Functional Servicing and Stormwater Management Design Report for:

465 Garafraxa Street West
Township of Centre Wellington (Fergus)

GMBP File: 422144

Revised: June 2023

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FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT DESIGN REPORT

465 GARAFRAXA STREET WEST

TOWNSHIP OF CENTRE WELLINGTON (FERGUS)

REVISED: JUNE 2023

GMBP FILE: 422144

1. INTRODUCTION

This revised report documents the proposed servicing and stormwater management system design for the proposed development at 465 Garafraxa Street West in the Township of Centre Wellington (Fergus), and addresses comments received from the Township of Centre Wellington (dated May 16, 2023).

The Owner is required to have a Professional Engineer design a stormwater management system and have said Engineer supervise and certify that the stormwater management system was installed in accordance with the approvals given under Section 41 of the Planning Act.

The topographic survey of the site was completed by GM BluePlan Engineering Limited (dated January 30, 2022). The site layout was prepared by Dryden, Smith and Head Planning Consultants Ltd. (dated June 1, 2023).

2. SITE INFORMATION

The 0.42-hectare site is located at 465 Garafraxa Street West in the Township of Centre Wellington (Fergus). The site is bound by Garafraxa Street West to the east and farmland to the north, south and west.

Under existing conditions, runoff generated from the site sheetflows generally from west to east of the roadside ditch on Garafraxa Street West.

At this time, the intent of the Owner is to construct three 3-storey stacked townhouse buildings. The total number of units is proposed to be 32. The site will be serviced with municipal sanitary sewer and water, via an extension of the existing municipal services on Garafraxa Street West from Maiden Lane.

3. PROPOSED DEVELOPMENT

3.1 Site Grading

The site layout and the internal roads are shown on the Site Grading Plan (GM BluePlan Engineering Limited Drawing No. 2). The elevations of the internal road network is controlled by the centerline road elevations of Garafraxa Street West, the building elevations, and the existing property line elevations.

3.2 Water Supply

Water supply for the proposed development will be provided via a future 150mm diameter watermain along Garafraxa Street West, and a 150mm diameter service connection to the from the 150mm watermain on Garafraxa Street West.

Watermain will be installed to a minimum depth of 2.0 meters below finished grade.

Fire protection for the proposed development will be provided by the proposed on-site fire hydrant.

3.3 Sanitary Servicing

Sanitary servicing for the proposed development will be provided via the extension of a 200mm diameter sanitary sewer from the future 200mm diameter sanitary sewer on Garafraxa Street West.

Sanitary sewers (minimum grade of 0.5%) will be installed at a minimum depth of 2.5 metres below finished grade. Sanitary sewer design sheets have been provided in Appendix C.

3.4 Storm Servicing

Under existing conditions, runoff generated from the site sheetflows overland to the existing ditch along the northwesterly boundary of the site.

Storm service for the proposed development will be provided via the installation of storm sewers on site and connection to the future storm sewer on Garafraxa Street West. The on-site storm sewers will convey runoff to the future storm sewers to be installed on Garafraxa Street West.

All storm sewers within the development will be sized (at minimum) to accommodate the 5-year design storm event. Major storm runoff will be conveyed within the limits of the internal road network, ultimately discharging to the Garafraxa Street West right-of-way. Storm sewer design sheets have been provided in Appendix D.

4. STORMWATER MANAGEMENT DESIGN

4.1 Stormwater Management Criteria

The stormwater management criteria for the site are as follows:

1. Post-development flows from the site are to be attenuated to pre-development levels for the 5 through 100-year design storm events.
2. Promoting the infiltration of rooftop runoff, if feasible, to achieve a site water balance should be explored.
3. Enhanced (80% TSS removal) quality control treatment is required for runoff generated by the site.
4. Major storm flows are to be routed overland to an appropriate outlet.

The Fergus Shad Dam Chicago Storm parameters and the total depth of rainfall used for the full range of design storms are as follows:

Table No. 1: Chicago Rainfall Distribution Parameters

	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
a =	695.047	1,459.072	2,327.596	3,701.648	5,089.418	6,933.019
b =	6.387	13.690	19.500	25.500	30.000	34.699
c =	0.793	0.850	0.894	0.937	0.967	0.998
r =	0.380	0.380	0.380	0.380	0.380	0.380
Duration (minutes) =	180	180	180	180	180	180
Rainfall Depth (mm) =	33.014	49.792	61.359	75.581	86.737	97.921

The Horton infiltration method was used in the runoff calculations. The parameters used in MIDUSS are as follows:

Table No. 2: Horton Infiltration Parameters

	Impervious Areas	Pervious Areas
Maximum Infiltration	0.0 mm/hr	75.0 mm/hr
Minimum Infiltration	0.0 mm/hr	12.5 mm/hr
Lag Constant	0.0 hr	0.25 hr
Depression Storage	1.5 mm	5.0 mm

The hydrologic model MIDUSS was used to create runoff hydrographs and to route the flows through the storage structures.

4.2 Existing Conditions

For the existing condition analysis, the site was modelled as one (1) drainage catchment (see Figure No. 1).

Catchment 10 (0.42-hectares, 0% Impervious) represents the entire site under existing conditions. Runoff generated from Catchment 10 discharges to the existing swale at the rear of the property, and ultimately to the existing pond adjacent to Beatty Line North and Black Street.

Table No. 3: Existing Condition Flow Rates

	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Catchment 10	0.003 m^3/s	0.033 m^3/s	0.054 m^3/s	0.085 m^3/s	0.109 m^3/s	0.132 m^3/s

4.3 Allowable Release Rates

From the Township of Centre Wellington, the post-development flows generated from the site are to be attenuated to the existing condition levels. Therefore, the allowable release rates from the site under post-development conditions are as follows:

Table No. 4: Allowable Release Rates

	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Catchment 10	0.003 m^3/s	0.033 m^3/s	0.054 m^3/s	0.085 m^3/s	0.109 m^3/s	0.132 m^3/s

4.4 Post-Development Condition Drainage Areas

For the post-development condition analysis, the site was modelled as five (5) drainage catchments (see Figure No. 2).

Catchment 100 (0.03-hectares, 100% Impervious) represents the rooftop of Block A. Discharge from Block A is directed to a proposed infiltration gallery.

The on-site infiltration gallery proposed for Catchment 100, having an area of $42m^2$, provides $14m^3$ of storage. This gallery was designed to infiltrate the 5-year design storm event runoff volume from the rooftop of Block A. Overflow from the on-site infiltration gallery is directed to the proposed on-site storm sewers via a 250mm diameter pipe connected to MH.8.

Catchment 200 (0.03-hectares, 100% Impervious) represents the rooftop of Block B. Discharge from Block B is directed to a proposed infiltration gallery.

Catchment 300 (0.04-hectares, 100% Impervious) represents the rooftop of Block C. Discharge from Block C is directed to a proposed infiltration gallery.

The on-site infiltration gallery proposed for Catchments 200 and 300, having an area of $95m^2$, provides $31.7m^3$ of storage. This gallery was designed to infiltrate the 5-year design storm event runoff volume from the rooftop of Blocks B and C. Overflow from the on-site infiltration gallery is directed to the proposed on-site storm sewers via a 250mm diameter pipe connected to MH.5.

Catchment 400 (0.09-hectares, 0% Impervious) represents the perimeter of the site. Runoff generated from Catchment 400 will continue to discharge to the existing ditch to the northwest of the site via sheetflow overland.

Catchment 500 (0.23-hectares, 95% Impervious) represents the proposed on-site driving and parking areas. Runoff generated from Catchment 500 will discharge to the proposed storm sewers, prior to discharging to the future storm sewers on Garafraxa Street West. Quantity control for runoff generated by Catchment 500 will be provided by a 100mm diameter orifice plate installed in CBMH.6, along with pipe storage and parking lot ponding. The proposed oversized storm sewers pipe will provide approximately 15.6m^3 of storage and the proposed parking lot ponding will provide an additional 22.8m^3 of storage up to the weir elevation of 415.32.

Quality control treatment for runoff generated by Catchment 500 will be provided via the proposed oil/grit separator structure (Stormceptor EFO4 or approved equivalent).

Stormceptor sizing details can be found in Appendix B.

4.5 Routing

The hydrologic model MIDUSS was used to create the design storm runoff hydrographs and to route the hydrographs. A copy of the final printout of the hydrologic modelling is appended in Appendix "B".

The results of the routing analysis are as follows:

Table No. 5: Catchment 100 Infiltration Gallery Stage/Storage/Discharge Capacities

	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	0.0	412.55	---	---	---
2-Year	---	---	---	0.0001	8.1	413.13
5-Year	---	---	---	0.0002	12.6	413.45
Top of Stone	0.0002	14.0	413.55	---	---	---
Invert of Overflow Pipe	0.0002	14.7	414.33	---	---	---
10-Year	---	---	---	0.001	14.7	414.33
25-Year	---	---	---	0.004	14.7	414.35
50-Year	---	---	---	0.006	14.8	414.37
100-Year	---	---	---	0.009	14.8	414.38
Obvert of Overflow Pipe	0.0463	15.0	414.58	---	---	---

Table No. 6: Catchment 200 & 300 Infiltration Gallery Stage/Storage/Discharge Capacities

	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	0.0	411.80	---	---	---
2-Year	---	---	---	0.0001	19.0	412.40
5-Year	---	---	---	0.0002	30.4	412.76
Top of Stone	0.0003	31.7	412.80	---	---	---
Invert of Overflow Pipe	0.0003	32.6	414.50	---	---	---
10-Year	---	---	---	0.003	32.6	414.52
25-Year	---	---	---	0.009	32.7	414.56
50-Year	---	---	---	0.014	32.7	414.60
100-Year	---	---	---	0.022	32.8	414.63
Obvert of Overflow Pipe	0.0465	32.9	414.75	---	---	---

Table No. 7: Catchment 500 Superpipe and Parking Lot Ponding Stage/Storage/Discharge Capacities

	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**
Invert of Orifice Plate	0.000	0.0	413.60	---	---	---
Invert of Pipe	0.003	0.0	413.63	---	---	---
Obvert of Pipe	0.016	15.6	414.23	---	---	---
T/G DCB.6	0.024	16.5	415.02	---	---	---
2-Year	---	---	---	0.026	18.6	415.15
5-Year	---	---	---	0.026	31.9	415.28
Weir (Parking Lot overflow 0.30m)	0.027	38.4	415.32	---	---	---
10-Year	---	---	---	0.039	39.0	415.32
25-Year	---	---	---	0.059	40.2	415.33
50-Year	---	---	---	0.085	40.6	415.33
100-Year	---	---	---	0.100	41.2	415.34
Overflow	0.269	69.4	415.47	---	---	---

In summary, the post-development flow rates from the site are as follows:

Table No. 8: Post-Development Condition Flow Rates

	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Catchment 100	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s
Catchment 200 & 300	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s	0.000 m^3/s
Catchment 400	0.000 m^3/s	0.005 m^3/s	0.010 m^3/s	0.016 m^3/s	0.020 m^3/s	0.024 m^3/s
Catchment 500 and overflow from Catchments 100, 200 & 300	0.026 m^3/s	0.026 m^3/s	0.039 m^3/s	0.059 m^3/s	0.085 m^3/s	0.100 m^3/s
Total	**0.026 m^3/s**	**0.032 m^3/s**	**0.047 m^3/s**	**0.073 m^3/s**	**0.095 m^3/s**	**0.124 m^3/s**

Table No. 9: Comparison of Allowable Release Rate and Post-Development Condition Flow Rates

	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Allowable Release Rate	0.003 m^3/s	0.033 m^3/s	0.054 m^3/s	0.085 m^3/s	0.109 m^3/s	0.132 m^3/s
Post-Development Flow Rate	0.026 m^3/s	0.032 m^3/s	0.047 m^3/s	0.073 m^3/s	0.095 m^3/s	0.124 m^3/s

Therefore, under post-development conditions, runoff during the 5 through 100-year design storm events has been attenuated to less than the allowable release rates.

Although the post-development flows generated during the 2-year design storm event are greater than those under existing conditions, we note that no negative effects will result. Under existing conditions, a peak flow of 0.003 m^3/s discharges to the existing swale at the rear of 465 Garafraxa Street West. Under post-development conditions, 0.001 m^3/s is directed to the swale at the rear. The remaining flows are directed to the future storm sewers on Garafraxa Street West. As the storm sewers on Garafraxa Street West will be designed to accommodate the 5-year design flows, there will be no negative effects as a result of the post-development flows exceeding existing levels for the 2-year design storm event.

5. MAINTENANCE PLAN

To ensure that the stormwater management system continues to function as designed and constructed, we recommend that the following inspections and maintenance activities be completed on an annual basis:

1. Is there any noticeable damage to the asphalt and grassed swale (i.e. erosion, blockages)? If yes, complete any necessary repairs.
2. Is there any indication of a spill (i.e. frothy water, oily sheen)? If yes, investigate, inform the appropriate agencies and complete the necessary clean-up and restoration.
3. Inspect all roof drains and associated piping. Remove and dispose of any accumulated sediment, trash/litter, debris (i.e. leaves).
4. Inspect the oil/grit structure and complete any necessary maintenance/repair activities as identified by the manufacturer.
5. Inspect all catchbasins, and manholes. Remove and dispose of any accumulated sediment, trash/litter, debris (i.e. sediment, garbage, leaves, etc.).
6. Inspect all swales and overflow locations. Remove and dispose of any accumulated sediment, trash/litter, debris (i.e. sediment, garbage, leaves. etc.).

Please note that any structures identified during the annual inspection to be worn, missing or damaged are to be repaired or replaced within 48 hours.

6. SEDIMENT AND EROSION CONTROL

A silt fence will be installed along the property boundary in all locations where runoff will discharge from the site to adjacent lands. The silt fence will serve to minimize the opportunity for waterborne sediments to be washed on to the adjacent properties.

Inspection and maintenance of all silt fencing will start after installation is complete. The fence will be inspected on a weekly basis during active construction 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 and landscaping has been substantially completed, the silt fence will be removed, any accumulated sediment will be removed and the landscaping will be completed.

Prior to construction, a mud mat will be installed at the entrance/exit location for the site. Similarly, prior to construction silt sacks will be placed in each catchbasin, as outlined in the Erosion and Sediment Control Plan. Once construction and landscaping has been substantially completed, the mud mat, catchbasin silt sacks, and any accumulated sediment therein will be removed.

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

7. CONCLUSIONS

In summary, the features of the design for the proposed development at 465 Garafraxa Street West in the Township of Centre Wellington (Fergus) are as follows:

1. Water supply for the proposed development will be provided via a future 150mm diameter watermain along Garafraxa Street West, and a 150mm diameter service connection to the from the 150mm watermain on Garafraxa Street West.
2. Sanitary servicing for the proposed development will be provided via the extension of a 200mm diameter sanitary sewer from the future 200mm diameter sanitary sewer on Garafraxa Street West.
3. Storm service for the proposed development will be provided via the installation of storm sewers on site and connection to the future storm sewer on Garafraxa Street West. All storm sewers within the development have been sized to accommodate the 5-year design storm event.
4. The post-development flow rates for the 5 through 100-year design storm events have been attenuated to less than the allowable release rates.
5. Major overland flows are routed through the site to Garafraxa Street West, while not exceeding a maximum ponding depth of 0.30m.
6. Prior to construction, a silt fence will be installed along the property boundary in all locations where runoff will discharge from the site to adjacent lands. A mud mat will be installed at the entrance/exit location for the site. Silt sacks will be placed in each catchbasin, as outlined in the Erosion and Sediment Control Plan. This will minimize the transport of sediment off-site during the construction period.
7. Quality control for the site is provided via the proposed oil/grit separator (Stormceptor EFO4 or approved equivalent).

All of which is respectfully submitted.

GM BLUEPLAN ENGINEERING LIMITED

Per:

Patrick Grier, P. Eng.

Encl.

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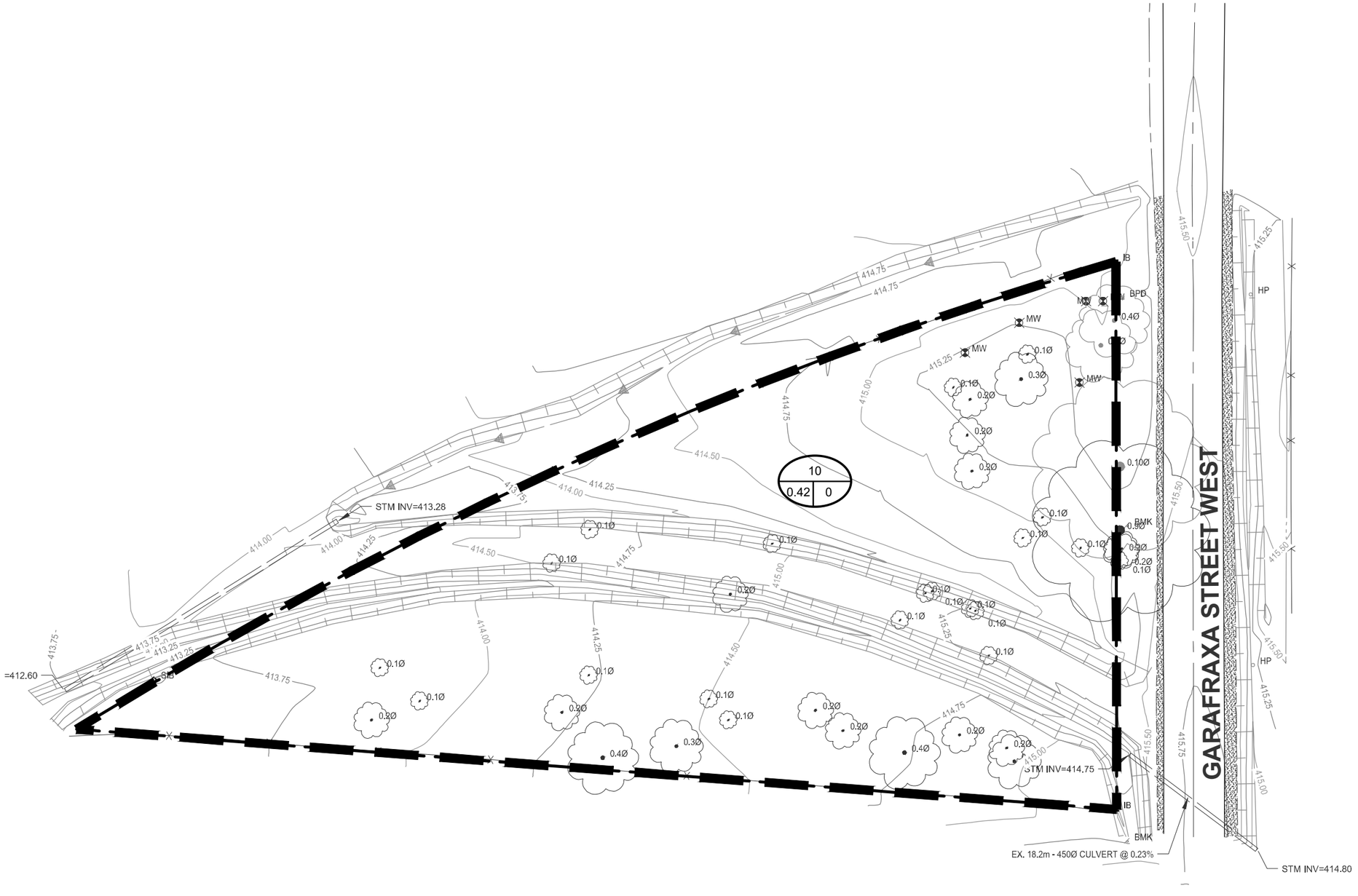
465 GARAFRAXA STREET WEST TOWNSHIP OF CENTRE WELLINGTON



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LEGEND

- EX. STORM SEWER
- DRAINAGE AREA BOUNDARY
- 100 / 0.11 | 80 — CATCHMENT NUMBER; % IMPERVIOUS; CATCHMENT AREA IN HECTARES

5 0 5 10 20
1:500 (m)

