2596 Carp Road
Ottawa, Ontario
Industrial Development
Servicing and Stormwater Management Report

Prepared For:

1384341 Ontario Ltd.

Prepared By:

Robinson Land Development

Our Project No. 18047
September 2018
Revised April 2019

Legal Notification

This report was prepared by **Robinson Land Development** for the account of **1384341 Ontario Ltd**.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Robinson Land Development** accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

TABLE OF CONTENTS

LEGAL NOTIFICATION I
1.0 INTRODUCTION 1
2.0 EXISTING CONDITIONS 1
3.0 DEVELOPMENT PROPOSAL 2
4.0 GRADING DESIGN 2
5.0 WATER SERVICING 2
6.0 SANITARY SERVICING 3
7.0 STORMWATER MANAGEMENT REQUIREMENTS 4
    7.1 General Requirements 4
    7.2 Quality Control 4
    7.3 Quality Storage Requirements 6
    7.4 Pre-Treatment 8
    7.5 Infiltration Rates 9
    7.6 Water Balance/ Stormwater Flows 11
    7.7 Temperature Control 13
    7.8 Monitoring Program 13
8.0 CULVERT SIZING 17
9.0 EROSION AND SEDIMENT CONTROL MEASURES 18
10.0 CONCLUSIONS 19

LIST OF TABLES

Table 1 – Bioretention Facility General Specifications 4
Table 2 – Quality Storage Volume Requirements 6
Table 3 – SWM1 Treatment Facility Provided Storage Volume 7
Table 4 – SWM2 Treatment Facility Provided Storage Volume 7
Table 5 – Quality Storage Volume Summary 8
Table 6 – Water Balance Assessment Summary 11
Table 7 – Stormwater Flows to Treatment Facilities 12
Table 8 – Total Available Storage Volume Summary 12
Table 9 – Bioretention Monitoring Activities 17
Table 10 – Culvert Design Summary 18

LIST OF FIGURES

Figure 1 – Key Plan .... following Page 1
Figure 2 – Existing Conditions 1
Figure 3 – Available Surface Storage .... Appendix B

LIST OF APPENDICES

Appendix A Site Plan (DWG. OSP-1) *prepared by Stantec Consulting Ltd.*
    Pre-Development Drainage Area Plan (DWG. 18047-PRE1)
    Grading Plan (DWG. 18047-GR1)
    Grading Plan (DWG. 18047-GR2)
    Grading Plan (DWG. 18047-GR3)
    Erosion and Sediment Control Plan (DWG. 18047-ESC1)
    Notes and Details (DWG. 18047-N1)
    Washout Pond Details

Table of Contents Con’t

Appendix B Runoff Coefficient Calculations
Inspection and Maintenance
Figure 3.67 – Recommended Regional 90% Percentile Volume Targets for Ontario
Stormwater Management Plan (DWG. 18047-SWM1)
Infiltration Rate Assessment *prepared by Golder Associates Ltd.*
Technical Memorandum *prepared by Golder Associated Ltd.*
Treatment Facility Flow Calculations
Figure 3 – Available Surface Storage Plan
Culvert Sizing Details

1.0 INTRODUCTION

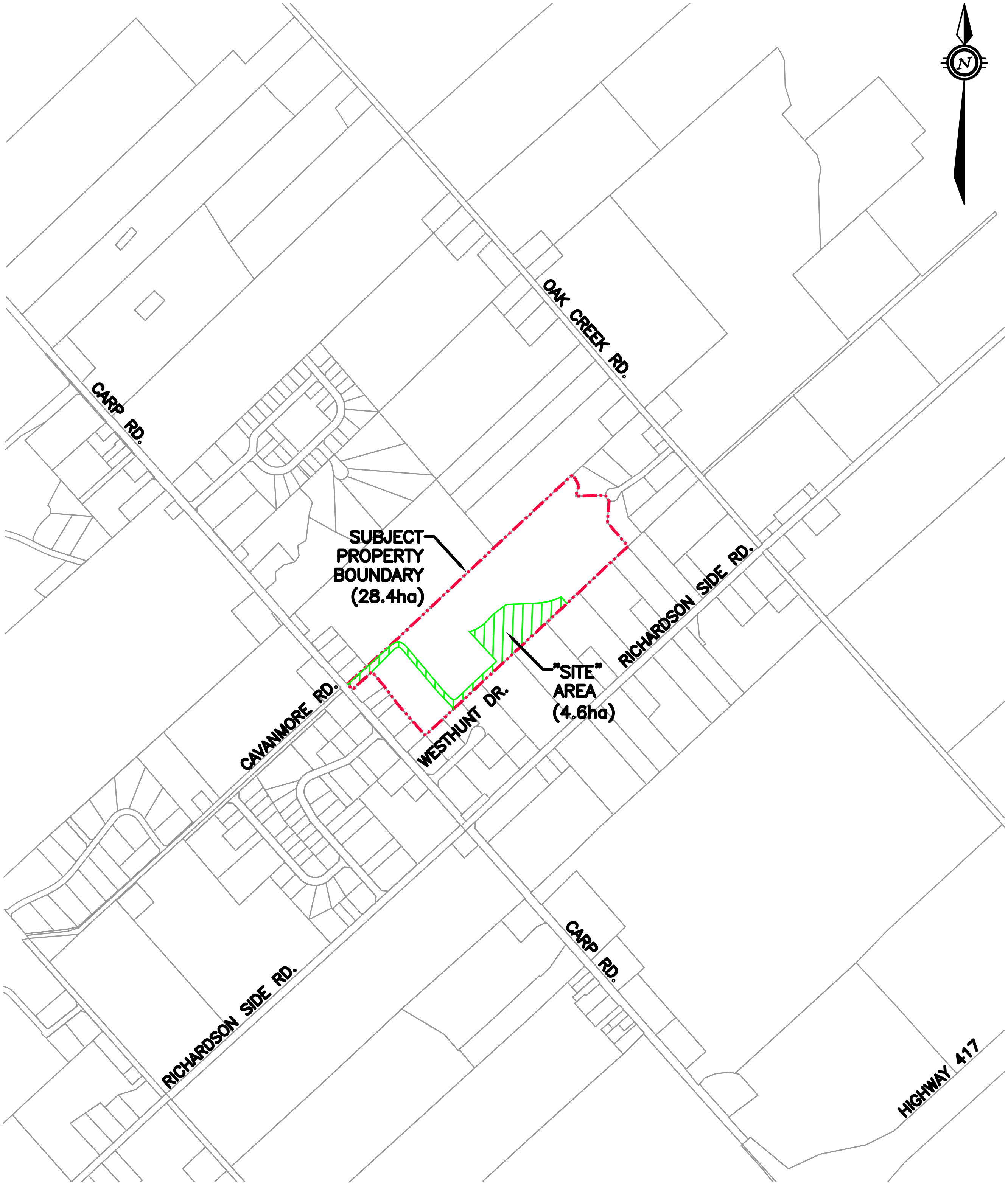
Robinson Land Development has been retained by 1384341 Ontario Ltd. to provide engineering services for a proposed industrial development located at 2596 Carp Road in the City of Ottawa (see **Figure 1 - Key Plan** following page 1). The crux of this report will focus on the stormwater management design required to develop a portion of the subject property and provide guidance for servicing of the proposed development area.

2.0 EXISTING CONDITIONS

The 28.4 hectare subject property (currently zoned for rural heavy industrial use under a zoning amendment with the City of Ottawa) is mainly undeveloped but areas of the property have been previously disturbed. An existing private gravel road provides access from Carp Road to existing buildings and structures located adjacent to Huntley Creek as well as granular stockpiles located on the property. The existing Huntley Creek crosses through the subject property from the northern property line towards the east. The subject property is bounded by undeveloped rural industrial lands to the north, developed rural industrial lands to the west and partially developed rural industrial lands to the south. The subject property is also bounded by a rural residential subdivision to the east which is zoned as rural countryside. The subject property contains existing ditches which convey stormwater runoff through the site under pre-development conditions.

The proposed portion of the subject property to be developed (approximately 4.6 hectares, herein referred to as the “site”) is bounded by Huntley Creek and woodlands to the north (refer to **Figure 1 – Key Plan**). The site is further constrained by a 30 metre meander belt setback and 15 metre setback along the south side of Huntley Creek. Refer to **Figure 2** below for an aerial view of the subject property and site under pre-development conditions.

Figure 2 - Existing Conditions



Robinson
Land Development

scale N.T.S.	ADDRESS: 2596 CARP ROAD, OTTAWA	project no. 18047
date 09/04/19	TITLE: KEY PLAN	FIG 1.0
drawn by BLM		

3.0 DEVELOPMENT PROPOSAL

As mentioned previously, approximately 4.6 hectares of the 28.4 hectare subject property is proposed to be developed. The development works, located outside of the setback constraints noted above, will include a concrete batching plant building, material stockpile areas and an area designated for employee parking. The existing building located on the south side of Huntley Creek is to remain and be used as an administration building for the plant. The site will be accessed by a new access road connection to Carp Road. The connection to Carp Road will be of similar location to the existing gravel road currently used for the property. Refer to the Site Plan (DWG. OSP-1) prepared by Stantec Consulting Ltd. in **Appendix A** for more details.

4.0 GRADING DESIGN

The existing topography of the site generally slopes towards the north-east to Huntley Creek. (Refer to the Pre-Development Drainage Area Plan, DWG.18047-PRE1, in **Appendix A**). The proposed grading design of the property will be as such to tie into existing elevations along the site boundaries and to not impede any existing drainage patterns. The developed area of the property designated for the concrete batching plant and associated features will be graded to sheet flow runoff towards the proposed LID stormwater management (SWM) facilities to receive quality control treatment (refer to **Section 7.2**).

The proposed washout pond (refer to location on the Site Plan in **Appendix A**) contains discharged slurry water from the concrete trucks. The washout pond is constructed such that a rainfall event would not cause the slurry water to overflow and enter the SWM facilities. A detailed description of how the washout pond functions and detailed plan and profiles of the unit are provided in **Appendix A**.

The proposed access roadway will be of rural cross section with gravel shoulders and roadside ditches. The roadside ditches will be grassed and convey stormwater runoff from the right-of-way (ROW) areas to the designated LID SWM treatment. Refer to the Grading Plans (DWG. 18047-GR1, GR2, GR3) in **Appendix A**. Note that all elevations provided on the plans and herein are geodetic.

5.0 WATER SERVICING

An existing drilled well is located on the subject property to the north of the existing building (proposed administration building) adjacent to Huntley Creek. The existing well currently provides water supply to the existing building and will continue to provide water supply for the proposed administration building following development of the site without modification.

Since no municipal watermains are located in the vicinity of the site, on-site drilled wells will be required to provide water supply for the proposed concrete batching plant. The proposed water supply for the plant will be groundwater taken from two on-site wells (noted as well TW5 and TW6 by Golder Associates Ltd.). The anticipated average pumping rate at the concrete batching plant is 283 L/min for 11-12 hours per day. The concrete batching plant will also have two 20,000 litre water storage tanks located within the plant building to supplement production.

Golder Associates Ltd. (Golder) conducted field tests to determine the water yield generated from the on-site wells. Golder's testing, documented in the Hydrogeology Investigation, Terrain Analysis and Impact Assessment, concluded that both on-site wells can each individually provide at least 340 L/min of water supply, which is greater than the anticipated average pumping rate of 283 L/min for 11-12 hours per day. The water yield of the existing well was also tested and concluded that it can provide at least 18 L/min, which is greater than the anticipated water use at the administration building of 2,700 L/day (1.9 L/min).

Given that the water yields determined by Golder are higher than the anticipated water demands, it was concluded in the Golder report that the proposed wells and existing well will provide adequate water supply to meet the water demands for the proposed site development. Refer to the proposed well and existing well locations shown on the Grading Plan (DWG. 18047-GR1) in **Appendix A**.

In the Hydrogeology Investigation, Terrain Analysis and Impact Assessment, Golder made the following conclusions regarding the quality of the on-site well water based on their analytical results.

> “Test wells TW5 and TW6 have exceedances of the ODWQS for chloride, hydrogen sulphide, TDS, hardness and total coliforms. However, the post-chlorination results at TW5 indicated that the total coliform, fecal coliform and E. coli concentrations were 0 ct/100 mL. Furthermore, the total coliform level at TW6 (5 ct/100 mL) was equal to the 5 ct/100 mL level used to evaluate non-disinfected private water supplies (as described in Procedure D-5-5; MOE, 1996). Therefore, TW5 and TW6 are considered to satisfy the ODWQS and Procedure D-5-5 for bacteriological parameters. Test wells TW5 and TW6 will be used to supply water for concrete production and for employees at the concrete plant.“
>
> “Based on the analytical results, the House Well has exceedances of the ODWQS for colour and TDS. It also had exceedances for total coliforms, fecal coliforms and E.coli. However, the post-chlorination results indicated that the total coliform, fecal coliform and E. coli concentrations were 0 ct/100 mL. Therefore, the House Well is considered to satisfy the ODWQS for bacteriological parameters. The House Well will be used to supply water to the future administration building.”

Fire suppression for the development will be provided by the local rural fire department. The proposed building will qualify for F-3 occupancy under the Ontario Building Code as the combustible content is expected to be less than 50 kg per square metre of floor area. The local Fire Chief has been contacted to provided comment on the development.

6.0 SANITARY SERVICING

An existing septic system is located on the subject property to the south-east of the existing building (proposed administration building) adjacent to Huntley Creek. The intention is for the existing septic system to remain in use without modification following development of the site and function to service the proposed administration building (existing building). The existing septic system was reviewed by GEMTEC Consulting Engineers and Scientists and it is our understanding that it is suitable to service the proposed administration building.

Further, it is our understanding that the existing septic system is not sufficient to treat the additional sewage flows from the proposed plant building. Therefore, a new on-site septic system is proposed to provide treatment of all sewage flows generated from the concrete batching plant. GEMTEC has designed a new on-site septic system (refer to the Preliminary Septic System Design, dated November 30, 2018, submitted under a separate cover) which has been sized to adequately treat all sewage flows generated from the concrete batching plant. The general locations of the existing and proposed septic systems are shown on the Grading Plan (DWG. 18047-GR1) in **Appendix A**.

7.0 STORMWATER MANAGEMENT REQUIREMENTS

7.1 General Requirements

A primary constraint of the subject property is the adjacent Huntley Creek. According to the Carp River Subwatershed Study, this section of Huntley Creek provides cold water aquatic habitat with local groundwater recharge. The type of fish habitat present is uncommon in the Ottawa area and as such requires a high level of protection.

The Mississippi Valley Conservation Authority (MVCA) have been consulted and they have requested that the following design details be implemented for the subject site:

- Provide enhanced (Level 1) quality control (80% TSS removal)
- Provide thermal temperature control to 25 degrees Celsius
- No new development should occur within the floodplain or meander belt hazards

7.2 Quality Control

As directed by the MVCA, enhanced (Level 1) quality control of stormwater runoff must be achieved for the developed portion of the subject property (i.e. the “site”). In order to meet the enhanced quality control requirement, two bioretention facilities will be utilized to capture stormwater runoff and provide quality cleansing. Bioretention temporarily stores, treats (filters) and infiltrates runoff. The proposed bioretention facilities will provide enhanced quality control via filtration of stormwater through the various treatment layers within the facility, if full infiltration of the runoff volume control target (RVC_T) is achieved (refer to **Section 7.3** for details). The typical elements of a bioretention facility and their general specifications are provided in **Table 1** below.

Table 1 - Bioretention Facility General Specifications

Material	Specification	Typical Depth (m)
Mulch Layer	Shredded hardwood bark mulch	0.075
Filter Media	• 85 to 88% sand • 8 to 12% soil fines • 3 to 5% organic matter • P-Index value between 10 to 30 ppm • Cationic exchange capacity greater than 10 meq/ 100g • pH between 5.5 to 7.5 • Infiltration rate greater than 25 mm/hr	0.50-1.25
Choke Layer	Washed 10 mm diameter clear stone	0.10
Gravel Storage Layer	Washed 50 mm diameter clear stone	0.30 MIN.
Underdrain (if required)	Perforated HDPE, minimum diameter of 100 mm	MIN. 0.10 above facility bottom

Mulch Layer:

A 75 mm deep layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth and pretreats runoff before it reaches the filter media layer. Shredded hardwood bark mulch creates an excellent surface cover for bioretention facilities, as it retains a significant amount of nitrogen and plays a key role in the removal of heavy metals, sediment and nutrients according to the Low Impact Development Stormwater Management Planning and Design Guide.

Filter Media:

The primary component of bioretention is the filter media which is a mixture of sand, fines and organic material. To ensure a consistent and homogeneous bed, filter media should come pre-mixed from an approved vendor. Pollutant removal benefits may be achieved in beds as shallow as 0.50 metres according to the Low Impact Development Stormwater Management Planning and Design Guide.

Choke Layer:

A 100 mm deep layer of 10 mm diameter washed clear stone should be placed on top of the coarse gravel storage layer as a choking layer separating it from the overlying filter media bed. The use of a stone choke layer is preferred over filter fabric as filter fabric has been found to be prone to clogging.

Gravel Storage Layer:

A minimum 300 mm depth of 50 mm diameter washed clear stone should be placed below the choke layer to provide quality storage volume.

Underdrain (if required):

A minimum 100 mm diameter perforated underdrain pipe may be placed in the gravel storage layer of the facility in order to provide a positive outlet for the facility in the event that infiltration is not being achieved. An underdrain is only needed where the native soil infiltration rate is less than 15 mm/hr. As per the Infiltration Rate Assessment (refer to **Appendix B**), prepared by Golder, the design infiltration rate calculated for the subject site is 22 mm/hr. Therefore, underdrains will not be required for the on-site bioretention facilities. In the event that the facilities are full, (i.e. not infiltrating stormwater into the native soils) runoff can be conveyed overland via the vegetated surface swale. Surface storage and subsurface storage are available to contain all storm events up to and including the 100 year design event (as requested by the Conservation Authority) within the system (i.e. without bypassing treatment) until full infiltration can be achieved (refer to **Section 7.6**).

Monitoring Well:

The monitoring well is a standpipe that extends from the bottom of the facility to above finished grade. The portion of the standpipe within the gravel layer is to be perforated. The monitoring well allows for measurement of the subsurface water level to track the drainage performance of the facility over time. Standpipes should be securely capped on both ends and remain undamaged.

Water Table:

A minimum 1.0 metre separation is recommended between the seasonally high water table and the bottom of the facility for best performance. Based on the field measurements recorded by Golder and summarized in the *Technical Memorandum – Response to City Comments on Robinson Land Development LID Design* (refer to **Appendix B**), over 1.0 metre of separation is provided between the bottom of the proposed bioretention facilities and the seasonally high water table. The seasonally high water table was interpreted to be at an elevation of 108.80 m and 108.50 m for the SWM1 and SWM2 treatment facilities respectively, which provides the recommended 1.0 metre separation from the bottom of the facilities.

7.3 Quality Storage Requirements

As per the Ministry of the Environment, Stormwater Management Planning and Design Manual (2003), enhanced level protection can be achieved using infiltration type stormwater management measures. **Table 3.2 – Water Quality Storage Requirements based on Receiving Waters** of the manual provides a required storage volume to meet enhanced level protection using infiltration measures based on the impervious level of the drainage area. However, even when using a highly impervious drainage area, the water quality storage requirements calculated using **Table 3.2** are approximately six times less (refer to **Table 2** below) than the quality storage requirements calculated using methods outlined by the Sustainable Technologies Evaluation Program (STEP). STEP is a multi-agency initiative developed to support broader implementation of sustainable technologies and practices within a Canadian context. The water component of STEP is a partnership between Toronto and Region Conservation Authority (TRCA), Credit Valley Conservation (CVC) and Lake Simcoe Region Conservation Authority (LSRCA). Since the methods outlined by STEP, to calculate water quality storage requirements, are much more stringent than using **Table 3.2**, STEP methods will be used to size the on-site bioretention facilities.

As outlined by STEP, the total quality storage volume required can be calculated using the following equation:

$V = RCV_T \times A_C$

Where: V = Required Storage Volume (m^3)
RCV_T = Runoff Volume Control Target for Site (m)
A_C = Catchment Area (m^2)

The runoff volume control target (RVC_T) for the subject site is in the range of 26 mm to 27 mm (0.026 m to 0.027 m) based on **Figure 3.67 – Recommended Regional 90% Percentile Volume Targets for Ontario** from the *Runoff Volume Control Targets for Ontario Final Report,* prepared by Aquafor Beech Ltd., for the Ministry of the Environment and Climate Change (MOECC). To be conservative, a runoff volume control target of 27 mm has been used to calculate the required storage volumes for the subject site. **Figure 3.67** has been provided in **Appendix B** for reference.

Using the above STEP equation, the required storage volumes have been calculated for each catchment area. Refer to the Stormwater Management Plan (DWG. 18047-SWM1) in **Appendix B**. The required storage volumes using STEP methods have been summarized in **Table 2** below. Required storage volumes using MOECP **Table 3.2** have also been provided for comparison.

Table 2 - Quality Storage Volume Requirements

Catchment Area ID	Catchment Area (m^2)	Required Storage Volume^{*1,*2} (m^3)	Required Storage Volume per MOECP Table 3.2^{*3} (m^3)
SWM1	17,482	472.0	70.6
SWM2	15,243	411.5	59.0

Notes:
1. Required Storage Volume = Runoff Volume Control Target x Catchment Area
2. Runoff Volume Control Target is 0.027m based on **Figure 3.67** provided in **Appendix B**.
3. Required storage volume using MOECP SWM Planning & Design Manual, Table 3.2.

The required quality storage volumes for each catchment area (summarized in **Table 2** above) will be provided within their respective bioretention facility (SWM1 facility and SWM2 facility). The facilities have been sized accordingly to meet the storage volume requirements. The quality storage volume is provided within the multiple layers of the bioretention facility. The depth of filter media and gravel storage layer may vary from facility to facility based on the storage requirements and the localized constraints. The provided storage volumes for the SWM1 facility and SWM2 facility have been summarized in **Table 3** and **Table 4** below.

Table 3 - SWM1 Treatment Facility Provided Storage Volume

Layer	Surface Area*2 (m^2)	Depth (m)	Void Ratio	Provided Storage Volume*1 (m^3)
Mulch	1275	0.075	0.7	66.9
Filter Media	1275	0.50	0.3	191.3
Choke Layer	1275	0.10	0.4	51.0
Gravel Storage Layer	1275	0.32	0.4	163.2
Total		1.00		472.4

Notes:
1. Provided Storage Volume = Surface Area x Depth x Void Ratio
2. Facility surface areas are calculated using AutoCAD Civil 3D. The facility areas are incrementally increased until the required storage volumes are achieved.

Table 4 - SWM2 Treatment Facility Provided Storage Volume

Layer	Surface Area*2 (m^2)	Depth (m)	Void Ratio	Provided Storage Volume*1 (m^3)
Mulch	875	0.075	0.7	45.9
Filter Media	875	0.90	0.3	236.3
Choke Layer	875	0.10	0.4	35.0
Gravel Storage Layer	875	0.30	0.4	105.0
Total		1.38		422.2

Notes:
1. Provided Storage Volume = Surface Area x Depth x Void Ratio
2. Facility surface areas are calculated using AutoCAD Civil 3D. The facility areas are incrementally increased until the required storage volumes are achieved.

As demonstrated in **Table 3** and **Table 4** above, the bioretention facilities for catchment areas SWM1 and SWM2 have provided adequate storage volume to meet the quality storage volume requirements. The required and provided storage volumes have been summarized in **Table 5** below.

Table 5 - Quality Storage Volume Summary

Catchment Area	Required Storage Volume (m^3)	Provided Storage Volume*1,*2 (m^3)
SWM1	472.0	472.4
SWM2	411.5	422.2

Notes:
1. Provided storage volumes are contained within the multiple layers of the bioretention facility.
2. Surface storage is not included within the total provided storage volume.

As demonstrated in **Table 5** above, the bioretention facilities for catchment areas SWM1 and SWM2 have provided adequate storage volume to meet the quality control storage volume requirements using methods outlined by STEP and the Aquafor Beech Report.

Under pre-development conditions, drainage from the western portion of the property (which is to remain primarily undeveloped aside from the access road construction), is conveyed to an existing on-site ditch (running parallel to the northern property boundary). To maintain the existing drainage patterns (as much as possible) and to tie into the existing elevations along the property boundary, the outlet for the proposed access road side ditches has been designed to outlet to the existing ditch within the subject property (at the 15 metre setback established by the Conservation Authority). As per the Geotechnical Investigation, prepared by GEMTEC, and the Infiltration Assessment, prepared by Golder, the depth from ground surface to the water table at this location is approximately 0.70 metres. Since the water table is close to the surface at this location, a bioretention facility to treat stormwater runoff is not suitable. Furthermore, due to the lack of head between an inlet and positive outlet, typical oil and grit separator treatment units are also not suitable for this location. Therefore, the runoff from catchment area SWM3 (access road and side ditches and not the concrete batching plant area) is proposed to receive quality treatment via a “treatment train” approach and LID measures. The stormwater runoff from the access road will be “treated” by the grassed roadside ditches, followed by a rip-rap treatment strip and then by a vegetated swale before discharging into the existing on-site ditch. Rock check dams will also be placed within the vegetated swale to slow the stormwater and promote infiltration. This “treatment train” approach will provide quality cleansing of the runoff by:

- Reducing flow velocities with low slopes within the roadside ditches and rock check dams within the vegetated swale, thereby, encouraging infiltration through the soil
- Utilizing the rip-rap strip as an energy dissipater and settling basin for larger sediments
- Promoting settling of sediments and cleansing of stormwater within the vegetation of the swale
- Re-vegetation of the swale within the meander belt setback area will be provided for additional shading of the stormwater runoff

7.4 Pre-Treatment

In addition to the quality treatment provided by the bioretention facilities themselves, the site’s stormwater runoff will also experience a measure of quality cleansing via pre-treatment methods. Along the outer perimeter of the concrete batching plant developed portion of the site, a 3.0 metre wide pre-treatment strip has been provided. The pre-treatment strip will be comprised of a 2.0 metre wide rip-rap strip along the interface with the gravel surface which will aid in reducing flow velocities. The rip-rap strip will also function as a “settling basin” for larger sediments. Stormwater runoff will then be conveyed from the 2.0 metre rip-rap strip to a 1.0 metre vegetated strip. The vegetated strip will be graded with a minor depression to further capture sediments contained within the runoff. The vegetation type will be specified by the Landscape Architect to achieve the desired function. The site’s runoff will be pre-treated by the rip-rap strip and vegetation strip prior to entering the bioretention facilities.

