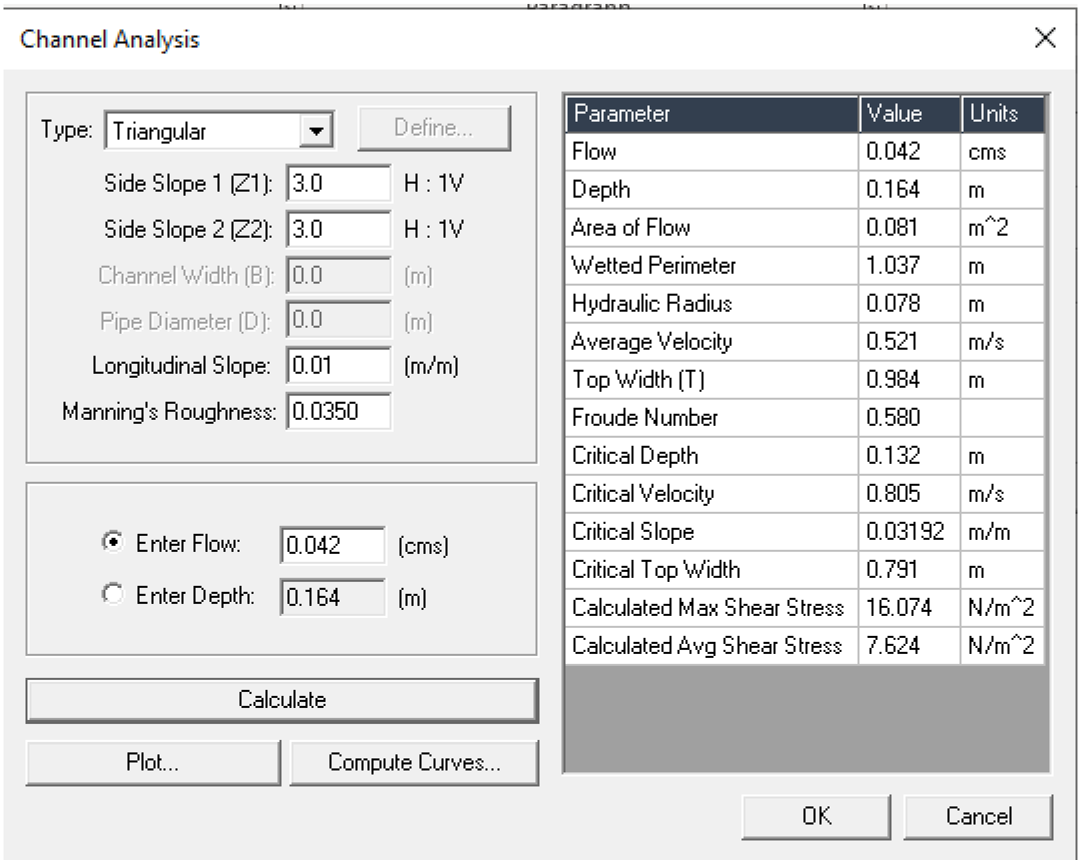


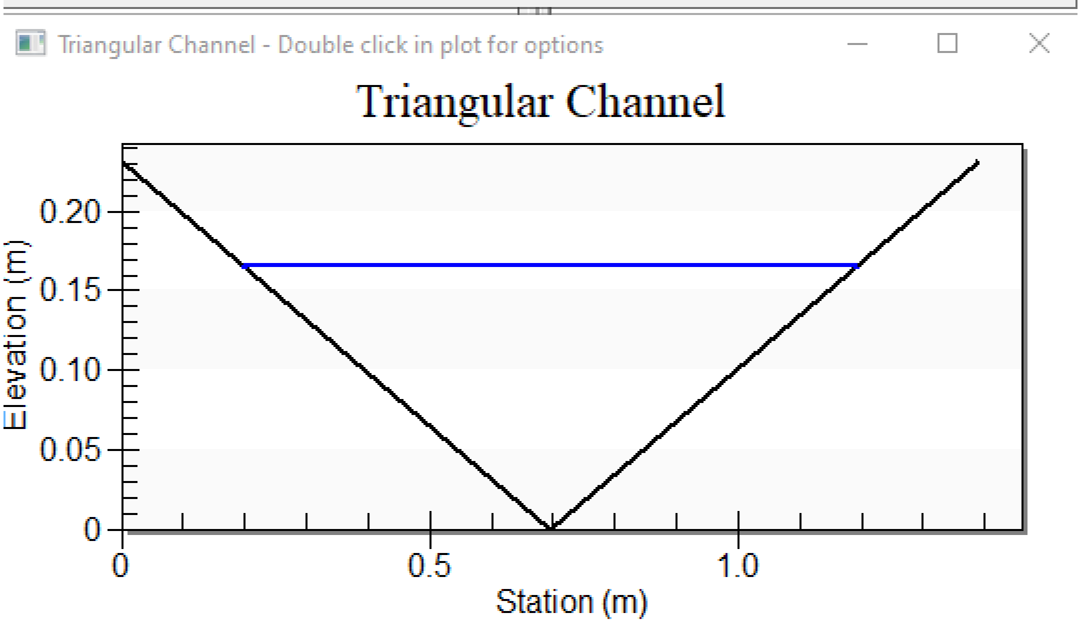
**FLOW VELOCITY CACULATION**

DITCH AT CATCHMENT 500

(FROM FHWA HYDRAULIC TOOLBOX 5.2)




| Parameter | Value | Units |
|---|---|---|
| Flow | 0.042 | cms |
| Depth | 0.164 | m |
| Area of Flow | 0.081 | m^2 |
| Wetted Perimeter | 1.037 | m |
| Hydraulic Radius | 0.078 | m |
| Average Velocity | 0.521 | m/s |
| Top Width (T) | 0.984 | m |
| Froude Number | 0.580 | |
| Critical Depth | 0.132 | m |
| Critical Velocity | 0.805 | m/s |
| Critical Slope | 0.03192 | m/m |
| Critical Top Width | 0.791 | m |
| Calculated Max Shear Stress | 16.074 | N/m^2 |
| Calculated Avg Shear Stress | 7.624 | N/m^2 |



# APPENDIX E

## Water Balance Calculations

| Month | Recharge | | | | | | Runoff | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Existing Condition TOTAL RECHARGE ($m^3$) | Post-Development Recharge ($m^3$) | Infiltration Cell Recharge* ($m^3$) | Post-Development TOTAL RECHARGE ($m^3$) | Total Difference ($m^3$) | Total Difference (%) | Existing Condition ($m^3$) | Post-Development (no infiltration) ($m^3$) | Catchment 400 Infiltration ($m^3$) | Total Difference ($m^3$) | Total Difference (%) |
| January | 422 | 395 | 34 | 429 | 7 | 2% | 422 | 488 | 0 | 66 | 16% |