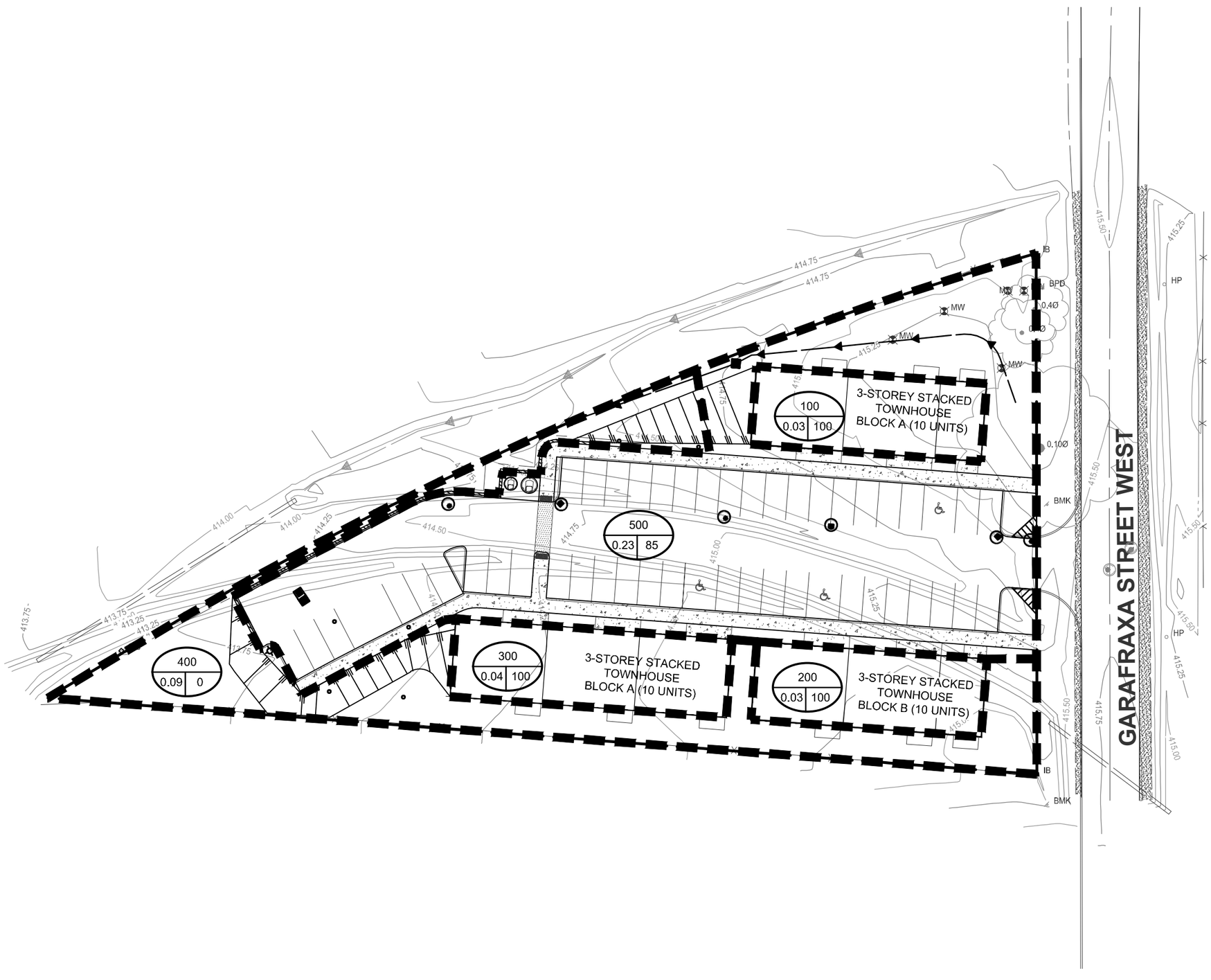
EXISTING CONDITIONS DRAINAGE AREA PLAN

Figure No. 1

BluePlan ENGINEERING

422144
JANUARY 2023
Scale: 1:500 | NAD 1983 UTM Zone 17N

465 GARAFRAXA STREET WEST TOWNSHIP OF CENTRE WELLINGTON



LEGEND

- PROP. STORM SEWER
- DRAINAGE AREA BOUNDARY
- 1000 / 0.11 | 80 — CATCHMENT NUMBER; % IMPERVIOUS; CATCHMENT AREA IN HECTARES

5 0 5 10 20
1:500 (m)

POST DEVELOPMENT DRAINAGE AREA PLAN

Figure No. 2

BluePlan ENGINEERING

422144
JANUARY 2023
Scale: 1:500 | NAD 1983 UTM Zone 17N

FILE:W:\Kitchener\422-2022\422144 - 465 Garafraxa Street West Fergus\Design Phase\Drawings\422144 - Design.dwg LAYOUT:Post SWM
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APPENDIX A:
Geotechnical Investigation
(CMT Engineering Inc., November 28, 2022)

GEOTECHNICAL INVESTIGATION

GEOTECH – PROPOSED TOWNHOUSE DEVELOPMENT
465 GARAFRAXA STREET WEST
FERGUS, ONTARIO

CMT Project 22-765.R01

Prepared for:

Habitat for Humanity

November 28, 2022

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November 28, 2022 22-765.R01

Habitat for Humanity
104 Dawson Road
Suite 100B
Guelph, Ontario
N1H 1A6

Attention: Janey Secnic

Dear Janey:

Re: Geotechnical Investigation
Geotech – Proposed Townhouse Development
465 Garafraxa Street West
Fergus, 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,

Jake Feeney P. Eng.

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Drawing 2 - Site Plan Showing Borehole Locations

Appendix A - Borehole Logs
Appendix B - Grain Size Analyses

1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Janey Secnic of Habitat for Humanity to conduct a geotechnical investigation for the proposed new townhouse development to be constructed at 465 Garafraxa Street West, Fergus, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will involve the construction of three (3) townhouse blocks with associated roadways and parking areas.

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 to the Northwest of Garafraxa Street West. The site is bounded by Garafraxa Street West to the Southeast, undeveloped land to the Northeast and Northwest, and agricultural land to the Southwest. The site currently comprises vacant land, with some trees and a walking trail. In general, the site topography is relatively flat with existing ditches throughout the proposed construction area. It is understood that the site is to be serviced by municipal services.

3.0 FIELD AND LABORATORY PROCEDURES

The field investigation was conducted on November 16, 2022 and comprised the advancement of seven (7) boreholes (referenced as Boreholes 1 to 7), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. Boreholes 1 to 5 were advanced to depths of approximately 5.18 m (17.00 ft) below the existing ground surface in the area of the proposed townhouses. Boreholes 6 and 7 were advanced to depths of approximately 1.52 m (5.00 ft) below the existing ground surface in the area of the proposed parking lot. Prior to the field investigation being carried out, underground service locates were undertaken to ensure that existing utilities would not be damaged, or any personnel injured.

Standard penetration testing and sampling was carried out in Boreholes 1 to 5 using 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 conducted between the SPT soil samples conducted below 3.05 m (10.0 ft) depth and throughout Boreholes 6 and 7. 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 the boreholes at the following depths were submitted to the CMT Inc. laboratory in St. Clements, Ontario for grain size analyses:

- Borehole 3 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft); and
- Borehole 5 – 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.

The ground surface elevations of the boreholes were surveyed by CMT Inc. (using laser survey equipment) following the completion of drilling. The ground surface elevation of the existing bell pedestal located on the Southeast side of the site beside Garafraxa Street West was utilized as a temporary benchmark, with an assumed elevation of 100.00 m. As such, the ground surface elevation at the borehole locations ranged from approximately 99.34 m to 100.20 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, dark brown, silty, organic topsoil in a moist state was encountered at the surface of Boreholes 4 and 7 and buried within the sand and gravel fill soil at Boreholes 1 and 2. The thickness of the topsoil was observed to range from about 300 mm to 600 mm (average 450 m) 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 was encountered at the surface of Boreholes 1 to 3 and 6. Black buried topsoil was observed within the sand and gravel fill at Boreholes 1 and 2. The sand and gravel fill were compact with SPT N-values ranging from about 14 to 19 blows per 0.30 m (average 17 blows per 0.30 m). The sand and gravel fill soils are considered to be moist, with moisture contents ranging from about 7.6% to 10.6% (average 9.4%).

4.3. Silt Fill

Brown silt fill with trace gravel was encountered at the surface of Borehole 4. Black staining was observed within the silt fill. The silt fill was considered to be firm with a SPT N-value of about 4 blows per 0.30 m. The silt fill was considered to be moist, with a moisture content of about 11.8%.

4.4. Silty Sand

Brown silty sand was encountered underlying the sand and gravel fill at Borehole 1, the sandy silt at Borehole 2, the silt fill at Borehole 4 and the topsoil at Borehole 5 and 7. The silty sand was observed to extend to the termination depth of Borehole 7. The silty sand was considered to be loose to compact with SPT N-values ranging from about 9 to 29 blows per 0.30 m (average 18 blows per 0.30 m). The silty sand soils are considered to be moist, with moisture contents ranging from about 5.2% to 14.3% (average 9.7%).

4.5. Sandy Silt/Sandy Silt Till

Brown to grey sandy silt/sandy silt till with some clay and trace gravel were encountered underlying the silty sand at Boreholes 1, 2, 4 and 5 and underlying the sand and gravel fill at Boreholes 2, 3 and 6. The sandy silt/sandy silt till was observed to extend to the termination depths of Boreholes 1 to 6. The sandy silt/sandy silt till was considered to be stiff to hard with SPT N-values ranging from about 10 to greater than 100 blows per 0.30 m (average 43 blows per 0.30 m). The sandy silt/sandy silt till soils are considered to be moist, with moisture contents ranging from about 3.1% to 15.9% (average 9.3%).

4.6. Groundwater

No accumulated groundwater or seepage was observed upon completion of the boreholes. It should be noted that the stiff to hard sandy silt till soils encountered in the boreholes have the potential to created perched groundwater conditions in any overlying soils. Groundwater conditions (particularly perched water) are generally dependent on the weather conditions, amount of precipitation, site grading and other measures in place to control surface water drainage, as well as the time of year, and can fluctuate significantly in elevation over time.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report, and recommendations regarding waterproofing and drainage are presented in Section 5.10.

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:

BH 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
BH1	100.20	150 (3,000)	225 (4,500)	99.13 to 97.15	1.07	Sand and Gravel Fill/Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.15 to 95.02 (termination)	3.05	
BH2	99.83	150 (3,000)	225 (4,500)	98.86 to 97.54	0.97	Sandy Silt/Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.54 to 94.65 (termination)	2.29	
BH3	99.34	150 (3,000)	225 (4,500)	98.58 to 97.05	0.76	Sandy Silt Till
		200 (4,000)	300 (6,000)	97.05 to 94.16 (termination)	2.29	
BH4	99.40	100 (2,000)	150 (3,000)	98.64 to 97.11	0.76	Silty Sand/Sandy Silt Till
		150 (3,000)	225 (4,500)	97.11 to 96.35	2.29	
		200 (4,000)	300 (6,000)	96.35 to 94.22 (termination)	3.05	
BH5	100.17	150 (3,000)	225 (4,500)	99.57 to 97.12	0.60	Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.12 to 94.99 (termination)	3.05	

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 in the shallower native soils encountered underlying the fill soils in the boreholes at depths ranging from 0.6 m to 2.29 m below the existing ground surface.

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 200 kPa (4,000 psf) at SLS and 300 kPa (6,000 psf) at ULS were typically encountered in the deeper native till soils encountered in the boreholes at depths ranging from 2.29 m to 3.05 m below the existing ground surface.

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 fill 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 founding 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 5.18 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
Silty Sand	1,800	32°	0.31	3.25	0.47	0.41	0
Sandy Silt Till	1,850	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 new townhouses 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 (including buried topsoil) must be removed from within the proposed building, parking lot and driveway areas 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, parking lot and driveway areas 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

Any existing underground services (if present) that may be located within the proposed building areas should 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 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 have been disturbed by construction processes and is deemed unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building areas, 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 parking 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 if it is decided to leave it 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 debris 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 parking lot 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;

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

Any wet soils encountered in the boreholes 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 changes 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 envelope 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 to a sump (as required) located outside the building footprints (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 placed in order to protect the structural integrity of the founding soils.

Due to the variability of the native soils encountered in the boreholes, 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/Sandy Silt Till	61,200 kN/m^3 (225 lb/in^3)
Silty Sand	61,200 kN/m^3 (225 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. If wet to saturated conditions are encountered during the excavation of the site, it would be recommended that for any basement floor slabs, 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) should be used 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 till 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, the silty sand/silty sand and any existing fill materials (including backfill of existing foundations and services) 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

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. 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. 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 centreline 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 0.15*D* (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 any zone of wet soils 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 any 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). 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 townhouses 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 parking lot; 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.

The existing fill soils are generally considered suitable for reuse as trench backfill and bulk fill in the parking lot areas.

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

Any soils containing organics or other deleterious material must be stripped/subexcavated from within the parking 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 parking subgrade soils. Based on the information from the boreholes it is expected that the subgrade will comprise fine-grained, 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) and a factory installed filter sock is not required. 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 parking lot 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") HL4 or HL8 - 50 mm (2.0")	HL3 - 50 mm (2.0") 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. Excess Soil Management

5.12.1. Chemical Testing was NOT Undertaken

Generally, if surplus soils are to be exported off-site, it will be necessary to perform 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.

5.12.2 Leachate Testing Requirement

If soils are transported off-site, additional chemical testing may be required. The extent of the leachate testing will be determined by the results of the initial chemical testing as well as the requirements of the disposal site.

The chemical analysis results would be compared to the site condition standards of Ontario Regulation 406/19. Typically, the results are compared to; *T1-Leachate Screening Levels – Res/Park/Inst/Ind/Com/Commu Property Use; T3.1-Leachate Screening Levels – Ind/Com/Commu/Property Use.*

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.

5.13. 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.

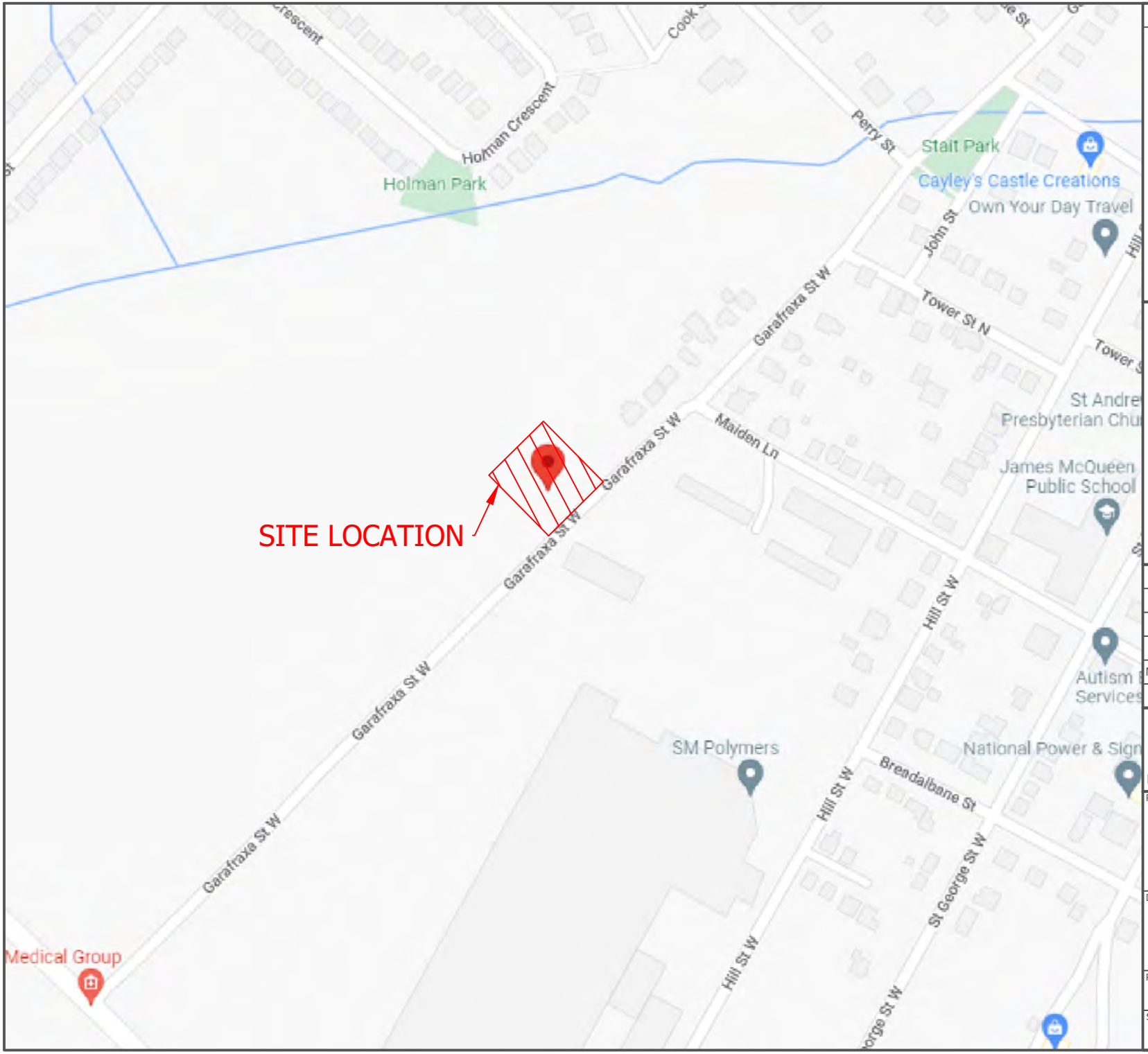
We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

Prepared by:

Jake Feeney P. Eng.
ht

Reviewed by:

Nathan Chortos, P.Eng.
Senior Geotechnical Engineer



NOTES:

Base map provided by Google.

N

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

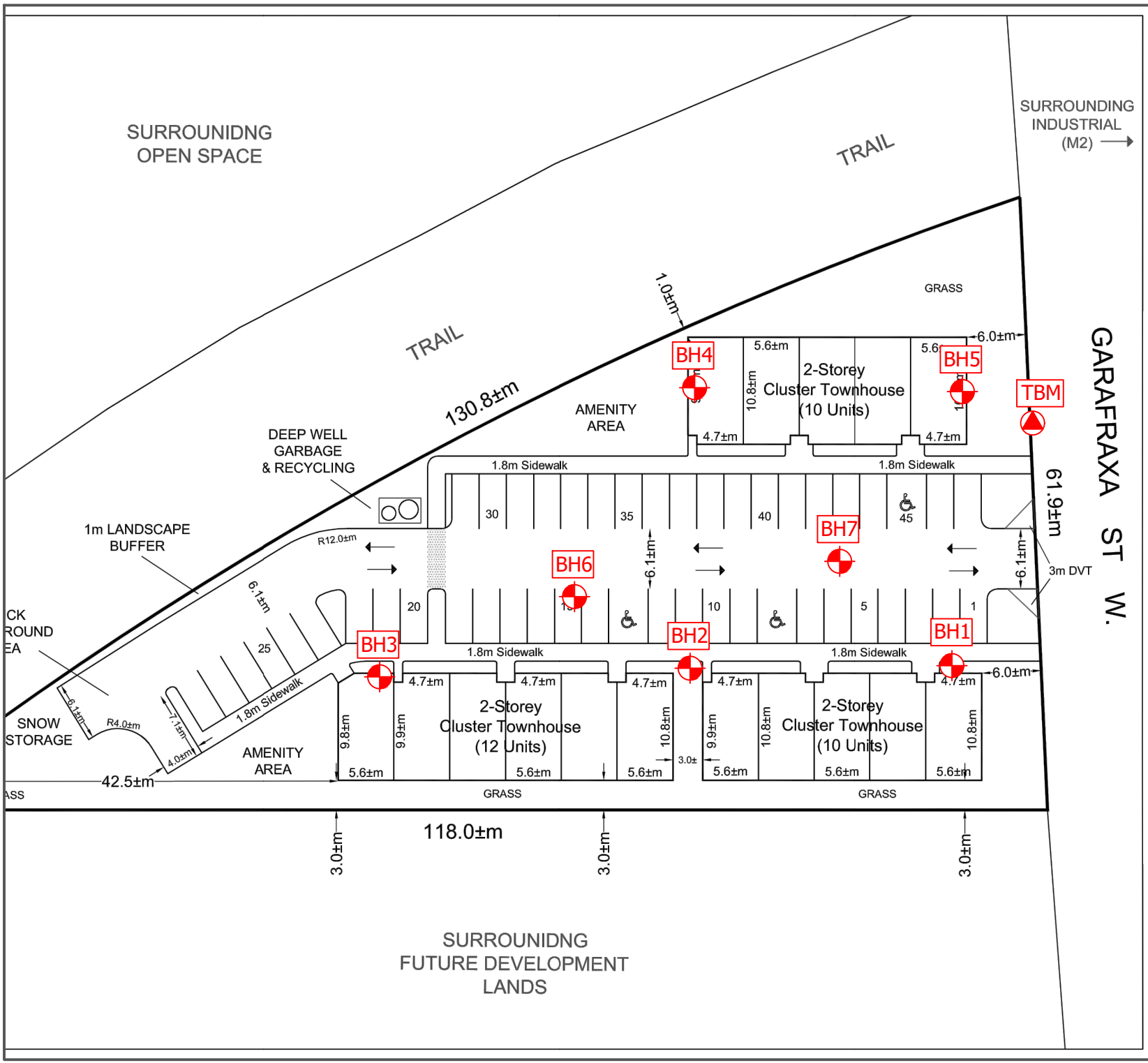
PROJECT:

TOWNHOUSE DEVELOPMENT
465 Garafraxa Street West
Fergus, Ontario

DRAWING TITLE:

SITE LOCATION MAP

PROJECT NO.:	DATE:
22-765	November 24, 2022
SCALE:	DRAWING NO.
N.T.S.	1



NOTES:

Base map provided by Dryden Smith & Head Planning Consultants Ltd.