Rip-rap “check dams” have been placed at intervals along the 3.0 metre pre-treatment strip to direct flows toward the bioretention facilities and to ensure that there is no circumventing of the treatment system. Rip-rap check dams have also been placed inline with the vegetated swale/bioretention facilities to lower flow velocities and further encourage infiltration of stormwater.

For portions of the catchment area SWM1, the runoff will receive additional pre-treatment from a vegetated swale. The vegetated swale, which will covey runoff to the SWM1 facility, will provide additional pre-treatment of the stormwater by:

- Reducing flow velocities with low slopes and therefore encourage infiltration through the soil
- Promoting settling of sediments within the vegetation

7.5 Infiltration Rates

STEP also outlines methods to calculate the time to drain stormwater from a bioretention facility. In the Ottawa area, the acceptable time to drain (via infiltration) is 24 to 48 hours. Using STEP methods, the time to drain is calculated using the following equation:

Time to drain = (Vr/f’) x (Ap/P) x ln([ds + (Ap/P)] / (Ap/P))

Where:

Vr = void ratio of the media
ds = depth of facility (m)
f’ = design infiltration rate (m/hr)
Ap = area of the infiltration practice (m^2)
P = perimeter of the infiltration practice (m)

Under typical conditions (i.e. full infiltration of stormwater is being achieved and no surface ponding is occurring), the estimated time to drain for the SWM1 facility has been calculated as follows:

Given:

Vr = 0.40
ds = 1.00 m
f’ = 0.011 mm/hr (refer to Infiltration Rate Assessment by Golder in **Appendix B**)
Ap = 1275 m^2
P = 378 m
Ap/ P = 1275 m^2 / 378 m = 3.4 m

SWM1 Time to drain = (0.40 / 0.011) x (3.4) x ln([1.00 + 3.4] / 3.4)

SWM1 Time to drain = 31.7 hours

Under typical conditions (i.e. full infiltration of stormwater is being achieved and no surface ponding is occurring), the estimated time to drain for the SWM2 facility has been calculated as follows:

Given:

Vr = 0.40
ds = 1.38 m
f' = 0.017 mm/hr (refer to Infiltration Rate Assessment by Golder in **Appendix B**)
Ap = 875 m^2
P = 304.5 m

Ap/ P = 875 m^2 / 304.5 m = 2.9 m

SWM2 Time to drain = (0.40 / 0.017) x (2.9) x ln([1.38 + 2.9] / 2.9)

SWM2 Time to drain = 26.4 hours

In the event that full infiltration of stormwater is not being achieved and surface ponding is occurring, the time to drain for the facilities will be increased. The estimated time to drain for the SWM1 facility, under maximum surface ponding conditions, has been calculated as follows:

Given:

Vr = 0.40
ds = 1.00 m + 0.20 m (surface ponding) = 1.20 m
f' = 0.011 mm/hr (refer to Infiltration Rate Assessment by Golder in **Appendix B**)
Ap = 1275 m^2
P = 378 m
Ap/ P = 1275 m^2 / 378 m = 3.4 m

SWM1 (Max. Ponding) Time to drain = (0.40 / 0.011) x (3.4) x ln([1.20 + 3.4] / 3.4)

SWM1 (Max. Ponding) Time to drain = 37.2 hours

The estimated time to drain for the SWM2 facility, under maximum surface ponding conditions, has been calculated as follows:

Given:

Vr = 0.40
ds = 1.38 m + 0.15 m (surface ponding) = 1.53 m
f' = 0.017 mm/hr (refer to Infiltration Rate Assessment by Golder in **Appendix B**)
Ap = 875 m^2
P = 304.5 m

Ap/ P = 875 m^2 / 304.5 m = 2.9 m

SWM2 (Max. Ponding) Time to drain = (0.40 / 0.017) x (2.9) x ln([1.53 + 2.9] / 2.9)

SWM2 (Max. Ponding) Time to drain = 28.8 hours

As calculated above, the times to drain for the SWM1 facility and SWM2 facility are 31.7 hours and 26.4 hours respectively. Under maximum surface ponding conditions, the times to drain for the SWM1 facility and SWM2 facility are 37.2 hours and 28.8 hours respectively. It should be noted that the equation does not consider lateral infiltration through the sides of the facilities. Given that the times to drain for both facilities are within the acceptable time of 24 to 48 hours, it has been shown that the native soils at each facility location are suitable for the type of quality treatment proposed.

7.6 Water Balance/ Stormwater Flows

A water balance assessment for the existing and proposed conditions was conducted by Golder Associates Ltd. (Golder) and detailed in the *Hydrogeology Investigation, Terrain Analysis and Impact Assessment* (available under a separate cover). Based on the results of the water balance assessment, it was concluded by Golder that the average annual infiltration is estimated to increase by 30 percent and the average annual runoff volume increase by 3 percent from pre-development to mitigated post-development conditions. A summary of the water balance results has been provided in **Table 6** below.

Table 6 – Water Balance Assessment Summary

Development Condition	Estimated Average Annual Runoff (m^3)	Estimated Annual Infiltration (m^3)
Pre-Development	44,748	51,293
Post-Development	69,793	42,969
Mitigated Post-Development^{*2}	46,281	66,482

Notes:
1. Results were determined by Golder, detailed in the Hydrogeology Investigation, Terrain Analysis and Impact Assessment (available under a separate cover).
2. Mitigated post-development condition takes into consideration the use of on-site bioretention facilities.

Stormwater quantity control is not a requirement for the subject site and therefore will not be discussed within this report. However, the stormwater flows which are conveyed to the bioretention facilities and the impacts on the treatment systems will be discussed. If full infiltration of stormwater is not being achieved, the stormwater flows will be conveyed by the major overland flow route (vegetated swales) to the outlet. The flows being conveyed overland will receive cleansing by the 3.0 metre pre-treatment strip and the surface vegetation. The side slopes of the facilities have been designed to provide a freeboard of 0.20 metres before overtopping. At the downstream end of the system, the side slopes have been designed to a constant elevation to provide a “level spreader” flow if overtopping does occur. To analyze the worst-case condition (i.e. groundwater table at surface or soils are fully saturated), a release rate of zero has been assumed, however, it should be noted that this condition is highly unlikely to occur as over 1.0 metre of separation is provided between the bottom of the facilities and the seasonally high water table (refer to Technical Memorandum prepared by Golder in **Appendix B**). The stormwater flows for the 2 year, 5 year and 100 year design events and the corresponding required storage volumes (assuming zero infiltration) have been summarized in **Table 7** below.

Table 7 – Stormwater Flows to Treatment Facilities

Return Period	Stormwater Flow (L/s)*1	Required Storage Volume (m^3)*3
2 Year	399.7	383.7
5 Year	540.4	518.8
100 Year	1154.8*2	1108.7

Notes:
1. Flows were calculated using the Rational Method and a time of concentration estimated using the Uplands Method for the longest flow path in the contributing drainage area to the bioretention facilities. Refer to **Appendix B**.
2. The 100 year stormwater flow is calculated using a C-value increased by 25 percent as per City of Ottawa Standards.
3. Required storage volume assumes zero infiltration is occurring.

To ensure stormwater runoff does not bypass the system (i.e. pass through untreated) if full infiltration (into the surrounding soils) is not being achieved, surface storage has been provided to contain the runoff until infiltration can occur. Surface storage is provided at the downstream end of the facilities (contained by the side slopes) and at two locations upstream (contained by inline check dams). It should be noted that because temperature control is a requirement for the subject site (refer to **Section 7.7**), surface storage is only intended for rare occurrences if infiltration is limited. Any runoff contained on the surface would be "cooled" by the underlying soils when infiltration eventually does occur. In addition to surface storage, subsurface storage, within the bioretention facilities, is available. Based on the water table measurements provided by Golder (refer to Technical Memorandum in **Appendix B**), over 1.0 metre of separation is provided between the bottom of the facilities and the seasonally high water table. Therefore, it can be safely assumed that even during a period of abnormally high water table (i.e. above the seasonally high groundwater table) that the full storage within the facilities would be available. The total available storage volumes (surface and subsurface) have been summarized in **Table 8** below.

Table 8 – Total Available Storage Volume Summary

Available Surface Storage Volume (m^3)*1	Available Sub-Surface Storage Volume (m^3)*2	Total Available Storage Volume (m^3)
272.8	894.6	1167.7

Notes:
1. Available surface storage volumes are calculated using AutoCAD Civil 3D by Autodesk.
2. Available subsurface storage volumes are a summation of the available storage volumes contained only within the multiple layers of the facilities. Refer to **Table 3** and **Table 4** above.

As indicated in **Table 8** above, 272.8 m^3 of surface storage volume is available (refer to **Fig. 3 - Available Surface Storage Plan** in **Appendix B**). Assuming an abnormally high water table, which does not exceed the seasonally high water table by over 1.0 metre, an additional 894.6 m^3 of subsurface storage volume is available, for a total available storage volume of 1167.7 m^3. As shown in **Table 8** above, the system has provided adequate storage volume to contain the 2 year, 5 year and 100 year design storm event required storage volumes (assuming zero infiltration into the surrounding soils and abnormally high water table). Given that quantity control of stormwater runoff is not a requirement for the subject site, it has been demonstrated that the proposed bioretention facilities will sufficiently mitigate any impacts of storm events occurring during periods of the seasonally high water table by providing surface and sub-surface storage volume of runoff until infiltration can be achieved.

7.7 Temperature Control

As noted in **Section 7.1** above, the MVCA has stated that thermal temperature control to 25 degrees Celsius is required for the subject site due to the proximity to Huntley Creek. The following design features have been implemented in order to meet the temperature control requirements:

- Utilization of bioretention facilities over pond facilities limits the opportunity to heat up the stormwater by reducing the amount of ponding water at the surface.
- The layers of the bioretention facilities (specifically the gravel storage layer) promotes the cooling of stormwater prior to infiltrating into the native soils.
- Plantings contained within the vegetated swales and bioretention facilities provide a degree of shading which limits the opportunity to heat up the stormwater.

7.8 Monitoring Program

To ensure the long-term performance of the on-site bioretention facilities, a monitoring program is recommended to be implemented following the commissioning of the facilities. The objectives of the monitoring program will be to assess the performance of each facility, specifically:

- Observe plant health, survivability and develop or confirm plant maintenance requirements.
- Observe infiltration characteristics over various seasons and storm events.
- Verify general drawdown times.
- Development of facility specific routine maintenance activities.

The monitoring program shall begin following the construction and commissioning of the bioretention facilities. However, pre-construction sampling shall be obtained to establish a baseline condition for the site and the adjacent Huntley Creek. The sampling should determine, at minimum, baseline levels of the following:

- Total suspended solids (TSS)
- Temperature
- pH
- Conductivity
- Metal concentrations

The pre-construction sampling should be taken from the on-site monitoring well (denoted as BH18-6 on **Figure 4 – Field Investigation Locations**, prepared by Golder, for the Hydrogeological Investigation) and upstream and downstream of Huntley Creek. Further details regarding the pre-construction sampling are provided under the sampling and testing section below.

Additional monitoring will be required in the first two years to ensure the facilities are functioning as intended. The monitoring program will include the following key four elements:

- Visual inspections and photo logs
- Maintenance monitoring
- Water level monitoring
- Sampling and testing of influent and effluent

Visual Inspections and Photo Logs:

Visual inspections will involve inspecting each bioretention facility for evidence of malfunction or deviation from the intended function. During the first two years following construction, visual inspections will consist of a minimum of one inspection every two months, from April to November, and twice over the winter period from December to March. During the April to November period, at minimum two visual inspections shall be conducted immediately after a rainfall event of 25 mm or higher to observe inflow function and to observe surface ponding and drawdown. Following the first two years, visual inspections should be conducted in the spring and fall of each year. In addition, each facility shall be inspected and photo logged immediately following major rainfall events (equal to or greater than the 100 year design storm) at least once (if available). At each site inspection, the following items are to be documented:

- Sediment accumulation
- Type and volume of accumulated debris (i.e. trash)
- Evidence of flow bypass (i.e. overtopping)
- Presence of ponded water at the facility surface beyond the specified time to drain following a rainfall event.
- Plant health (i.e. plant vigour, colour, necrosis, bare soil areas)

The documented visual inspections and photo logs will be used as a comparison assessment tool for the bioretention facilities from inspection to inspection and year to year. Photographs shall be taken at the same vantage point for comparison purposes.

Maintenance Monitoring:

Bioretention facilities require routine maintenance of the landscaping as well as other periodic inspection for less frequent maintenance needs. During the visual inspection periods, noted above, the facilities should be inspected for vegetation density, damage by foot or vehicular traffic, channelization and accumulation of debris, trash and sediment. Maintenance activities include reapplying mulch, pruning, weeding, replacing dead vegetation and repairing eroded areas as needed. Some of the most common maintenance procedures are detailed below:

General

- Sediment depth should be measured during cleaning to estimate the accumulation rate and optimize frequency of maintenance.

Pre-Treatment Areas

- Trash, debris and sediment should be removed from the contributing drainage area biannually to quarterly.
- Trash, debris and sediment should be removed from the pre-treatment (3.0 metre pre-treatment strip) areas annually to biannually or when the sumps are half full (approximately 5 cm).

Filter Bed

- Side slopes of the facilities should be inspected for erosion.

- Inspect filter bed for standing water, barren/eroded areas, sinkholes or animal burrows.
- Remove trash from the filter bed biannually to quarterly.
- Rake filter bed regularly to redistribute mulch and prevent sediment crusts.
- Maintain 75 mm of mulch cover to prevent weed growth and soil erosion.
- Repair sunken areas when greater than 10 cm deep and barren/eroded areas when greater than 30 cm long.
- Remove sediment when greater than 5 cm deep or time to drain water ponded on the surface exceeds 48 hours.
- Removal of sediment from the filter bed surface should be done with a rake and shovel, or vacuum equipment to minimize plant disturbance. If a small excavator is to be used, keep it off the facility footprint to avoid damage to side slopes and over-compaction of the filter media.
- To avoid over-compaction of the filter media soil, any maintenance tasks involving vehicle or foot traffic on the filter bed should not be performed during wet weather.
- Grades should be restored with filter media that meets the approved design specifications.
- Replace stone, mulch and plant cover as required.

Vegetation

- In the first two months water plantings frequently (as recommended by the Landscape Architect) and as needed (e.g. bimonthly) over the remainder of the first growing season.
- Remove weeds and undesirable plants biannually to quarterly.
- Replace dead plantings annually to achieve 80 percent cover by the third growing season.
- Never apply chemical fertilizers or herbicides.

Additional inspection and maintenance details have been provided in **Appendix B**.

Water Level Monitoring:

Water level recordings shall be taken from the monitoring wells at each facility using a measuring device (i.e. tape measure) to observe the drainage performance. During the April to November period, at minimum two water level recordings shall be conducted immediately after and 48 hours after a rainfall event of 25 mm or higher. If water is still observed after 48 hours, and no additional rainfall events have occurred, water level recordings should be taken every 24 hours until the water has subsided. At minimum one water level recording shall be conducted during the winter period from December to March.

Sampling and testing:

As recommended by the MVCA, it should be demonstrated that the bioretention facilities are providing enhanced quality control (80% TSS removal), thermal control of 25 degrees Celsius and that the treated water is not adversely affecting the water chemistry (pH, conductivity, metal concentrations, TSS, etc.) of the adjacent Huntley Creek.

Enhanced Quality Control (80% TSS removal)

In order to determine if enhanced quality control of the site’s runoff is being achieved, water samples of the influent and effluent must be observed. A sample of the site’s runoff shall be taken prior to it reaching the designated pre-treatment and bioretention areas. This sample should be compared to samples of the site’s runoff taken from the proposed monitoring wells located within the bioretention facilities. The samples taken from the monitoring wells should demonstrate that a minimum of 80 percent TSS removal has been achieved. At minimum one test per facility should be conducted twice per year for a period of two years following the commissioning of the facilities.

Thermal Control of 25 Degrees Celsius and Water Chemistry of Huntley Creek

Prior to any on-site construction works, on-site water samples and water samples in Huntley Creek must be taken to be used as a baseline for comparison. Following the commissioning of the site (and bioretention facilities), regular sampling of the water on-site and in Huntley Creek must be taken to observe any adverse impacts to the water chemistry (pH, conductivity metal concentrations, TSS, etc.) in comparison to the baseline samples. Water samples shall be taken on-site and in Huntley Creek, upstream and downstream of the site. The samples should be taken twice per year (winter and summer), for a period of five years, to monitor the impacts, if any, to the watercourse.

Corrective Actions:

In the event that the facilities appear to not be functioning as designed, corrective actions may be required to improve the facility performance. Possible correction actions include:

- Remove dead and diseased plants
- Add reinforcement planting
- Apply aeration or deep tiling
- Remove and replace the top 75 mm of the bioretention media
- Replace full depth of bioretention media
- Additional testing (i.e. infiltration test, only if water is shown to be present after 48 hours of a 25 mm storm event)

Infiltration testing may be conducted to determine the field saturated hydraulic conductivity using industry or manufacture approved methodologies and equipment. Recommended approaches include the double ring infiltrometer, Philip-Dunne infiltrometer or the Guelph permeameter. In-situ infiltration testing must be performed in non-saturated (minimum of 48 hours of no rain preceding testing) and unfrozen soil conditions. A minimum of one test per facility would be required to confirm that the infiltration rates, as prescribed in the Infiltration Rate Assessment (**Appendix B**), prepared by Golder, are being achieved.

A summary of the monitoring activities detailed above have been provided in **Table 9** below.

Table 9 – Bioretention Monitoring Activities

Monitoring Activity	Monitoring Period	Monitoring Frequency
Visual Inspection and Photo Logs	Year 1-2	• April to November – once every two months (total 4 times) • December to March – twice • After >25mm storm event – two events only • After major event (100 year design storm) – one event (if available)
	Year 3+	• Spring and fall – once each • After major event (100 year design storm) – one event (if available)
Maintenance Monitoring	Year 1-2	• April to November – once every two months (total 4 times) • December to March – twice • After >25mm storm event – two events • After major event (100 year design storm) – one event (if available)
	Year 3+	• Spring and fall – once each • After major event (100 year design storm) – one event (if available)
Water Level Monitoring	Year 1-2	April to November: • After >25mm storm event – Immediately after and 48 hours after - twice • After major event (100 year design storm) – Immediately after and 48 hours after – one event (if available) • December to March - once
	Year 3+	April to November: • After >25mm storm event – Immediately after and 48 hours after - twice • After major event (100 year design storm) – Immediately after and 48 hours after – one event (if available) • December to March - once
Water Sampling for TSS Removal	Year 1-2	• Twice per year, per facility, for two years • Sample influent and effluent
Water Sampling for Water Chemistry	Year 1-5	• Twice per year (winter and summer), for five years

8.0 CULVERT SIZING

The proposed access road will have three culverts in order to convey stormwater runoff from the roadside ditches to the on-site existing ditch. As per MTO design guidelines, the minimum road crossing culvert size is 600 mm in diameter. Although the on-site roadway is considered to be an “access road”, 600 mm diameter culverts have been specified for the two road crossing locations. A 500 mm diameter culvert has been specified for the inline culvert which conveys stormwater through the access to the proposed Enbridge gas station. The contributing drainage areas were used to assess the culverts using a 10 year design storm frequency. Time of concentration values for each contributing drainage area were estimated using the Uplands Method. Using MTO culvert design charts, the maximum capacities of the culverts were determined based on the proposed culvert diameters and the maximum heads (overtopping spill elevation of the centerline of the access road minus the invert elevation). The culvert design charts determined that the three culverts are all inlet controlled with maximum capacities of 700 L/s and 500 L/s for the 600 mm diameter and 500 mm diameter culverts respectively.

Under ideal circumstances, the culverts would not be overtopped during the 10 year design storm event. Using MTO culvert design charts, the minimum culvert diameter to avoid overtopping of the culvert (i.e. water does not exceed the obvert elevation) was determined based on the 10 year peak flow (calculated using the Rational Method) and the head (obvert elevation minus the invert elevation). The culvert design charts determined that the minimum required culvert diameter for the culvert located at STA 0+222.49 is 550 mm and <300 mm for the culverts located at STA 0+105.64 and STA 0+687.11. The proposed culvert design details have been summarized in **Table 10** below. Additional culvert sizing details, such as runoff coefficient calculations, time of concentration calculations and drainage area plans have been provided in **Appendix B**.

Table 10 – Culvert Design Summary

Station	10 Year Peak Flow*1 (L/s)	Drainage Area (ha)	Proposed Culvert Diameter (mm)	Minimum Required Culvert Diameter*3 (mm)	Maximum Culvert Capacity*4 (L/s)
0+105.64	36.3	0.18	500	<300	500
0+222.49	250.6	4.24	600	550	700
0+687.11	28.8	0.14	600	<300	700

Notes:
1. Peak flows are calculated using the Rational Method. Refer to **Appendix B**.
2. Time of concentration values were estimated using the Uplands Method. Refer to **Appendix B**.
3. Minimum required culvert diameter determined using MTO culvert design charts. Refer to **Appendix B**.
4. Culvert capacity determined using MTO culvert design charts. Refer to **Appendix B**.

As shown in **Table 10** above, stormwater flows from the contributing drainage areas can be adequately conveyed by the proposed 500 mm diameter and 600 mm diameter culverts for the 10 year design storm event.

9.0 EROSION AND SEDIMENT CONTROL MEASURES

Temporary erosion and sediment control measures are to be implemented and maintained during construction. At a minimum, the erosion and sediment control measures should include (but not be limited to) use of silt fences and straw bale check dams. These measures are to be inspected daily and after every rain event to determine maintenance, repair or replacement requirements. It is recommended that these measures will be implemented prior to the commencement of construction and maintained in good order until vegetation has been established (refer to details on DWG. 18047-ESC1, Erosion and Sediment Control Plan, in **Appendix A**).

A higher level of precaution will need to be implemented during the construction of the bioretention facilities to ensure that the facilities do not become compromised, thereby, reducing the long-term performance of the facilities. Erosion and sediment control measures, specific to the bioretention facilities themselves, are detailed on the Notes and Details plan (DWG. 18047-N1) in **Appendix A**.

10.0 CONCLUSIONS

It has been demonstrated that the proposed industrial development located at 2596 Carp Road can be adequately serviced to meet the requirements of the City of Ottawa and MVCA. Specifically, the on-site design will incorporate the following design features:

- Two proposed on-site drilled wells will provide the required water supply to meet the site demands.
- The existing well located on the subject property will continue to provide water supply for the proposed administration (existing) building.
- Sewage flows from proposed concrete batching plant will be collected and treated by a new on-site septic system. The existing septic system will continue to treat sewage flows from the proposed administration (existing) building.
- Enhanced quality control requirements for stormwater runoff will be met by use of two bioretention facilities.
- Infiltration of stormwater from the facilities will occur in under 48 hours based on measured infiltration rates of the native soils.
- Surface and subsurface storage will contain all storm events up to an including the 100 year design event within the system (without bypassing) until infiltration/filtration can be achieved in the event of an abnormally high groundwater table (which is unlikely).
- Temperature control requirements will be met by use of infiltration measures and vegetation.
- Two new on-site 600 mm culverts and a 500 mm culvert will convey roadside drainage to a proper outlet.
- Development will not occur within the floodplain or meander belt setbacks.
- Erosion and sediment control measures will be implemented and maintained until vegetation has been reestablished.

Prepared By:

LICENSED PROFESSIONAL ENGINEER
April 12/19
B. L. MACKECHNIE
100199554
PROVINCE OF ONTARIO

Brandon MacKechnie, P.Eng.
Project Engineer

Reviewed By:

LICENSED PROFESSIONAL ENGINEER
April 12/19
A. H. JONKMAN
PROVINCE OF ONTARIO

Angela Jonkman, P.Eng.
Senior Project Manager

Appendix A

Site Plan
(DWG. OSP-1)
(Prepared by Stantec Consulting Ltd.)