| February | 211 | 198 | 17 | 214 | 4 | 2% | 211 | 244 | 0 | 33 | 16% |
| March | 105 | 99 | 8 | 107 | 2 | 2% | 105 | 122 | 0 | 16 | 16% |
| April | 2,124 | 1,899 | 145 | 2,044 | -80 | -4% | 2,124 | 2,350 | 0 | 227 | 11% |
| May | 5,726 | 5,128 | 393 | 5,522 | -204 | -4% | 5,726 | 6,347 | 0 | 621 | 11% |
| June | 2,863 | 2,747 | 244 | 2,991 | 128 | 4% | 2,863 | 3,384 | 0 | 521 | 18% |
| July | 1,432 | 1,571 | 173 | 1,745 | 313 | 22% | 1,432 | 1,921 | 0 | 489 | 34% |
| August | 716 | 961 | 132 | 1,093 | 378 | 53% | 716 | 1,163 | 0 | 447 | 62% |
| September | 358 | 610 | 100 | 710 | 352 | 98% | 358 | 731 | 0 | 373 | 104% |
| October | 179 | 367 | 66 | 432 | 253 | 142% | 179 | 437 | 0 | 258 | 144% |
| November | 1,838 | 1,715 | 144 | 1,858 | 20 | 1% | 1,838 | 2,116 | 0 | 278 | 15% |
| December | 841 | 790 | 67 | 857 | 16 | 2% | 841 | 974 | 0 | 133 | 16% |
| **Annual Total** | **16,814** | **16,479** | **1,523** | **18,002** | **1,188** | **7%** | **16,814** | **20,275** | **0** | **3,461** | **21%** |

* Assumed that runoff volume fromt Catchment 400 will be infiltrated by the proposed infiltration gallery

**5782 6th Line East**
**Township of Guelph/Eramosa**
**August/17/2023**
**Pre-Development Conditions**
**Monthly Water Balance**