Legend

CMT Borehole - 2022

Temporary Benchmark

NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
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PROJECT:

TOWNHOUSE DEVELOPMENT
465 Garafraxa Street West
Fergus, Ontario

DRAWING TITLE:

AERIAL VIEW SHOWING
BOREHOLE LOCATIONS

PROJECT NO.:	DATE:
22-765	November 24, 2022
SCALE:	DRAWING NO.
N.T.S.	2

APPENDIX A

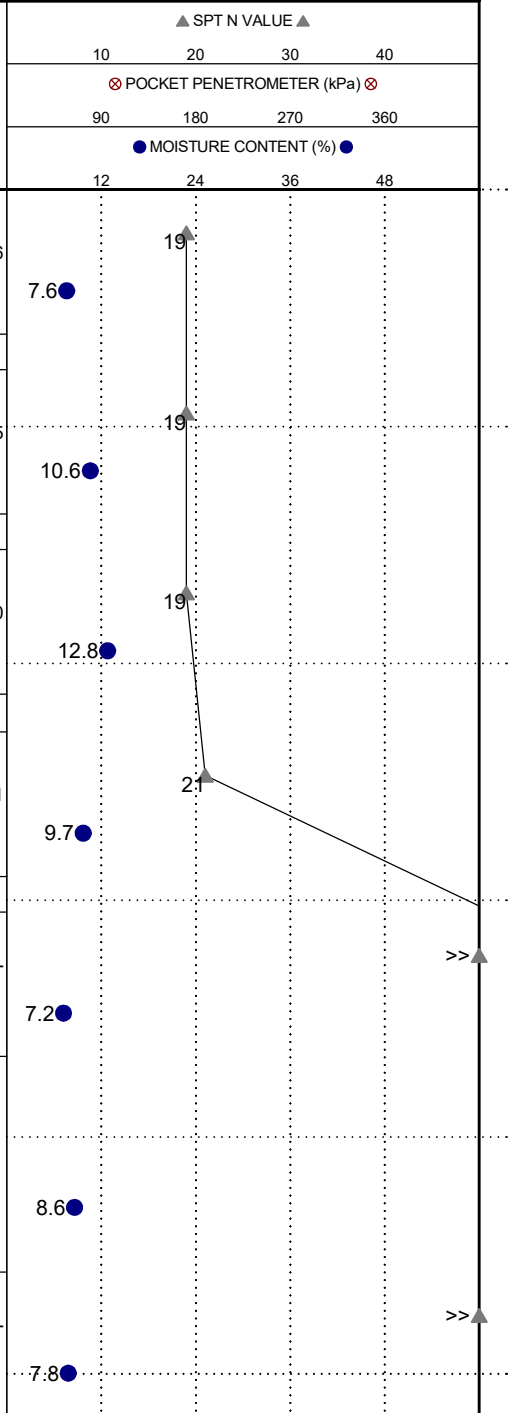
BOREHOLE LOGS

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

BOREHOLE NUMBER 1

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 100.20 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)
	Sand and Gravel Fill: Compact, brown sand and gravel fill, trace silt, moist	0.00, 100.20	SPT 1	49	2-7-12-16 (19)
	Topsoil: Black silty, organic, buried topsoil layer	0.60, 99.60			
1			SPT 2	100	3-5-14-15 (19)
	Sand and Gravel Fill: Compact, brown sand and gravel fill, trace silt, moist	1.07, 99.13			
	Silty Sand: Compact, brown silty sand, moist	1.52, 98.68	SPT 3	100	8-9-10-10 (19)
2					
	Sandy Silt Till: Very stiff, brown sandy silt till, some clay, trace gravel, moist	2.29, 97.91	SPT 4	100	5-9-12-11 (21)
3					
	becoming hard	3.05, 97.15	SPT 5	100	10-28-33-33 (61)
4			MC5 6	100	
	becoming grey	4.57, 95.63	SPT 7	100	30-48-44-37 (92)
5					



Borehole open to about 5.18 m below the ground surface. No accumulated groundwater observed upon completion.

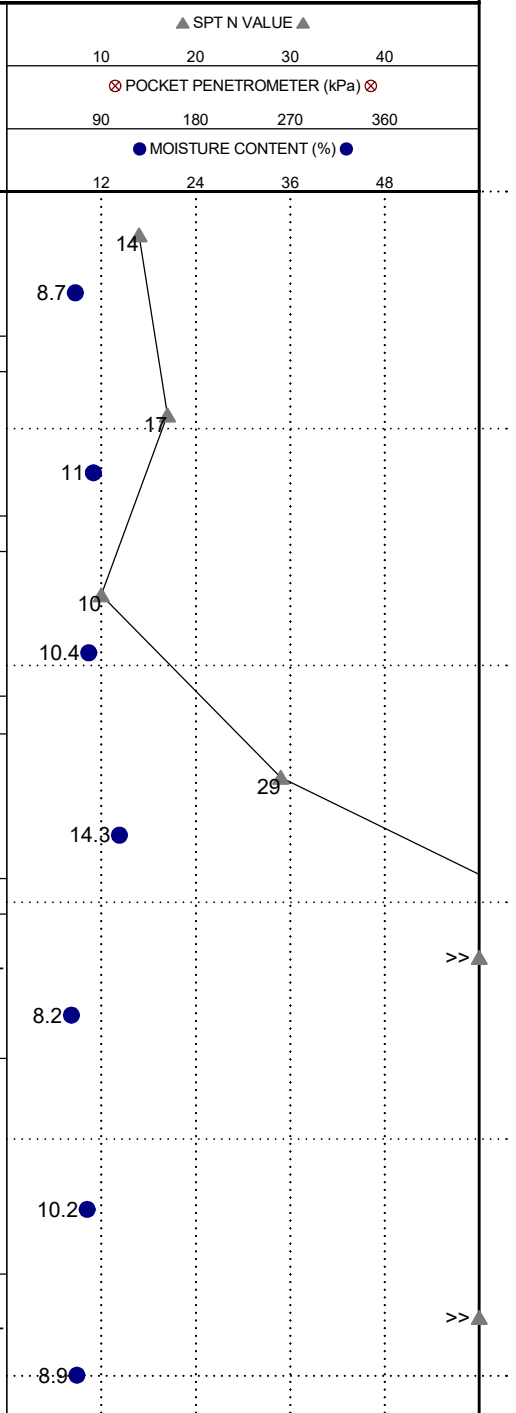
Bottom of borehole at 5.18 m, Elevation 95.02 m.

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

BOREHOLE NUMBER 2

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 99.83 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
		Sand and Gravel Fill: Compact, brown sand and gravel fill, trace silt, moist Black silty topsoil layer observed at about 0.76 m (210 mm)	0.00, 99.83	SPT 1	49	2-7-7-14 (14)
1		Black silty, organic, buried topsoil layer	0.76, 99.07	SPT 2	100	7-8-9-10 (17)
		Sandy Silt: Stiff to very stiff, brown sandy silt, some clay, trace gravel, moist	0.97, 98.86			
2				SPT 3	25	4-5-5-12 (10)
		Silty Sand: Compact, brown silty sand, moist	2.29, 97.54	SPT 4	100	4-10-19-26 (29)
3						
		Sandy Silt Till: Hard, brown sandy silt till, some clay, trace gravel, moist	3.05, 96.78	SPT 5	100	12-30-38-50 (68)
4				MC5 6	100	
5				SPT 7	100	50-50-50-50 (100)



Borehole caved at about 2.95 m below the ground surface. No accumulated groundwater observed upon completion.

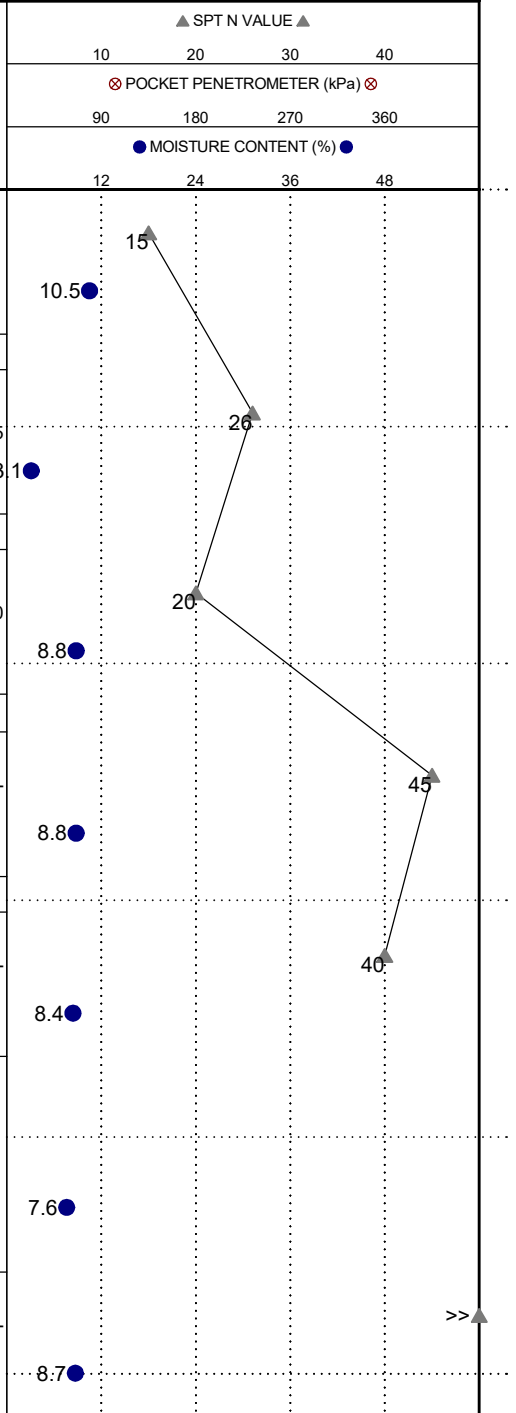
Bottom of borehole at 5.18 m, Elevation 94.65 m.

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

BOREHOLE NUMBER 3

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 99.34 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
		Sand and Gravel Fill: Compact, brown sand and gravel fill, trace silt, moist	0.00, 99.34	SPT 1	25	3-9-6-18 (15)
1		**Sandy Silt Till:** Very stiff, brown sandy silt till, some clay, trace gravel, moist Black staining observed at about 0.76 m below the ground surface (210 mm)	0.76, 98.58	SPT 2	100	13-18-8-5 (26)
				SPT 3	100	4-8-12-10 (20)
2		becoming hard	2.29, 97.05	SPT 4	100	16-26-19-21 (45)
3				SPT 5	100	15-16-24-38 (40)
4				MC5 6	100	
				SPT 7	100	29-50-50-50 (100)
5						



Borehole caved at about 4.88 m below the ground surface. No accumulated groundwater observed upon completion.

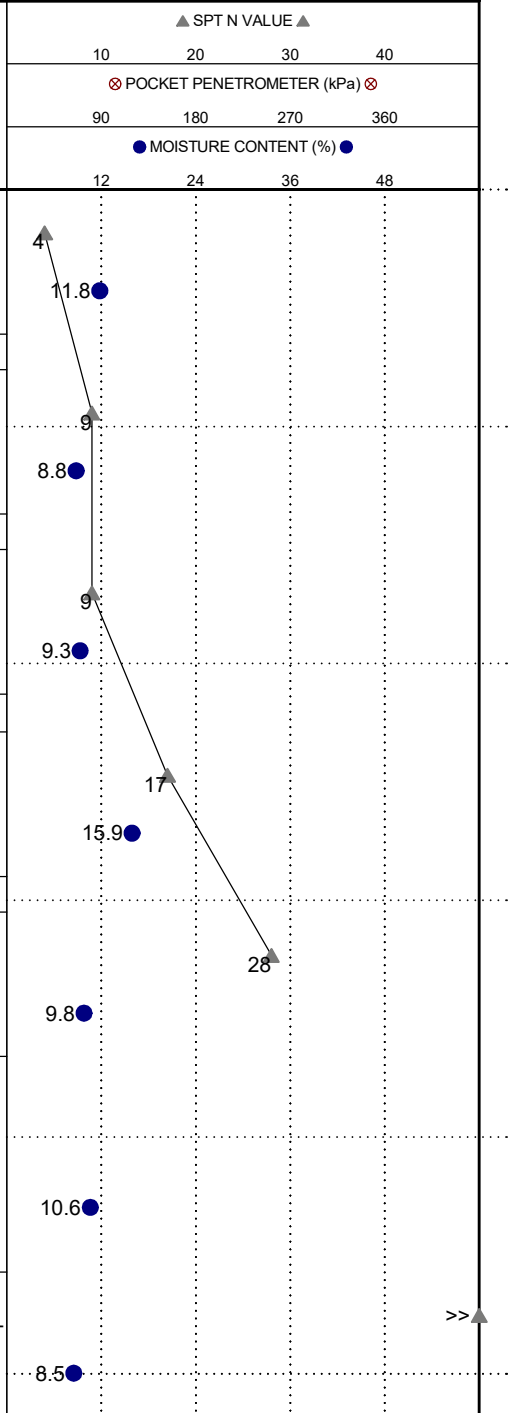
Bottom of borehole at 5.18 m, Elevation 94.16 m.

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

BOREHOLE NUMBER 4

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 99.40 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)
	Silt Fill: Firm, brown silt fill, trace gravel, moist Black staining observed	0.00, 99.40	SPT 1	49	1-2-2-2 (4)
1	**Silty Sand:** Loose, brown silty sand, moist	0.76, 98.64	SPT 2	100	3-4-5-7 (9)
2	**Sandy Silt Till:** Stiff, brown sandy silt till, some clay, trace gravel, moist	1.52, 97.88	SPT 3	100	6-6-3-3 (9)
	becoming very stiff	2.29, 97.11	SPT 4	100	7-7-10-7 (17)
3			SPT 5	100	8-13-15-16 (28)
4			MC5 6	100	
	becoming hard	4.57, 94.83	SPT 7	100	30-27-25-23 (52)
5					



Borehole open to about 5.18 m below the ground surface. No accumulated groundwater observed upon completion.

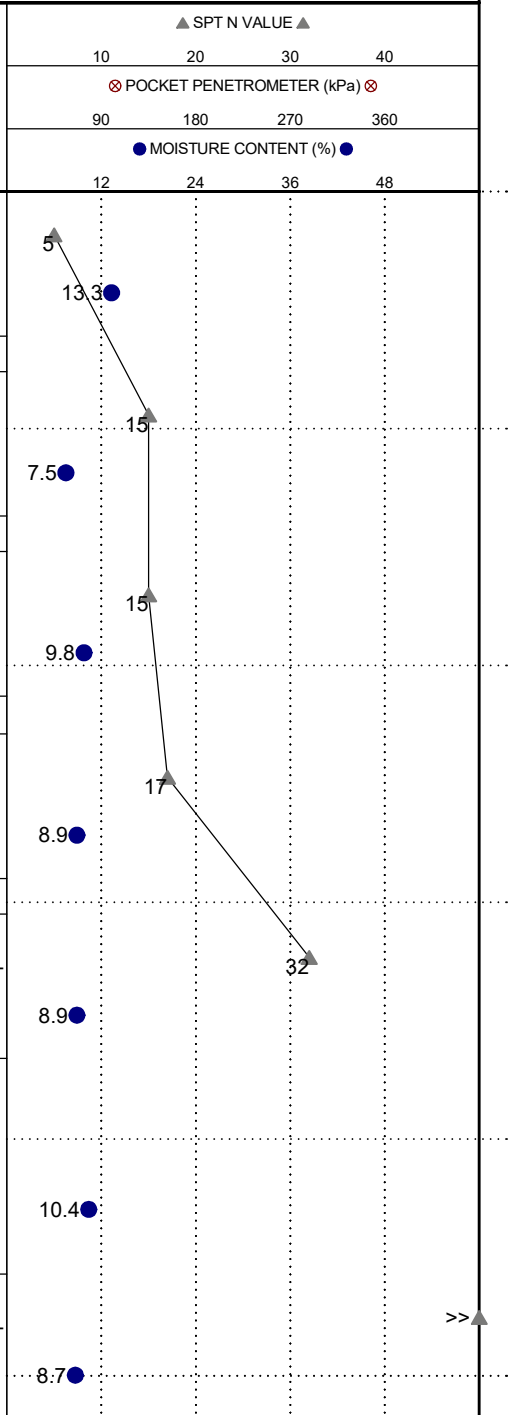
Bottom of borehole at 5.18 m, Elevation 94.22 m.

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

BOREHOLE NUMBER 5

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 100.17 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
		Topsoil: Loose, dark brown, silty, organic topsoil, moist	0.00, 100.17	SPT 1	49	2-2-3-4 (5)
		Silty Sand: Compact, brown silty sand, moist	0.60, 99.57			
1				SPT 2	100	6-6-9-14 (15)
		Sandy Silt Till: Stiff to very stiff, brown sandy silt till, some clay, trace gravel, moist	1.52, 98.65	SPT 3	100	8-8-7-7 (15)
2						
				SPT 4	100	7-8-9-15 (17)
3		becoming hard	3.05, 97.12	SPT 5	100	18-13-19-19 (32)
				MC5 6	100	
4						
				SPT 7	100	32-50-50-50 (100)
5						



Borehole open to about 5.18 m below the ground surface. No accumulated groundwater observed upon completion.

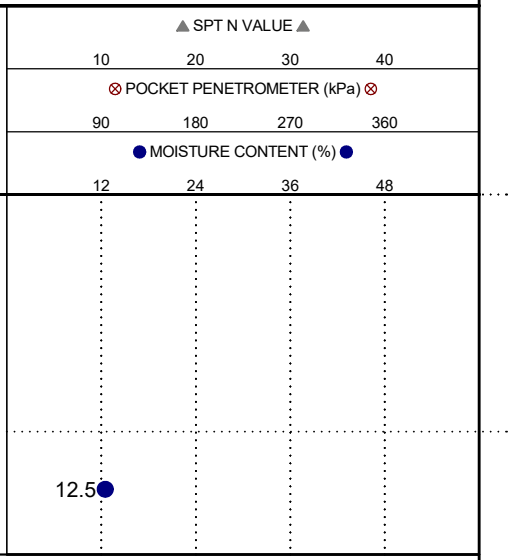
Bottom of borehole at 5.18 m, Elevation 94.99 m.

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

BOREHOLE NUMBER 6

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 99.51 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
		Sand and Gravel Fill: Brown sand and gravel fill, trace silt, moist	0.00, 99.51			
1		**Sandy Silt Till:** Brown sandy silt till, some clay, trace gravel, moist	0.60, 98.91	MC5 1	100	
		Borehole open to 1.52 m below the ground surface , elevation. No accumulated groundwater observed upon completion.				
		Bottom of borehole at 1.52 m, Elevation 97.99 m.				