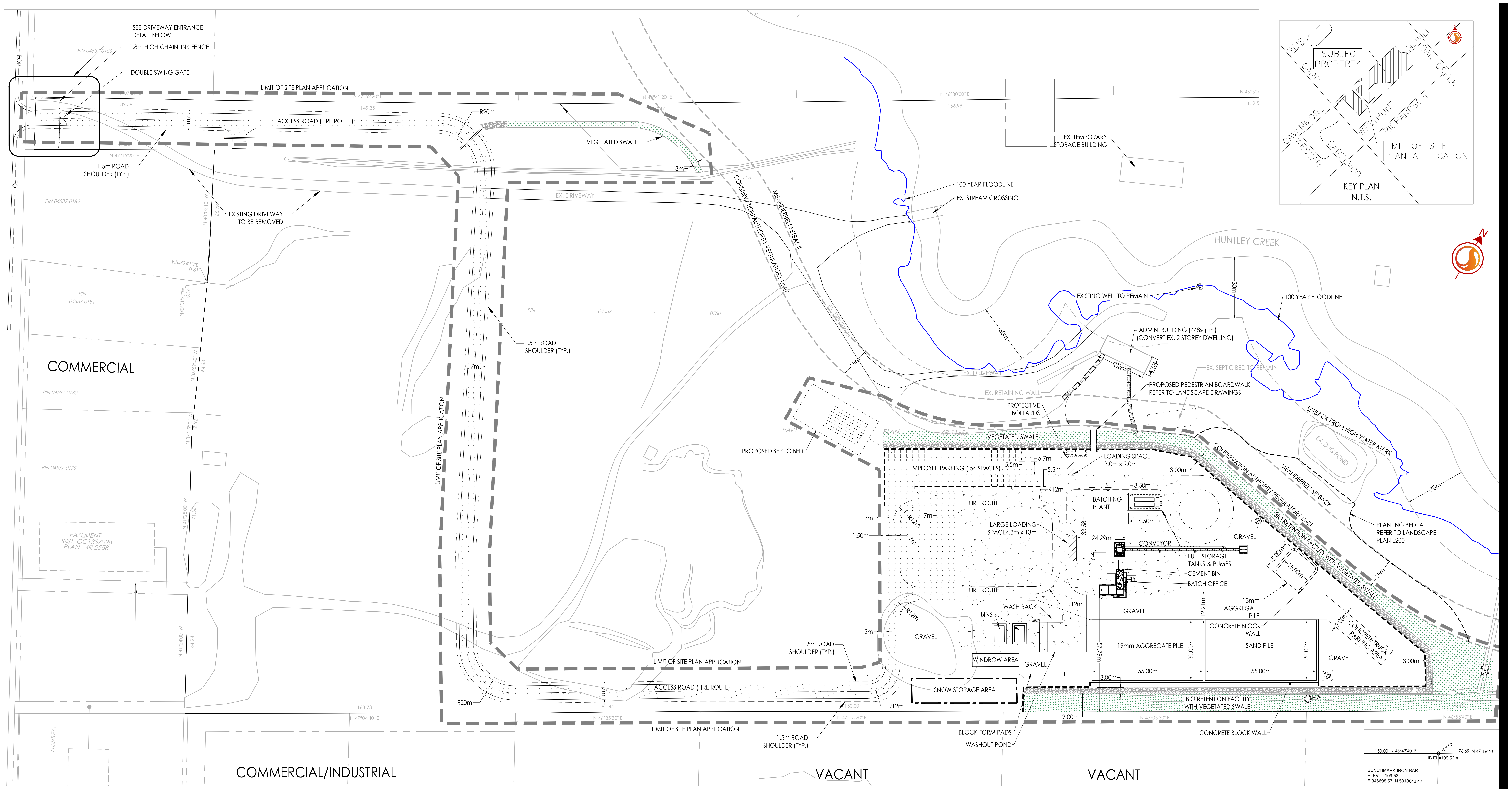
Pre-Development Drainage Area Plan
(DWG. 18047-PRE1)

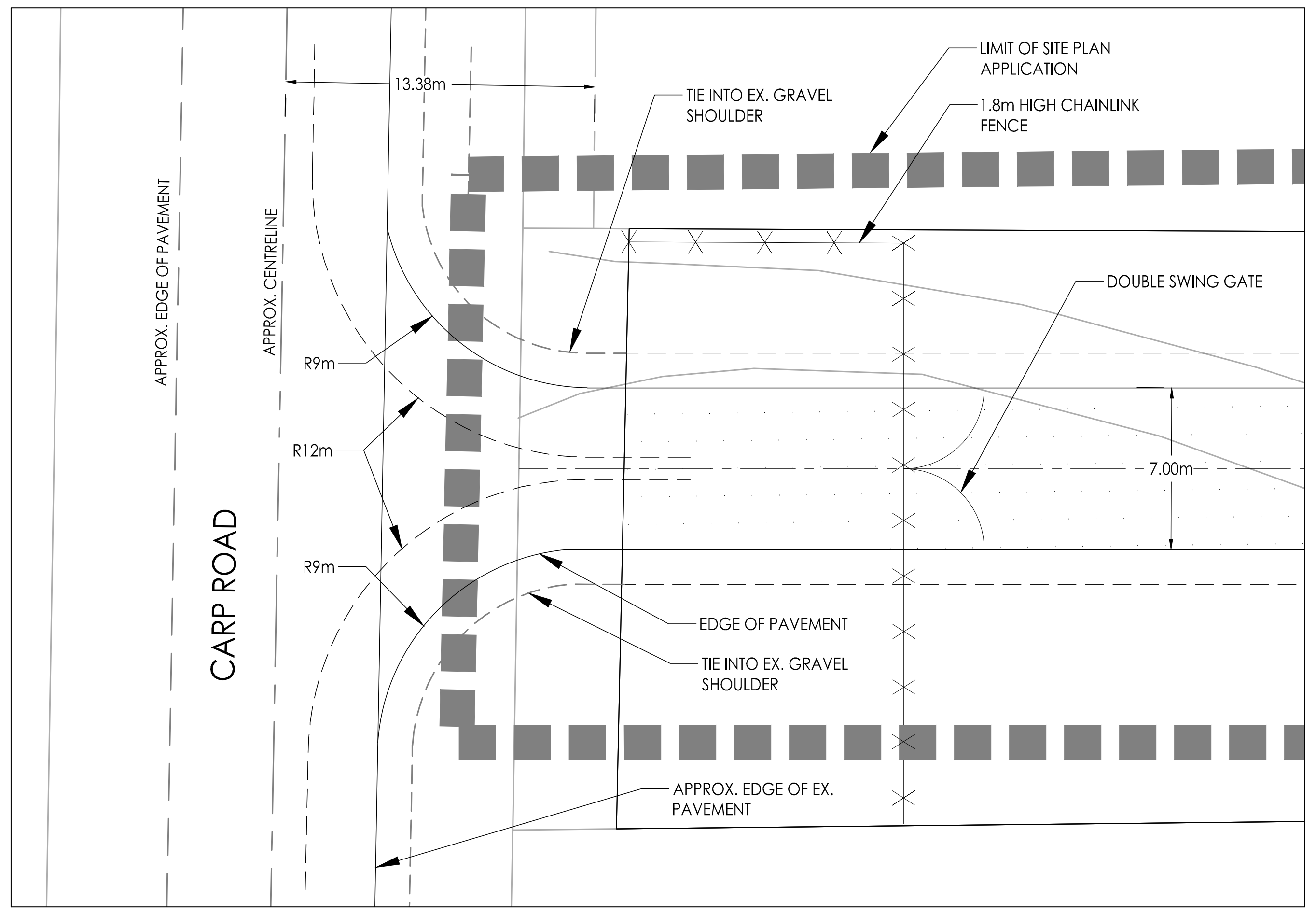
Grading Plans
(DWG. 18047-GR1,
18047-GR2, 18047-GR3)

Erosion and Sediment Control Plan
(DWG. 18047-ESC1)

Notes and Details
(DWG. 18047-N1)

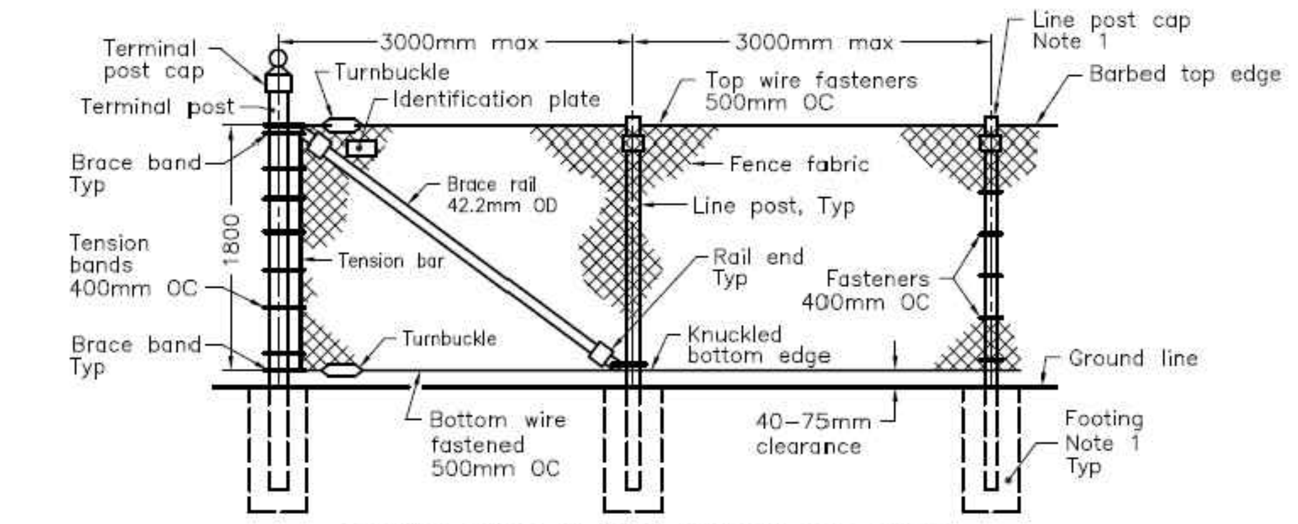
Washout Pond Details



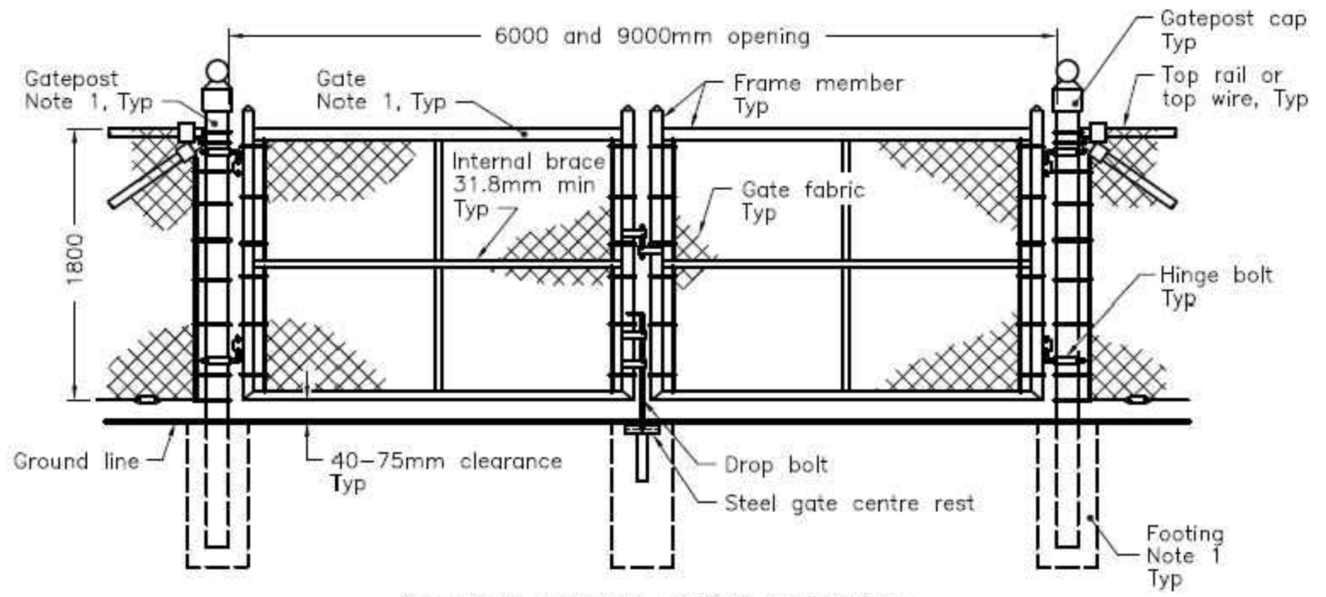


DETAIL OF DRIVEWAY ENTRANCE

1:250 0 2.5 7.5 12.5m



CHAIN–LINK FENCE WITH TOP WIRE



DOUBLE SWING GATE OPENING

RURAL GENERAL INDUSTRIAL ZONE- RG5[275r]-h

City of Ottawa Comprehensive Zoning By-law 2008-250

Holding Provisions: the holding sybmol may only be removed by amendment to this by-law upon compliance with the following:

a) submission and appproval by the City of a site plan, consent or subdivision application

Land Uses		Existing GFA	Proposed GFA
Principal use(s)	heavy industrial	-	668 m^2
Accessory use(s)	office*	-	448 m^2
	TOTAL	448 m^2 *	1116 m^2

* exisitng detached dwelling to be converted to office

Provision	Required	Provided
Lot width	≥ 30 m	30 m
Lot area	≥ 4000 m^2	283,968 m^2
Front yard setback	≥ 12 m	538 m
Rear yard setback	-	-
abutting a RG, RH or RC zone	≥ 7.5 m	N/A
other cases	≥ 10 m	508 m
Interior side yard setback	≥ 10 m	59.7 m
Corner side yard setback	≥ 12 m	N/A
Principal building height	≤ 15 m	24.0 m
Lot coverage	≤ 50%	0.6%
Vehicle Parking (Area D on Schedule 1A)		
office (2.4/100 m^2 GFA)	≥ 10.8	12
heavy industrial use (0.8/100 m^2 GFA)	≥ 5.4	42
TOTAL	10.8	54
Parking lot landscape buffer	-	-
abutting a street	≥ 3 m	N/A
not abutting a street	≥ 1.5 m	3 m
Bicycle Parking		
office (1.0/250 m^2 GFA)	1.8	2
all other non-residential uses (1.0/1500 m^2 GFA)	0.8	1
TOTAL	2.6	3
Loading Spaces		
office	1	1
heavy industrial use	1	1

W:\active\1 Planning_landscape\1604 Projects\160410099_Carp Road Business Park\design\drawing\xref\160401146-SP.dwg
2019/04/08 4:28 PM By: Johnston, Anthony

ORIGINAL SHEET - ARCH D

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Copyright Reserved

Legend

Ⓦ	PROPOSED WELL LOCATION
○	PROPOSED BOLLARDS
🟩	STORM WATER MANAGEMENT AREA
▨	CONCRETE PAD
░	ASPHALT AREA
▶	BUILDING ENTRANCE
▩	RIP-RAP
◎ MW	MONITORING WELL
- - - -	ENCROACHMENT BARRIER AT 3m SPACING (LARGE BOULDERS OR BLOCKS)

APPROVED ☐ REFUSED ☐

THIS ____ DAY OF __________, 20____

ADAM BROWN, MANAGER
DEVELOPMENT REVIEW RURAL
PLANNING, INFRASTRUCTURE AND ECONOMIC
DEVELOPMENT DEPARTMENT, CITY OF OTTAWA

Notes

PROPERTY BOUNDARY BY ANNIS O'SULLIVAN VOLLEBEKK

PART OF LOT 6, CONCESSION 2, GEOGRAPHIC TOWNSHIP OF HUNTLEY PART 1 ON 4R-11656 SAVE & EXCEPT PARTS 1-10 ON 4R-17391, SAVE & EXCEPT PART 1-4 ON 4R-17194, CITY OF OTTAWA

5	REVISED AS PER CITY COMMENTS	DC	EB	19.04.08
4	REVISED AS PER CITY COMMENTS	AJ	EB	18.12.20
3	REVISED AS PER COMMENTS	MS	DK	18.09.19
2	REVISED AS PER COMMENTS	MS	EB	18.08.31
1	FOR SITE PLAN SUBMISSION	MS	EB	18.07.17
Revision		By	Appd.	YY.MM.DD

File Name: 160410099-DB	JP			18.06.05
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

THOMAS CAVANAGH CONSTRUCTION LIMITED
9094 CAVANAGH ROAD

2596 CARP ROAD
CONCRETE BATCHING PLANT
OTTAWA, ONTARIO

Title

SITE PLAN

Project No. 160410099

Scale 1:1000 0 10 30 50m

Drawing No. OSP-1

Sheet 1 of 1

Revision 5

D07-12-18-0141

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
2	REVISED PER COMMENTS	12/04/19	AHJ
1	REVISED PER COMMENTS	20/12/18	AHJ

SCALE

0 10m 20m 40m
HORIZONTAL 1:1000

Apr.12/19
A. H. JONKMAN

Robinson
Land Development

350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN BLM
CHECKED AHJ
DRAWN BLM
CHECKED AHJ
APPROVED AHJ

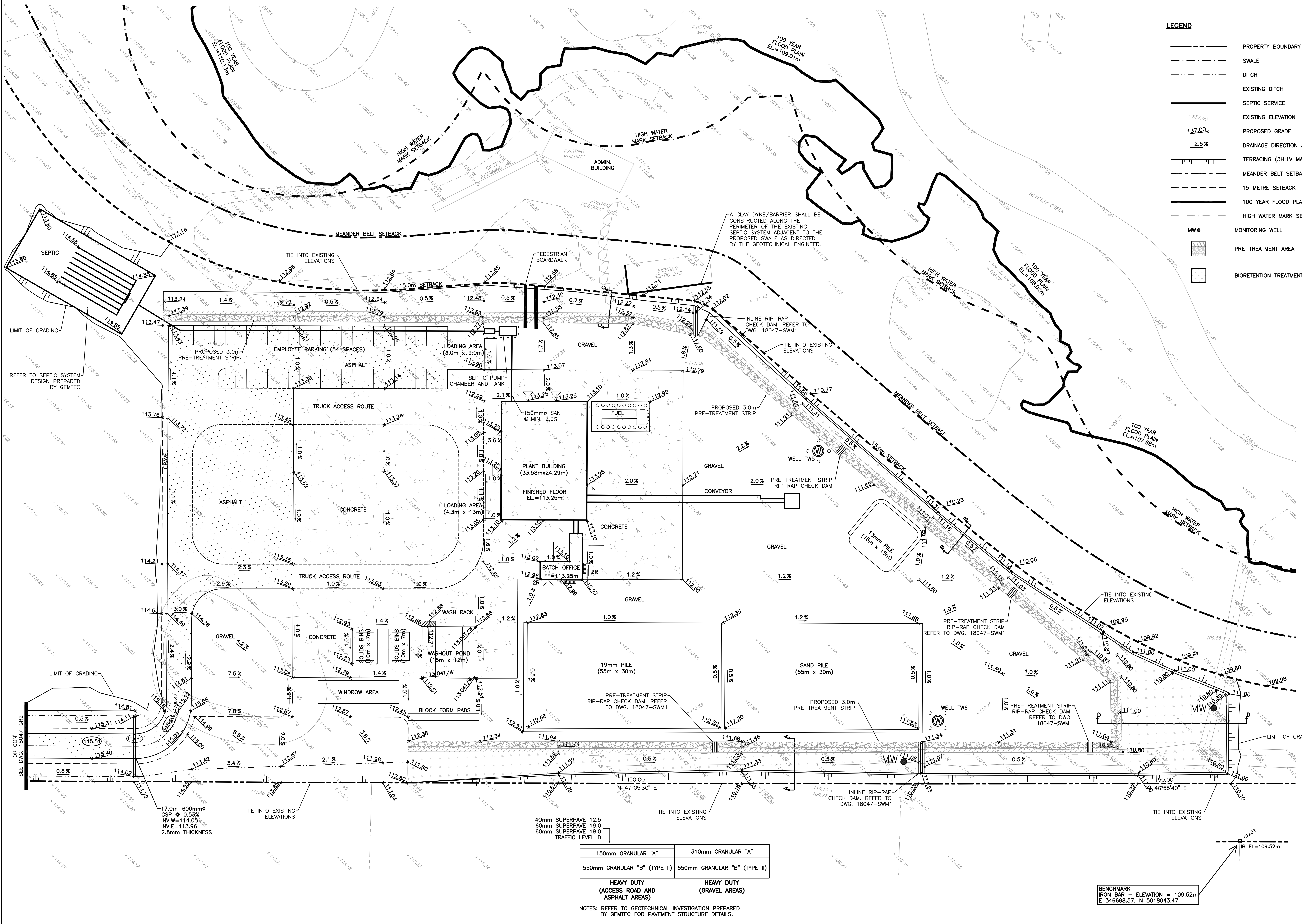
1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

PRE-DEVELOPMENT
DRAINAGE AREA PLAN

PROJECT No. 18047
SURVEY CAVANAGH
DATED SEPTEMBER 2018
DWG. No: 18047-PRE1

D-07-12-18-0141



40mm SUPERPAVE 12.5
60mm SUPERPAVE 19.0
60mm SUPERPAVE 19.0
TRAFFIC LEVEL D

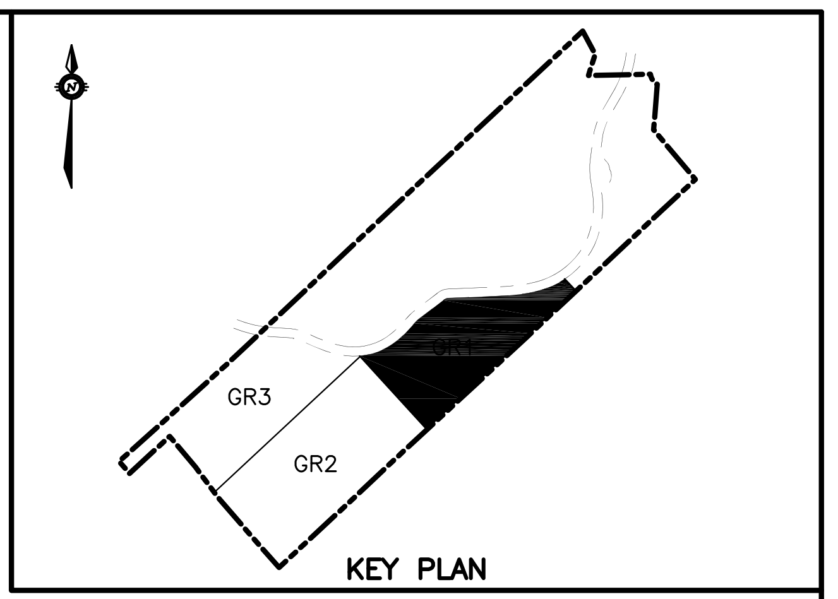
150mm GRANULAR "A"	310mm GRANULAR "A"
550mm GRANULAR "B" (TYPE II)	550mm GRANULAR "B" (TYPE II)
HEAVY DUTY (ACCESS ROAD AND ASPHALT AREAS)	**HEAVY DUTY (GRAVEL AREAS)**

NOTES: REFER TO GEOTECHNICAL INVESTIGATION PREPARED BY GEMTEC FOR PAVEMENT STRUCTURE DETAILS.