Station Name Fergus Shand Dam
Latitude 43.7 degrees N

**PRE-DEVELOPMENT CONDITIONS**

Contributing Catchments: Current farm site
Contributing Area = 8.788 ha
Percent Impervious = 0.0%

Soil Type: Silt Loam
Vegetation: Shallow-Rooted Crops
Root Zone Depth 0.62 m
Soil Moisture Retention Capacity (mm) = 125 mm
Impervious ET Constant = 183 mm

| Calculated Summary | | |
|---|---|---|
| Total ET | 49,502 | m3 |
| Total Runoff | 16,814 | m3 |
| Total Recharge | 16,814 | m3 |
| Error | -0.01% | |

Runoff Factor = 0.50
ET Factor for Impervious Surfaces = 0.32

| Month | Daily Average Temperature | Monthly Heat Index (I) | PET Adjustment Factor | Mean Monthly Daylight Hours | Adjusted Potential Evapotranspiration (PE) | Average Precipitation (P) | P-PE | Accum. Pot. Water Loss | Storage (ST) | ΔS | Pervious ET | Actual Evapotrans-piration (AE) | Pervious ET - Actual ET | Moisture Deficit (D) | Moisture Surplus (S) | Water Runoff (RO) | Snow Melt Runoff (SMRO) | Total Runoff and Recharge (TR) | Actual Runoff | Runoff Volume | Recharge Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (°C) | | (mm) | (x12 hrs) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | ($m^3$) | ($m^3$) |
| Jan | -7.4 | 0.0 | 0.0 | 24.3 | 0.0 | 67.9 | 67.9 | 0.0 | 261.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 0.0 | 9.6 | 4.8 | 422 | 422 |
| Feb | -6.3 | 0.0 | 0.0 | 24.3 | 0.0 | 55.9 | 55.9 | 0.0 | 317.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.8 | 0.0 | 4.8 | 2.4 | 211 | 211 |
| Mar | -1.9 | 0.0 | 0.0 | 30.6 | 0.0 | 59.6 | 59.6 | 0.0 | 377.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | 0.0 | 2.4 | 1.2 | 105 | 105 |
| Apr | 5.7 | 1.2 | 0.9 | 33.6 | 30.2 | 74.1 | 43.9 | 0.0 | 125.0 | 0.0 | 30.2 | 30.2 | 0.0 | 0.0 | 43.9 | 23.1 | 25.2 | 48.3 | 24.2 | 2,124 | 2,124 |
| May | 12.2 | 3.9 | 2.0 | 38.1 | 76.2 | 86.9 | 10.7 | 0.0 | 125.0 | 0.0 | 76.2 | 76.2 | 0.0 | 0.0 | 10.7 | 16.9 | 113.4 | 130.3 | 65.2 | 5,726 | 5,726 |
| Jun | 17.5 | 6.7 | 2.9 | 38.7 | 112.2 | 83.8 | -28.4 | -28.4 | 99.0 | -26.0 | 109.8 | 109.8 | 0.0 | 2.4 | 0.0 | 8.5 | 56.7 | 65.2 | 32.6 | 2,863 | 2,863 |
| Jul | 20 | 8.2 | 3.4 | 39.0 | 132.6 | 89.2 | -43.4 | -71.8 | 69.0 | -30.0 | 119.2 | 119.2 | 0.0 | 13.4 | 0.0 | 4.2 | 28.4 | 32.6 | 16.3 | 1,432 | 1,432 |
| Aug | 19 | 7.6 | 3.2 | 36.0 | 115.2 | 96.6 | -18.6 | -90.4 | 60.0 | -9.0 | 105.6 | 105.6 | 0.0 | 9.6 | 0.0 | 2.1 | 14.2 | 16.3 | 8.1 | 716 | 716 |
| Sep | 14.9 | 5.2 | 2.5 | 31.2 | 78.0 | 93.1 | 15.1 | 0.0 | 75.1 | 15.1 | 78.0 | 78.0 | 0.0 | 0.0 | 0.0 | 1.1 | 7.1 | 8.1 | 4.1 | 358 | 358 |
| Oct | 8.3 | 2.2 | 1.3 | 28.5 | 37.1 | 77.2 | 40.2 | 0.0 | 115.3 | 40.2 | 37.1 | 37.1 | 0.0 | 0.0 | 0.0 | 0.5 | 3.5 | 4.1 | 2.0 | 179 | 179 |
| Nov | 2.1 | 0.3 | 0.3 | 24.0 | 7.2 | 93 | 85.8 | 0.0 | 125.0 | 9.8 | 7.2 | 7.2 | 0.0 | 0.0 | 76.1 | 38.3 | 3.5 | 41.8 | 20.9 | 1,838 | 1,838 |
| Dec | -3.9 | 0.0 | 0.0 | 22.8 | 0.0 | 68.6 | 68.6 | 0.0 | 193.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.1 | 0.0 | 19.1 | 9.6 | 841 | 841 |
| **Total** | | **35.1** | | | **588.7** | **945.9** | **357.2** | **-190.7** | | | **563.3** | **563.3** | **0.0** | **25.4** | **130.6** | **130.7** | **252.0** | **382.7** | **191.3** | **16,814** | **16,814** |
| | | | | | | **Snow months** | | | | | | | | | | 50% of December | | | | | |