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

BOREHOLE NUMBER 7

PROJECT: Proposed Townhouse Development
PROJECT ADDRESS: 465 Garafraxa Street West
PROJECT NUMBER: 22-765
PROJECT LOCATION: Fergus, Ontario
DRILLING DATE: 22-11-16
GROUND ELEVATION: 99.70 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
		Topsoil: Dark brown, silty, organic topsoil, moist	0.00, 99.70			
		Silty Sand: Brown silty sand, moist	0.30, 99.40			
1				MC5 1	100	

SPT N VALUE: 10, 20, 30, 40
POCKET PENETROMETER (kPa): 90, 180, 270, 360
MOISTURE CONTENT (%): 12, 24, 36, 48
5.2

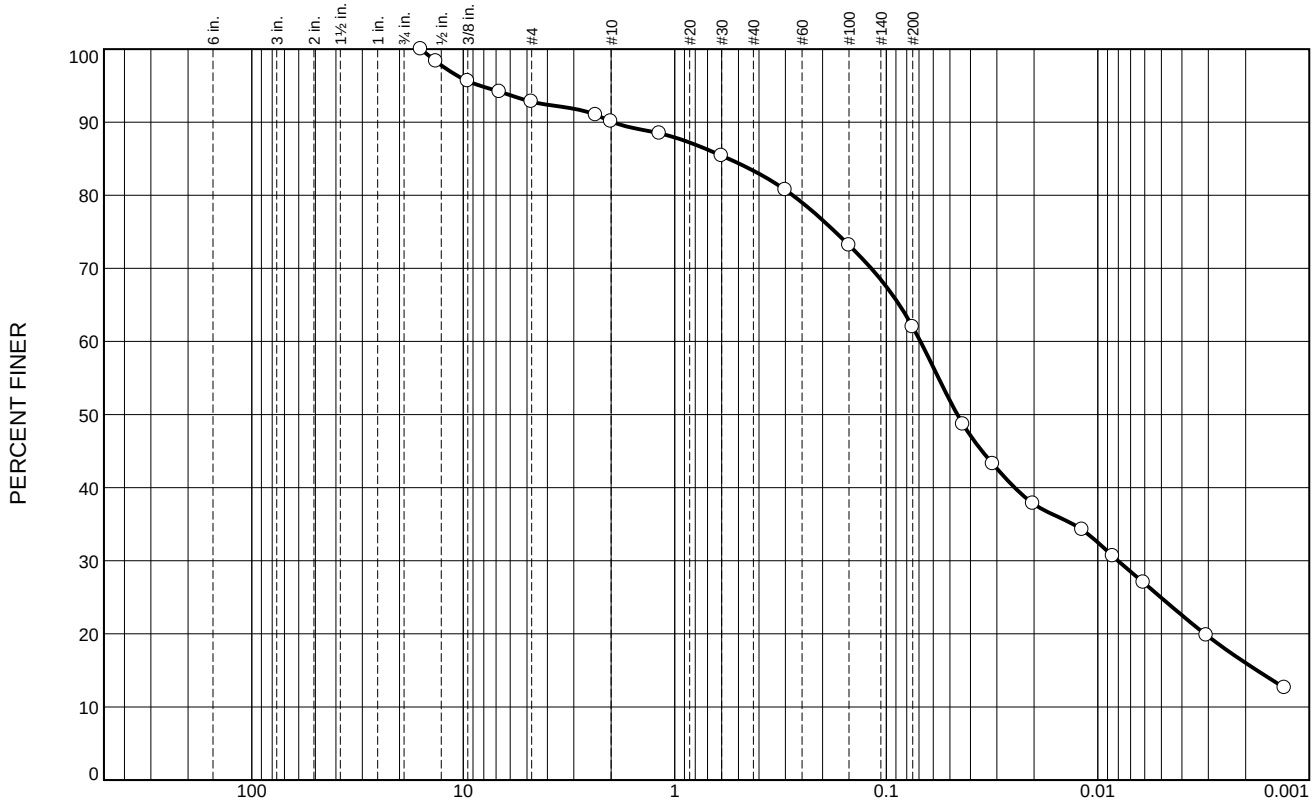
Borehole open to 1.52 m below the ground surface , elevation. No accumulated groundwater observed upon completion.

Bottom of borehole at 1.52 m, Elevation 98.18 m.

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	2.7	6.7	21.4	46.0	16.0

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH3	3	1.52-2.13m	sandy silt, some clay, trace gravel	ML
				Sampled by JF of CMT Engineering Inc. November 16, 2022	
				Tested by JM of CMT Engineering Inc. November 18, 2022	

CMT Engineering Inc.

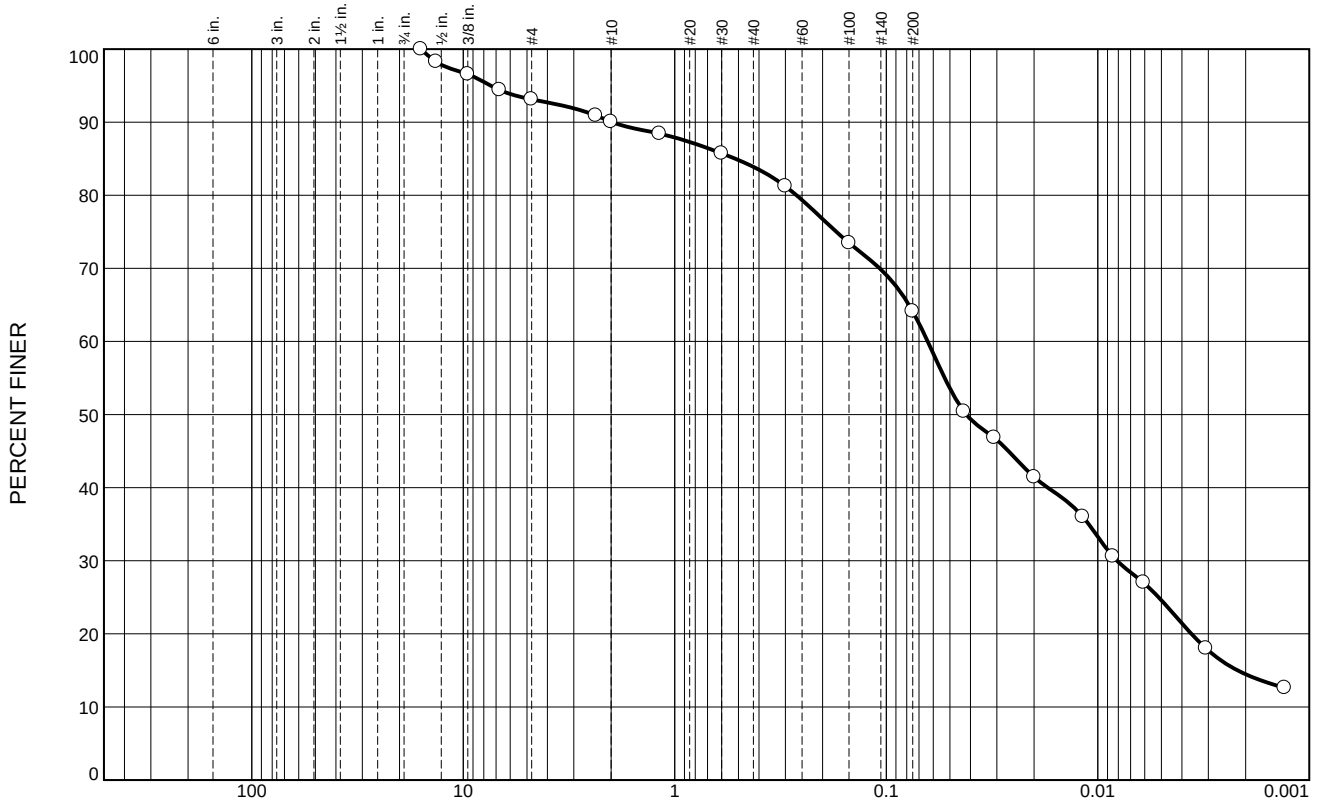
St. Clements, ON

Client: Habitat for Humanity

Project: 465 Garafraxa Street West
Fergus, Ontario

Project No.: 22-765 **Figure** 1

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.9	3.0	6.2	19.8	49.6	14.5

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	5	3.05-3.66m	sandy silt, some clay, trace gravel	ML
				Sampled by JF of CMT Engineering Inc. November 16, 2022	
				Tested by JM of CMT Engineering Inc. November 18, 2022	

CMT Engineering Inc.

St. Clements, ON

Client: Habitat for Humanity

Project: 465 Garafraxa Street West
Fergus, Ontario

Project No.: 22-765 **Figure** 2

APPENDIX B:
Stormwater Management Analysis

Existing Condition Modelling Files
Stage-Storage-Discharge Tables
Post-Development Condition Modelling Files
Oil/Grit Separator Sizing Details