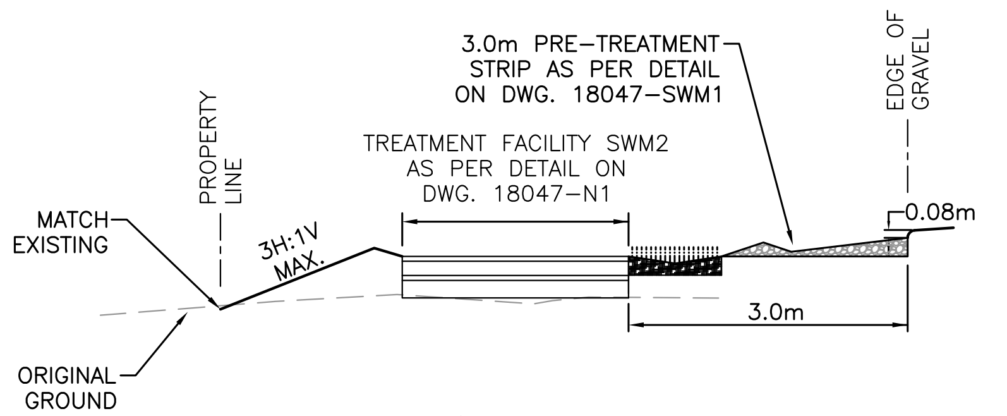
BENCHMARK
IRON BAR – ELEVATION = 109.52m
E 346698.57, N 5018043.47

LEGEND

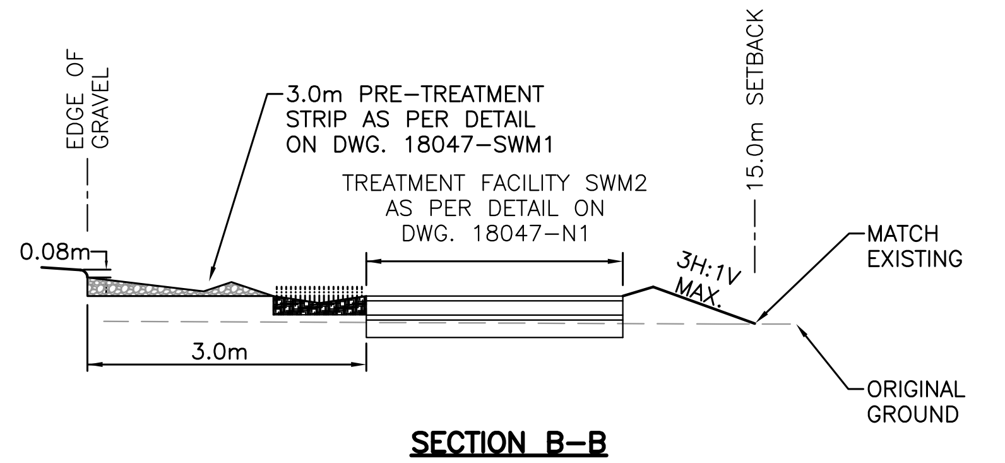
— — —	PROPERTY BOUNDARY
— · — · —	SWALE
— ·· — ·· —	DITCH
— ·· — ·· —	EXISTING DITCH
———	SEPTIC SERVICE
× 137.00	EXISTING ELEVATION
137.00×	PROPOSED GRADE
2.5 %	DRAINAGE DIRECTION AND SLOPE
┴┴┴	TERRACING (3H:1V MAX.)
— - — - —	MEANDER BELT SETBACK
- - - - -	15 METRE SETBACK
━━━	100 YEAR FLOOD PLAIN
— · — · —	HIGH WATER MARK SETBACK
MW●	MONITORING WELL
▨	PRE-TREATMENT AREA
☐	BIORETENTION TREATMENT AREA



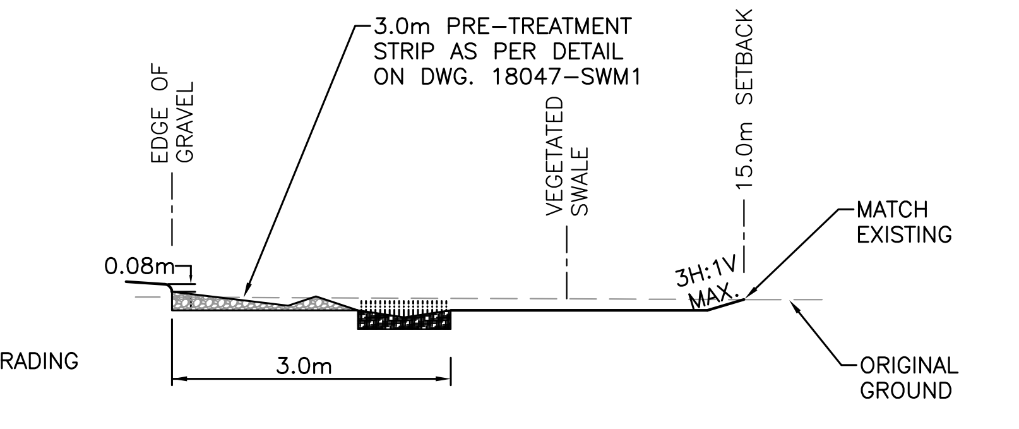
KEY PLAN



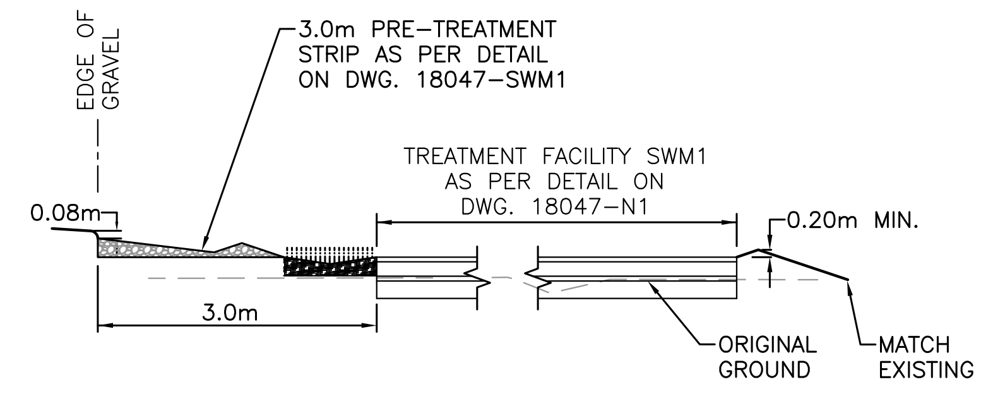
SECTION A-A
N.T.S.



SECTION B-B
N.T.S.



SECTION C-C
N.T.S.



SECTION D-D
N.T.S.

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
3	REVISED PER COMMENTS	12/04/19	AHJ
2	REVISED PER COMMENTS	20/12/18	AHJ
1	ISSUED FOR SITE PLAN APPLICATION	19/09/18	AHJ

SCALE
0 5m 10m 20m
HORIZONTAL 1:500

LICENSED PROFESSIONAL ENGINEER
Apr.12/19
A. H. JONKMAN
PROVINCE OF ONTARIO

Robinson
Land Development

350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	AHJ
DRAWN	BLM
CHECKED	AHJ
APPROVED	AHJ

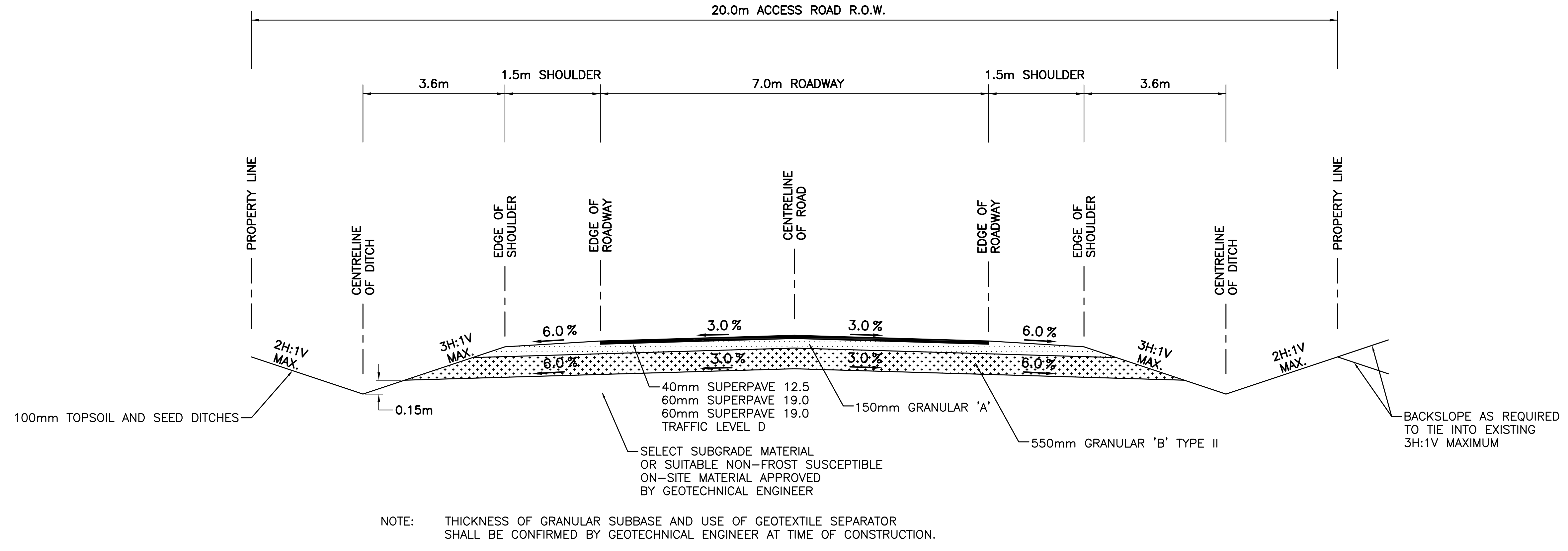
1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

GRADING PLAN

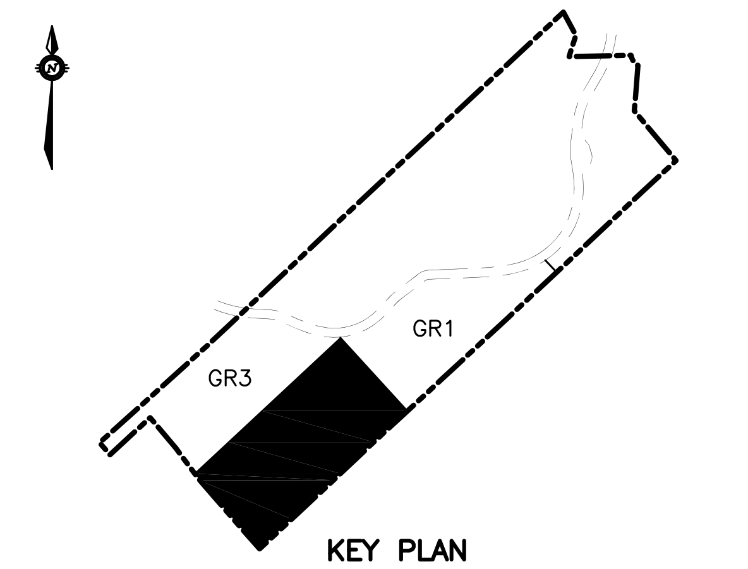
PROJECT No.	18047
SURVEY	CAVANAGH
DATED	SEPTEMBER 2018
DWG. No:	18047-GR1

D-07-12-18-0141



NOTE: THICKNESS OF GRANULAR SUBBASE AND USE OF GEOTEXTILE SEPARATOR SHALL BE CONFIRMED BY GEOTECHNICAL ENGINEER AT TIME OF CONSTRUCTION.

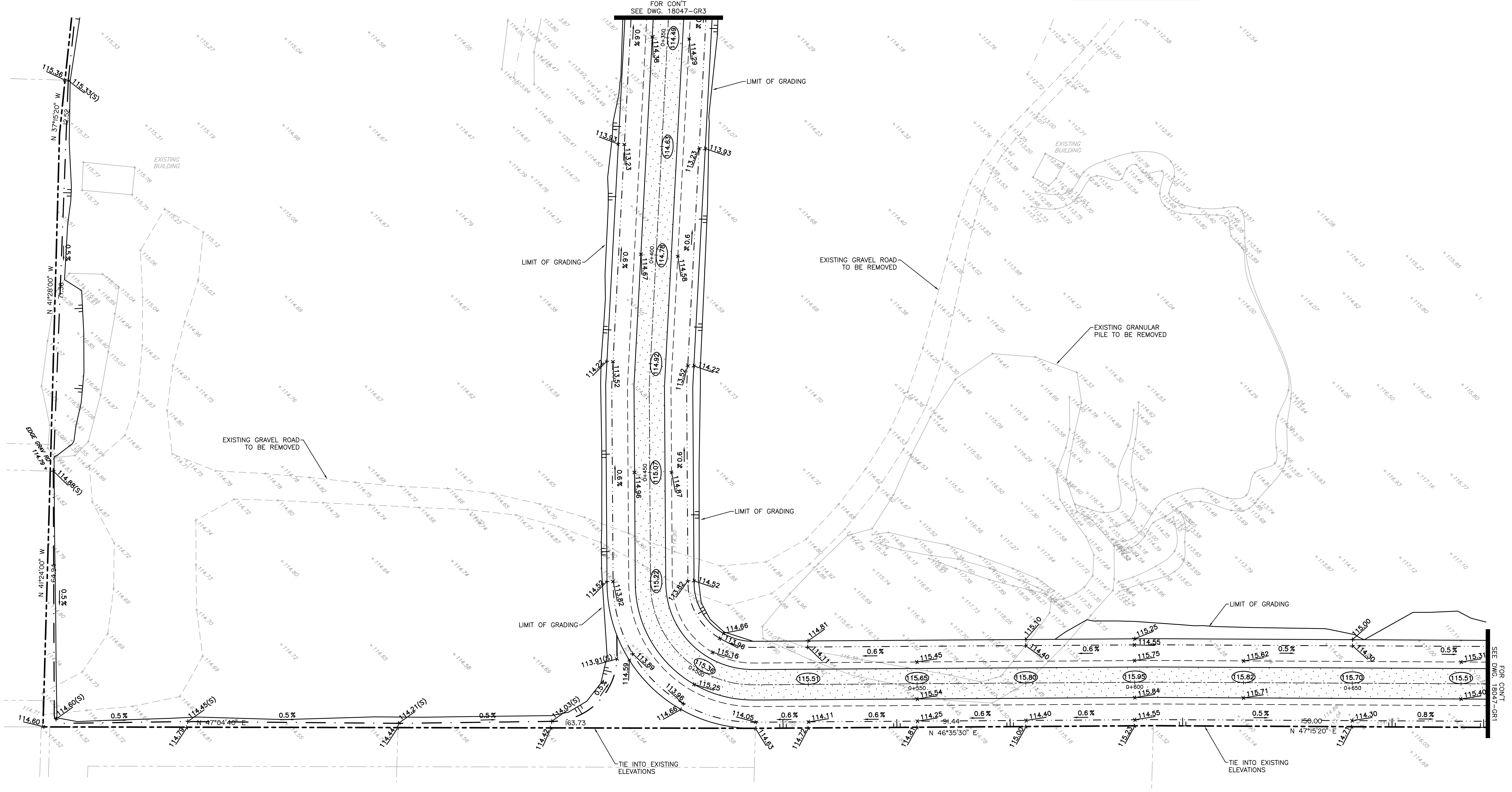
TYPICAL ACCESS ROAD SECTION



KEY PLAN

LEGEND

——— – – ———	PROPERTY BOUNDARY
— · — · —	SWALE
— ·· — ·· —	DITCH
— ·· — ·· —	EXISTING DITCH
× 137.00	EXISTING ELEVATION
137.00 ×	PROPOSED GRADE
2.5 %	DRAINAGE DIRECTION AND SLOPE
─┬┬┬─┬┬┬─	TERRACING (3H:1V MAX.)
—— - —— - ——	MEANDER BELT SETBACK
— — — — —	15 METRE SETBACK
━━━━━	100 YEAR FLOOD PLAIN
— ˙ — ˙ —	HIGH WATER MARK



BENCHMARK
IRON BAR – ELEVATION = 109.52m
E 346698.57, N 5018043.47

IB EL=109.52m

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
3	REVISED PER COMMENTS	12/04/19	AHJ
2	REVISED PER COMMENTS	20/12/18	AHJ
1	ISSUED FOR SITE PLAN APPLICATION	19/09/18	AHJ

SCALE
0 5m 10m 20m
HORIZONTAL 1:500

LICENSED PROFESSIONAL ENGINEER
Apr.12/19
A. H. JONKMAN
PROVINCE OF ONTARIO

Robinson
Land Development

350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	AHJ
DRAWN	BLM
CHECKED	AHJ
APPROVED	AHJ

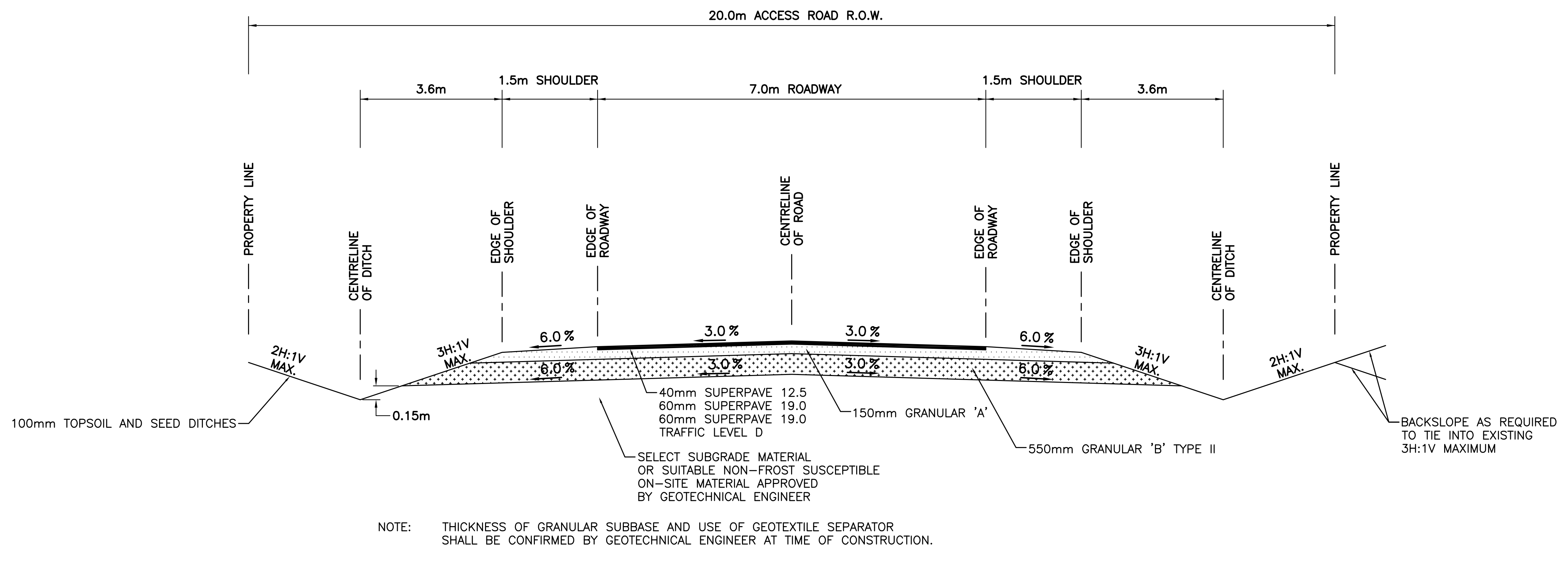
1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

GRADING PLAN

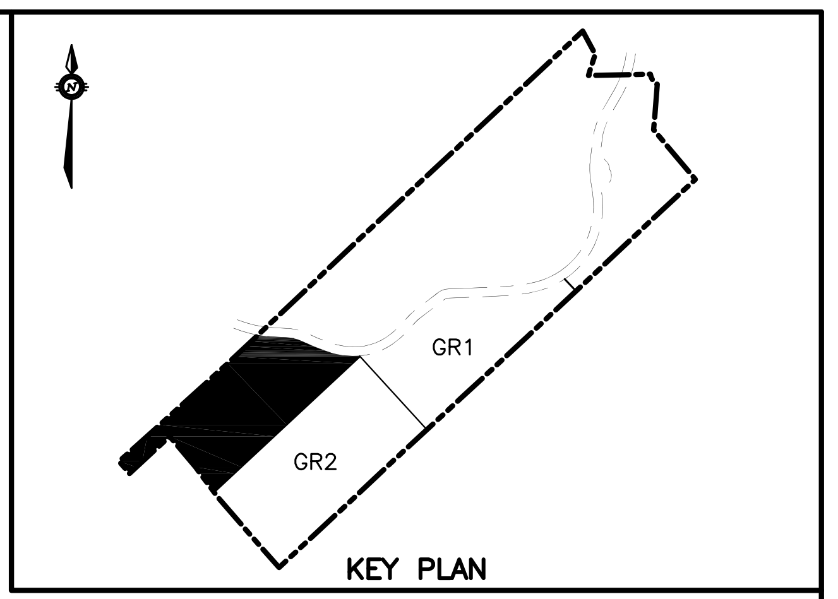
PROJECT No.	18047
SURVEY	CAVANAGH
DATED	SEPTEMBER 2018
DWG. No:	18047-GR2

D-07-12-18-0141



NOTE: THICKNESS OF GRANULAR SUBBASE AND USE OF GEOTEXTILE SEPARATOR SHALL BE CONFIRMED BY GEOTECHNICAL ENGINEER AT TIME OF CONSTRUCTION.

TYPICAL ACCESS ROAD SECTION



KEY PLAN

LEGEND

	PROPERTY BOUNDARY
	SWALE
	DITCH
	EXISTING DITCH
137.00	EXISTING ELEVATION
137.00	PROPOSED GRADE
2.5 %	DRAINAGE DIRECTION AND SLOPE
	TERRACING (3H:1V MAX.)
	MEANDER BELT SETBACK
	15 METRE SETBACK
	100 YEAR FLOOD PLAIN
	HIGH WATER MARK

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
3	REVISED PER COMMENTS	12/04/19	AHJ
2	REVISED PER COMMENTS	20/12/18	AHJ
1	ISSUED FOR SITE PLAN APPLICATION	19/09/18	AHJ

SCALE
0 5m 10m 20m
HORIZONTAL 1:500

A. H. JONKMAN
Apr.12/19

Robinson
Land Development
350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	AHJ
DRAWN	BLM
CHECKED	AHJ
APPROVED	AHJ

1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

GRADING PLAN

PROJECT No.
18047
SURVEY
CAVANAGH
DATED
SEPTEMBER 2018
DWG. No:
18047-GR3

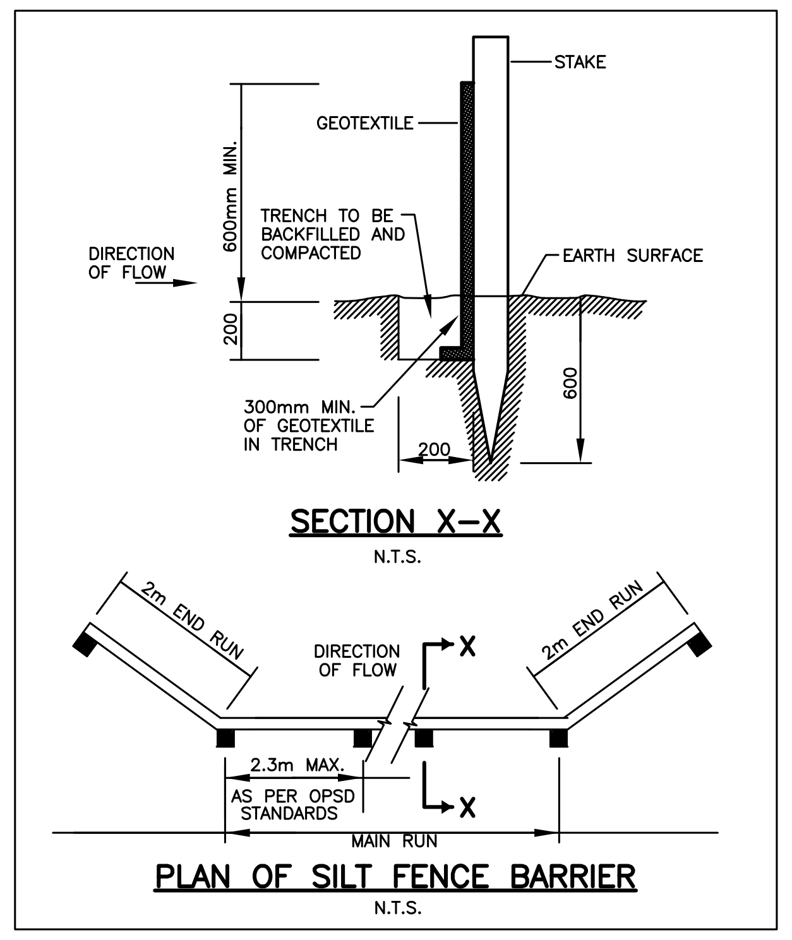
D-07-12-18-0141

LEGEND

▬ ‒ ‒ ▬	PROPERTY BOUNDARY
— · — · —	SWALE
— ·· — ·· —	DITCH
— ·· — ·· —	EXISTING DITCH
— ‒ — ‒ —	MEANDER BELT SETBACK
— — — — —	15 METRE SETBACK
━━━━	100 YEAR FLOOD PLAIN
— ˈ — ˈ —	HIGH WATER MARK SETBACK
▩	PRE–TREATMENT AREA
☐	TREATMENT AREA
—x—x—x—	SILT FENCE
▨	STRAW BALE CHECK DAM

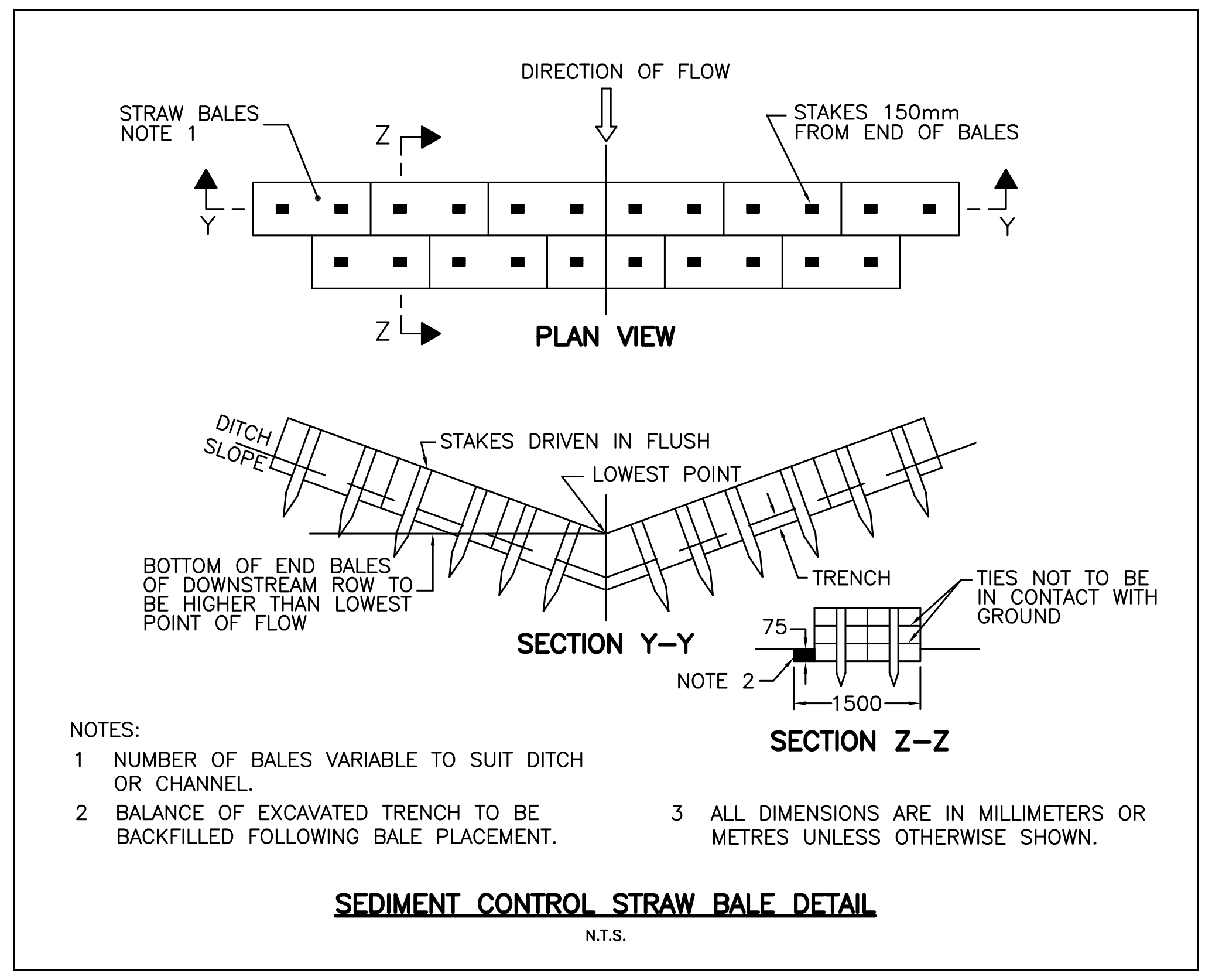
EROSION & SEDIMENT CONTROL

1. SILT FENCE AND STRAW BALE CHECK DAMS ARE TO BE INSTALLED WHERE INDICATED AND MAINTAINED DURING CONSTRUCTION.
2. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES, TO PROVIDE FOR PROTECTION OF THE AREA DRAINAGE SYSTEM DURING CONSTRUCTION ACTIVITIES. THE CONTRACTOR ACKNOWLEDGES THAT FAILURE TO IMPLEMENT APPROPRIATE EROSION AND SEDIMENT CONTROL MEASURES MAY BE SUBJECT TO PENALTIES IMPOSED BY ANY APPLICABLE REGULATORY AGENCY.
3. REFER TO DWG. 18047–N1 FOR EROSION AND SEDIMENT CONTROL DETAILS FOR THE BIORETENTION FACILITIES.