Notes: Precipitation and Temperature data from Environment Canada Climate Normals 1981-2010 Canadian Climate Normals - Climate - Environment and Climate Change Canada (weather.gc.ca)
Monthly water balance strategy as outlined in the document *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance (Thornthwaite and Mather, 1957)*
Monthy Heat Index (I) from Table 2 of *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance*
Correction Factors from Table 6 of *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance*
Infiltration Factor as per MOE Manual (Tab 2)
Runoff Factor = [(Impervious Percentage of Site x Average Annual Runoff for Impervious Surfaces) + (Pervious Silt Percentage of Site x Average Annual Runoff for Pervious Silt Surfaces)] / Total Annual Recharge & Runoff

Station Name Fergus Shand Dam
Latitude 43.7 degrees N

**5782 6th Line East**
**Township of Guelph/Eramosa**
**August/17/2023**
**Post-Development Conditions**
**Monthly Water Balance**

**POST-DEVELOPMENT CONDITIONS**

Contributing Catchments: Current farm site

Contributing Area = 8.454 ha
Percent Impervious = 12.0%

Soil Type: Silt Loam
Vegetation: Shallow-Rooted Crops
Root Zone Depth 0.62 m
Soil Moisture Retention Capacity (mm) = 125 mm
Impervious ET Constant = 183 mm

| Calculated Summary | | |
|---|---|---|
| Total ET | 43,763 | m3 |
| Total Runoff | 20,275 | m3 |
| Total Recharge | 15,931 | m3 |
| Error | 0.00% | |