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                       422144  465 Garafraxa"
"                Output filename:                       422144  2-year pre.out"
"                Licensee name:                                          gmbp"
"                Company                                                    "
"                Date & Time last used:                 1/3/2023 at 4:30:05 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"      695.047   Coefficient A"
"        6.387   Constant B"
"        0.793   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           93.292    mm/hr"
"             Total depth                 33.014    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.003     0.000     0.000     0.000 c.m/sec"
"             Catchment 10           Pervious   Impervious Total Area "
"             Surface Area           0.420      0.000      0.420      hectare"
"             Time of concentration  24.993     2.044      24.993     minutes"
"             Time to Centroid       93.891     0.000      93.891     minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        138.66     0.00       138.66     c.m"
"             Rainfall losses        32.003     33.014     32.003     mm"
"             Runoff depth           1.010      0.000      1.010      mm"
"             Runoff volume          4.24       0.00       4.24       c.m"
"             Runoff coefficient     0.031      0.000      0.031      "
"             Maximum flow           0.003      0.000      0.003      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.003     0.003     0.000     0.000"
" 38          START/RE-START TOTALS 10"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                     0.420    hectare"
"             Total Impervious area                    0.000    hectare"
"             Total % impervious                       0.000"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                       422144  465 Garafraxa"
"                Output filename:                       422144  5-year pre.out"
"                Licensee name:                                          gmbp"
"                Company                                                    "
"                Date & Time last used:                 1/4/2023 at 8:29:49 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1459.072   Coefficient A"
"       13.690   Constant B"
"        0.850   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          113.586    mm/hr"
"             Total depth                 49.792    mm"
"            6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.033     0.000     0.000     0.000 c.m/sec"
"             Catchment 10           Pervious   Impervious Total Area "
"             Surface Area           0.420      0.000      0.420      hectare"
"             Time of concentration  13.471     1.890      13.470     minutes"
"             Time to Centroid       90.770     85.354     90.770     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        209.12     0.00       209.13     c.m"
"             Rainfall losses        39.012     2.179      39.012     mm"
"             Runoff depth           10.780     47.613     10.780     mm"
"             Runoff volume          45.28      0.00       45.28      c.m"
"             Runoff coefficient     0.217      0.000      0.217      "
"             Maximum flow           0.033      0.000      0.033      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.033     0.033     0.000     0.000"
" 38          START/RE-START TOTALS 10"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                     0.420    hectare"
"             Total Impervious area                    0.000    hectare"
"             Total % impervious                       0.000"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                        422144  465 Garafraxa"
"                Output filename:                     422144  10-year pre.out"
"                Licensee name:                                          gmbp"
"                Company                                                    "
"                Date & Time last used:                1/4/2023 at 8:30:55 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     2327.596   Coefficient A"
"       19.500   Constant B"
"        0.894   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          126.171    mm/hr"
"             Total depth                 61.359    mm"
"            6   010hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.054     0.000     0.000     0.000 c.m/sec"
"             Catchment 10           Pervious   Impervious Total Area "
"             Surface Area           0.420      0.000      0.420      hectare"
"             Time of concentration  12.045     1.812      12.045     minutes"
"             Time to Centroid       90.582     84.870     90.582     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        257.71     0.00       257.71     c.m"
"             Rainfall losses        41.728     2.332      41.728     mm"
"             Runoff depth           19.631     59.027     19.631     mm"
"             Runoff volume          82.45      0.00       82.45      c.m"
"             Runoff coefficient     0.320      0.000      0.320      "
"             Maximum flow           0.054      0.000      0.054      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.054     0.054     0.000     0.000"
" 38          START/RE-START TOTALS 10"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                     0.420    hectare"
"             Total Impervious area                    0.000    hectare"
"             Total % impervious                       0.000"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                        422144  465 Garafraxa"
"                Output filename:                     422144  25-year pre.out"
"                Licensee name:                                          gmbp"
"                Company                                                    "
"                Date & Time last used:                1/4/2023 at 8:32:57 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3701.648   Coefficient A"
"       25.500   Constant B"
"        0.937   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          143.371    mm/hr"
"             Total depth                 75.581    mm"
"            6   025hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.085     0.000     0.000     0.000 c.m/sec"
"             Catchment 10           Pervious   Impervious Total Area "
"             Surface Area           0.420      0.000      0.420      hectare"
"             Time of concentration  10.252     1.722      10.252     minutes"
"             Time to Centroid       90.488     84.485     90.488     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        317.44     0.00       317.44     c.m"
"             Rainfall losses        44.281     2.520      44.280     mm"
"             Runoff depth           31.300     73.061     31.300     mm"
"             Runoff volume          131.46     0.00       131.46     c.m"
"             Runoff coefficient     0.414      0.000      0.414      "
"             Maximum flow           0.085      0.000      0.085      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.085     0.085     0.000     0.000"
" 38          START/RE-START TOTALS 10"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                      0.420    hectare"
"             Total Impervious area                     0.000    hectare"
"             Total % impervious                        0.000"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                        422144  465 Garafraxa"
"                Output filename:                     422144  50-year pre.out"
"                Licensee name:                                          gmbp"
"                Company                                                    "
"                Date & Time last used:                1/4/2023 at 8:34:37 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     5089.418   Coefficient A"
"       30.000   Constant B"
"        0.967   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          156.350    mm/hr"
"             Total depth                 86.737    mm"
"            6   050hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.109     0.000     0.000     0.000 c.m/sec"
"             Catchment 10           Pervious   Impervious Total Area "
"             Surface Area           0.420      0.000      0.420      hectare"
"             Time of concentration  9.574      1.663      9.574      minutes"
"             Time to Centroid       90.779     84.291     90.779     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        364.29     0.00       364.29     c.m"
"             Rainfall losses        45.966     2.621      45.966     mm"
"             Runoff depth           40.771     84.116     40.771     mm"
"             Runoff volume          171.24     0.00       171.24     c.m"
"             Runoff coefficient     0.470      0.000      0.470      "
"             Maximum flow           0.109      0.000      0.109      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.109     0.109     0.000     0.000"
" 38          START/RE-START TOTALS 10"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.420    hectare"
"             Total Impervious area                   0.000    hectare"
"             Total % impervious                      0.000"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                        ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                                        422144  465 Garafraxa"
"                Output filename:                     422144  100-year pre.out"
"                Licensee name:                                           gmbp"
"                Company                                                     "
"                Date & Time last used:                 1/4/2023 at 8:35:33 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     6933.019   Coefficient A"
"       34.699   Constant B"
"        0.998   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          168.777    mm/hr"
"             Total depth                 97.921    mm"
"            6   100hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 10"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"           10   Catchment 10"
"        0.000   % Impervious"
"        0.420   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.420   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.132     0.000     0.000     0.000 c.m/sec"
"              Catchment 10           Pervious   Impervious Total Area "
"              Surface Area           0.420      0.000      0.420      hectare"
"              Time of concentration  9.201      1.613      9.201      minutes"
"              Time to Centroid       90.800     84.151     90.800     minutes"
"              Rainfall depth         97.921     97.921     97.921     mm"
"              Rainfall volume        411.27     0.00       411.27     c.m"
"              Rainfall losses        47.274     2.759      47.274     mm"
"              Runoff depth           50.647     95.162     50.647     mm"
"              Runoff volume          212.72     0.00       212.72     c.m"
"              Runoff coefficient     0.517      0.000      0.517      "
"              Maximum flow           0.132      0.000      0.132      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                    0.132     0.132     0.000     0.000"
" 38           START/RE-START TOTALS 10"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                    0.420    hectare"
"              Total Impervious area                   0.000    hectare"
"              Total % impervious                      0.000"
" 19           EXIT"
```

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144
April 21, 2023

Catchment 100 - Infiltration Gallery

Storage Volume Calculations

Elevation (m)	Depth (m)	Surface Area (m^2)	Incremental Stone Volume (m^3)	Incremental Storage Volume (m^3)	Accum. Storage Volume (m^3)	
412.55	0.000	42.00	0.00	0.00	0.00	Bottom of Stone
412.56	0.010	42.00	0.42	0.14	0.14	
412.65	0.100	42.00	3.78	1.26	1.40	
412.75	0.200	42.00	4.20	1.40	2.80	
412.85	0.300	42.00	4.20	1.40	4.20	
412.95	0.400	42.00	4.20	1.40	5.60	
413.05	0.500	42.00	4.20	1.40	7.00	
413.15	0.600	42.00	4.20	1.40	8.40	
413.25	0.700	42.00	4.20	1.40	9.80	
413.35	0.800	42.00	4.20	1.40	11.20	
413.45	0.900	42.00	4.20	1.40	12.60	
413.55	1.000	42.00	4.20	1.40	14.00	Top of Stone
413.70	1.150	1.13	0.00	0.00	14.00	
414.33	1.780	1.13	0.00	0.71	14.71	Invert of Overflow
414.58	2.030	1.13	0.00	0.28	14.99	Obvert of Overflow

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144

Bottom Infiltration			**Side Infiltration (2 Sides Only)**			**Overflow Pipe**		
L(dw) =	6.00	m	L(dw) =	12.00	m	Q =	0.046	m^3/s
W(dw) =	7.00	m	W(dw) =	7.00	m	Cd =	0.6	
D(dw) =	1.00	m	D(dw) =	1.00	m	H =	0.125	m
A(c) =	42.0	sq m	A(c) =	24.0	sq m	2g =	19.62	
VOL(dw)=	42.0	cu m				A =	0.049	m^2
VOL(st)=	14.0	cu m				D =	0.250	m
K =	10.0	mm/hr	K =	10.0	mm/hr	D/2 =	0.125	m
	2.78E-04	cm/s		2.78E-04	cm/s			

Stage/Storage/Discharge Table

Stage (m)	Storage (m^3)	Infiltration (m^3/s)	Overflow Pipe (m^3/s)	Discharge (m^3/s)	
412.55	0.00	0.0000	0.000	0.0000	Bottom of Stone
412.56	0.14	0.00012	0.000	0.0001	
412.65	1.40	0.00012	0.000	0.0001	
412.75	2.80	0.00012	0.000	0.0001	
412.85	4.20	0.00013	0.000	0.0001	
412.95	5.60	0.00013	0.000	0.0001	
413.05	7.00	0.00013	0.000	0.0001	
413.15	8.40	0.00014	0.000	0.0001	
413.25	9.80	0.00014	0.000	0.0001	
413.35	11.20	0.00014	0.000	0.0001	
413.45	12.60	0.00015	0.000	0.0001	
413.55	14.00	0.00015	0.000	0.0002	Top of Stone
413.70	14.00	0.00015	0.000	0.0002	
414.33	14.71	0.00018	0.000	0.0002	Invert of Overflow
414.58	14.99	0.00018	0.046	0.0463	Obvert of Overflow

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144

Catchment 200 & 300 - Infiltration Gallery

Storage Volume Calculations

Elevation (m)	Depth (m)	Surface Area (m^2)	Incremental Stone Volume (m^3)	Incremental Storage Volume (m^3)	Accum. Storage Volume (m^3)	
411.80	0.000	95.00	0.00	0.00	0.00	Bottom of Stone
411.81	0.010	95.00	0.95	0.32	0.32	
411.90	0.100	95.00	8.55	2.85	3.17	
412.00	0.200	95.00	9.50	3.17	6.33	
412.10	0.300	95.00	9.50	3.17	9.50	
412.20	0.400	95.00	9.50	3.17	12.67	
412.30	0.500	95.00	9.50	3.17	15.83	
412.40	0.600	95.00	9.50	3.17	19.00	
412.50	0.700	95.00	9.50	3.17	22.17	
412.60	0.800	95.00	9.50	3.17	25.33	
412.70	0.900	95.00	9.50	3.17	28.50	
412.80	1.000	95.00	9.50	3.17	31.67	Top of Stone
413.65	1.850	1.13	0.00	0.00	31.67	
414.50	2.700	1.13	0.00	0.96	32.63	Invert of Overflow
414.75	2.950	1.13	0.00	0.28	32.91	Obvert of Overflow

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144

Bottom Infiltration			**Side Infiltration (2 Sides Only)**			**Overflow Pipe**		
L(dw) =	10.00	m	L(dw) =	20.00	m	Q =	0.046	m^3/s
W(dw) =	9.50	m	W(dw) =	9.50	m	Cd =	0.6	
D(dw) =	1.00	m	D(dw) =	1.00	m	H =	0.125	m
A(c) =	95.0	sq m	A(c) =	40.0	sq m	2g =	19.62	
VOL(dw)=	95.0	cu m				A =	0.049	m^2
VOL(st)=	31.7	cu m				D =	0.250	m
K =	10.0	mm/hr	K =	10.0	mm/hr	D/2 =	0.125	m
	2.78E-04	cm/s		2.78E-04	cm/s			

Stage/Storage/Discharge Table

Stage (m)	Storage (m^3)	Infiltration (m^3/s)	Overflow Pipe (m^3/s)	Discharge (m^3/s)	
411.80	0.00	0.0000	0.000	0.0000	Bottom of Stone
411.81	0.32	0.00026	0.000	0.0003	
411.90	3.17	0.00027	0.000	0.0003	
412.00	6.33	0.00028	0.000	0.0003	
412.10	9.50	0.00028	0.000	0.0003	
412.20	12.67	0.00029	0.000	0.0003	
412.30	15.83	0.00029	0.000	0.0003	
412.40	19.00	0.00030	0.000	0.0003	
412.50	22.17	0.00030	0.000	0.0003	
412.60	25.33	0.00031	0.000	0.0003	
412.70	28.50	0.00031	0.000	0.0003	
412.80	31.67	0.00032	0.000	0.0003	Top of Stone
413.65	31.67	0.00037	0.000	0.0004	
414.50	32.63	0.00041	0.000	0.0004	Invert of Overflow
414.75	32.91	0.00043	0.046	0.0466	Obvert of Overflow

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144

Catchment 500 - Parking Lot Ponding

Storage Volume Calculations

Elevation (m)	Depth (m)	Surface Area (m^2)	Pipe Area (m^2)	Incremental Storage Volume (m^3)	Accum. Storage Volume (m^3)	
413.60	0.000	1.13	0.00	0.00	0.00	Invert of Orifice Plate
413.63	0.030	1.13	0.00	0.03	0.03	Invert of Pipe
413.83	0.230	1.13	4.98	5.20	5.24	
414.03	0.430	1.13	4.98	5.20	10.44	
414.23	0.630	1.13	4.98	5.20	15.64	Obvert of Pipe
414.48	0.880	1.13	0.00	0.28	15.92	
414.73	1.130	1.13	0.00	0.28	16.21	
414.98	1.380	1.13	0.00	0.28	16.49	
415.02	1.420	0.36	0.00	0.03	16.52	T/G DCB.6
415.05	1.450	3.0	0.00	0.05	16.57	
415.10	1.500	15.0	0.00	0.45	17.02	
415.15	1.550	45.0	0.00	1.50	18.52	
415.20	1.600	100.0	0.00	3.63	22.14	
415.25	1.650	135.0	0.00	5.88	28.02	
415.32	1.720	161.0	0.00	10.36	38.38	Weir
415.37	1.770	205.0	0.00	9.15	47.53	
415.42	1.820	215.0	0.00	10.50	58.03	
415.47	1.870	241.0	0.00	11.40	69.43	Overflow

465 Garafraxa Street West
Township of Centre Wellington
Our File: 422144

Overflow Weir

Elevation=415.25

d1 =	1.87	m
h =	1.72	m
H =	0.15	m
2g =	19.62	
L =	3	m
Q =	0.241	m^3/s

Orifice

invert = 413.25

Q =	0.028	m^3/s
Cd =	0.6	
H =	1.82	m
2g =	19.62	
A =	0.008	m^2
D =	0.100	m
D/2 =	0.050	m

Stage/Storage/Discharge Table

Stage (m)	Storage (m^3)	Orifice Discharge (m^3/s)	Weir Discharge (m^3/s)	Total Discharge (m^3/s)	
413.60	0.00	0.000	0.000	0.000	Invert of Orifice Plate
413.63	0.03	0.003	0.000	0.003	Invert of Pipe
413.83	5.24	0.009	0.000	0.009	
414.03	10.44	0.013	0.000	0.013	
414.23	15.64	0.016	0.000	0.016	Obvert of Pipe
414.48	15.92	0.019	0.000	0.019	
414.73	16.21	0.022	0.000	0.022	
414.98	16.49	0.024	0.000	0.024	
415.02	16.52	0.024	0.000	0.024	T/G DCB.6
415.05	16.57	0.025	0.000	0.025	
415.10	17.02	0.025	0.000	0.025	
415.15	18.52	0.026	0.000	0.026	
415.20	22.14	0.026	0.000	0.026	
415.25	28.02	0.026	0.000	0.026	
415.32	38.38	0.027	0.000	0.027	Weir
415.37	47.53	0.027	0.238	0.265	
415.42	58.03	0.028	0.240	0.267	
415.47	69.43	0.028	0.241	0.269	Overflow

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                    C:\Users\pgrier\Documents\Work\"
"                                              422144  465 Garafraxa\2023-04-19"
"                Output filename:                       422144  2-year post.out"
"                Licensee name:                                            gmbp"
"                Company                                                      "
"                Date & Time last used:                 4/21/2023 at 2:23:22 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"      695.047   Coefficient A"
"        6.387   Constant B"
"        0.793   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity            93.292    mm/hr"
"             Total depth                  33.014    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

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"                    0.006     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  24.993     2.044      2.044      minutes"
"             Time to Centroid       93.891     86.566     86.566     minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        0.00       9.90       9.90       c.m"
"             Rainfall losses        32.003     1.926      1.926      mm"
"             Runoff depth           1.010      31.087     31.087     mm"
"             Runoff volume          0.00       9.33       9.33       c.m"
"             Runoff coefficient     0.000      0.942      0.942      "
"             Maximum flow           0.000      0.006      0.006      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.006     0.006     0.000     0.000"
" 54          POND DESIGN"
"         0.006   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"           9.3   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.000    c.m/sec"
"             Maximum level               413.130    metre"
"             Maximum storage               8.123    c.m"
"             Centroidal lag               10.659   hours"
"                  0.006     0.006     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
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"             Hydrograph volume              9.326    c.m"
"                    0.006     0.006     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.006     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.006     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  24.993     2.044      2.044      minutes"
"             Time to Centroid       93.891     86.566     86.566     minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        0.00       9.90       9.90       c.m"
"             Rainfall losses        32.003     1.926      1.926      mm"
"             Runoff depth           1.010      31.087     31.087     mm"
"             Runoff volume          0.00       9.33       9.33       c.m"
"             Runoff coefficient     0.000      0.942      0.942      "
"             Maximum flow           0.000      0.006      0.006      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.006     0.006     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
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"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.008     0.006     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  24.993     2.044      2.044      minutes"
"             Time to Centroid       93.891     86.566     86.566     minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        0.00       13.21      13.21      c.m"
"             Rainfall losses        32.003     1.926      1.926      mm"
"             Runoff depth           1.010      31.087     31.087     mm"
"             Runoff volume          0.00       12.43      12.43      c.m"
"             Runoff coefficient     0.000      0.942      0.942      "
"             Maximum flow           0.000      0.008      0.008      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.008     0.014     0.000     0.000"
" 54          POND DESIGN"
"        0.014   Current peak flow    c.m/sec"
"        0.003   Target outflow    c.m/sec"
"         21.8   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
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"               412.200   0.00029    12.670"
"               412.300   0.00029    15.830"
"               412.400   0.00030    19.000"
"               412.500   0.00030    22.170"
"               412.600   0.00031    25.330"
"               412.700   0.00031    28.500"
"               412.800   0.00032    31.670"
"               413.650   0.00037    31.670"
"               414.500   0.00041    32.630"
"               414.750   0.04655    32.910"
"            Peak outflow                  0.000    c.m/sec"
"            Maximum level              412.400    metre"
"            Maximum storage             19.002    c.m"
"            Centroidal lag              11.196   hours"
"                 0.008     0.014     0.000     0.000 c.m/sec"
" 40         HYDROGRAPH   Combine    1"
"           6   Combine "
"           1   Node #"
"               Infiltrated on-site"
"            Maximum flow                  0.000    c.m/sec"
"            Hydrograph volume            31.085    c.m"
"                    0.008     0.014     0.000     0.000"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.008     0.000     0.000     0.000"
" 33         CATCHMENT 400"
"           1   Triangular SCS"
"           1   Equal length"
"           2   Horton equation"
"         400   Catchment 400"
"       0.000   % Impervious"
"       0.090   Total Area"
"      45.000   Flow length"
"       2.000   Overland Slope"
"       0.090   Pervious Area"
"      45.000   Pervious length"
"       2.000   Pervious slope"
"       0.000   Impervious Area"
"      45.000   Impervious length"
"       2.000   Impervious slope"
"       0.250   Pervious Manning 'n'"
"      75.000   Pervious Max.infiltration"
"      12.500   Pervious Min.infiltration"
"       0.250   Pervious Lag constant (hours)"
"       5.000   Pervious Depression storage"
"       0.015   Impervious Manning 'n'"
"       0.000   Impervious Max.infiltration"
"       0.000   Impervious Min.infiltration"
"       0.050   Impervious Lag constant (hours)"
"       1.500   Impervious Depression storage"
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"                    0.000     0.000     0.000     0.000 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  35.561     2.909      35.560     minutes"
"             Time to Centroid       101.605    87.888     101.605    minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        29.71      0.00       29.71      c.m"
"             Rainfall losses        32.002     2.087      32.002     mm"
"             Runoff depth           1.012      30.926     1.012      mm"
"             Runoff volume          0.91       0.00       0.91       c.m"
"             Runoff coefficient     0.031      0.000      0.031      "
"             Maximum flow           0.000      0.000      0.000      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.000     0.000     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.000     0.000     0.000     0.000"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.000    c.m/sec"
"             Hydrograph volume            0.910    c.m"
"                    0.000     0.000     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.000     0.000     0.000     0.000"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
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"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.043     0.000     0.000     0.000 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  24.993     2.044      2.084      minutes"
"             Time to Centroid       93.891     86.566     86.579     minutes"
"             Rainfall depth         33.014     33.014     33.014     mm"
"             Rainfall volume        3.80       72.14      75.93      c.m"
"             Rainfall losses        32.003     1.926      3.430      mm"
"             Runoff depth           1.010      31.087     29.584     mm"
"             Runoff volume          0.12       67.93      68.04      c.m"
"             Runoff coefficient     0.031      0.942      0.896      "
"             Maximum flow           0.000      0.043      0.043      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.043     0.043     0.000     0.000"
" 54          POND DESIGN"
"        0.043   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"         68.0   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.026    c.m/sec"
"             Maximum level               415.152    metre"
"             Maximum storage              18.642    c.m"
"             Centroidal lag                1.604   hours"
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```
"                0.043     0.043     0.026     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.026    c.m/sec"
"             Hydrograph volume            70.550    c.m"
"                     0.043     0.043     0.026     0.026"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            31.085    c.m"
"                     0.043     0.000     0.026     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.043     0.000     0.000     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            31.085    c.m"
"                     0.043     0.000     0.000     0.000"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.026    c.m/sec"
"             Hydrograph volume            70.550    c.m"
"                     0.043     0.026     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.043     0.026     0.026     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.027    c.m/sec"
"             Hydrograph volume           101.636    c.m"
"                     0.043     0.026     0.026     0.027"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.027    c.m/sec"
"             Hydrograph volume           101.636    c.m"
"                     0.043     0.027     0.026     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.420    hectare"
"             Total Impervious area                       0.318    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                    C:\Users\pgrier\Documents\Work\"
"                                              422144  465 Garafraxa\2023-04-19"
"                Output filename:                       422144  5-year post.out"
"                Licensee name:                                            gmbp"
"                Company                                                      "
"                Date & Time last used:                 4/21/2023 at 2:13:19 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1459.072   Coefficient A"
"       13.690   Constant B"
"        0.850   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          113.586    mm/hr"
"             Total depth                 49.792    mm"
"            6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.008     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  13.471     1.890      1.890      minutes"
"             Time to Centroid       90.770     85.354     85.354     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        0.00       14.94      14.94      c.m"
"             Rainfall losses        39.012     2.179      2.179      mm"
"             Runoff depth           10.780     47.613     47.613     mm"
"             Runoff volume          0.00       14.28      14.28      c.m"
"             Runoff coefficient     0.000      0.956      0.956      "
"             Maximum flow           0.000      0.008      0.008      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.008     0.008     0.000     0.000"
" 54          POND DESIGN"
"         0.008   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"          14.3   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.000    c.m/sec"
"             Maximum level               413.450    metre"
"             Maximum storage              12.603    c.m"
"             Centroidal lag               15.124   hours"
"                  0.008     0.008     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
```

```
"             Hydrograph volume            11.915    c.m"
"                    0.008     0.008     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.008     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.008     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  13.471     1.890      1.890      minutes"
"             Time to Centroid       90.770     85.354     85.354     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        0.00       14.94      14.94      c.m"
"             Rainfall losses        39.012     2.179      2.179      mm"
"             Runoff depth           10.780     47.613     47.613     mm"
"             Runoff volume          0.00       14.28      14.28      c.m"
"             Runoff coefficient     0.000      0.956      0.956      "
"             Maximum flow           0.000      0.008      0.008      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.008     0.008     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
```

```
"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.010     0.008     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  13.471     1.890      1.890      minutes"
"             Time to Centroid       90.770     85.354     85.354     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        0.00       19.92      19.92      c.m"
"             Rainfall losses        39.012     2.179      2.179      mm"
"             Runoff depth           10.780     47.613     47.613     mm"
"             Runoff volume          0.00       19.05      19.05      c.m"
"             Runoff coefficient     0.000      0.956      0.956      "
"             Maximum flow           0.000      0.010      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.010     0.018     0.000     0.000"
" 54          POND DESIGN"
"        0.018   Current peak flow    c.m/sec"
"        0.003   Target outflow    c.m/sec"
"         33.3   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
```

```
"               412.200   0.00029    12.670"
"               412.300   0.00029    15.830"
"               412.400   0.00030    19.000"
"               412.500   0.00030    22.170"
"               412.600   0.00031    25.330"
"               412.700   0.00031    28.500"
"               412.800   0.00032    31.670"
"               413.650   0.00037    31.670"
"               414.500   0.00041    32.630"
"               414.750   0.04655    32.910"
"            Peak outflow                  0.000    c.m/sec"
"            Maximum level               412.761    metre"
"            Maximum storage              30.432    c.m"
"            Centroidal lag               16.263   hours"
"                 0.010     0.018     0.000     0.000 c.m/sec"
" 40         HYDROGRAPH   Combine    1"
"           6   Combine "
"           1   Node #"
"               Infiltrated on-site"
"            Maximum flow                  0.000    c.m/sec"
"            Hydrograph volume            38.100    c.m"
"                    0.010     0.018     0.000     0.000"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.010     0.000     0.000     0.000"
" 33         CATCHMENT 400"
"           1   Triangular SCS"
"           1   Equal length"
"           2   Horton equation"
"         400   Catchment 400"
"       0.000   % Impervious"
"       0.090   Total Area"
"      45.000   Flow length"
"       2.000   Overland Slope"
"       0.090   Pervious Area"
"      45.000   Pervious length"
"       2.000   Pervious slope"
"       0.000   Impervious Area"
"      45.000   Impervious length"
"       2.000   Impervious slope"
"       0.250   Pervious Manning 'n'"
"      75.000   Pervious Max.infiltration"
"      12.500   Pervious Min.infiltration"
"       0.250   Pervious Lag constant (hours)"
"       5.000   Pervious Depression storage"
"       0.015   Impervious Manning 'n'"
"       0.000   Impervious Max.infiltration"
"       0.000   Impervious Min.infiltration"
"       0.050   Impervious Lag constant (hours)"
"       1.500   Impervious Depression storage"
```

```
"                    0.005     0.000     0.000     0.000 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  19.167     2.689      19.167     minutes"
"             Time to Centroid       96.351     86.563     96.351     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        44.81      0.00       44.81      c.m"
"             Rainfall losses        39.010     2.419      39.010     mm"
"             Runoff depth           10.782     47.373     10.782     mm"
"             Runoff volume          9.70       0.00       9.70       c.m"
"             Runoff coefficient     0.217      0.000      0.217      "
"             Maximum flow           0.005      0.000      0.005      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.005     0.005     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.005     0.005     0.005     0.000"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.005    c.m/sec"
"             Hydrograph volume            9.704    c.m"
"                    0.005     0.005     0.005     0.005"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.005     0.000     0.005     0.005"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.056     0.000     0.005     0.005 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  13.471     1.890      2.026      minutes"
"             Time to Centroid       90.770     85.354     85.417     minutes"
"             Rainfall depth         49.792     49.792     49.792     mm"
"             Rainfall volume        5.73       108.79     114.52     c.m"
"             Rainfall losses        39.012     2.179      4.020      mm"
"             Runoff depth           10.780     47.613     45.771     mm"
"             Runoff volume          1.24       104.03     105.27     c.m"
"             Runoff coefficient     0.217      0.956      0.919      "
"             Maximum flow           0.001      0.056      0.056      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.056     0.056     0.005     0.005"
" 54          POND DESIGN"
"        0.056   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"        105.3   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.026    c.m/sec"
"             Maximum level               415.276    metre"
"             Maximum storage              31.929    c.m"
"             Centroidal lag                1.650   hours"
```

```
"                0.056     0.056     0.026     0.005 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.032    c.m/sec"
"             Hydrograph volume           114.616    c.m"
"                      0.056     0.056     0.026     0.032"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            38.100    c.m"
"                      0.056     0.000     0.026     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                      0.056     0.000     0.000     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            38.100    c.m"
"                      0.056     0.000     0.000     0.000"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.032    c.m/sec"
"             Hydrograph volume           114.616    c.m"
"                      0.056     0.032     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                      0.056     0.032     0.032     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.032    c.m/sec"
"             Hydrograph volume           152.716    c.m"
"                      0.056     0.032     0.032     0.032"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.032    c.m/sec"
"             Hydrograph volume           152.716    c.m"
"                      0.056     0.032     0.032     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.420    hectare"
"             Total Impervious area                       0.318    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                             422144  465 Garafraxa\2023-04-19"
"                Output filename:                     422144  10-year post.out"
"                Licensee name:                                           gmbp"
"                Company                                                     "
"                Date & Time last used:                4/21/2023 at 2:02:50 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     2327.596   Coefficient A"
"       19.500   Constant B"
"        0.894   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          126.171    mm/hr"
"             Total depth                 61.359    mm"
"            6   010hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.009     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  12.045     1.812      1.812      minutes"
"             Time to Centroid       90.582     84.870     84.870     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        0.00       18.41      18.41      c.m"
"             Rainfall losses        41.728     2.332      2.332      mm"
"             Runoff depth           19.631     59.027     59.027     mm"
"             Runoff volume          0.00       17.71      17.71      c.m"
"             Runoff coefficient     0.000      0.962      0.962      "
"             Maximum flow           0.000      0.009      0.009      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.009     0.009     0.000     0.000"
" 54          POND DESIGN"
"         0.009   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"          17.7   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.001    c.m/sec"
"             Maximum level               414.334    metre"
"             Maximum storage              14.715    c.m"
"             Centroidal lag               15.112   hours"
"                  0.009     0.009     0.001     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.009     0.001     0.001     0.000"
" 56          DIVERSION"
"           100   Node number"
```

```
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.001    c.m/sec"
"             Volume of diverted flow       1.479    c.m"
"             DIV00100.010hyd"
"             Major flow at 100"
"                     0.009     0.001     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            12.583    c.m"
"                     0.009     0.001     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.009     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.009     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  12.045     1.812      1.812      minutes"
"             Time to Centroid       90.582     84.870     84.870     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        0.00       18.41      18.41      c.m"
```

```
"             Rainfall losses        41.728     2.332      2.332      mm"
"             Runoff depth           19.631     59.027     59.027     mm"
"             Runoff volume          0.00       17.71      17.71      c.m"
"             Runoff coefficient     0.000      0.962      0.962      "
"             Maximum flow           0.000      0.009      0.009      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.009     0.009     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.012     0.009     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  12.045     1.812      1.812      minutes"
"             Time to Centroid       90.582     84.870     84.870     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        0.00       24.54      24.54      c.m"
"             Rainfall losses        41.728     2.332      2.332      mm"
"             Runoff depth           19.631     59.027     59.027     mm"
"             Runoff volume          0.00       23.61      23.61      c.m"
"             Runoff coefficient     0.000      0.962      0.962      "
"             Maximum flow           0.000      0.012      0.012      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.012     0.021     0.000     0.000"
" 54          POND DESIGN"
"        0.021   Current peak flow    c.m/sec"
```

```
"        0.003   Target outflow    c.m/sec"
"         41.3   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
"                412.200   0.00029    12.670"
"                412.300   0.00029    15.830"
"                412.400   0.00030    19.000"
"                412.500   0.00030    22.170"
"                412.600   0.00031    25.330"
"                412.700   0.00031    28.500"
"                412.800   0.00032    31.670"