PLAN OF SILT FENCE BARRIER

N.T.S.



NOTES:

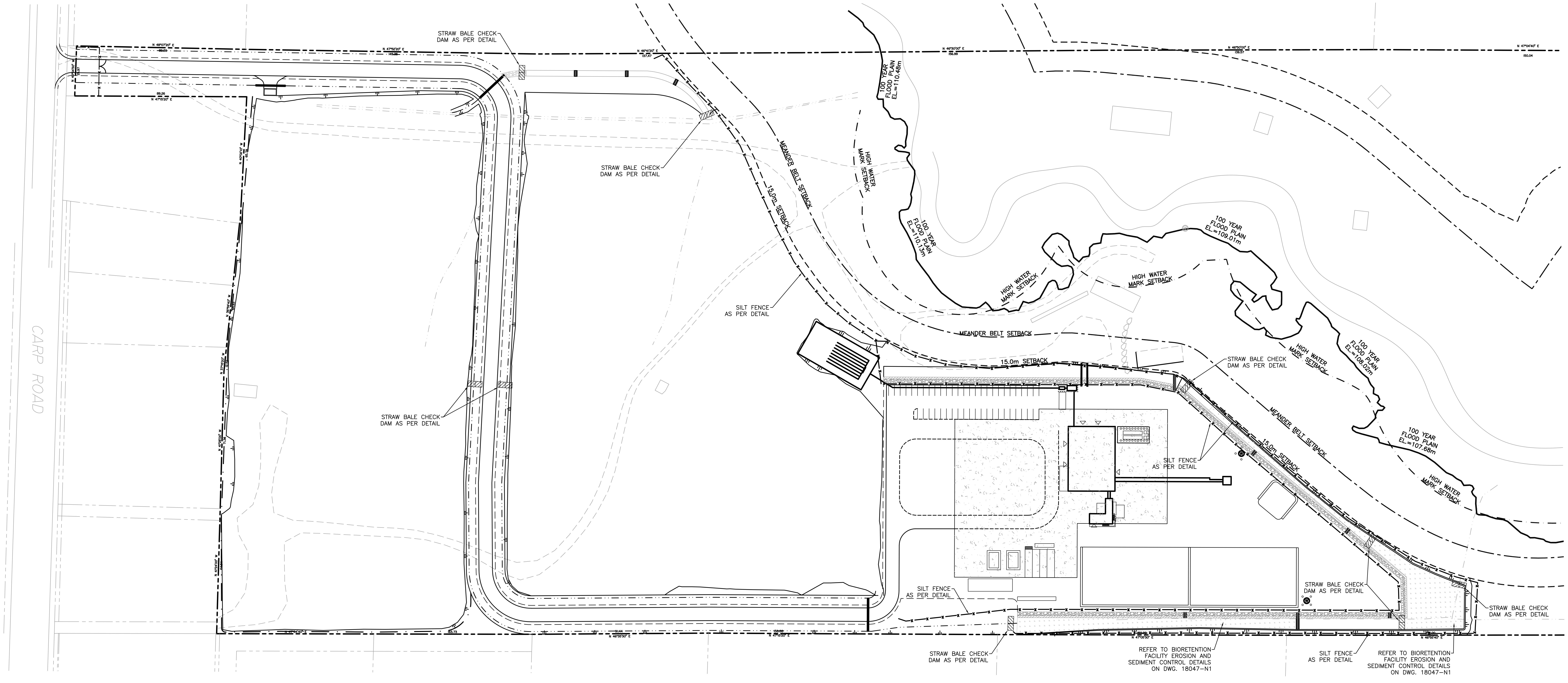
1 NUMBER OF BALES VARIABLE TO SUIT DITCH OR CHANNEL.

2 BALANCE OF EXCAVATED TRENCH TO BE BACKFILLED FOLLOWING BALE PLACEMENT.

3 ALL DIMENSIONS ARE IN MILLIMETERS OR METRES UNLESS OTHERWISE SHOWN.

SEDIMENT CONTROL STRAW BALE DETAIL

N.T.S.



NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
3	REVISED PER COMMENTS	12/04/19	AHJ
2	REVISED PER COMMENTS	20/12/18	AHJ
1	ISSUED FOR SITE PLAN APPLICATION	19/09/18	AHJ

SCALE

0 10m 20m 40m

HORIZONTAL 1:1000

Apr.12/19
A. H. JONKMAN

Robinson
Land Development

350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	AHJ
DRAWN	BLM
CHECKED	AHJ
APPROVED	AHJ

1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

EROSION & SEDIMENT CONTROL PLAN

PROJECT No.	18047
SURVEY	CAVANAGH
DATED	SEPTEMBER 2018
DWG. No:	18047-ESC1

D-07-12-18-0141

BIORETENTION GENERAL NOTES

1. BIORETENTION FILTER MEDIA SHOULD BE OBTAINED PREMIXED FROM APPROVED VENDOR. VENDOR TO PROVIDE TESTING RESULTS PRIOR TO INSTALLATION. DELIVERED MEDIA SHALL BE TESTED AND APPROVED BY ENGINEER PRIOR TO INSTALLATION. MEDIA INSTALLED WITHOUT FIELD ENGINEER CLEARANCE SHALL BE REMOVED AT THE CONTRACTOR'S EXPENSE IF DEEMED NECESSARY BY THE FIELD ENGINEER. THE CONTRACTOR WILL BE SOLELY RESPONSIBLE FOR ALL REQUIRED MEDIA TESTING EXPENSES. THE CONTRACTOR IS RESPONSIBLE FOR ANY DELAYS SUFFERED AS A RESULT OF TESTING. NO COMPENSATION WILL BE PROVIDED FOR DELAYS DUE TO MEDIA ANALYSIS.
2. SEDIMENT CONTROL MEASURES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF CONSTRUCTION TO PREVENT RUNOFF FROM CONTAMINATING EXCAVATED SURFACE OF THE NATIVE SOILS.
3. FINAL GRADE OF BIORETENTION FACILITIES TO BE EXCAVATED IMMEDIATELY PRIOR TO BACKFILLING WITH SPECIFIED FILTER MEDIA TO AVOID PREMATURE FACILITY CLOGGING. OPEN EXCAVATIONS BEYOND 1 DAY SHALL INSTALL TEMPORARY SACRIFICIAL FILTER FABRIC.
4. APPROVED FILTER MEDIA MIXES SHALL BE INSTALLED IMMEDIATELY PRIOR TO INSTALLATION OF THE PLANTINGS AND STABILIZATION MEASURES.
5. REFER TO THE SERVICING & STORMWATER MANAGEMENT REPORT, PREPARED BY ROBINSON LAND DEVELOPMENT.

CONSTRUCTION SEQUENCING

1. EROSION AND SEDIMENTATION PROTECTION MEASURES ARE REQUIRED PRIOR TO THE COMMENCEMENT OF ANY ALL EXCAVATION ACTIVITIES.
2. FINAL GRADE OF THE FACILITIES ARE TO BE EXCAVATED IMMEDIATELY PRIOR TO BACKFILLING WITH SPECIFIED FILTER MEDIA TO AVOID PREMATURE FACILITY CLOGGING.
3. EXCAVATION, BACKFILLING AND MEDIA INSTALLATION IS ONLY TO OCCUR AFTER THE CONTRIBUTING DRAINAGE AREA HAS BEEN STABILIZED.
4. APPLY FILTER MEDIA IN 300mm LIFTS UNTIL DESIRED ELEVATION IS ACHIEVED. THOROUGHLY WET EACH LIFT BEFORE ADDING NEXT LEVEL. ALLOW WATER TO FULLY PERCOLATE THROUGH THE SOIL BEFORE ADDING EACH COURSE.
5. THE FILTER MEDIA SHALL BE FINE GRADED AFTER PLACEMENT. FINISHED GRADING SHALL CONFORM TO THE ELEVATIONS SHOWN ON THE DESIGN DRAWINGS AND SHALL BE FREE OF DEBRIS AND OTHER MATERIALS THAT WOULD BE DETRIMENTAL TO THE PERFORMANCE OF THE GROWING MEDIA.
6. THE FINISHED SURFACE SHALL BE SMOOTH AND UNIFORM, AND BE FIRM AGAINST DEEP FOOTPRINTING, WITH A FINE LOOSE SURFACE TEXTURE.
7. PROTECTION OF THE FINISHED GRADE AND CORRECTION OF ANY IRREGULARITIES CAUSED BY WORK OPERATIONS OVER THE FINISHED GRADE SHALL BE ENFORCED.
8. SETTLING OF ANY FINISHED GRADE SHALL NOT BE MORE THAN 10cm FROM SPECIFIED ELEVATIONS, AND IF SETTLING IS GREATER, THE CONTRACTOR SHALL BRING THE GRADE TO THE SPECIFIED ELEVATIONS USING APPROVED MATERIALS.
9. PLANTING NOT TO OCCUR PRIOR TO 5 DAYS AFTER MEDIA PLACEMENT TO ALLOW FOR MEDIA SETTLEMENT. ADD ADDITIONAL MEDIA IF REQUIRED.
10. PLANTING IS TO OCCUR IN ACCORDANCE WITH THE LANDSCAPE PLANS. AS NECESSARY, PROVIDE A MINIMUM OF 1 IRRIGATION PER WEEK THROUGHOUT THE MAINTENANCE PERIOD AS REQUIRED.
11. AFTER PLANTING, 75mm OF SHREDDED HARDWOOD MULCH (AGED A MINIMUM OF 12 MONTHS) IS TO BE PLACED ON TOP OF THE FILTER MEDIA AND AROUND PLANT MATERIAL. MULCH SHALL BE FREE OF ALL DELETERIOUS SUBSTANCES AND SHALL CONTAIN ONLY 100% SHREDDED HARDWOOD MUCH. MULCH SAMPLES SHALL BE SUBMITTED TO FIELD ENGINEER FOR APPROVAL PRIOR TO INSTALLATION. MULCH INSTALLATION WITHOUT FIELD ENGINEER APPROVAL SHALL BE REMOVED AT THE CONTRACTOR'S EXPENSE.
12. GEOTECHNICAL ENGINEER TO DETERMINE IF GEOTEXTILE MATERIAL IS REQUIRED ALONG THE SIDES OF THE FACILITIES DURING CONSTRUCTION.

BIORETENTION EROSION AND SEDIMENT CONTROL

1. DURING CONSTRUCTION, PROVISION SHALL BE MADE FOR PROPER WATER MANAGEMENT AND DRAINAGE OF THE SITE. AT NO TIME SHALL SEDIMENT LADEN WATER BE ALLOWED TO ENTER THE EXCAVATED/BACKFILLED OR COMPLETED BIORETENTION AREAS. PRIOR TO STABILIZATION OF THE PLANTING MATERIAL, NO SITE DRAINAGE IS TO ENTER THE PROPOSED FACILITIES. SHOULD SEDIMENT ENTER THE FACILITY PRIOR TO RECEIVING APPROVAL FROM THE FIELD ENGINEER, THE INFILTRATION RATE OF THE CONTAMINATED AREA SHOULD BE TESTED USING GUELPH PERMEAMETER TEST OR DOUBLE–RING INFILTRATION TEST, TO CONFIRM NO LOSS IN INFILTRATION POTENTIAL. SHOULD A LOSS OF INFILTRATION CAPACITY BE CONFIRMED, THE CONTRACTOR WILL BE RESPONSIBLE FOR THE REPAIR/REMEDIATION OF THE CONTAMINATED AREA TO THE SATISFACTION OF THE ENGINEER, USING APPROVED MEASURES, MATERIALS AND PRACTICES.
2. TEMPORARY SEDIMENT CONTROLS ARE TO BE INSTALLED PRIOR TO THE START OF CONSTRUCTION.
3. SILT FENCE SHALL BE INSTALLED AROUND THE PERIMETER OF THE FACILITIES PRIOR TO CONSTRUCTION TO PREVENT SEDIMENT ENTRY INTO THE FACILITIES.
4. CONTRACTOR IS RESPONSIBLE FOR ANY REMEDIATION/REPAIR OF INFILTRATION FACILITIES DAMAGED AS A RESULT OF INADEQUATE OR IMPROPER SEDIMENT CONTROL.
5. THE CONTRACTOR SHALL DELINEATE THE REQUIRED WORKING AREA ON–SITE PRIOR TO THE START OF WORK AND SHALL CONFINE OPERATIONS WITHIN THE DEFINED AREA.
6. TEMPORARY TOPSOIL AND/OR FILL MATERIAL STOCKPILE AREAS TO BE ENCLOSED WITH SEDIMENT CONTROLS.
7. WORKING AREAS, ACCESS REQUIREMENTS, AND TEMPORARY MATERIAL STORAGE AREAS TO BE MAINTAINED IN GOOD CONDITION BY THE CONTRACTOR AT ALL TIMES. AREAS AFFECTED BY THE CONTRACTOR'S ACTIVITIES TO BE REINSTATED TO THE EXISTING CONDITIONS OR BETTER.
8. ALL ACCUMULATED SEDIMENTS TO BE REMOVED PRIOR TO THE REMOVAL OF CONTROLS AND DISPOSED OF IN AN APPROVED ON–SITE LOCATION BY THE CONTRACTOR.
9. ON–SITE EQUIPMENT REFUELING AND MAINTENANCE TO BE ONLY COMPLETED IN DESIGNATED AREAS.
10. SEDIMENT CONTROLS TO BE INSPECTED DAILY AND AFTER EACH RAINFALL EVENT. SEDIMENT CONTROLS TO BE MAINTAINED AND REPAIRED BY THE CONTRACTOR UNTIL COMPLETION OF CONSTRUCTION AND SITE RESTORATION.
11. REMOVE TEMPORARY SEDIMENT CONTROLS FOLLOWING COMPLETION OF CONSTRUCTION AND SITE RESTORATION, AND REINSTATE AFFECTED AREAS TO EXISTING CONDITIONS OR BETTER.

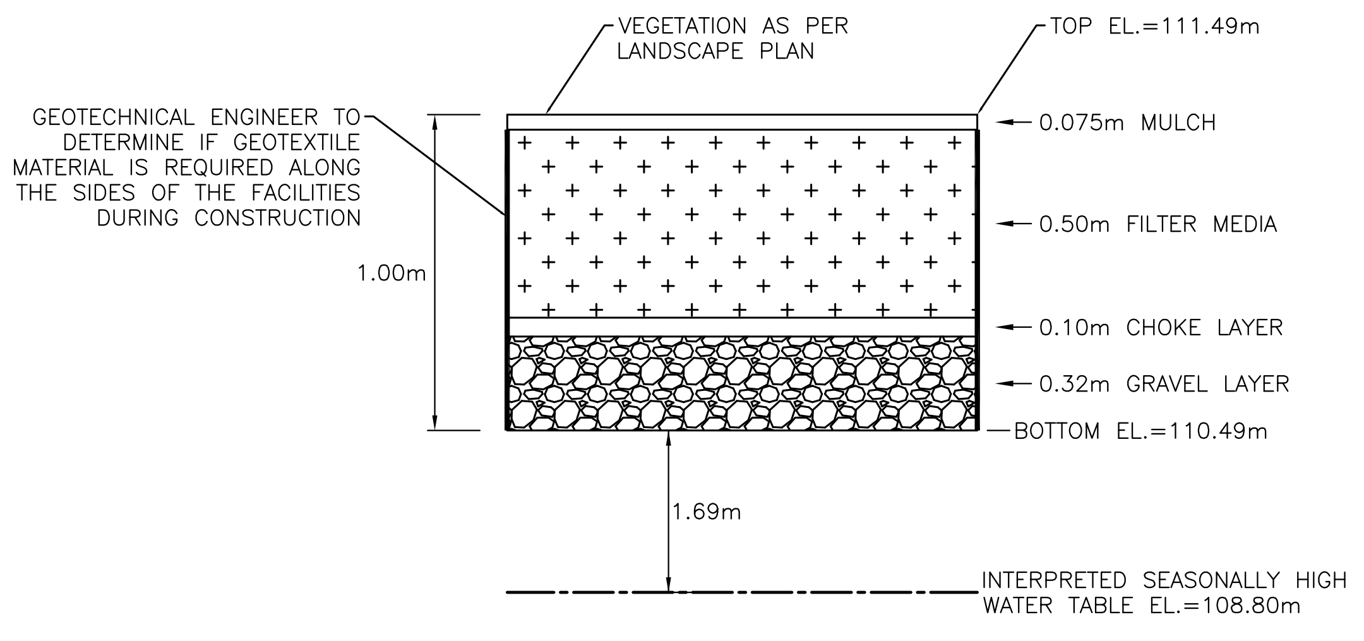
INSPECTION AND MAINTENANCE

1. TRASH, DEBRIS AND SEDIMENT SHOULD BE REMOVED FROM THE CONTRIBUTING DRAINAGE AREA BIANNUALLY TO QUARTERLY.
2. TRASH DEBRIS, AND SEDIMENT SHOULD BE REMOVED FROM THE PRE–TREATMENT AREAS ANNUALLY TO BIANNUALLY OR WHEN SUMPS ARE HALF FULL.
3. SIDE SLOPES OF THE FACILITIES SHOULD BE INSPECTED FOR EROSION.
4. REMOVED TRASH FROM THE FILTER BED BIANNUALLY TO QUARTERLY.
5. RAKE FILTER BED REGULARLY TO REDISTRIBUTE MULCH AND PREVENT SEDIMENT CRUSTS.
6. MAINTAIN 75mm OF MULCH COVER TO PREVENT WEED GROWTH AND SOIL EROSION.
7. REPAIR SUNKEN AREAS WHEN GREATER THAT 10 cm DEEP AND BARREN/ERODED AREAS WHEN GREATER THAN 30 cm LONG.
8. REMOVE SEDIMENT FROM FILTER BED WHEN GREATER THAN 5 cm DEEP OR TIME TO DRAIN WATER PONDED ON THE SURFACE EXCEEDS 48 HOURS.
9. REMOVAL OF SEDIMENT FROM THE FILTER BED SURFACE SHOULD BE DONE WITH A RAKE AND SHOVEL, OR VACUUM EQUIPMENT TO MINIMIZE PLANT DISTURBANCE. IF A SMALL EXCAVATOR IS TO BE USED, KEEP IT OFF THE FACILITY FOOTPRINT TO AVOID DAMAGE TO SIDE SLOPES AND OVER–COMPACTION OF THE FILTER MEDIA.
10. TO AVOID OVER–COMPACTION OF THE FILTER MEDIA SOIL, ANY MAINTENANCE TASKS INVOLVING VEHICLE OR FOOT TRAFFIC ON THE FILTER BED SHOULD NOT BE PERFORMED DURING WET WEATHER.
11. GRADES SHOULD BE RESTORED WITH FILTER MEDIA THAT MEETS THE APPROVED DESIGN SPECIFICATIONS.
12. REPLACE STONE, MULCH AND PLANT COVER AS REQUIRED.
13. WATER PLANTINGS FREQUENTLY, AS RECOMMENDED BY THE LANDSCAPE ARCHITECT.
14. REMOVE WEEDS AND UNDESIRABLE PLANTS BIANNUALLY TO QUARTERLY.
15. REPLACE DEAD PLANTINGS ANNUALLY TO ACHIEVE 80 PERCENT COVER BY THE THIRD GROWING SEASON.
16. NEVER APPLY CHEMICAL FERTILIZERS OR HERBICIDES.

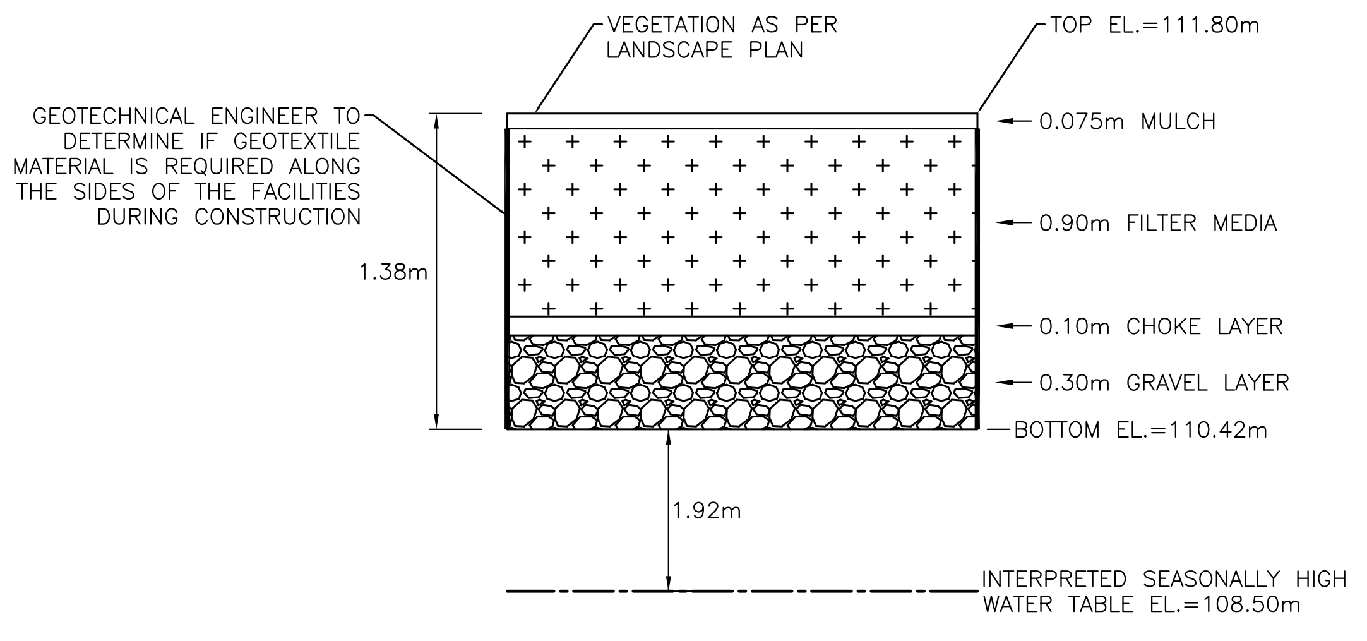
BIORETENTION TREATMENT FACILITY SPECIFICATIONS

MATERIAL	SPECIFICATION
MULCH LAYER	SHREDDED HARDWOOD BARK MULCH
FILTER MEDIA	SOIL MIXTURE TO CONTAIN: – 85 TO 88% SAND – 8 TO 12% SOIL FINES – 3 TO 5% ORGANIC MATTER – P–INDEX VALUE BETWEEN 10 TO 30 PPM – CATIONIC EXCHANGE CAPACITY GREATER THAN 10 meq/100 g – pH BETWEEN 5.5 TO 7.5 – INFILTRATION RATE GREATER THAN 25mm/hr
CHOKE LAYER	WASHED 3 TO 10mm DIAMETER CLEAR STONE
GRAVEL STORAGE LAYER	WASHED 50mm DIAMETER CLEAR STONE

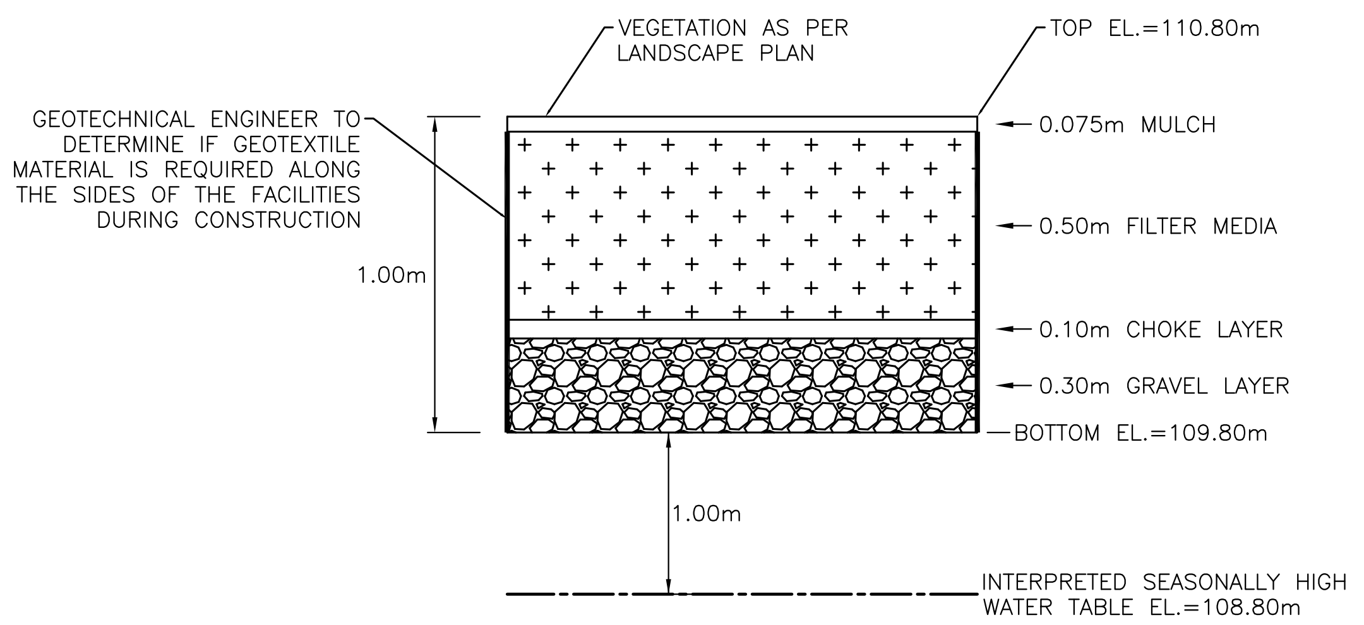
NOTES:
1. FILTER MEDIA OBTAINED FROM VENDOR TO BE TESTED TO CONFIRM DESIGN SPECIFICATIONS PRIOR TO INSTALLATION.
2. REFER TO SURFACE VEGETATION SPECIFIED ON THE LANDSCAPE PLAN BY STANTEC.