Runoff Factor = 0.56
ET Factor for Impervious Surfaces = 0.32

| Month | Daily Average Temperature | Monthly Heat Index (I) | PET Adjustment Factor | Mean Monthly Daylight Hours | Adjusted Potential Evapotranspiration (PE) | Average Precipitation (P) | P-PE | Accum. Pot. Water Loss | Storage (ST) | ΔS | Pervious ET | Actual Evapotrans-piration (AE) | Pervious ET - Actual ET | Moisture Deficit (D) | Moisture Surplus (S) | Water Runoff (RO) | Snow Melt Runoff (SMRO) | Total Runoff and Recharge (TR) | Actual Runoff | Runoff Volume | Recharge Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (°C) | | (mm) | (x12 hrs) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | ($m^3$) | ($m^3$) |
| Jan | -7.4 | 0.0 | 0.0 | 24.3 | 0.0 | 67.9 | 67.9 | 0.0 | 261.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.3 | 0.0 | 10.3 | 5.8 | 488 | 383 |
| Feb | -6.3 | 0.0 | 0.0 | 24.3 | 0.0 | 55.9 | 55.9 | 0.0 | 317.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.2 | 0.0 | 5.2 | 2.9 | 244 | 192 |
| Mar | -1.9 | 0.0 | 0.0 | 30.6 | 0.0 | 59.6 | 59.6 | 0.0 | 377.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 0.0 | 2.6 | 1.4 | 122 | 96 |
| Apr | 5.7 | 1.2 | 0.9 | 33.6 | 30.2 | 74.1 | 43.9 | 0.0 | 125.0 | 0.0 | 30.2 | 27.8 | 2.4 | 2.4 | 46.3 | 24.4 | 25.2 | 49.6 | 27.8 | 2,350 | 1,847 |
| May | 12.2 | 3.9 | 2.0 | 38.1 | 76.2 | 86.9 | 10.7 | 0.0 | 125.0 | 0.0 | 76.2 | 70.0 | 6.2 | 6.2 | 16.9 | 20.7 | 113.4 | 134.1 | 75.1 | 6,347 | 4,987 |
| Jun | 17.5 | 6.7 | 2.9 | 38.7 | 112.2 | 83.8 | -28.4 | -28.4 | 99.0 | -26.0 | 109.8 | 100.9 | 8.9 | 11.3 | 8.9 | 14.8 | 56.7 | 71.5 | 40.0 | 3,384 | 2,659 |
| Jul | 20 | 8.2 | 3.4 | 39.0 | 132.6 | 89.2 | -43.4 | -71.8 | 69.0 | -30.0 | 119.2 | 109.5 | 9.7 | 23.1 | 9.7 | 12.2 | 28.4 | 40.6 | 22.7 | 1,921 | 1,509 |
| Aug | 19 | 7.6 | 3.2 | 36.0 | 115.2 | 96.6 | -18.6 | -90.4 | 60.0 | -9.0 | 105.6 | 97.0 | 8.6 | 18.2 | 8.6 | 10.4 | 14.2 | 24.6 | 13.8 | 1,163 | 914 |
| Sep | 14.9 | 5.2 | 2.5 | 31.2 | 78.0 | 93.1 | 15.1 | 0.0 | 75.1 | 15.1 | 78.0 | 71.7 | 6.3 | 6.3 | 6.3 | 8.4 | 7.1 | 15.4 | 8.6 | 731 | 574 |
| Oct | 8.3 | 2.2 | 1.3 | 28.5 | 37.1 | 77.2 | 40.2 | 0.0 | 115.3 | 40.2 | 37.1 | 34.0 | 3.0 | 3.0 | 3.0 | 5.7 | 3.5 | 9.2 | 5.2 | 437 | 343 |
| Nov | 2.1 | 0.3 | 0.3 | 24.0 | 7.2 | 93 | 85.8 | 0.0 | 125.0 | 9.8 | 7.2 | 6.6 | 0.6 | 0.6 | 76.6 | 41.2 | 3.5 | 44.7 | 25.0 | 2,116 | 1,663 |
| Dec | -3.9 | 0.0 | 0.0 | 22.8 | 0.0 | 68.6 | 68.6 | 0.0 | 193.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.6 | 0.0 | 20.6 | 11.5 | 974 | 765 |
| **Total** | | **35.1** | | | **588.7** | **945.9** | **357.2** | **-190.7** | | | **563.3** | **517.7** | **45.6** | **71.1** | **176.2** | **176.3** | **252.0** | **428.3** | **239.8** | **20,275** | **15,931** |
| | | | | | | **Snow months** | | | | | | | | | | 50% of December | | | | | |

Notes: Precipitation and Temperature data from Environment Canada Climate Normals 1981-2010 Canadian Climate Normals - Climate - Environment and Climate Change Canada (weather.gc.ca)
Monthly water balance strategy as outlined in the document *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance (Thornthwaite and Mather, 1957)*
Monthy Heat Index (I) from Table 2 of *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance*
Correction Factors from Table 6 of *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance*
Infiltration Factor as per MOE Manual (Tab 2)
Runoff Factor = [(Impervious Percentage of Site x Average Annual Runoff for Impervious Surfaces) + (Pervious Silt Percentage of Site x Average Annual Runoff for Pervious Silt Surfaces)] / Total Annual Recharge & Runoff

**5782 6th Line East**
**Township of Guelph/Eramosa**
**August/17/2023**
**Post-Development Conditions**
**Monthly Water Balance**

Station Name Fergus Shand Dam
Latitude 43.7 degrees N

**POST-DEVELOPMENT CONDITIONS (INFILTRATION GALLERY, CATCHMENT 400)**

| | | | | | |
|---|---|---|---|---|---|
| Contributing Catchments: | Current farm site | Soil Type: | Silt Loam | | |
| | | Vegetation: | Shallow-Rooted Crops | | |
| Contributing Area = | 0.369 ha | Root Zone Depth | 0.62 m | | |
| Percent Impervious = | 47.0% | Soil Moisture Retention Capacity (mm) = | 125 mm | | |
| | | Impervious ET Constant = | 183 mm | | |

| Calculated Summary | | |
|---|---|---|
| Total ET | 1,419 | m3 |
| Total Runoff | 1,523 | m3 |
| Total Recharge | 549 | m3 |
| Error | 0.00% | |