"                413.650   0.00037    31.670"
"                414.500   0.00041    32.630"
"                414.750   0.04655    32.910"
"             Peak outflow                  0.003    c.m/sec"
"             Maximum level               414.515    metre"
"             Maximum storage              32.647    c.m"
"             Centroidal lag               15.195   hours"
"                  0.012     0.021     0.003     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.012     0.003     0.003     0.000"
" 56          DIVERSION"
"           300   Node number"
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.002    c.m/sec"
"             Volume of diverted flow       6.154    c.m"
"             DIV00300.010hyd"
"             Major flow at 300"
"                    0.012     0.003     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.669    c.m"
"                    0.012     0.003     0.000     0.001"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
```

```
"                    0.012     0.000     0.000     0.001"
" 33          CATCHMENT 400"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          400   Catchment 400"
"        0.000   % Impervious"
"        0.090   Total Area"
"       45.000   Flow length"
"        2.000   Overland Slope"
"        0.090   Pervious Area"
"       45.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       45.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.010     0.000     0.000     0.001 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  17.138     2.578      17.138     minutes"
"             Time to Centroid       95.559     86.001     95.559     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        55.22      0.00       55.22      c.m"
"             Rainfall losses        41.654     2.661      41.654     mm"
"             Runoff depth           19.705     58.698     19.705     mm"
"             Runoff volume          17.73      0.00       17.73      c.m"
"             Runoff coefficient     0.321      0.000      0.321      "
"             Maximum flow           0.010      0.000      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.010     0.010     0.000     0.001"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.010     0.010     0.010     0.001"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.010    c.m/sec"
"             Hydrograph volume           17.735    c.m"
```

```
"                    0.010     0.010     0.010     0.010"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.010     0.000     0.010     0.010"
" 47          FILEI_O Read/Open DIV00100.010hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00100.010hyd"
"             Major flow at 100"
"             Total volume                  1.479    c.m"
"             Maximum flow                  0.001    c.m/sec"
"                  0.001     0.000     0.010     0.010 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.001     0.001     0.010     0.010"
" 47          FILEI_O Read/Open DIV00300.010hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00300.010hyd"
"             Major flow at 300"
"             Total volume                  6.154    c.m"
"             Maximum flow                  0.002    c.m/sec"
"                  0.002     0.001     0.010     0.010 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.002     0.003     0.010     0.010"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.065     0.003     0.010     0.010 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  12.045     1.812      1.988      minutes"
"             Time to Centroid       90.582     84.870     84.968     minutes"
"             Rainfall depth         61.359     61.359     61.359     mm"
"             Rainfall volume        7.06       134.07     141.13     c.m"
"             Rainfall losses        41.728     2.332      4.302      mm"
"             Runoff depth           19.631     59.027     57.057     mm"
"             Runoff volume          2.26       128.97     131.23     c.m"
"             Runoff coefficient     0.320      0.962      0.930      "
"             Maximum flow           0.001      0.065      0.065      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.065     0.065     0.010     0.010"
" 54          POND DESIGN"
"        0.065   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"        138.9   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.039    c.m/sec"
"             Maximum level               415.324    metre"
"             Maximum storage              39.030    c.m"
"             Centroidal lag                1.721   hours"
```

```
"                0.065     0.065     0.039     0.010 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.047    c.m/sec"
"             Hydrograph volume           157.678    c.m"
"                     0.065     0.065     0.039     0.047"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.669    c.m"
"                     0.065     0.001     0.039     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.065     0.001     0.001     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.669    c.m"
"                     0.065     0.001     0.001     0.001"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.047    c.m/sec"
"             Hydrograph volume           157.678    c.m"
"                     0.065     0.047     0.001     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.065     0.047     0.047     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.047    c.m/sec"
"             Hydrograph volume           196.347    c.m"
"                     0.065     0.047     0.047     0.047"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.047    c.m/sec"
"             Hydrograph volume           196.347    c.m"
"                     0.065     0.047     0.047     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.840    hectare"
"             Total Impervious area                       0.637    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                             422144  465 Garafraxa\2023-04-19"
"                Output filename:                     422144  25-year post.out"
"                Licensee name:                                           gmbp"
"                Company                                                     "
"                Date & Time last used:                4/21/2023 at 2:10:41 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3701.648   Coefficient A"
"       25.500   Constant B"
"        0.937   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          143.371    mm/hr"
"             Total depth                 75.581    mm"
"            6   025hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.010     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  10.252     1.722      1.722      minutes"
"             Time to Centroid       90.488     84.485     84.485     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        0.00       22.67      22.67      c.m"
"             Rainfall losses        44.281     2.520      2.520      mm"
"             Runoff depth           31.300     73.061     73.061     mm"
"             Runoff volume          0.00       21.92      21.92      c.m"
"             Runoff coefficient     0.000      0.967      0.967      "
"             Maximum flow           0.000      0.010      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.010     0.010     0.000     0.000"
" 54          POND DESIGN"
"         0.010   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"          21.9   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.004    c.m/sec"
"             Maximum level               414.351    metre"
"             Maximum storage              14.734    c.m"
"             Centroidal lag               12.254   hours"
"                  0.010     0.010     0.004     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.010     0.004     0.004     0.000"
" 56          DIVERSION"
"           100   Node number"
```

```
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.004    c.m/sec"
"             Volume of diverted flow       5.767    c.m"
"             DIV00100.025hyd"
"             Major flow at 100"
"                     0.010     0.004     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            12.692    c.m"
"                     0.010     0.004     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.010     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.010     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  10.252     1.722      1.722      minutes"
"             Time to Centroid       90.488     84.485     84.485     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        0.00       22.67      22.67      c.m"
```

```
"             Rainfall losses        44.281     2.520      2.520      mm"
"             Runoff depth           31.300     73.061     73.061     mm"
"             Runoff volume          0.00       21.92      21.92      c.m"
"             Runoff coefficient     0.000      0.967      0.967      "
"             Maximum flow           0.000      0.010      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.010     0.010     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.014     0.010     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  10.252     1.722      1.722      minutes"
"             Time to Centroid       90.488     84.485     84.485     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        0.00       30.23      30.23      c.m"
"             Rainfall losses        44.281     2.520      2.520      mm"
"             Runoff depth           31.300     73.061     73.061     mm"
"             Runoff volume          0.00       29.22      29.22      c.m"
"             Runoff coefficient     0.000      0.967      0.967      "
"             Maximum flow           0.000      0.014      0.014      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.014     0.024     0.000     0.000"
" 54          POND DESIGN"
"        0.024   Current peak flow    c.m/sec"
```

```
"        0.003   Target outflow    c.m/sec"
"         51.1   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
"                412.200   0.00029    12.670"
"                412.300   0.00029    15.830"
"                412.400   0.00030    19.000"
"                412.500   0.00030    22.170"
"                412.600   0.00031    25.330"
"                412.700   0.00031    28.500"
"                412.800   0.00032    31.670"
"                413.650   0.00037    31.670"
"                414.500   0.00041    32.630"
"                414.750   0.04655    32.910"
"             Peak outflow                  0.009    c.m/sec"
"             Maximum level               414.559    metre"
"             Maximum storage              32.696    c.m"
"             Centroidal lag               13.228   hours"
"                  0.014     0.024     0.009     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.014     0.009     0.009     0.000"
" 56          DIVERSION"
"           300   Node number"
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.009    c.m/sec"
"             Volume of diverted flow      15.036    c.m"
"             DIV00300.025hyd"
"             Major flow at 300"
"                    0.014     0.009     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.832    c.m"
"                    0.014     0.009     0.000     0.001"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
```

```
"                    0.014     0.000     0.000     0.001"
" 33          CATCHMENT 400"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          400   Catchment 400"
"        0.000   % Impervious"
"        0.090   Total Area"
"       45.000   Flow length"
"        2.000   Overland Slope"
"        0.090   Pervious Area"
"       45.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       45.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.016     0.000     0.000     0.001 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  14.587     2.450      14.587     minutes"
"             Time to Centroid       94.912     85.513     94.912     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        68.02      0.00       68.02      c.m"
"             Rainfall losses        44.164     2.905      44.164     mm"
"             Runoff depth           31.417     72.676     31.417     mm"
"             Runoff volume          28.28      0.00       28.28      c.m"
"             Runoff coefficient     0.416      0.000      0.416      "
"             Maximum flow           0.016      0.000      0.016      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.016     0.016     0.000     0.001"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.016     0.016     0.016     0.001"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.016    c.m/sec"
"             Hydrograph volume           28.275    c.m"
```

```
"                    0.016     0.016     0.016     0.016"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.016     0.000     0.016     0.016"
" 47          FILEI_O Read/Open DIV00100.025hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00100.025hyd"
"             Major flow at 100"
"             Total volume                  5.767    c.m"
"             Maximum flow                  0.004    c.m/sec"
"                  0.004     0.000     0.016     0.016 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.004     0.004     0.016     0.016"
" 47          FILEI_O Read/Open DIV00300.025hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00300.025hyd"
"             Major flow at 300"
"             Total volume                 15.036    c.m"
"             Maximum flow                  0.009    c.m/sec"
"                  0.009     0.004     0.016     0.016 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.009     0.012     0.016     0.016"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.077     0.012     0.016     0.016 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  10.252     1.722      1.910      minutes"
"             Time to Centroid       90.488     84.485     84.617     minutes"
"             Rainfall depth         75.581     75.581     75.581     mm"
"             Rainfall volume        8.69       165.14     173.84     c.m"
"             Rainfall losses        44.281     2.520      4.608      mm"
"             Runoff depth           31.300     73.061     70.973     mm"
"             Runoff volume          3.60       159.64     163.24     c.m"
"             Runoff coefficient     0.414      0.967      0.939      "
"             Maximum flow           0.002      0.075      0.077      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.077     0.077     0.016     0.016"
" 54          POND DESIGN"
"        0.077   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"        184.0   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.059    c.m/sec"
"             Maximum level               415.330    metre"
"             Maximum storage              40.170    c.m"
"             Centroidal lag                1.735   hours"
```

```
"                0.077     0.077     0.059     0.016 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           209.359    c.m"
"                      0.077     0.077     0.059     0.073"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.832    c.m"
"                      0.077     0.001     0.059     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                      0.077     0.001     0.001     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.832    c.m"
"                      0.077     0.001     0.001     0.001"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           209.359    c.m"
"                      0.077     0.073     0.001     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                      0.077     0.073     0.073     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           248.190    c.m"
"                      0.077     0.073     0.073     0.073"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           248.190    c.m"
"                      0.077     0.073     0.073     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.420    hectare"
"             Total Impervious area                       0.318    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                             422144  465 Garafraxa\2023-04-19"
"                Output filename:                     422144  50-year post.out"
"                Licensee name:                                           gmbp"
"                Company                                                     "
"                Date & Time last used:                4/21/2023 at 2:15:37 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     5089.418   Coefficient A"
"       30.000   Constant B"
"        0.967   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          156.350    mm/hr"
"             Total depth                 86.737    mm"
"            6   050hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.011     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  9.574      1.663      1.663      minutes"
"             Time to Centroid       90.779     84.291     84.291     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        0.00       26.02      26.02      c.m"
"             Rainfall losses        45.966     2.621      2.621      mm"
"             Runoff depth           40.771     84.116     84.116     mm"
"             Runoff volume          0.00       25.23      25.23      c.m"
"             Runoff coefficient     0.000      0.970      0.970      "
"             Maximum flow           0.000      0.011      0.011      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.011     0.011     0.000     0.000"
" 54          POND DESIGN"
"         0.011   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"          25.2   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.006    c.m/sec"
"             Maximum level               414.367    metre"
"             Maximum storage              14.752    c.m"
"             Centroidal lag               11.322   hours"
"                  0.011     0.011     0.006     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.011     0.006     0.006     0.000"
" 56          DIVERSION"
"           100   Node number"
```

```
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.006    c.m/sec"
"             Volume of diverted flow       8.703    c.m"
"             DIV00100.050hyd"
"             Major flow at 100"
"                     0.011     0.006     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            12.726    c.m"
"                     0.011     0.006     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.011     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.011     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  9.574      1.663      1.663      minutes"
"             Time to Centroid       90.779     84.291     84.291     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        0.00       26.02      26.02      c.m"
```

```
"             Rainfall losses        45.966     2.621      2.621      mm"
"             Runoff depth           40.771     84.116     84.116     mm"
"             Runoff volume          0.00       25.23      25.23      c.m"
"             Runoff coefficient     0.000      0.970      0.970      "
"             Maximum flow           0.000      0.011      0.011      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.011     0.011     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.015     0.011     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  9.574      1.663      1.663      minutes"
"             Time to Centroid       90.779     84.291     84.291     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        0.00       34.69      34.69      c.m"
"             Rainfall losses        45.966     2.621      2.621      mm"
"             Runoff depth           40.771     84.116     84.116     mm"
"             Runoff volume          0.00       33.65      33.65      c.m"
"             Runoff coefficient     0.000      0.970      0.970      "
"             Maximum flow           0.000      0.015      0.015      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.015     0.027     0.000     0.000"
" 54          POND DESIGN"
"        0.027   Current peak flow    c.m/sec"
```

```
"        0.003   Target outflow    c.m/sec"
"         58.9   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
"                412.200   0.00029    12.670"
"                412.300   0.00029    15.830"
"                412.400   0.00030    19.000"
"                412.500   0.00030    22.170"
"                412.600   0.00031    25.330"
"                412.700   0.00031    28.500"
"                412.800   0.00032    31.670"
"                413.650   0.00037    31.670"
"                414.500   0.00041    32.630"
"                414.750   0.04655    32.910"
"             Peak outflow                  0.014    c.m/sec"
"             Maximum level               414.597    metre"
"             Maximum storage              32.739    c.m"
"             Centroidal lag               12.208   hours"
"                  0.015     0.027     0.014     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                     0.015     0.014     0.014     0.000"
" 56          DIVERSION"
"           300   Node number"
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.014    c.m/sec"
"             Volume of diverted flow      21.932    c.m"
"             DIV00300.050hyd"
"             Major flow at 300"
"                     0.015     0.014     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.903    c.m"
"                     0.015     0.014     0.000     0.001"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
```

```
"                    0.015     0.000     0.000     0.001"
" 33          CATCHMENT 400"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          400   Catchment 400"
"        0.000   % Impervious"
"        0.090   Total Area"
"       45.000   Flow length"
"        2.000   Overland Slope"
"        0.090   Pervious Area"
"       45.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       45.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.020     0.000     0.000     0.001 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  13.622     2.366      13.622     minutes"
"             Time to Centroid       95.105     85.267     95.105     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        78.06      0.00       78.06      c.m"
"             Rainfall losses        45.735     3.110      45.735     mm"
"             Runoff depth           41.002     83.627     41.002     mm"
"             Runoff volume          36.90      0.00       36.90      c.m"
"             Runoff coefficient     0.473      0.000      0.473      "
"             Maximum flow           0.020      0.000      0.020      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.020     0.020     0.000     0.001"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.020     0.020     0.020     0.001"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.020    c.m/sec"
"             Hydrograph volume           36.901    c.m"
```

```
"                    0.020     0.020     0.020     0.020"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.020     0.000     0.020     0.020"
" 47          FILEI_O Read/Open DIV00100.050hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00100.050hyd"
"             Major flow at 100"
"             Total volume                   8.703    c.m"
"             Maximum flow                   0.006    c.m/sec"
"                  0.006     0.000     0.020     0.020 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.006     0.006     0.020     0.020"
" 47          FILEI_O Read/Open DIV00300.050hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00300.050hyd"
"             Major flow at 300"
"             Total volume                  21.932    c.m"
"             Maximum flow                   0.014    c.m/sec"
"                  0.014     0.006     0.020     0.020 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.014     0.020     0.020     0.020"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.085     0.020     0.020     0.020 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  9.574      1.663      1.860      minutes"
"             Time to Centroid       90.779     84.291     84.452     minutes"
"             Rainfall depth         86.737     86.737     86.737     mm"
"             Rainfall volume        9.97       189.52     199.49     c.m"
"             Rainfall losses        45.966     2.621      4.788      mm"
"             Runoff depth           40.771     84.116     81.948     mm"
"             Runoff volume          4.69       183.79     188.48     c.m"
"             Runoff coefficient     0.470      0.970      0.945      "
"             Maximum flow           0.003      0.083      0.085      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.085     0.085     0.020     0.020"
" 54          POND DESIGN"
"        0.085   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"        219.1   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.085    c.m/sec"
"             Maximum level               415.332    metre"
"             Maximum storage              40.592    c.m"
"             Centroidal lag                1.693   hours"
```

```
"                 0.085     0.085     0.085     0.020 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.095    c.m/sec"
"             Hydrograph volume           260.419    c.m"
"                     0.085     0.085     0.085     0.095"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.903    c.m"
"                     0.085     0.001     0.085     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.085     0.001     0.001     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.903    c.m"
"                     0.085     0.001     0.001     0.001"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.095    c.m/sec"
"             Hydrograph volume           260.419    c.m"
"                     0.085     0.095     0.001     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.085     0.095     0.095     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.096    c.m/sec"
"             Hydrograph volume           299.322    c.m"
"                     0.085     0.095     0.095     0.096"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.096    c.m/sec"
"             Hydrograph volume           299.322    c.m"
"                     0.085     0.096     0.095     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.420    hectare"
"             Total Impervious area                       0.318    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                   C:\Users\pgrier\Documents\Work\"
"                                             422144  465 Garafraxa\2023-04-19"
"                Output filename:                     422144  100-year post.out"
"                Licensee name:                                            gmbp"
"                Company                                                      "
"                Date & Time last used:                4/21/2023 at 2:19:29 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     6933.019   Coefficient A"
"       34.699   Constant B"
"        0.998   Exponent C"
"        0.380   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          168.777    mm/hr"
"             Total depth                 97.921    mm"
"            6   100hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Catchment 100"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.012     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  9.201      1.613      1.613      minutes"
"             Time to Centroid       90.800     84.151     84.151     minutes"
"             Rainfall depth         97.921     97.921     97.921     mm"
"             Rainfall volume        0.00       29.38      29.38      c.m"
"             Rainfall losses        47.274     2.759      2.759      mm"
"             Runoff depth           50.647     95.162     95.162     mm"
"             Runoff volume          0.00       28.55      28.55      c.m"
"             Runoff coefficient     0.000      0.972      0.972      "
"             Maximum flow           0.000      0.012      0.012      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.012     0.012     0.000     0.000"
" 54          POND DESIGN"
"         0.012   Current peak flow    c.m/sec"
"         0.003   Target outflow    c.m/sec"
"          28.5   Hydrograph volume    c.m"
"           15.   Number of stages"
"         0.000   Minimum water level    metre"
"         3.000   Maximum water level    metre"
"         0.000   Starting water level    metre"
"             0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 412.550     0.000     0.000"
"                 412.560   0.00012    0.1400"
"                 412.650   0.00012     1.400"
"                 412.750   0.00012     2.800"
"                 412.850   0.00013     4.200"
"                 412.950   0.00013     5.600"
"                 413.050   0.00013     7.000"
"                 413.150   0.00014     8.400"
"                 413.250   0.00014     9.800"
"                 413.350   0.00014    11.200"
"                 413.450   0.00015    12.600"
"                 413.550   0.00015    14.000"
"                 413.700   0.00016    14.000"
"                 414.330   0.00018    14.710"
"                 414.580   0.04631    14.990"
"             Peak outflow                  0.009    c.m/sec"
"             Maximum level               414.382    metre"
"             Maximum storage              14.768    c.m"
"             Centroidal lag                9.121   hours"
"                  0.012     0.012     0.009     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                    0.012     0.009     0.009     0.000"
" 56          DIVERSION"
"           100   Node number"
```

```
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.009    c.m/sec"
"             Volume of diverted flow      12.894    c.m"
"             DIV00100.100hyd"
"             Major flow at 100"
"                     0.012     0.009     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.000    c.m/sec"
"             Hydrograph volume            12.758    c.m"
"                     0.012     0.009     0.000     0.000"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.012     0.000     0.000     0.000"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catchment 200"
"      100.000   % Impervious"
"        0.030   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.030   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.012     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.030      0.030      hectare"
"             Time of concentration  9.201      1.613      1.613      minutes"
"             Time to Centroid       90.800     84.151     84.151     minutes"
"             Rainfall depth         97.921     97.921     97.921     mm"
"             Rainfall volume        0.00       29.38      29.38      c.m"
```

```
"             Rainfall losses        47.274     2.759      2.759      mm"
"             Runoff depth           50.647     95.162     95.162     mm"
"             Runoff volume          0.00       28.55      28.55      c.m"
"             Runoff coefficient     0.000      0.972      0.972      "
"             Maximum flow           0.000      0.012      0.012      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.012     0.012     0.000     0.000"
" 33          CATCHMENT 300"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          300   Catchment 300"
"      100.000   % Impervious"
"        0.040   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.040   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.017     0.012     0.000     0.000 c.m/sec"
"             Catchment 300          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.040      0.040      hectare"
"             Time of concentration  9.201      1.613      1.613      minutes"
"             Time to Centroid       90.800     84.151     84.151     minutes"
"             Rainfall depth         97.921     97.921     97.921     mm"
"             Rainfall volume        0.00       39.17      39.17      c.m"
"             Rainfall losses        47.274     2.759      2.759      mm"
"             Runoff depth           50.647     95.162     95.162     mm"
"             Runoff volume          0.00       38.06      38.06      c.m"
"             Runoff coefficient     0.000      0.972      0.972      "
"             Maximum flow           0.000      0.017      0.017      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.017     0.029     0.000     0.000"
" 54          POND DESIGN"
"        0.029   Current peak flow    c.m/sec"
```

```
"        0.003   Target outflow    c.m/sec"
"         66.6   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                411.800     0.000     0.000"
"                411.810   0.00026    0.3200"
"                411.900   0.00027     3.170"
"                412.000   0.00027     6.330"
"                412.100   0.00028     9.500"
"                412.200   0.00029    12.670"
"                412.300   0.00029    15.830"
"                412.400   0.00030    19.000"
"                412.500   0.00030    22.170"
"                412.600   0.00031    25.330"
"                412.700   0.00031    28.500"
"                412.800   0.00032    31.670"
"                413.650   0.00037    31.670"
"                414.500   0.00041    32.630"
"                414.750   0.04655    32.910"
"             Peak outflow                  0.022    c.m/sec"
"             Maximum level               414.631    metre"
"             Maximum storage              32.776    c.m"
"             Centroidal lag                9.814   hours"
"                  0.017     0.029     0.022     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                      0.017     0.022     0.022     0.000"
" 56          DIVERSION"
"           300   Node number"
"        0.000   Overflow threshold"
"        1.000   Required diverted fraction"
"            0   Conduit type; 1=Pipe;2=Channel"
"             Peak of diverted flow         0.021    c.m/sec"
"             Volume of diverted flow      31.740    c.m"
"             DIV00300.100hyd"
"             Major flow at 300"
"                      0.017     0.022     0.000     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.963    c.m"
"                      0.017     0.022     0.000     0.001"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
```

```
"                    0.017     0.000     0.000     0.001"
" 33          CATCHMENT 400"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          400   Catchment 400"
"        0.000   % Impervious"
"        0.090   Total Area"
"       45.000   Flow length"
"        2.000   Overland Slope"
"        0.090   Pervious Area"
"       45.000   Pervious length"
"        2.000   Pervious slope"
"        0.000   Impervious Area"
"       45.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                    0.024     0.000     0.000     0.001 c.m/sec"
"             Catchment 400          Pervious   Impervious Total Area "
"             Surface Area           0.090      0.000      0.090      hectare"
"             Time of concentration  13.091     2.295      13.091     minutes"
"             Time to Centroid       94.931     85.055     94.931     minutes"
"             Rainfall depth         97.921     97.921     97.921     mm"
"             Rainfall volume        88.13      0.00       88.13      c.m"
"             Rainfall losses        47.175     3.229      47.175     mm"
"             Runoff depth           50.747     94.693     50.747     mm"
"             Runoff volume          45.67      0.00       45.67      c.m"
"             Runoff coefficient     0.518      0.000      0.518      "
"             Maximum flow           0.024      0.000      0.024      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.024     0.024     0.000     0.001"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.024     0.024     0.024     0.001"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                 0.024    c.m/sec"
"             Hydrograph volume           45.672    c.m"
```

```
"                    0.024     0.024     0.024     0.024"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.024     0.000     0.024     0.024"
" 47          FILEI_O Read/Open DIV00100.100hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00100.100hyd"
"             Major flow at 100"
"             Total volume                  12.894    c.m"
"             Maximum flow                   0.009    c.m/sec"
"                  0.009     0.000     0.024     0.024 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.009     0.009     0.024     0.024"
" 47          FILEI_O Read/Open DIV00300.100hyd"
"            1   1=read/open; 2=write/save"
"            2   1=rainfall; 2=hydrograph"
"            1   1=runoff; 2=inflow; 3=outflow; 4=junction"
"             DIV00300.100hyd"
"             Major flow at 300"
"             Total volume                  31.740    c.m"
"             Maximum flow                   0.021    c.m/sec"
"                  0.021     0.009     0.024     0.024 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.021     0.031     0.024     0.024"
" 33          CATCHMENT 500"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          500   Catchment 500"
"       95.000   % Impervious"
"        0.230   Total Area"
"       25.000   Flow length"
"        2.000   Overland Slope"
"        0.012   Pervious Area"
"       25.000   Pervious length"
"        2.000   Pervious slope"
"        0.219   Impervious Area"
"       25.000   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.015   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.050   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.093     0.031     0.024     0.024 c.m/sec"
"             Catchment 500          Pervious   Impervious Total Area "
"             Surface Area           0.012      0.219      0.230      hectare"
"             Time of concentration  9.201      1.613      1.820      minutes"
"             Time to Centroid       90.800     84.151     84.332     minutes"
"             Rainfall depth         97.921     97.921     97.921     mm"
"             Rainfall volume        11.26      213.96     225.22     c.m"
"             Rainfall losses        47.274     2.759      4.985      mm"
"             Runoff depth           50.647     95.162     92.936     mm"
"             Runoff volume          5.82       207.93     213.75     c.m"
"             Runoff coefficient     0.517      0.972      0.949      "
"             Maximum flow           0.004      0.091      0.093      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.093     0.102     0.024     0.024"
" 54          POND DESIGN"
"        0.102   Current peak flow    c.m/sec"
"        0.002   Target outflow    c.m/sec"
"        258.4   Hydrograph volume    c.m"
"          18.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                413.600     0.000     0.000"
"                413.630   0.00300   0.03000"
"                413.830   0.00900     5.240"
"                414.030   0.01300    10.440"
"                414.230   0.01600    15.640"
"                414.480   0.01900    15.920"
"                414.730   0.02200    16.210"
"                414.980   0.02400    16.490"
"                415.020   0.02400    16.520"
"                415.050   0.02500    16.570"
"                415.100   0.02500    17.020"
"                415.150   0.02600    18.520"
"                415.200   0.02600    22.140"
"                415.250   0.02600    28.020"
"                415.320   0.02700    38.380"
"                415.370    0.2650    47.530"
"                415.420    0.2670    58.030"
"                415.470    0.2690    69.430"
"             Peak outflow                  0.100    c.m/sec"
"             Maximum level               415.335    metre"
"             Maximum storage              41.203    c.m"
"             Centroidal lag                1.681   hours"
```

```
"                0.093     0.102     0.100     0.024 c.m/sec"
" 40          HYDROGRAPH   Combine    2"
"            6   Combine "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.124    c.m/sec"
"             Hydrograph volume           301.668    c.m"
"                     0.093     0.102     0.100     0.124"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Infiltrated on-site"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.963    c.m"
"                     0.093     0.001     0.100     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.093     0.001     0.001     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.001    c.m/sec"
"             Hydrograph volume            38.963    c.m"
"                     0.093     0.001     0.001     0.001"
" 40          HYDROGRAPH   Confluence    2"
"            7   Confluence "
"            2   Node #"
"                Off-Site"
"             Maximum flow                  0.124    c.m/sec"
"             Hydrograph volume           301.668    c.m"
"                     0.093     0.124     0.001     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.093     0.124     0.124     0.000"
" 40          HYDROGRAPH   Combine    3"
"            6   Combine "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.124    c.m/sec"
"             Hydrograph volume           340.631    c.m"
"                     0.093     0.124     0.124     0.124"
" 40          HYDROGRAPH   Confluence    3"
"            7   Confluence "
"            3   Node #"
"                TOTAL"
"             Maximum flow                  0.124    c.m/sec"
"             Hydrograph volume           340.631    c.m"
"                     0.093     0.124     0.124     0.000"
" 38          START/RE-START TOTALS 3"
```

```
"            3   Runoff Totals on EXIT"
"             Total Catchment area                        0.420    hectare"
"             Total Impervious area                       0.318    hectare"
"             Total % impervious                         75.833"
" 19          EXIT"
```