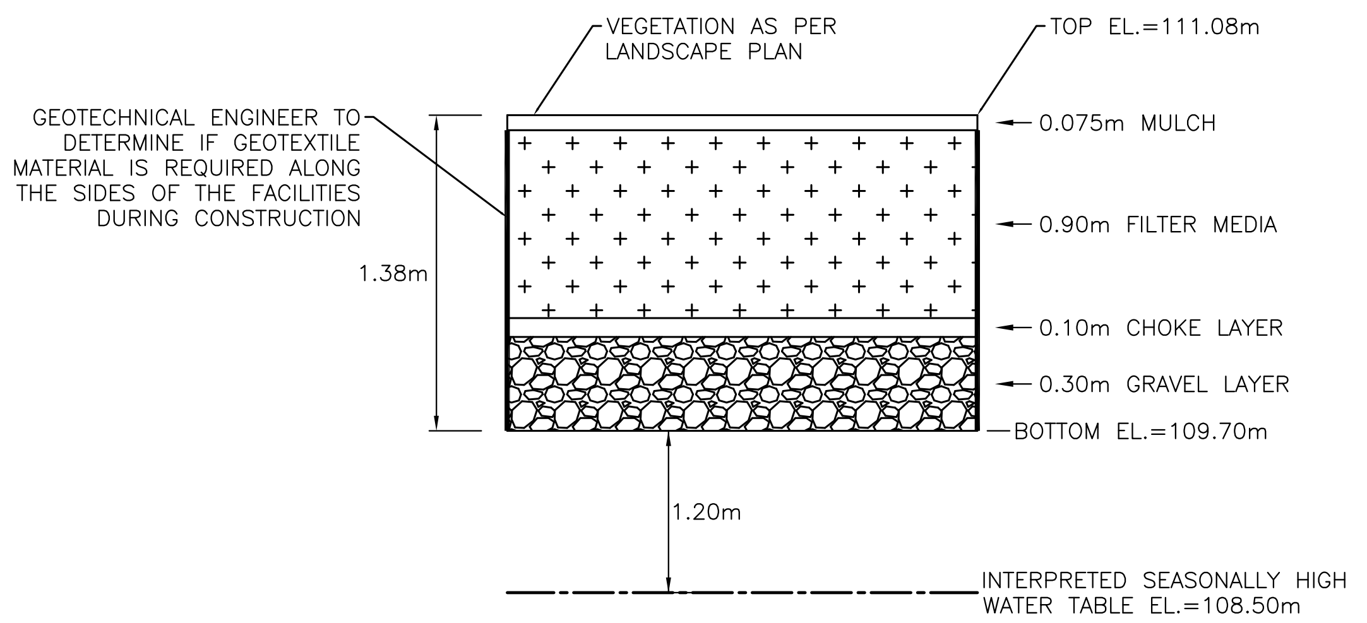
SWM1 BIORETENTION (INLET) TREATMENT FACILITY TYPICAL SECTION
N.T.S.



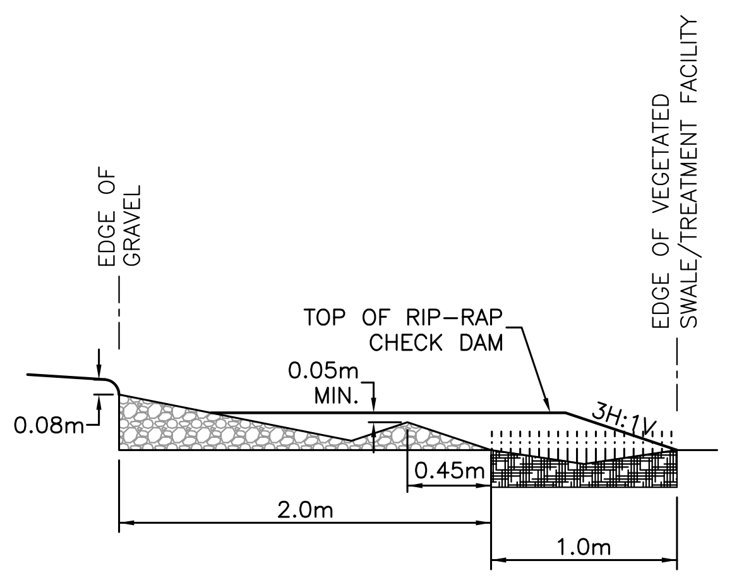
SWM2 BIORETENTION (INLET) TREATMENT FACILITY TYPICAL SECTION
N.T.S.



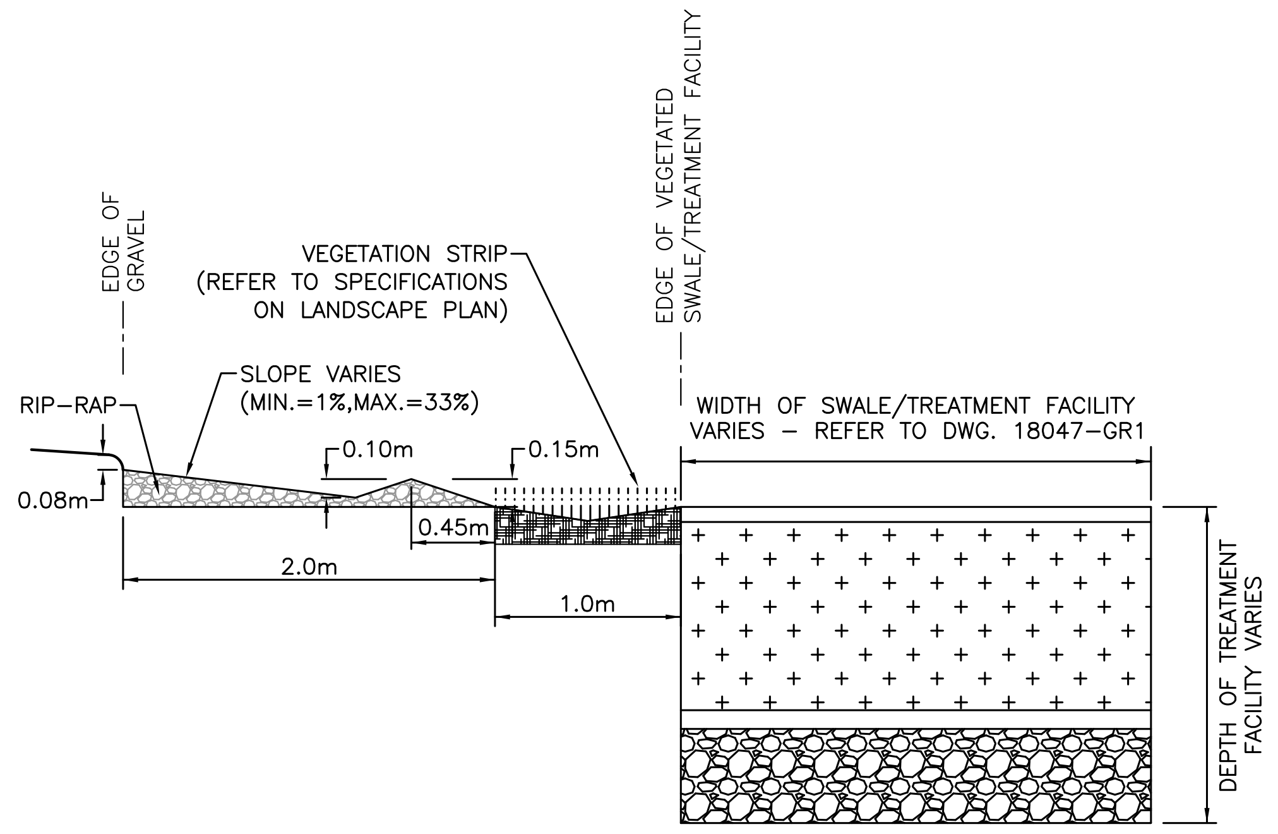
SWM1 BIORETENTION (OUTLET) TREATMENT FACILITY TYPICAL SECTION
N.T.S.



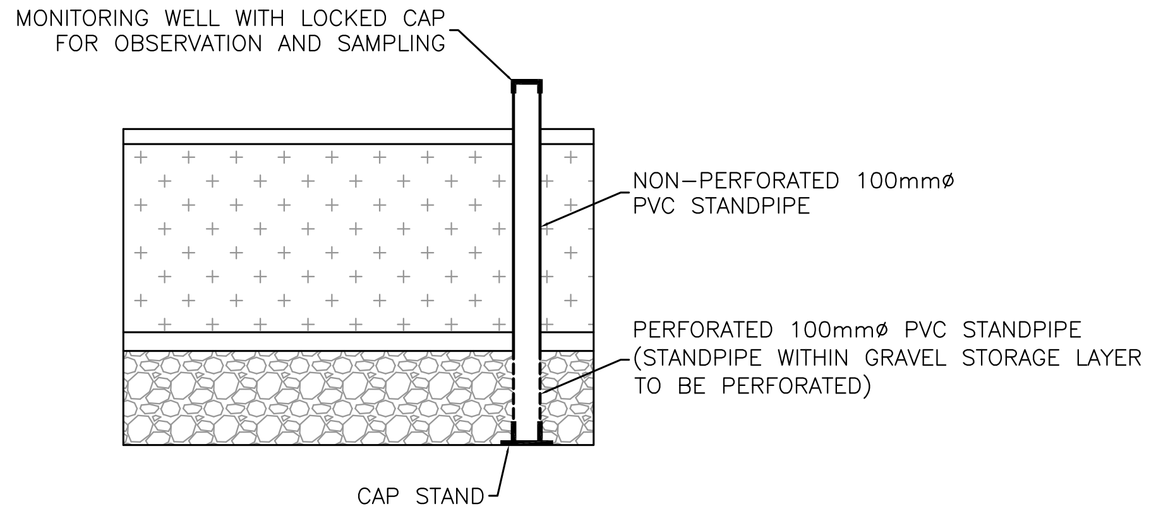
SWM2 BIORETENTION (OUTLET) TREATMENT FACILITY TYPICAL SECTION
N.T.S.



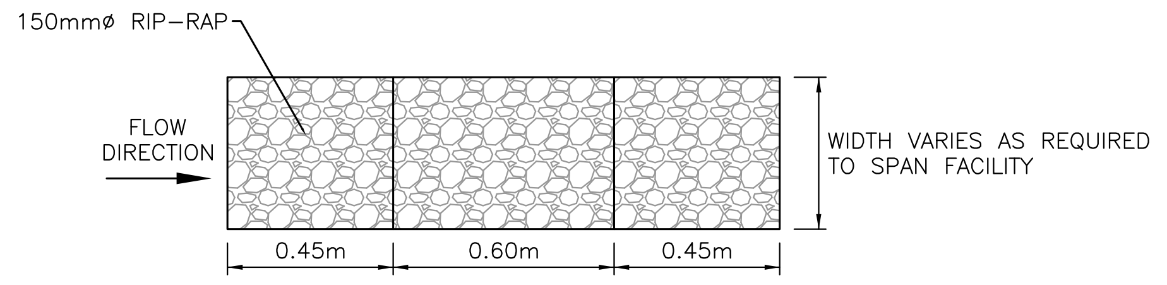
PRE–TREATMENT STRIP RIP–RAP CHECK DAM TYPICAL DETAIL
N.T.S.



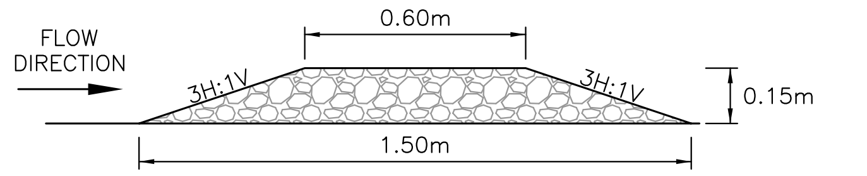
PRE–TREATMENT STRIP TYPICAL DETAIL
N.T.S.



MONITORING WELL TYPICAL DETAIL
N.T.S.



PLAN



PROFILE

INLINE RIP–RAP CHECK DAM TYPICAL DETAIL
N.T.S.

NOTES
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
2	REVISED PER COMMENTS	12/04/19	AHJ
1	REVISED PER COMMENTS	20/12/18	AHJ

SCALE
0 10m 20m 40m
HORIZONTAL 1:1000

Robinson
Land Development
350 Palladium Drive
Ottawa. ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN BLM
CHECKED AHJ
DRAWN BLM
CHECKED AHJ
APPROVED AHJ

1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

NOTES and DETAILS

PROJECT No. 18047
SURVEY CAVANAGH
DATED SEPTEMBER 2018
DWG. No: 18047-N1

D-07-12-18-0141

Brandon Mackechnie

Subject: 2596 Carp Road
Attachments: Washout Pit Design.docx

Hi Brandon,

- Concrete pad will be sloped towards the washout pits. At conclusion of shift for each truck, driver will add 300-400L of water to drum, mix and discharge slurry water into "Pit #1" on diagram. This is a ramp sloped down to a 6' drop. Weirs are cut into the concrete walls in the upper portion at opposite ends of each of the 4 pits. As the dirty, slurry water travels, the heavier fines rest at the bottom of the pits and cleaner water continues to filter as it progresses through each pit as more volume is added. The dirtiest pit being "Pit #1" sludge is removed by a front end loader and deposited into one of the two "Solids Bin" to dry out. Once majority of moisture dries out from the sludge by the sun in the enclosed concrete bin, material is loaded into dump trucks and brought to a Cavanagh quarry to be dumped. Since pits 2-4 cannot be accessed by a loader, these pits will cleaned out by a hydrovac truck as needed. (typically every couple months since majority of slurry solids stay in Pit #1.) Pit #4 in the washout system contains a submersible pump. Drivers will adjust (slump) their loads with the recycled water out of pit #4 after loading from the plant. This pit will eventually be plumbed directly to the water scale in the plant so the batcher can use 10% maximum directly in concrete batches to better manage the volume of recycled water in the pit. The entire system will need to be enclosed with a heater and access door for winter use. The washout pits will also capture truck rinse down after loading.

Kevin Brennan, PMP
Operations Manager
Cavanagh Concrete Ltd.
C: 613-327-3483
www.cavanaghconcrete.ca

Brandon Mackechnie

Subject: 2596 Carp Road - MVCA Comments

From: Kevin Brennan <KBrennan@cavanaghconcrete.ca>
Sent: April 3, 2019 1:08 PM
To: Brandon Mackechnie <bmackechnie@rcii.com>; Ben Houle <BHoule@thomascavanagh.ca>
Cc: Angela Jonkman <ajonkman@rcii.com>; Trevor Easton <TEaston@cavanaghconcrete.ca>
Subject: RE: 2596 Carp Road - MVCA Comments

Hi Brandon,

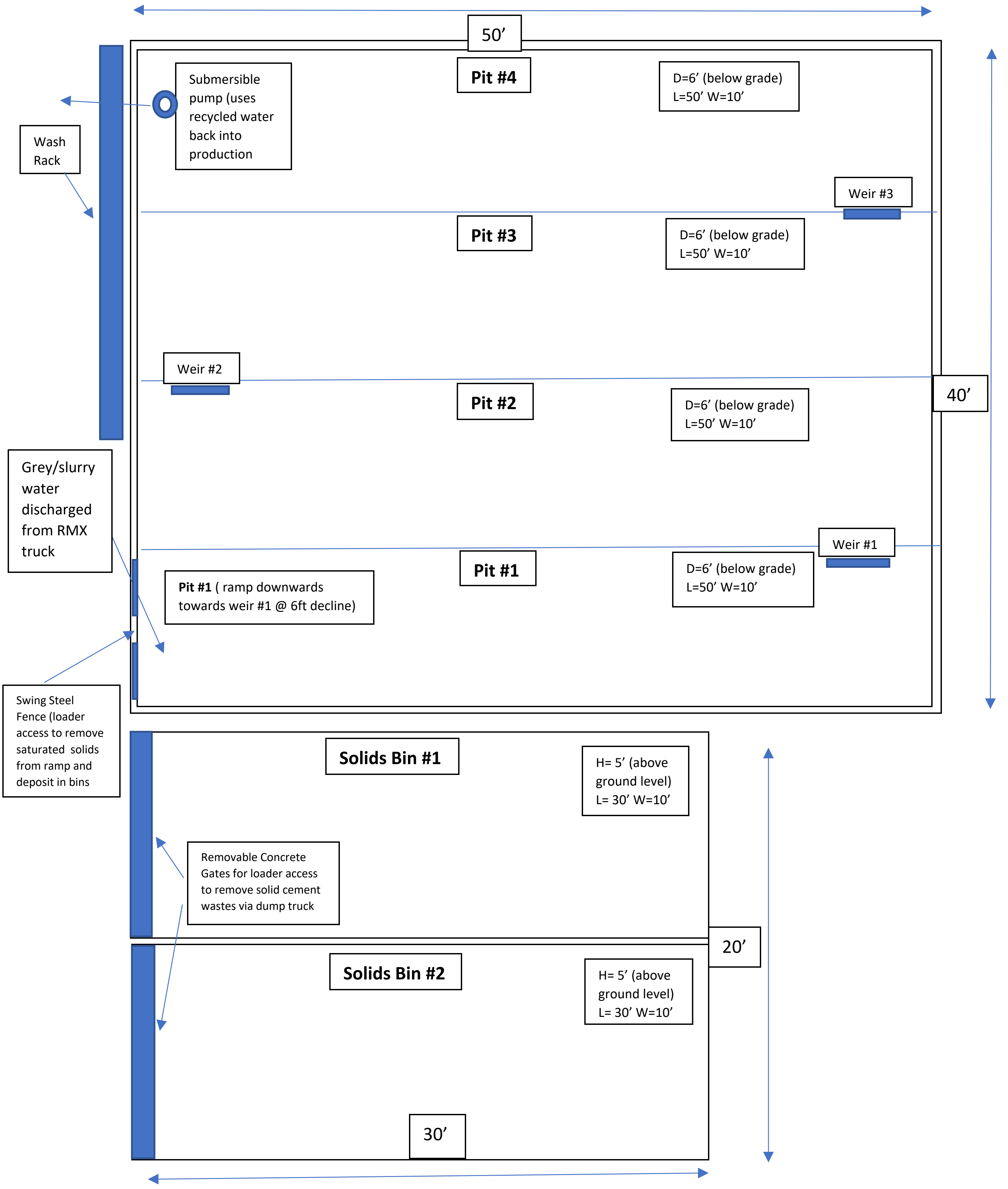
Percentage of recycled water content could likely be increased up to 20% provided concrete testing meets required strength in the event we approach pond capacity.
75% of the total pond capacity of 177,000L = 132,750L.
Max capacity day shift of 1000m3 of concrete @ avg. load size of 7m3 = 143 loads.
Avg. load rinse down activity = 75L(143 loads) = 10,725L/day
Avg. end of day rinse water = 400L(20 trucks) = 8,000L/day
Total daily input = 18,725L.

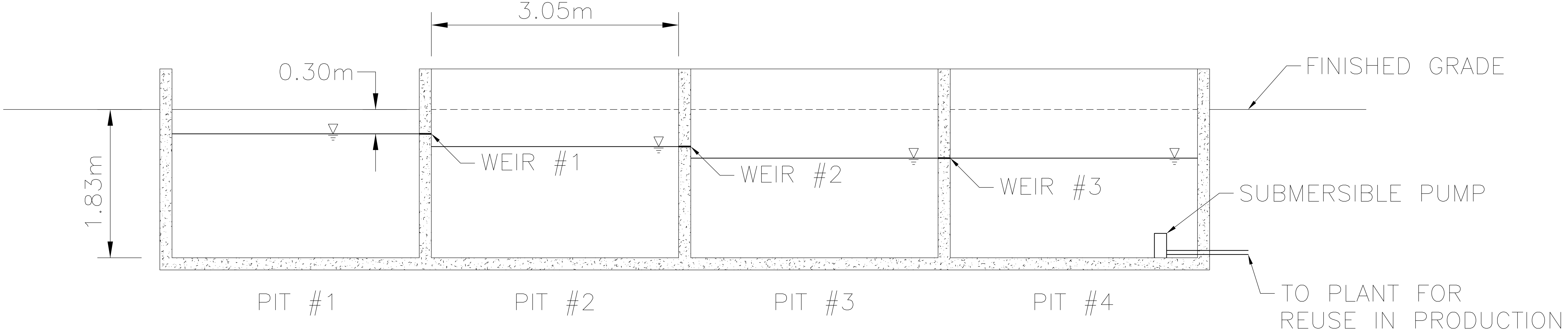
Avg water content per m3 concrete = 160L/m3 (1000m3) =160,000L (10% recycle content) = 16,000L

Therefore, at max production day, we would inputting 14% of capacity daily. Plant could operate at max production for approx. 7 consecutive days at 0% recycle water content before pond is full. 10% recycle should translate to the ponds near empty on daily basis. Hydrovac trucks are utilized to remove excess solids from the pits as required (typically every 2-3 months) In the unlikely event we are at pond capacity, excess water can be hauled off site through use of mixer trucks to a retention pond at the nearest Cavanagh quarry. The settling ponds will be covered and heated for winter operation.

Regards,

Kevin Brennan, PMP
Operations Manager
C: 613-327-3483
www.cavanaghconcrete.ca


50’
Pit #4
D=6’ (below grade) L=50’ W=10’
Submersible pump (uses recycled water back into production
Wash Rack
Weir #3
Pit #3
D=6’ (below grade) L=50’ W=10’
Weir #2
Pit #2
D=6’ (below grade) L=50’ W=10’
40’
Grey/slurry water discharged from RMX truck
Weir #1
Pit #1
D=6’ (below grade) L=50’ W=10’
Pit #1 (ramp downwards towards weir #1 @ 6ft decline)
Swing Steel Fence (loader access to remove saturated solids from ramp and deposit in bins
Solids Bin #1
H= 5’ (above ground level) L= 30’ W=10’
Removable Concrete Gates for loader access to remove solid cement wastes via dump truck
20’
Solids Bin #2
H= 5’ (above ground level) L= 30’ W=10’
30’


3.05m
0.30m
FINISHED GRADE
1.83m
WEIR #1
WEIR #2
WEIR #3
SUBMERSIBLE PUMP
PIT #1
PIT #2
PIT #3
PIT #4
TO PLANT FOR
REUSE IN PRODUCTION

Appendix B

Runoff Coefficient Calculations

Inspection and Maintenance

Figure 3.67 – Recommended Regional 90% Percentile Volume Control Targets for Ontario

Stormwater Management Plan
(DWG. 18047-SWM1)

Infiltration Rate Assessment
(Prepared by Golder Associates Ltd.)