Runoff Factor = 0.74
ET Factor for Impervious Surfaces = 0.32

| Month | Daily Average Temperature | Monthly Heat Index (I) | PET Adjustment Factor | Mean Monthly Daylight Hours | Adjusted Potential Evapotranspiration (PE) | Average Precipitation (P) | P-PE | Accum. Pot. Water Loss | Storage (ST) | ΔS | Pervious ET | Actual Evapotrans-piration (AE) | Pervious ET - Actual ET | Moisture Deficit (D) | Moisture Surplus (S) | Water Runoff (RO) | Snow Melt Runoff (SMRO) | Total Runoff and Recharge (TR) | Actual Runoff | Runoff Volume | Recharge Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (°C) | | (mm) | (x12 hrs) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | | (mm) | (mm) | (mm) | (mm) | (mm) | (mm) | ($m^3$) | ($m^3$) |
| Jan | -7.4 | 0.0 | 0.0 | 24.3 | 0.0 | 67.9 | 67.9 | 0.0 | 261.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 12.4 | 0.0 | 12.4 | 9.1 | 34 | 12 |
| Feb | -6.3 | 0.0 | 0.0 | 24.3 | 0.0 | 55.9 | 55.9 | 0.0 | 317.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.2 | 0.0 | 6.2 | 4.6 | 17 | 6 |
| Mar | -1.9 | 0.0 | 0.0 | 30.6 | 0.0 | 59.6 | 59.6 | 0.0 | 377.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 3.1 | 2.3 | 8 | 3 |
| Apr | 5.7 | 1.2 | 0.9 | 33.6 | 30.2 | 74.1 | 43.9 | 0.0 | 125.0 | 0.0 | 30.2 | 20.6 | 9.6 | 9.6 | 53.5 | 28.3 | 25.2 | 53.5 | 39.3 | 145 | 52 |
| May | 12.2 | 3.9 | 2.0 | 38.1 | 76.2 | 86.9 | 10.7 | 0.0 | 125.0 | 0.0 | 76.2 | 52.0 | 24.2 | 24.2 | 34.9 | 31.6 | 113.4 | 145.0 | 106.6 | 393 | 142 |
| Jun | 17.5 | 6.7 | 2.9 | 38.7 | 112.2 | 83.8 | -28.4 | -28.4 | 99.0 | -26.0 | 109.8 | 75.0 | 34.8 | 37.3 | 34.8 | 33.2 | 56.7 | 89.9 | 66.1 | 244 | 88 |
| Jul | 20 | 8.2 | 3.4 | 39.0 | 132.6 | 89.2 | -43.4 | -71.8 | 69.0 | -30.0 | 119.2 | 81.4 | 37.8 | 51.2 | 37.8 | 35.5 | 28.4 | 63.9 | 46.9 | 173 | 62 |
| Aug | 19 | 7.6 | 3.2 | 36.0 | 115.2 | 96.6 | -18.6 | -90.4 | 60.0 | -9.0 | 105.6 | 72.1 | 33.5 | 43.1 | 33.5 | 34.5 | 14.2 | 48.7 | 35.8 | 132 | 48 |
| Sep | 14.9 | 5.2 | 2.5 | 31.2 | 78.0 | 93.1 | 15.1 | 0.0 | 75.1 | 15.1 | 78.0 | 53.2 | 24.8 | 24.8 | 24.8 | 29.6 | 7.1 | 36.7 | 27.0 | 100 | 36 |
| Oct | 8.3 | 2.2 | 1.3 | 28.5 | 37.1 | 77.2 | 40.2 | 0.0 | 115.3 | 40.2 | 37.1 | 25.3 | 11.8 | 11.8 | 11.8 | 20.7 | 3.5 | 24.2 | 17.8 | 66 | 24 |
| Nov | 2.1 | 0.3 | 0.3 | 24.0 | 7.2 | 93 | 85.8 | 0.0 | 125.0 | 9.8 | 7.2 | 4.9 | 2.3 | 2.3 | 78.3 | 49.5 | 3.5 | 53.1 | 39.0 | 144 | 52 |
| Dec | -3.9 | 0.0 | 0.0 | 22.8 | 0.0 | 68.6 | 68.6 | 0.0 | 193.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.8 | 0.0 | 24.8 | 18.2 | 67 | 24 |
| **Total** | | **35.1** | | | **588.7** | **945.9** | **357.2** | **-190.7** | | | **563.3** | **384.6** | **178.7** | **204.2** | **309.3** | **309.4** | **252.0** | **561.4** | **412.6** | **1,523** | **549** |
| | | | | | | **Snow months** | | | | | | | | | | 50% of December | | | | | |

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