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

01/18/2023

Province:	Ontario
City:	Fergus
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
Climate Station Id:	6149387
Years of Rainfall Data:	34

Site Name:	465 Garafraxa

Drainage Area (ha):	0.19
% Imperviousness:	95.00

Runoff Coefficient 'c': 0.87

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	6.26
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	465 Garafraxa
Project Number:	60503
Designer Name:	Patrick Grier
Designer Company:	GM BluePlan Engineering Limited
Designer Email:	patrick.grier@gmblueplan.ca
Designer Phone:	519-748-1440
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	93
EFO6	98
EFO8	99
EFO10	100
EFO12	100

Recommended Stormceptor EFO Model: EFO4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 93

Water Quality Runoff Volume Capture (%): > 90

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
0.5	8.5	8.5	0.23	14.0	11.0	100	8.5	8.5
1	18.3	26.8	0.46	28.0	23.0	100	18.3	26.8
2	14.4	41.3	0.92	55.0	46.0	100	14.4	41.3
3	10.2	51.5	1.38	83.0	69.0	100	10.2	51.5
4	8.0	59.5	1.84	110.0	92.0	97	7.8	59.2
5	6.9	66.4	2.30	138.0	115.0	95	6.6	65.8
6	5.9	72.3	2.76	165.0	138.0	92	5.4	71.2
7	3.8	76.1	3.22	193.0	161.0	88	3.3	74.6
8	2.6	78.7	3.68	221.0	184.0	86	2.2	76.8
9	2.5	81.1	4.14	248.0	207.0	83	2.1	78.8
10	2.2	83.3	4.60	276.0	230.0	82	1.8	80.6
11	2.5	85.8	5.05	303.0	253.0	81	2.0	82.6
12	2.0	87.8	5.51	331.0	276.0	80	1.6	84.2
13	1.6	89.4	5.97	358.0	299.0	79	1.3	85.5
14	0.9	90.4	6.43	386.0	322.0	78	0.7	86.2
15	1.6	91.9	6.89	414.0	345.0	77	1.2	87.4
16	1.1	93.0	7.35	441.0	368.0	76	0.8	88.2
17	1.0	94.0	7.81	469.0	391.0	74	0.8	89.0
18	0.5	94.6	8.27	496.0	414.0	73	0.4	89.4
19	0.2	94.8	8.73	524.0	437.0	72	0.2	89.6
20	0.6	95.4	9.19	551.0	460.0	71	0.4	90.0
21	0.6	96.1	9.65	579.0	483.0	70	0.5	90.5
22	0.3	96.4	10.11	607.0	505.0	69	0.2	90.7
23	0.8	97.2	10.57	634.0	528.0	68	0.6	91.2
24	0.4	97.6	11.03	662.0	551.0	67	0.3	91.5
25	0.2	97.8	11.49	689.0	574.0	66	0.1	91.6
30	0.9	98.7	13.79	827.0	689.0	64	0.6	92.2
35	0.8	99.5	16.08	965.0	804.0	63	0.5	92.7
40	0.2	99.7	18.38	1103.0	919.0	62	0.1	92.9
45	0.3	100.0	20.68	1241.0	1034.0	61	0.2	93.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**93 %**

Climate Station ID: 6149387 *Years of Rainfall Data*: 34

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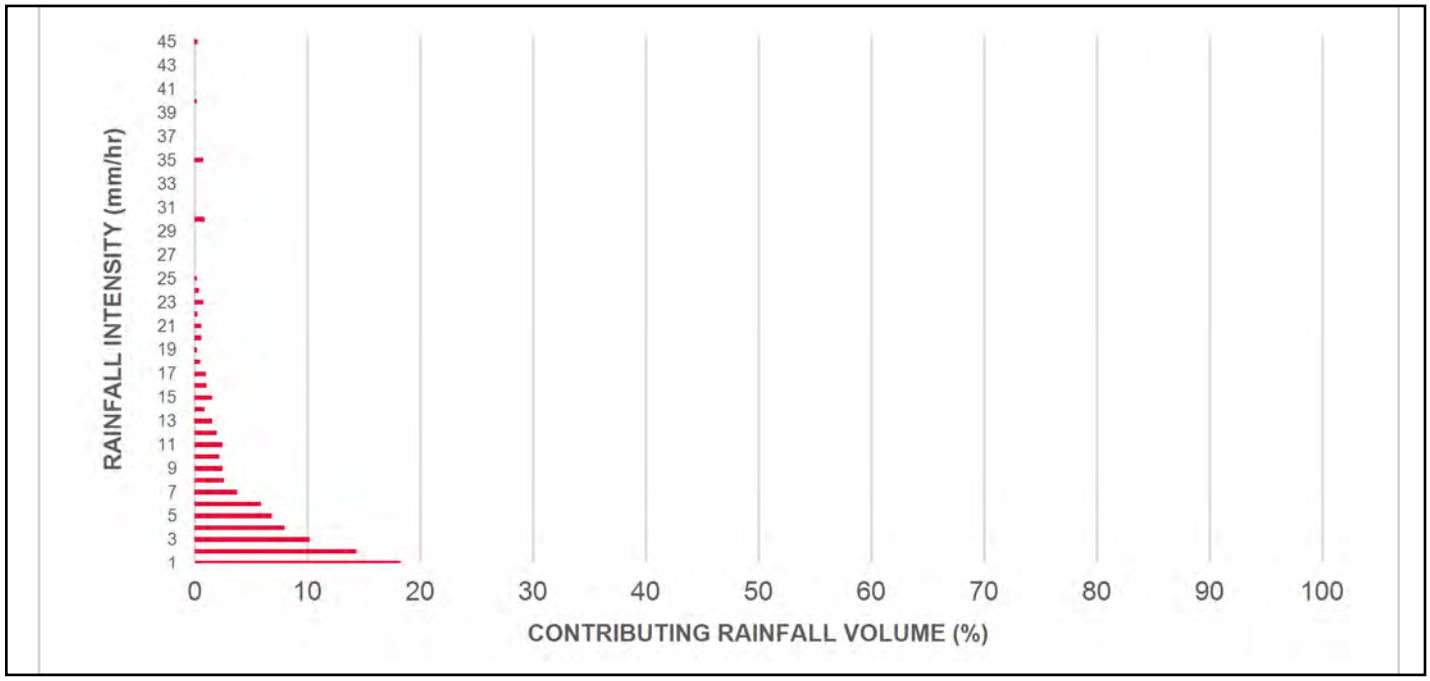
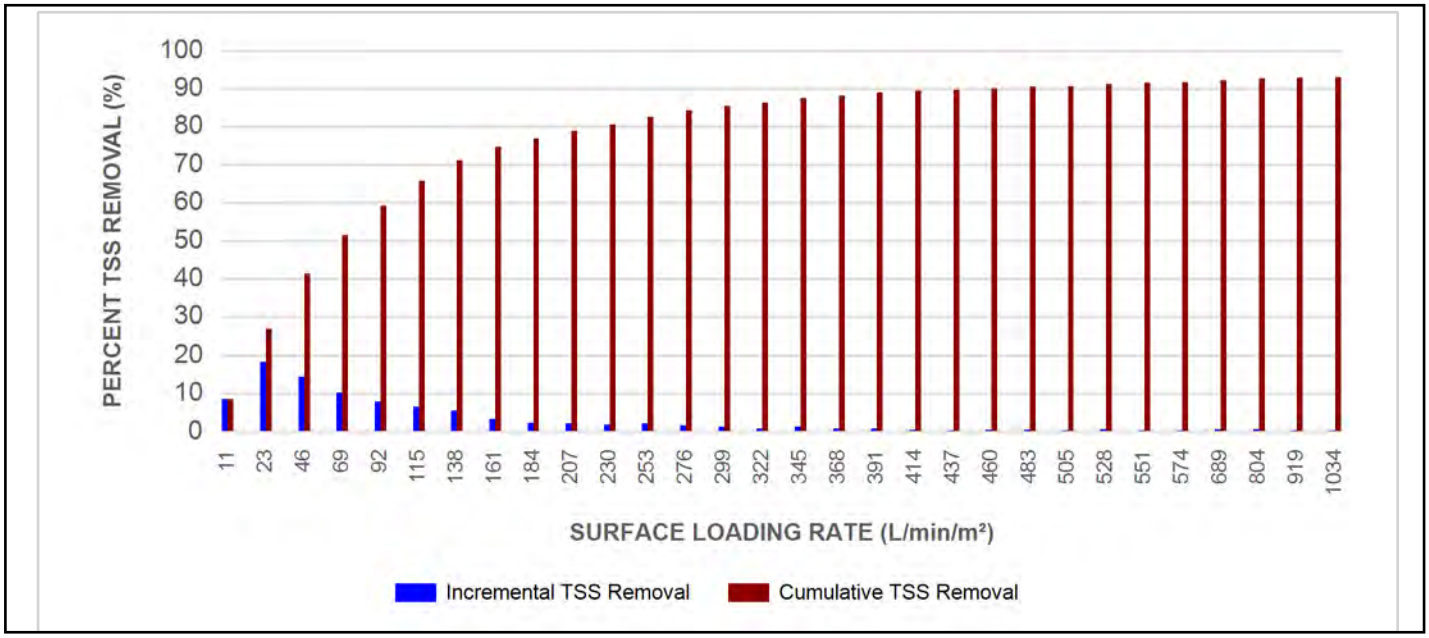
RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

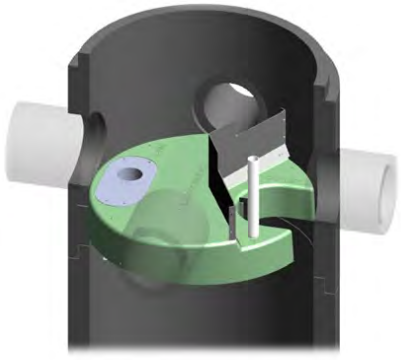
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

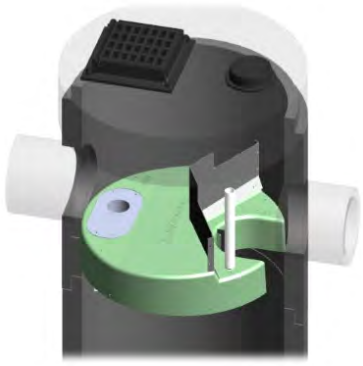
DESIGN FLEXIBILITY

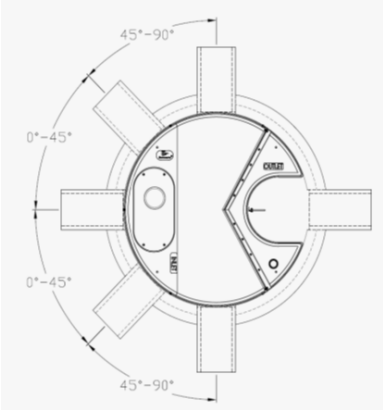
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada. Sizing shall also be determined by use of the sediment removal performance data derived from the ISO 14034 ETV third-party verified laboratory testing data from testing conducted in accordance with the Canadian ETV protocol Procedure for Laboratory Testing of Oil-Grit Separators, as follows:

3.2.1 Sediment removal efficiency for a given surface loading rate and its associated flow rate shall be based on sediment removal efficiency demonstrated at the seven (7) tested surface loading rates specified in the protocol, ranging 40 L/min/m^2 to 1400 L/min/m^2, and as stated in the ISO 14034 ETV Verification Statement for the OGS device.

3.2.2 Sediment removal efficiency for surface loading rates between 40 L/min/m^2 and 1400 L/min/m^2 shall be based on linear interpolation of data between consecutive tested surface loading rates.

3.2.3 Sediment removal efficiency for surface loading rates less than the lowest tested surface loading rate of 40 L/min/m^2 shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m^2. No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m^2.

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m^2 shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m^2, and shall be calculated using a simple proportioning formula, with 1400 L/min/m^2 in the numerator and the higher surface loading rate in the denominator, and multiplying the resulting fraction times the sediment removal efficiency at 1400 L/min/m^2.