Technical Memorandum
(Prepared by Golder Associates Ltd.)

Treatment Facility
Flow Calculations

Figure 3 - Available Surface Storage Plan

Culvert Sizing Details

Post-Development Runoff Coefficient Calculations

Drainage Area ID	Impervious Area (ha)	Pervious Area (ha)	Gravel Area (ha)	Total Area (ha)	C	C (100 YR)
SWM1	0.68	0.25	0.81	1.75	0.75	0.94
SWM2	0.55	0.29	0.69	1.52	0.72	0.90
SWM3	0.42	0.71	0.18	1.31	0.50	0.63
SWM4	0.00	3.56	0.00	3.56	0.20	0.25
SWM5	0.00	4.44	0.00	4.44	0.20	0.25

Pre-Development Runoff Coefficient Calculations

Drainage Area ID	Impervious Area (ha)	Pervious Area (ha)	Gravel Area (ha)	Total Area (ha)	C	C (100 YR)
PRE1	0.00	1.73	0.01	1.75	0.20	0.26
PRE2	0.00	1.52	0.00	1.52	0.20	0.25
PRE3	0.00	1.20	0.11	1.31	0.25	0.31
PRE4	0.01	3.25	0.30	3.56	0.25	0.31
PRE5	0.00	3.97	0.47	4.44	0.26	0.33

Notes:

1. $C_{impervious}$ = 0.90, $C_{pervious}$=0.20, C_{gravel}=0.80
2. 100 Year C = C + 25%

FACT SHEET

Sustainable Technologies
EVALUATION PROGRAM

Bioretention

Inspection and Maintenance of Stormwater Best Management Practices

Bioretention is a general term that refers to vegetated stormwater best management practices (BMPs) that temporarily store rainwater or snowmelt from roofs or pavements (i.e., stormwater runoff) in depressed planting beds or other structures (e.g., concrete planters). Bioretention treats stormwater by slowing it down, filtering it through soil and plant roots, soaking it into the ground and evaporating it back to the atmosphere. Runoff water is delivered to the practice through inlets such as curb-cuts, spillways or other concrete structures, sheet flow from pavement edges, or pipes connected to catchbasins or roof downspouts. The planting bed and side slopes are typically covered with a mixture of plants, mulch and stone. Water in excess of its storage capacity overflows to another BMP or the municipal storm sewer. Filtered water is either infiltrated into the underlying soil to replenish groundwater, or collected by a sub-drain (i.e., underground perforated pipe) and discharged to the storm sewer system or another BMP. Depending on the permeability of the underlying soil or other constraints, it may be designed with no sub-drain for full infiltration, with a sub-drain for partial infiltration, or with an impermeable liner and sub-drain for a no infiltration practice. The sub-drain pipe may feature a flow restrictor (e.g., orifice cap or valve) for gradually releasing detained water and optimizing the amount drained by infiltration. Key components of bioretention practices for inspection and maintenance are described in Table 1 and Figure 2.

Key components of bioretention to pay close attention to are the inlets, filter bed surface and overflow outlets. Trash, debris and sediment builds up at these locations and can prevent water from flowing into or out of the practice.

RELATED TERMS

Bioretention cell: A flat-bottomed, depressed planting bed containing filter media soil, a gravel water storage layer and optional sub-drain pipe(s); Also known as a **rain garden**.

Stormwater planter: A bioretention cell contained within an engineered (e.g., concrete) structure.

Biofilter: Bioretention cell or swale with an impermeable liner or containment structure and sub-drain.

Bioretention swale: A gently sloping, linear oriented bioretention practice designed to be capable of conveying water across an elevation gradient. Also known as a **bioswale** or **dry swale**.

BENEFITS

- Reduce the quantity of runoff and pollutants being discharged to municipal storm sewers and receiving waters (i.e., rivers, lakes and wetlands);
- Replenish groundwater resources and keep the flow of water to our rivers and lakes cool for temperature-sensitive fish like trout and salmon;
- Can be adapted to fit into many contexts (e.g., roadways, parking lots, plazas, parks and yards);
- Can provide a convenient area for snow storage and snowmelt treatment; and
- Can provide aesthetic value as attractive landscaped features.

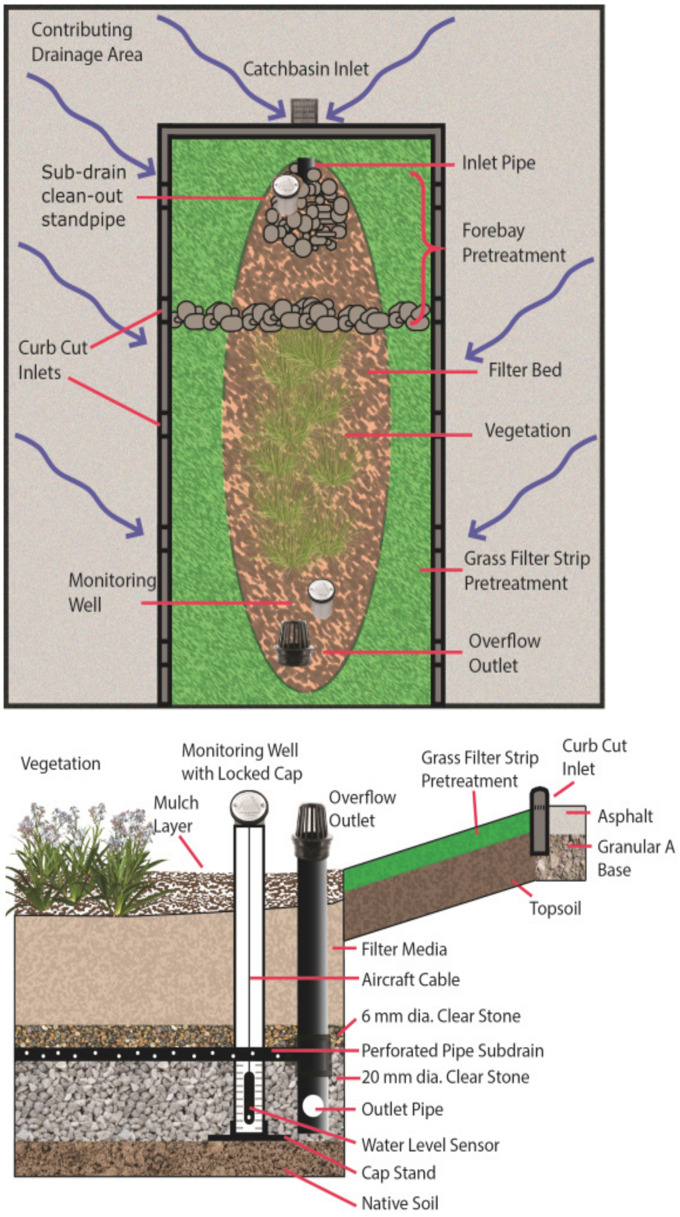
Figure 1. Bioretention in residential area

TIPS TO HELP PRESERVE BMP FUNCTION

- Maintain grading of the filter bed (or grass filter strip if present) at curb-cut inlets so at least 5 cm of the back of the curb is visible through regular sediment removal and regrading;
- To avoid over-compaction of the filter media soil, any maintenance tasks involving vehicle or foot traffic on the filter bed should not be performed during wet weather;
- For bioretention with sod (i.e., turf grass) as vegetation cover, maintain with a push mower or the lightest mulching ride mower available and core aerate and dethatch annually in the spring to help maintain permeability;
- Pruning of mature trees should be performed under the guidance of a Certified Arborist;
- Woody vegetation should not be planted or allowed to become established where snow will be piled/stored during winter; and
- Removal of sediment from the filter bed surface should be done with rake and shovel, or vacuum equipment to minimize plant disturbance. If a small excavator is to be used, keep it off the BMP footprint to avoid damage to side slopes/ embankments and over-compaction of the filter media.

KEY COMPONENTS AND INSPECTION AND MAINTENANCE TASKS

Figure 2. Generalized plan and cross-section view of a bioretention cell showing key components



* NOT TO SCALE *

Figure 3. Biofilter swale retrofit within the road right-of-way

Table 1. Key components, descriptions and routine inspection and maintenance tasks.

Component	Description	Inspection and Maintenance Tasks
Contributing drainage area (CDA)	Area(s) from which runoff directed to the BMP originates; includes both impervious and pervious areas.	• Remove trash, debris and sediment from pavements (biannually to quarterly) and eavestroughs (annually); • Replant or seed bare soil areas as needed.
Pretreatment	Devices or features that retain trash, debris and sediment; help to extend the operating life cycle; examples are eavestrough screens, catchbasin inserts and sumps, oil and grit separators, geotextile-lined inlets, gravel trenches, grass filter strips, forebays.	• Remove trash, debris and sediment annually to biannually or when the device sump is half full; • Measure sediment depth or volume during each cleaning, or annually to estimate accumulation rate and optimize frequency of maintenance.
Inlets	Structures that deliver water to the BMP (e.g., curb-cuts, spillways, pavement edges, catchbasins, pipes).	• Keep free of obstructions; • Remove trash, debris and sediment biannually to quarterly; • Measure sediment depth or volume during each cleaning or annually to estimate accumulation rate and optimize frequency of maintenance; • Remove woody vegetation from filter bed at inlets annually.
Perimeter	Side slopes or structures that define the BMP footprint; may be covered by a mixture of vegetation, mulch and stone with slopes up to 2:1 (H:V), or concrete or masonry structures with vertical walls.	• Confirm the surface ponding footprint area dimensions are within ±10% of the design and that maximum surface ponding depth meets design specifications; • Check for side slope erosion or damage that compromises water storage capacity.
Filter bed	Flat or gently sloping area composed of a 0.5 to 1 m deep layer of filter media soil covered by a mixture of vegetation, mulch and stone where surface ponding and filtration of runoff occurs.	• Check for standing water, barren/eroded areas, sinkholes or animal burrows; • Remove trash biannually to quarterly; • Rake regularly to redistribute mulch and prevent sediment crusts; • Maintain 5 to 10 cm of mulch or stone cover to prevent weed growth and soil erosion; • Repair sunken areas when ≥ 10 cm deep and barren/eroded areas when ≥ 30 cm long; • Remove sediment when > 5 cm deep or time to drain water ponded on the surface exceeds 48 hours.
Vegetation	A mixture of deep rooting perennial plants, tolerant to both wet and dry conditions and salt (if receiving pavement runoff); can include grasses, flowers, shrubs and trees; roots uptake water and return it to the atmosphere; provide habitat for organisms that break down trapped pollutants and help maintain soil structure and permeability.	• Routine maintenance is the same as a conventional perennial garden bed; • In the first 2 months water plantings frequently (biweekly in the absence or rain) and as needed (e.g., bimonthly) over the remainder of the first growing season; • Remove weeds and undesirable plants biannually to quarterly; • Replace dead plantings annually to achieve 80% cover by the third growing season; • Do not apply chemical fertilizers.
Overflow Outlet	Structures that convey overflows to another BMP or municipal storm sewer.	• Keep free of obstructions; • Remove trash, debris and sediment biannually to quarterly.
Sub-drain	Optional component; perforated pipe(s) surrounded by gravel and may be wrapped in geotextile filter fabric; installed below the filter media soil layer to collect and convey treated water to an adjacent drainage system; may also include a flow restrictor.	• Include standpipes or access points to provide means of flushing the perforated pipe; • Keep pipe and flow restrictor free of obstructions by flushing annually; • Inspect flow restrictor frequently (e.g., biannually to quarterly).
Monitoring well	Perforated standpipe that extends from the bottom of the BMP to above the invert of the overflow outlet. Allows measurement of subsurface water level to track drainage performance over time.	• Standpipes should be securely capped on both ends and remain undamaged.

Figure 4. Urban bioretentions

REHABILITATION

Table 2. Key components, typical problems and rehabilitation tasks.

Component	Problem	Rehabilitation Tasks
Inlets	Inlet is producing concentrated flow and causing filter bed erosion	Add flow spreading device or re-grade existing device back to level. Rake to regrade damaged portion of the filter bed and replant or restore mulch/stone cover. If problem persists, replace some mulch cover with stone.
Filter bed	Local or average sediment accumulation ≥ 5 cm in depth	At inlets remove stone and use vacuum equipment or rake and shovel to remove sediment. For large areas or BMPs, use of a small excavator may be preferable. Restore grades with filter media that meets design specifications. Test surface infiltration rate (one test for every 25 m^2 of filter bed area) to confirm it is > 25 mm/h. Replace stone, mulch and plant cover (re-use/transplant where possible). If problem persists, add pretreatment device(s) or investigate the source(s).
	Surface ponding remains for > 48 hours or surface infiltration rate is <25 mm/h.	Remove sediment as described above. Core aerate (for sodded bioretention); or remove stone, sediment, mulch, and plant cover and till the exposed filter media to a depth of 20 cm; or remove and replace the uppermost 15 cm of material with filter media that meets specifications. Test surface infiltration rate (one test for every 25 m^2 of filter bed area) to confirm it is > 25 mm/h. Replace stone, mulch and plants (re-use/transplant where possible).
	Damage to filter bed or slide slope is present (e.g., erosion rills, animal burrows, sink holes, ruts)	Regrade damaged portion by raking and replant or restore mulch/stone cover. Animal burrows, sink holes and compacted areas should be tilled to 20 cm depth prior to re-grading. If problems persist, consider adding flow spreading device to prevent erosion or barriers to discourage foot or vehicular traffic.
Vegetation	Vegetation is not thriving AND filter media is low in organic matter (<3%) or extractable phosphorus (<10 mg/kg)	Remove stone, mulch and plant cover and uppermost 5 cm of filter media, spread 5 cm of yard waste compost, incorporate into filter media to 20 cm depth by tilling. Replace stone, mulch and plants (re-use/transplant where possible).
Sub-drain	Sub-drain perforated pipe is obstructed by sediment or roots	Schedule hydro-vac truck or drain-snaking service to clear the obstruction.

TYPES OF INSPECTIONS

Routine Operation: Regular inspections (twice annually, at a minimum) done as part of routine maintenance tasks over the operating phase of the BMP life cycle to determine if maintenance task frequencies are adequate and determine when rehabilitation or further investigations into BMP function are warranted.

Maintenance and Performance Verification: Periodic inspections done every 5 years (Maintenance Verifications) and every 15 years (Performance Verifications) post-construction over the operating phase of the BMP life cycle to ensure compliance with maintenance agreement (e.g., Environmental Compliance Approval permit) conditions, evaluate functional performance and determine when rehabilitation or replacement is warranted.

INSPECTION TIME COMMITMENTS AND COSTS

Estimates are based on a typical partial infiltration bioretention design (i.e., includes a sub-drain); estimates for other designs (i.e., full infiltration and no-infiltration) are described in the Low Impact Development (LID) Stormwater Management Practice Inspection and Maintenance Guide available at https://sustainabletechnologies.ca.

Table 3. Time commitments and costs for inspection

Bioretention	Routine Operation	Maintenance Verification	Performance Verification
Tasks to complete	18	15	15
Visits (per year)	2	1 every 5 years	1 every 15 years
Time (hours per m^2 BMP area)	0.012	0.010	0.010
Cost	$1.33	$0.66	$2.31
Performance Verification Options ($ per m^2 BMP area)			
Surface infiltration rate testing: $5.48, 5 tests			
Simulated storm event testing: $15.70			
Natural storm event testing: $15.00, 2 months monitoring			

Figure 5. Sediment removal in Spring

Table 4. Task cost estimates for maintenance and rehabilitation of a partial infiltration bioretention

Bioretention	Costs per m^2 of BMP area	
Tasks	**Min.**	**High**
Watering - first year only	$3.67	$3.67
Watering - second year only	$1.24	$1.51
Annual watering - Starts in year 3	$0.37	$0.73
Drought watering	$0.19	$0.19
Remove litter and debris	$0.33	$0.63
Prune shrubs or trees	$0.45	$0.45
Weeding	$0.31	$0.61
Sediment removal - starts year 2	$1.36	$2.71
Add mulch to maintain 5 to 10 cm - starts year 2	$3.77	$3.77
Replace dead plantings - starts year 2	$3.35	$6.69
Flush sub-drain - starts year 2	$0.59	$0.59
Rehabilitation (every 25 years)	$59.46	$59.46

Figure 5. Leaves clogging inlet to bioretention

For a detailed description of construction, inspection, maintenance and rehabilitation cost assumptions see section 7.1.7 of the LID Stormwater Management Practice Inspection and Maintenance Guide. To generate BMP-specific cost estimates use the LID Life Cycle Costing Tool available at https://sustainabletechnologies.ca.

Table 2. Construction and life cycle cost estimates

Bioretention	**Costs per m^2 of BMP area + CDA**	
	Minimum	**High**
Construction	$17.02	
LIFE CYCLE COSTS		
25 year evaluation period		
Average annual maintenance	$0.75	$1.08
Maintenance and rehabilitation	$21.33	$28.36
50 year evaluation period		
Average annual maintenance	$0.70	$0.98
Maintenance and rehabilitation	$39.09	$53.25

Figure 6. Continuous water level monitoring in a bioretention

Figure 7. Overflow pipe in bioretention

This communication has been prepared by the Sustainable Technologies Evaluation Program (STEP) with funding support from the Toronto and Region Remedial Action Plan (RAP), Region of Peel, York Region and City of Toronto. The contents of this fact sheet do not necessarily represent the policies of the supporting agencies and the funding does not indicate an endorsement of the contents.

For more detailed information on inspection, testing and maintenance of bioretention and a field data form (checklist) to use for collecting and recording inspection results, please refer to Appendix D of the Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide, available at **https://sustainabletechologies.ca.**

For more information about STEP and other resources and studies related to stormwater management, visit our website or email us at **STEP@trca.on.ca.**

Toronto and Region
Conservation
for The Living City®

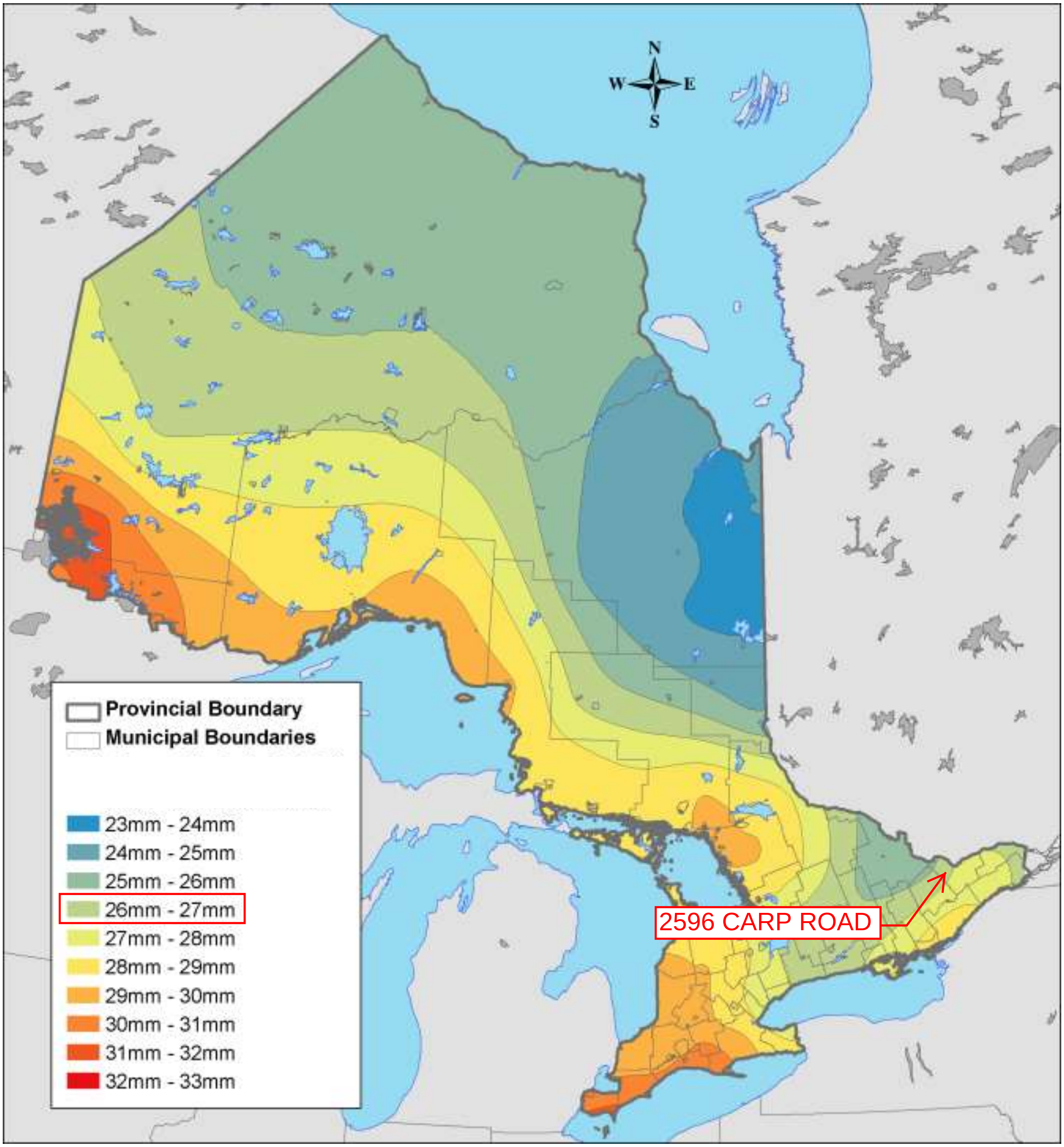
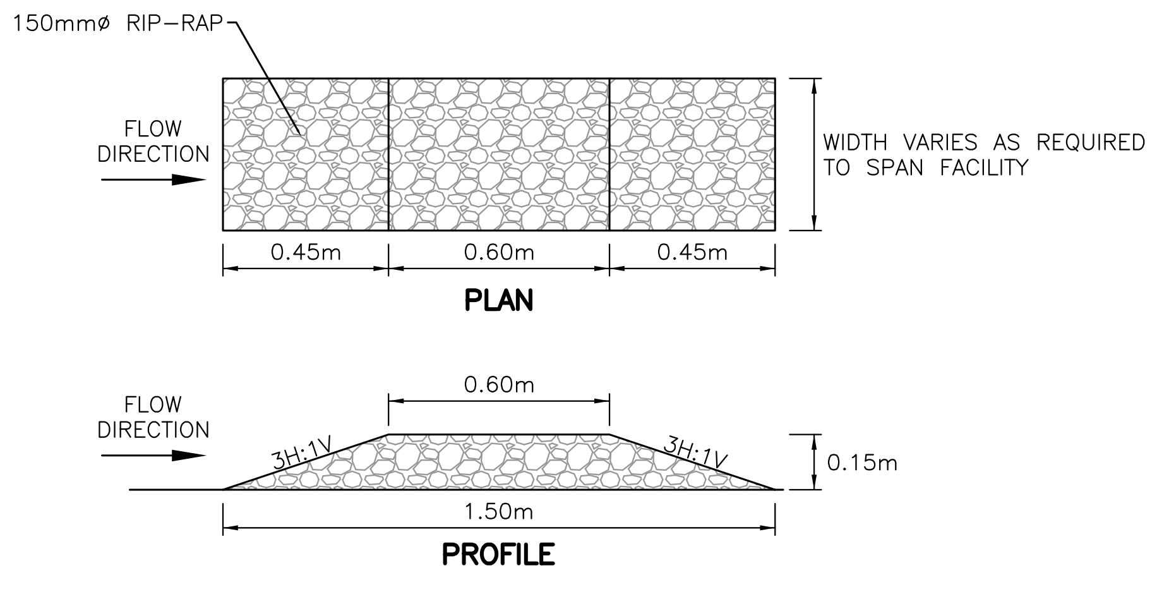
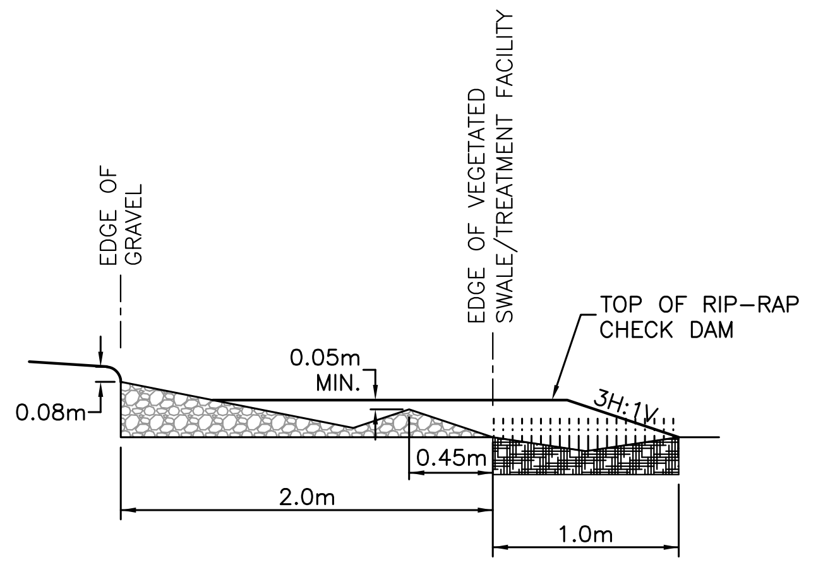


Figure 3.67 – Recommended Regional 90% Percentile Volume Targets for Ontario
(represented by the 95th percentile daily rainfall contours April - October, where daily volume exceeds 2 mm).