The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

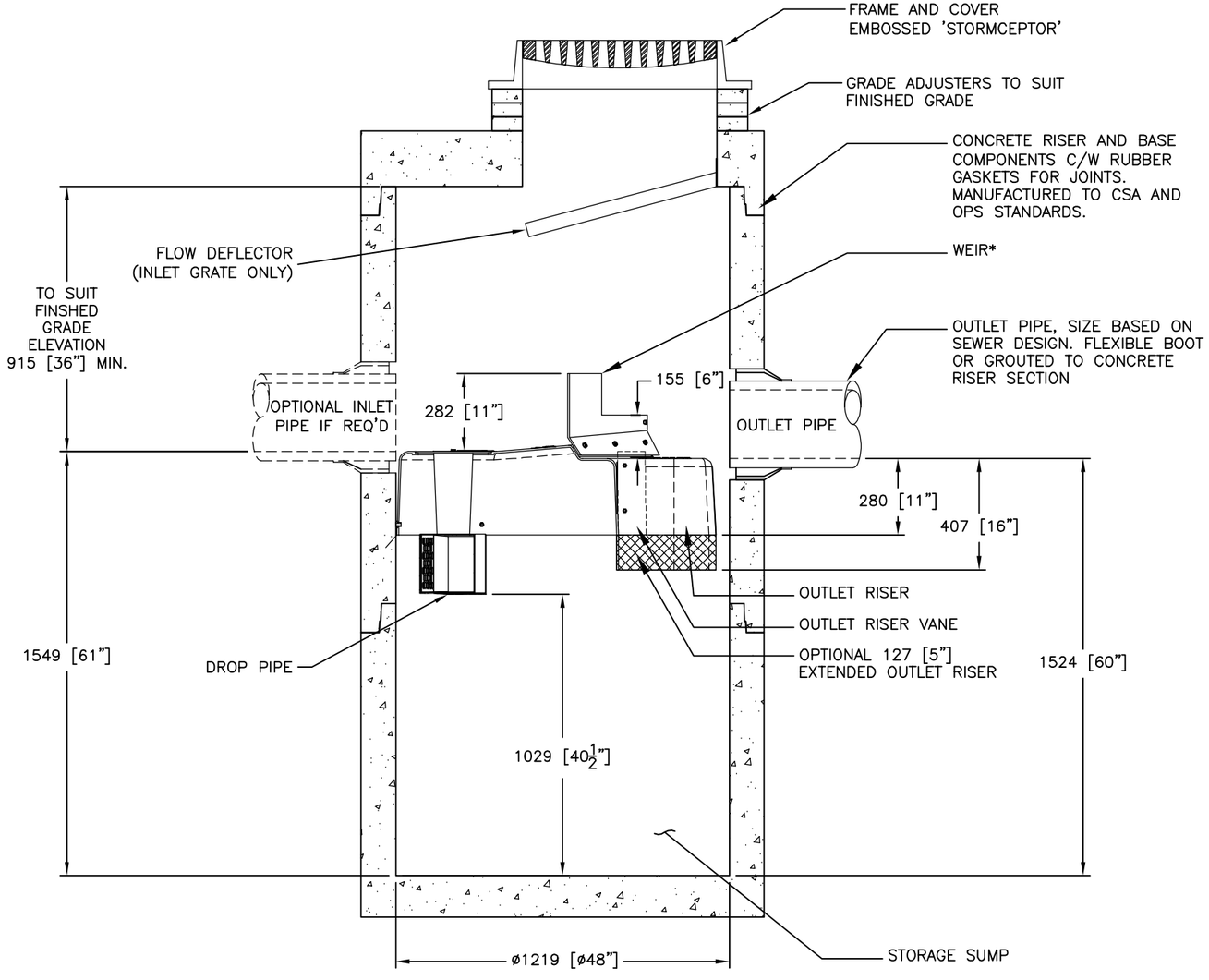
3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

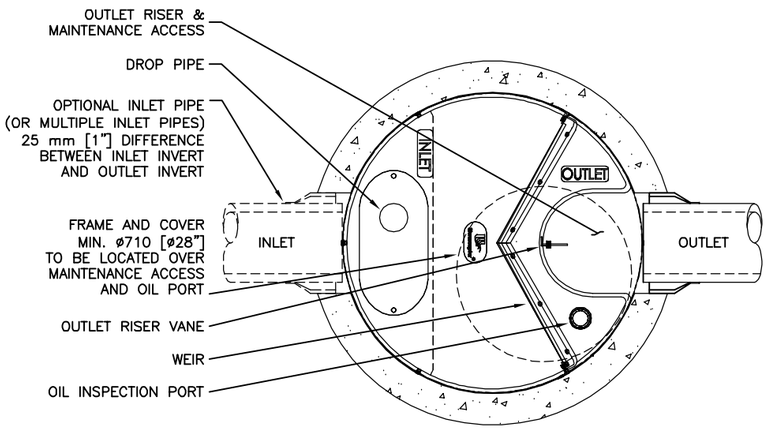
The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to

assess whether light liquids captured after a spill are effectively retained at high flow rates.

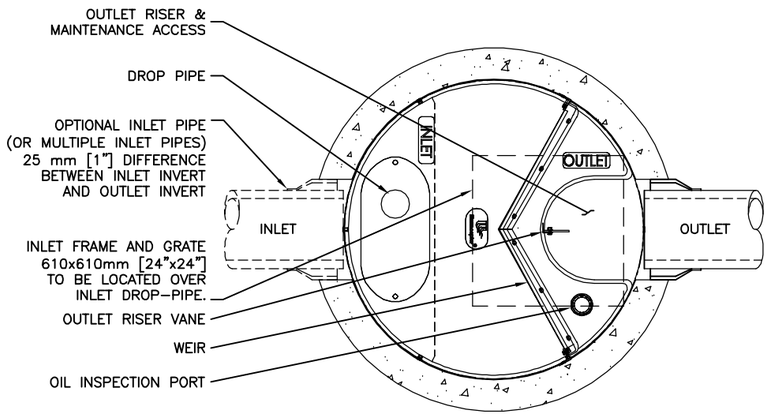
3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.** However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.



SECTION VIEW



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL STORMCEPTOR REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE (IF REQUIRED).

GENERAL NOTES:

* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m^2 (27.9 gpm/ft^2) FOR STORMCEPTOR EF4 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO4 (OIL CAPTURE CONFIGURATION). WEIR HEIGHT IS 150 mm (6 INCH) FOR EF04.

1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
2. STORMCEPTOR STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE STORMCEPTOR SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT THE DEVICE FROM CONSTRUCTION-RELATED EROSION RUNOFF.
E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

STANDARD DETAIL
NOT FOR CONSTRUCTION

SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL	EFO4
STRUCTURE ID	*
HYDROCARBON STORAGE REQ'D (L)	*
WATER QUALITY FLOW RATE (L/s)	*
PEAK FLOW RATE (L/s)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
DRAINAGE AREA (HA)	*
DRAINAGE AREA IMPERVIOUSNESS (%)	*

PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

MARK	DATE	REVISION DESCRIPTION	BY
1	6/8/18	UPDATES	JSK
0	5/26/17	INITIAL RELEASE	JSK

Stormceptor® EF

SCALE = NTS

imbrium®
407 FAIRVIEW DRIVE, WHITBY, ON, L1N 9A9
TF 800-565-4501 CA 416-800-9000 INTL +1-416-800-9000

DATE: 10/13/2017

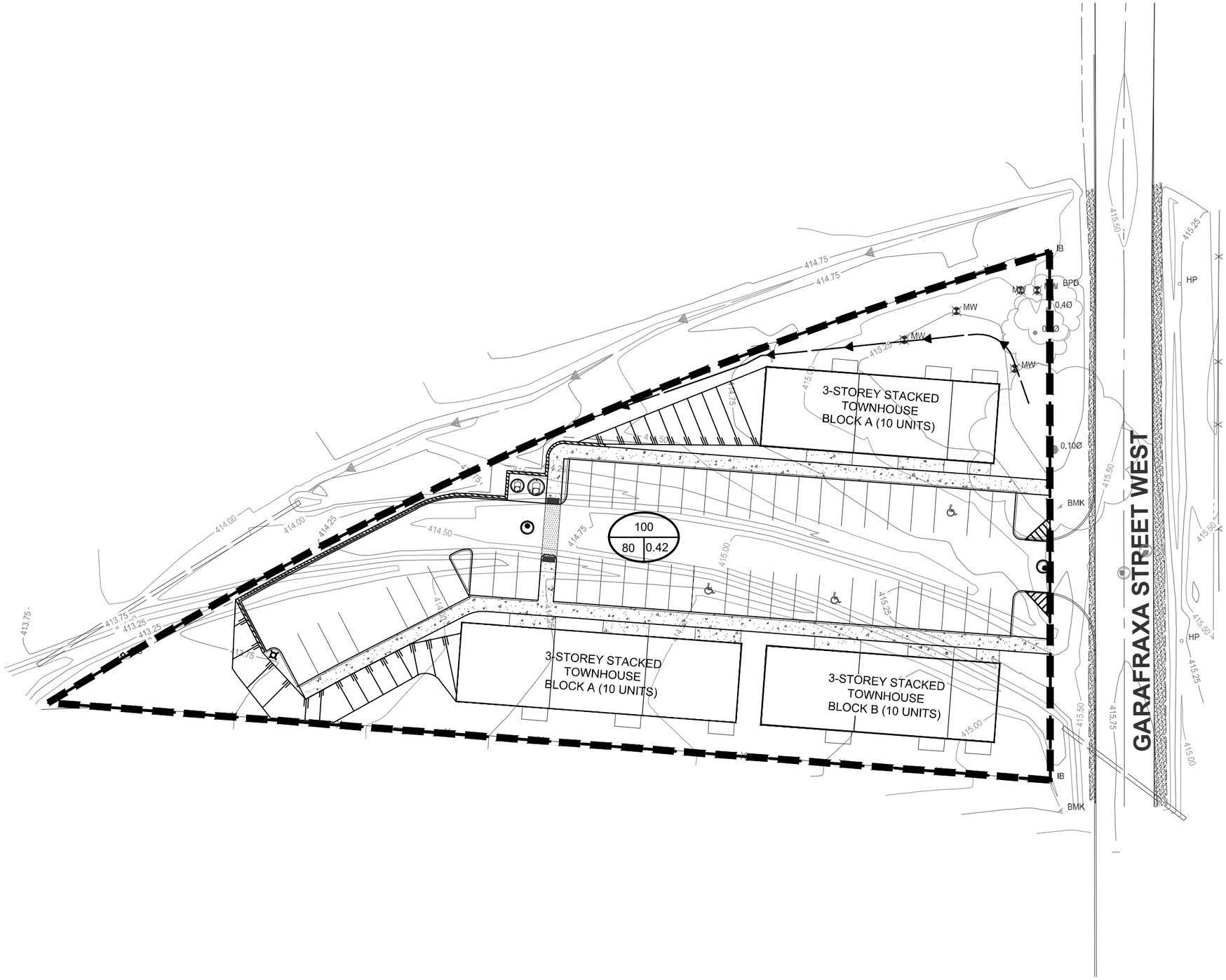
DESIGNED:	DRAWN:
JSK	JSK
CHECKED:	APPROVED:
BSF	SP
PROJECT No.:	SEQUENCE No.:
EFO4	*

SHEET: 1 OF 1

APPENDIX C:
Sanitary Sewer Design

Sanitary Sewer Drainage Area Plan
Sanitary Sewer Design Sheet

465 GARAFRAXA STREET WEST TOWNSHIP OF CENTRE WELLINGTON



N

LEGEND

PROP. SANITARY SEWER

DRAINAGE AREA BOUNDARY

201
25 | 0.21

CATCHMENT NUMBER

CATCHMENT AREA IN HECTARES

POPULATION

5 0 5 10 20
1:500 (m)

SANITARY SEWER DRAINAGE AREA PLAN

Figure No. 3

BluePlan ENGINEERING

422144
JANUARY 2023
Scale: 1:500 | NAD 1983 UTM Zone 17N

FILE:W:\Kitchener\422-2022\422144 - 465 Garafraxa Street West Fergus\Design Phase\Drawings\422144 - Design.dwg LAYOUT:San Plan
LAST SAVED BY:Earmstrong, 4/19/2023 2:30:05 PM PLOTTED BY:Erin Armstrong - GM BluePlan 4/19/2023 2:31:27 PM

q = average daily per capita flow (450 L/cap.d)
I = unit of peak extraneous flow (0.15 L/ha/s)
A = Tributary area in gross hectares
M = Peaking factor
Q(p) = peak population flow (L/s)
Q(i) = peak extraneous flow (L/s)
Q(d) = peak design flow

SANITARY SEWER DESIGN

TOWNSHIP OF CENTRE WELLINGTON

Sheet 1 of 1

$M = 1 + \frac{14}{4 + (P)^{1/2}}$ where P is population in 1000's

$Q(p) = \frac{PqM}{86.4}$ (L/s)

Q(i) = IA

Q(d) = Q(p) + Q(i) (L/s)

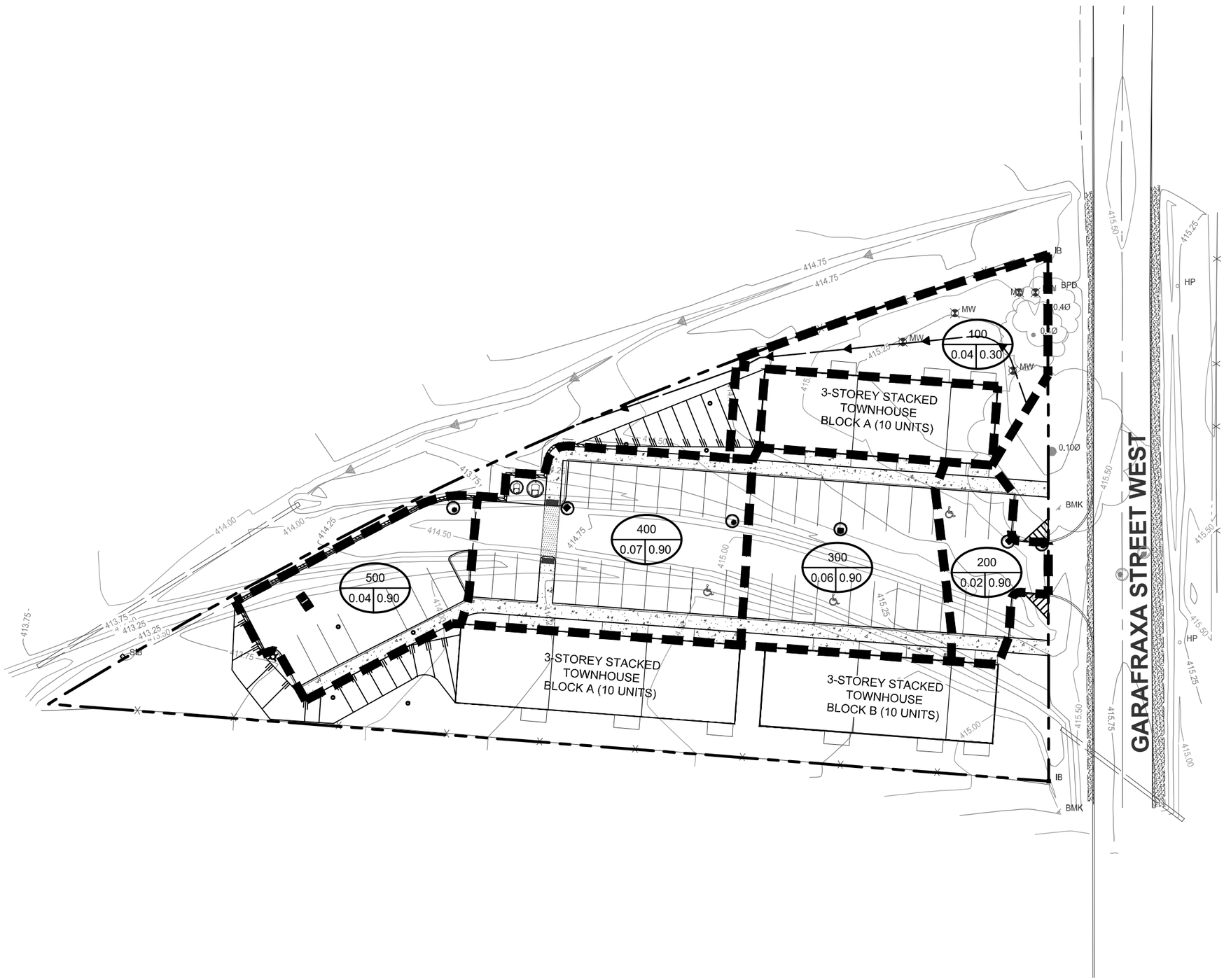
Location			Individual Population	Cumulative Population	Individual Area (ha)	Cumulative Area	Peaking Factor (M)	Pop. Flow Q(p) (L/s)	Peak Extraneous Flow Q(i) (L/s)	Peak Design Flow Q(d) (m3/s)	Proposed Sewer						
Street	From	To									Length (m)	Pipe Size (mm)	Type of Pipe	Grade %	Capacity (m^3/s)	Full Flow Velocity (m/s)	Actual velocity at Q(d)
	MH C	MH B	80	80	0.42	0.42	4.269	1.78	0.063	0.0018	61.8	200	0.013	0.60	0.0254	0.809	0.460

	Date Revised:	January 23, 2023	Project: 465 Garafraxa Street West
	Designed By:	PFG	G&M File: 422144
	Checked By:		

APPENDIX D:
Storm Sewer Design

Storm Sewer Drainage Area Plan
Storm Sewer Design Sheet

465 GARAFRAXA STREET WEST TOWNSHIP OF CENTRE WELLINGTON



N

LEGEND

- PROP. STORM SEWER
- DRAINAGE AREA BOUNDARY
- 201 / 0.30 | 0.30 — CATCHMENT NUMBER; RUN-OFF CO-EFFICIENT
- CATCHMENT AREA IN HECTARES

5 0 5 10 20

1:500 (m)

STORM SEWER DRAINAGE AREA PLAN

Figure No. 4

BluePlan ENGINEERING

422144
JANUARY 2023
Scale: 1:500 | NAD 1983 UTM Zone 17N

FILE:W:\Kitchener\422-2022\422144 - 465 Garafraxa Street West Fergus\Design Phase\Drawings\422144 - Design.dwg LAYOUT:Storm Plan
LAST SAVED BY:Earmstrong, 4/19/2023 2:30:05 PM PLOTTED BY:Erin Armstrong - GM BluePlan 4/19/2023 2:31:22 PM

Fergus Shand IDF Curves
A = 1459.072
B = 13.69
C = 0.85
Intensity = A / (t + B) ^ C

STORM SEWER DESIGN

5 Year Design

Township of Centre Wellington

Sheet 1 of 1

Location				Area (ha)	Runoff Coefficient	A x C	Cumulative A x C	TC (min.)	Intensity (mm/hr)	Flow (cms)	Proposed Sewer						
Reach No.	Catchment	From	To								Length (m)	Pipe Size (mm)	Type of Pipe	Grade %	Capacity (m^3/s)	Full Flow Velocity (m/s)	Time of Flow (min.)
	500	DCB.6	MH.5	0.04	0.90	0.04	0.04	10.00	99.01	0.010	21.0	300	0.013	0.50	0.07	0.97	0.36
	---	MH.5	CBMH.4	0.00	0.00	0.00	0.04	10.36	97.75	0.010	13.7	300	0.013	0.50	0.07	0.97	0.24
	400	CBMH.4	MH.8	0.07	0.90	0.06	0.10	10.60	96.94	0.027	19.8	600	0.013	0.50	0.43	1.54	0.21
	100	CB.7	MH.8	0.04	0.30	0.01	0.01	10.00	99.01	0.003	18.6	250	0.013	0.50	0.04	0.86	0.36
	---	MH.8	CBMH.3	0.00	0.00	0.00	0.11	10.36	97.75	0.030	13.0	600	0.013	0.50	0.43	1.54	0.14
	300	CBMH.3	CBMH.6	0.06	0.90	0.05	0.17	10.50	97.26	0.045	20.1	600	0.013	0.50	0.43	1.54	0.22
	200	CBMH.6	STC	0.02	0.90	0.02	0.18	10.72	96.52	0.049	4.1	300	0.013	0.50	0.07	0.97	0.07
	---	STC	MH.2	0.00	0.00	0.00	0.18	10.79	96.29	0.049	12.3	300	0.013	0.50	0.07	0.97	0.21

	Date: 06/08/23	Revised:	Project: 465 Garafraxa Road West
	Designed By: PFG	Revised By:	422144
	Checked By:	Checked By:	