STORMWATER QUALITY STORAGE VOLUME REQUIREMENTS				
CATCHMENT AREA	CATCHMENT AREA (m^2)	REQUIRED QUALITY STORAGE VOLUME (m^3)	EFFECTIVE TREATMENT SURFACE AREA (m^2)	PROVIDED QUALITY STORAGE VOLUME (m^3)
SWM1	17,482	472.0	1275	472.4
SWM2	15,243	411.5	875	422.2



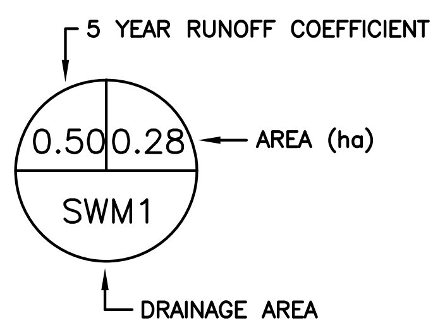
INLINE RIP–RAP CHECK DAM TYPICAL DETAIL
N.T.S.



PRE–TREATMENT STRIP
RIP–RAP CHECK DAM TYPICAL DETAIL
N.T.S.

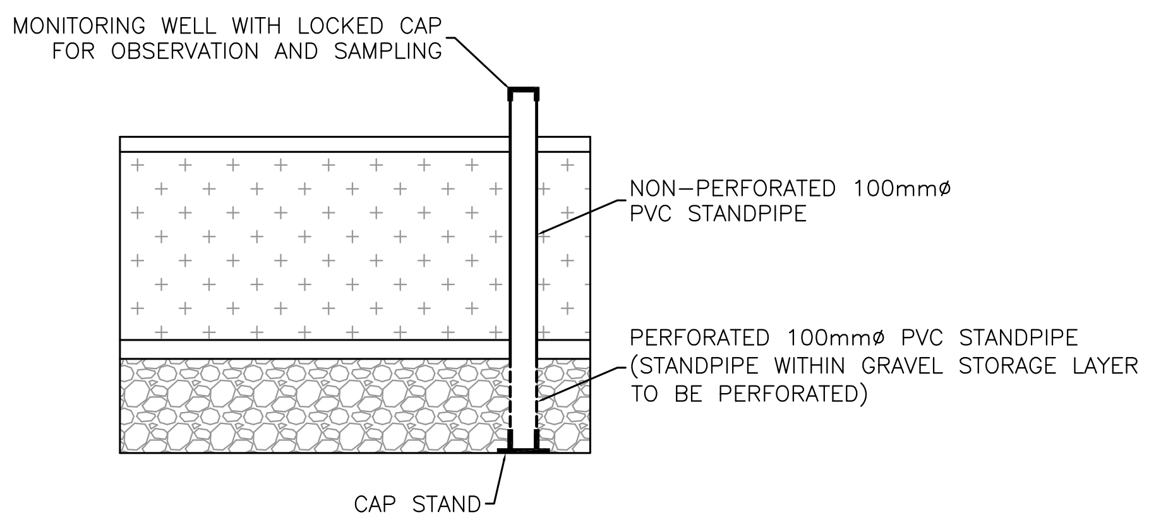
LEGEND

— – —	PROPERTY BOUNDARY
—	DRAINAGE AREA BOUNDARY
—— · ——	MEANDER BELT SETBACK
– – – –	15 METRE SETBACK
━━	100 YEAR FLOOD PLAIN
– · — · –	HIGH WATER MARK SETBACK
– – – –	EXISTING GRAVEL ROAD
– · – · –	EXISTING DITCH
MW ●	MONITORING WELL
⇒	MAJOR OVERLAND FLOW ROUTE
▨	PRE–TREATMENT AREA
☐	BIORETENTION TREATMENT AREA

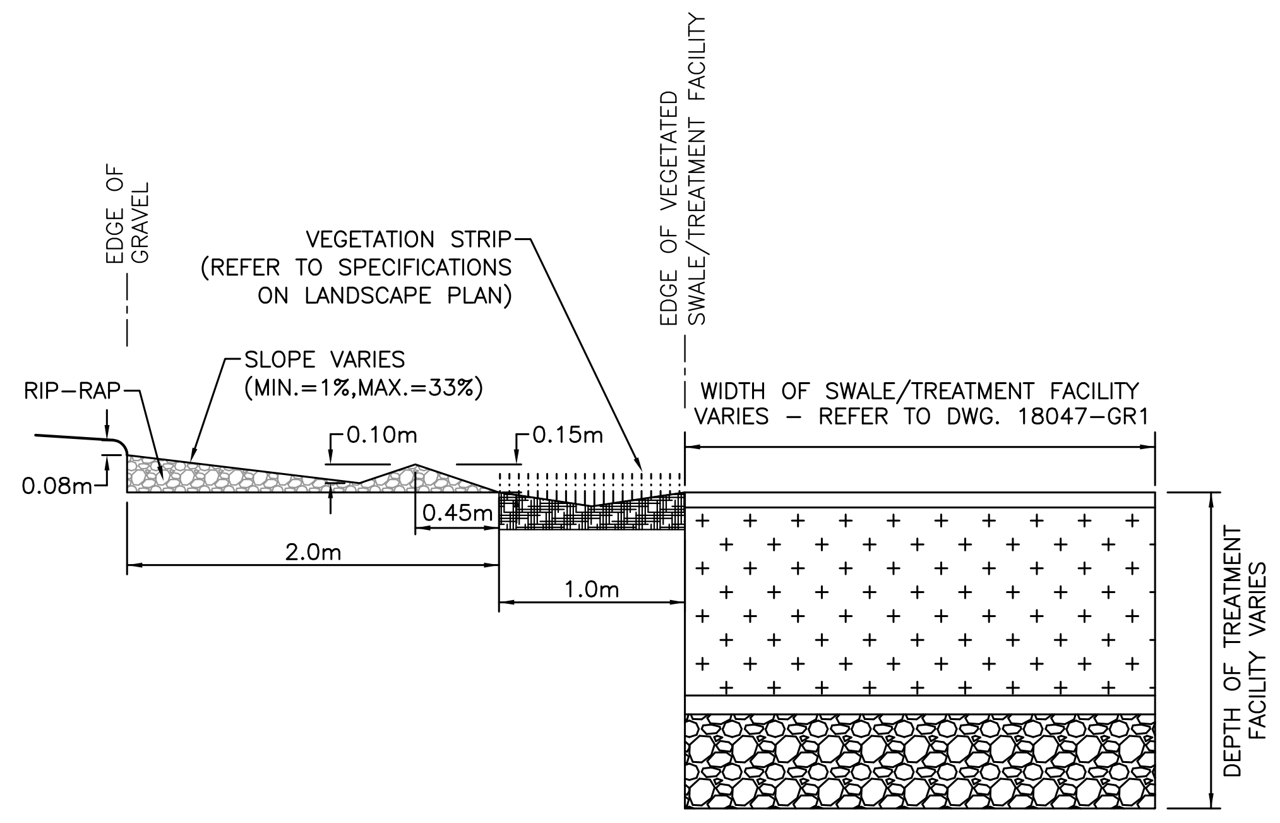


DRAINAGE AREA RUNOFF COEFFICIENTS			
DRAINAGE AREA	AREA (ha)	5 YEAR C–VALUE	100 YEAR C–VALUE
SWM1	1.75	0.75	0.94
SWM2	1.52	0.72	0.90
SWM3	1.31	0.50	0.63
SWM4	3.56	0.20	0.25
SWM5	4.44	0.20	0.25

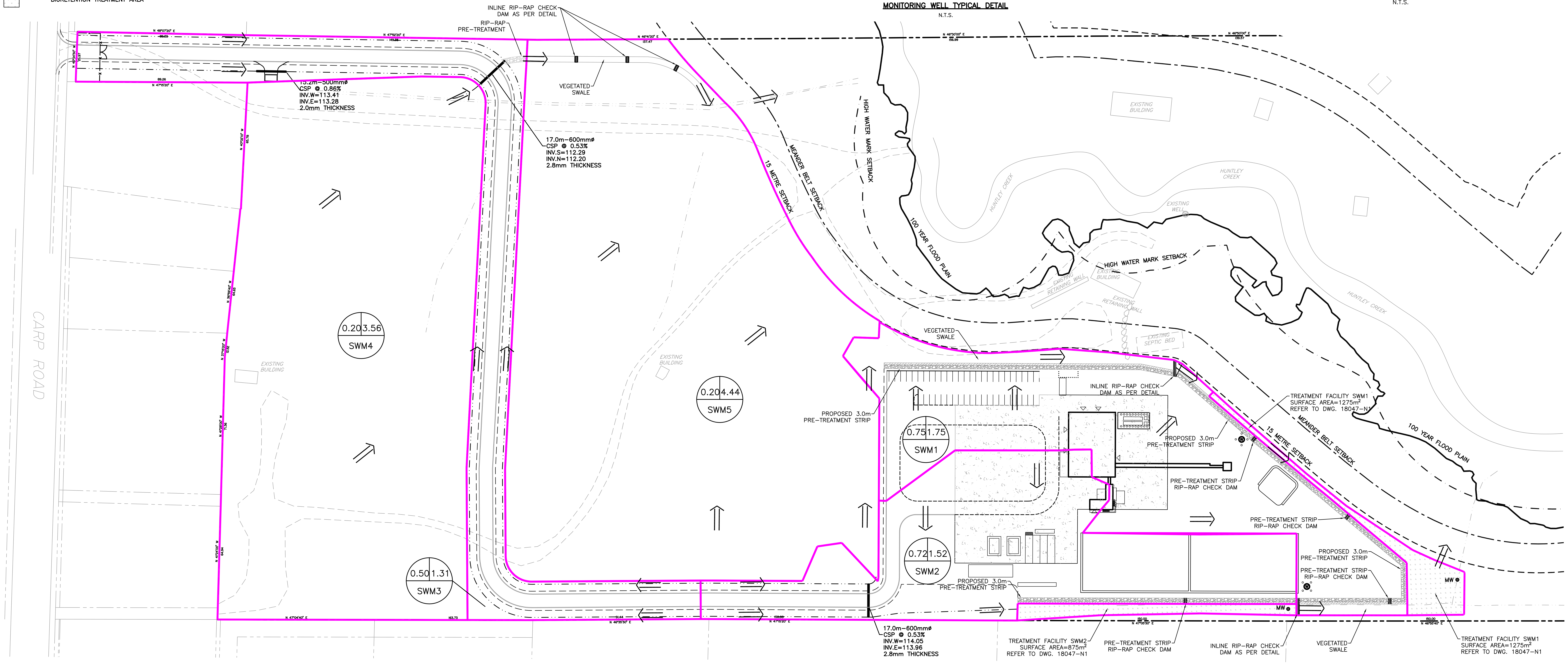
NOTES:
1. 100 YEAR C–VALUE = 5 YEAR C–VALUE + 25%



MONITORING WELL TYPICAL DETAIL
N.T.S.



PRE–TREATMENT STRIP TYPICAL DETAIL
N.T.S.



NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM. ALL ELEVATIONS SHOWN ARE GEODETIC.

NO.	REVISION DESCRIPTION	DATE	BY
3	REVISED PER COMMENTS	12/04/19	AHJ
2	REVISED PER COMMENTS	20/12/18	AHJ
1	ISSUED FOR SITE PLAN APPLICATION	19/09/18	AHJ

SCALE
0 10m 20m 40m
HORIZONTAL 1:1000

Apr.12/19
A. H. JONKMAN

Robinson
Land Development

350 Palladium Drive
Ottawa, ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	BLM
CHECKED	AHJ
DRAWN	BLM
CHECKED	AHJ
APPROVED	AHJ

1384341 ONTARIO LTD.

2596 CARP ROAD
OTTAWA, ON

STORMWATER MANAGEMENT PLAN

PROJECT No. 18047
SURVEY CAVANAGH
DATED SEPTEMBER 2018
DWG. No: 18047-SWM1

D-07-12-18-0141

GOLDER

TECHNICAL MEMORANDUM

DATE September 5, 2018 **Project No.** 1543767-2001

TO Ben Houle, P.Eng.
Cavanagh Developments

FROM Brian Byerley, P.Eng. **EMAIL** bbyerley@golder.com

INFILTRATION RATE ASSESSMENT
2596 CARP ROAD, OTTAWA, ONTARIO

Golder Associates Ltd. (Golder), under contract with Cavanagh Developments (Cavanagh), undertook an assessment of the infiltration characteristics of the soils at eleven locations within the footprint of a proposed stormwater management system. The tests were completed at 2596 Carp Road in Ottawa, Ontario, in order to support the stormwater management system design by Robinson Land Development Inc. (Robinson). Figure 1, attached, shows the site and testing locations.

Method

Measurement of the field-saturated hydraulic conductivity (K_{fs}) of near surface soils was carried out using a Guelph Permeameter apparatus (Model 2800K1) at 11 on-site locations by Golder personnel between August 13 and August 23, 2018. Testing locations were evenly distributed within the footprint of the proposed stormwater management system. The test locations, identified as GP-01 through GP-11 (see attached Figure 1), were surveyed by Cavanagh. The testing methodology was based on the stormwater infiltration best management practices described in the Stormwater Management Criteria: Appendix B: Water Balance and Recharge document prepared by the Credit Valley Conservation Authority (CVCA, 2012).

At each testing location, the Guelph Permeameter was installed in a 6 centimeter (cm) diameter hand-augered hole at a depth ranging from 0.27 to 1.25 metres below ground surface. All tests were completed in unsaturated soils (above the water table). The soils encountered during the hand augering were documented at each location. The Guelph Permeameter was operated according to the single head method. The outflow of water at the testing depth was monitored until it was determined that it had reached steady-state. The field-saturated hydraulic conductivity of the soil was estimated using the following equation (Elrick et al., 1989):

$$K_{fs} = \frac{C_1 Q_1}{2H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{a^*}}$$

Where: C_1 = shape factor
Q_1 = flow rate (cm^3/s)
H_1 = water column height (cm)
a = well radius (cm)
a^* = alpha factor (0.12 cm^{-1})

In accordance with CVCA, 2012, the percolation rate ("T-time" in min/cm) corresponding to each K_{fs} was estimated based on information presented in Tables 2 and 3 of the Supplementary Standard SB-6 Percolation Time and Soil Descriptions, of the Ontario Building Code (OMMAH, 2012) summarized below:

Field-Saturated Hydraulic Conductivity K_{fs} (cm/s)	Estimated Percolation Time, T (min/cm)	Infiltration Rate, 1/T (mm/hr)
10^{-1}	2	300
10^{-2}	4	150
10^{-3}	8	75
10^{-4}	12	50
10^{-5}	20	30
10^{-6}	50	12

Design infiltration rates were then determined in accordance with Table B3 of the Stormwater Management Criteria: Appendix B: Water Balance and Recharge document prepared by the Credit Valley Conservation Authority (CVCA, 2012).

Results

Description of the soils encountered during the hand augering for the Guelph Permeameter testing are presented in the auger holes records included in Attachment 1. The soils identified at the testing locations consist of silty sand, sandy silt, glacial till, sand fill and silty clay.

Groundwater conditions observed in each auger hole are included in Attachment 1. Groundwater levels were also measured in nearby monitoring wells as follows (Borehole Records are included as Attachment 2):

Monitoring Well Location	Measurement Date	Depth to Water Table (m)	Water Table Elevation (masl)
BH15-4	Aug 16, 2018	2.50	107.81
BH15-4	April 26, 2017	1.52	108.79
BH18-13	Aug 24, 2018	>4.19	<107.40
*BH18-6	Aug 18, 2018	1.25	109.61
*BH18-7	Aug 17, 2018	1.52	111.18
*BH 18-1	Aug 17, 2018	0.69	112.21

* Installed by Gemtec

The depth to the water table at/near the Guelph Permeameter testing locations ranged from 0.43 metres at GP1 to greater than 4.19 metres at BH18-13.

The results of the infiltration tests are summarized in the attached Table 1. Based on the testing results, the mean field-saturated hydraulic conductivity of the native soils ranges from 1×10^{-4} cm/s (silty sand) to 8×10^{-6} cm/s (silty clay). One test was completed in sand fill. Testing results indicate that the saturated hydraulic conductivity of the sand fill is 3×10^{-3} cm/s.

The percolation times (T-time) and the infiltration rates associated with each test result were determined, and are also summarized in Table 1. Percolation times range from 6 min/cm to 22 min/cm. Infiltration rates (the inverse of the T-times) were calculated to range from 27 mm/hr to 100 mm/hr.

Because the results of the Guelph Permeameter testing indicate that, at each testing location, K_{fs} does not decrease with depth, the recommended “safety correction factor” to calculate the design infiltration rate is 2.5 (CVCA, 2012). Therefore, the design infiltration rates were calculated to range from 11 mm/hr to 40 mm/hr. The design infiltration rate calculated using the geomean of the infiltration rates at all Guelph Permeameter testing locations is 22 mm/hr.

Closure

We trust the information included meets your current needs. Should you require clarification, please do not hesitate to contact us.

Yours truly,

Golder Associates Ltd.

Loren Bekeris, M.Sc., P.Eng.
Environmental Engineer

Brian Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Principal

LICENSED PROFESSIONAL ENGINEER
B. T. BYERLEY
Sept 5/18
PROVINCE OF ONTARIO

BTB/LEB/sg
\\golder.gds\gal\ottawa\active\2015\3 proj\1543767 cavanagh industrial subdivision carp\04_reporting\hydrogeology\stormwater infiltration\1543767-tm- infiltration rates_5sep2018.docx

Attachments: Table 1: Guelph Permeameter Infiltration Rate Testing Results August 2018
Figure 1: Field Investigation Locations
Attachment 1: Record of Guelph Permeameter Testing Auger Holes
Attachment 2: Borehole Records

References

Elrick, D.E., W.D. Reynolds, and K.A. Tan. 1989. Hydraulic conductivity measurements in the unsaturated zone using improved well analyses. Ground Water Monitoring Review. 9:184-193.

Credit Valley Conservation Authority (CVCA). 2012. Stormwater Management Criteria: Appendix B: Water Balance and Recharge document.

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2012. Supplementary Guidelines to the Ontario Building Code 2012. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

Table 1: Guelph Permeameter Infiltration Rate Testing Results August 2018

st Depth (m)	Test Elevation (masl)	Material	Depth to Water Table (m)[1]	K_{sat} (cm/s)	T-Time (min/cm)	1/T (Infiltration Rate mm/hr)	Design Infiltration Rate (mm/hr)
0.27	112.3	sand (fill)	0.43	3E-03	6	100	40
1.15	111.2	silty sand	dry to 1.15	1E-04	12	50	20
0.90	112.1	glacial till	dry to 0.90	6E-04	9	67	27
1.01	111.6	silty sand	dry to 1.01	8E-05	13	46	18
1.08	110.9	sandy silt	1.35	4E-05	14	43	17
1.25	109.0	weathered crust	2.50[2]	6E-05	13	46	18
1.18	108.9	silty clay	dry to 1.18	8E-06	22	27	11
1.10	108.9	silty sand	dry to 1.10	2E-04	10	60	24
1.12	109.4	silty sand to sand	dry to 1.12	1E-03	8	75	30
1.02	109.6	sandy silt	dry to 4.19[3]	3E-05	14	43	17
1.15	111.1	silty sand	dry to 4.19[3]	1E-04	12	50	20

in open auger hole except for GP-6, GP-10 and GP-11

4

13

Path: N:\Active\Spatial_IM\ThomasCavanagh\Industrial_Subd_Carp\99_PROJ\1543767_Cavanagh_Various\40_PROD\Phase2001_HydroG_Infiltration\1543767-2001-CH-0001.mxd

ATTACHMENT 1

Record of Guelph Permeameter Testing Auger Holes

RECORD OF GUELPH PERMEAMETER TESTING AUGER HOLES

Test Location Number	Depth (m)	DESCRIPTION
GP-01	0.00 – 0.15	TOPSOIL
	0.15 – 0.50	SAND, light brown; non-cohesive; moist (Fill)
	0.50	End of Test Location (test run at 0.27 m; water table at 0.43 m)
GP-02	0.00 – 0.45	SAND, light brown; non-cohesive; moist (Fill)
	0.45 – 0.70	SANDY SILT to SILTY SAND; grey-brown; non-cohesive; moist
	0.70 – 1.15	SILTY SAND to SAND; grey-brown; non-cohesive; moist
	1.15	End of Test Location
GP-03	0.00 – 0.32	TOPSOIL
	0.32 – 0.41	SILTY SAND; brown; non-cohesive; moist
	0.41 – 0.77	SILTY SAND; some gravel; brown; non-cohesive; moist
	0.77 – 0.90	SILTY SAND; cobbles; some gravel; brown; non-cohesive; moist (GLACIAL TILL)
	0.90	End of Test Location (auger refusal on cobble)
GP-04	0.00 – 0.25	TOPSOIL
	0.25 – 0.60	SILTY SAND; some gravel; brown; non-cohesive; moist
	0.60 – 1.01	SILTY SAND; some gravel; grey-brown; non-cohesive; moist
	1.01	End of Test Location
GP-05	0.00 – 0.10	TOPSOIL
	0.10 – 0.95	SAND, light brown; non-cohesive; moist (Fill)
	0.95 – 1.35	SANDY SILT; grey-brown; non-cohesive; moist
	1.35	End of Test Location (test run at 1.08 m; water table at 1.35 m)
GP-06	0.00 – 0.25	TOPSOIL
	0.25 – 0.65	SILTY SAND; brown; non-cohesive; moist
	0.65 – 1.25	SILTY CLAY; sand seams; grey-brown; cohesive; moist (Weathered Crust)
	1.25	End of Test Location
GP-07	0.00 – 0.30	TOPSOIL
	0.30 – 0.70	SILTY SAND to SAND; light brown; non-cohesive; moist
	0.70 – 0.95	SILTY CLAY; sand seams; grey-brown; cohesive; moist (Weathered Crust)
	0.95 – 1.18	SILTY CLAY; sand seams; grey-brown; cohesive; moist
	1.18	End of Test Location

RECORD OF GUELPH PERMEAMETER TESTING AUGER HOLES

Test Location Number	Depth (m)	DESCRIPTION
GP-08	0.00 – 0.20	TOPSOIL
	0.20 – 0.80	SILTY CLAY; sand seams; grey-brown; cohesive; moist (Weathered Crust)
	0.8 – 1.10	SILTY SAND; grey-brown; non-cohesive; moist
	1.10	End of Test Location
GP-09	0.00 – 0.30	TOPSOIL
	0.30 – 0.60	SILTY SAND; light brown; non-cohesive; moist
	0.60 – 0.85	SANDY SILT; grey-brown; non-cohesive; moist
	0.85 – 1.12	SILTY SAND to SAND; grey-brown; non-cohesive; moist
	1.12	End of Test Location
GP-10	0.00 – 0.40	TOPSOIL
	0.40 – 0.80	SILTY SAND; light brown; non-cohesive; moist
	0.80 – 1.02	SANDY SILT; grey-brown; non-cohesive; moist
	1.02	End of Test Location
GP-11	0.0 – 0.10	TOPSOIL
	0.10 – 1.15	SILTY SAND; brown; non-cohesive; moist
	1.15	End of Test Location

ATTACHMENT 2

Borehole Records

PROJECT: 1543767

RECORD OF BOREHOLE: 15-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 7, 2015

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m
		GROUND SURFACE	110.31			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive, moist	0.00			
		(SM) SILTY SAND to sandy SILT; brown; non-cohesive, moist	109.90 0.41			
		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	109.55 0.76			
1		(SM) SILTY SAND, fine, trace gravel; brown, contains organics; non-cohesive, moist, compact	0.91	1 2	SS SS	10 17
2		(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, dense to very dense	108.25 2.06	3	SS	30
3 4 5		(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL)	107.26 3.05	4 5 6	SS SS SS	53 82 41
6 7 8 9 10		End of Borehole Auger Refusal	105.05 5.26			

STRATA PLOT

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

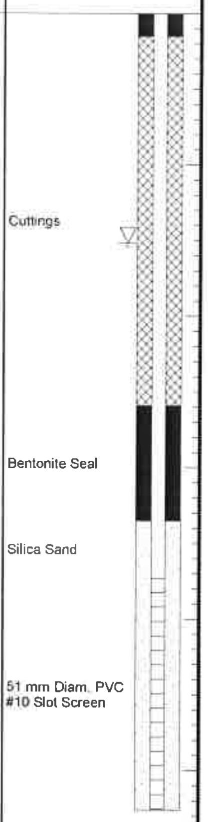
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



W.L. in Screen at Elev. 108.79 m on April 26, 2017

DEPTH SCALE
1 : 50

GOLDER

LOGGED: HEC
CHECKED: BTB

PROJECT: 1543767

RECORD OF BOREHOLE: 18-13

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 24, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		111.59							
0	Power Auger 200 mm Diam. (Hollow Stem)	Sandy GRAVEL; brown grey, contains cobbles (GLACIAL TILL); non-cohesive	▨	0.00							
1											Bentonite Seal
2											Silica Sand
3											51 mm Diam. PVC #10 Slot Screen
4				107.40 4.19							
		End of Borehole Auger Refusal									Well screen dry upon completion of borehole
5											
6											
7											
8											
9											
10											

MIS-BHS 001 1543767.GPJ GAL-MIS.GDT 09/05/18 JEM

DEPTH SCALE

1 : 50

GOLDER

LOGGED: EL

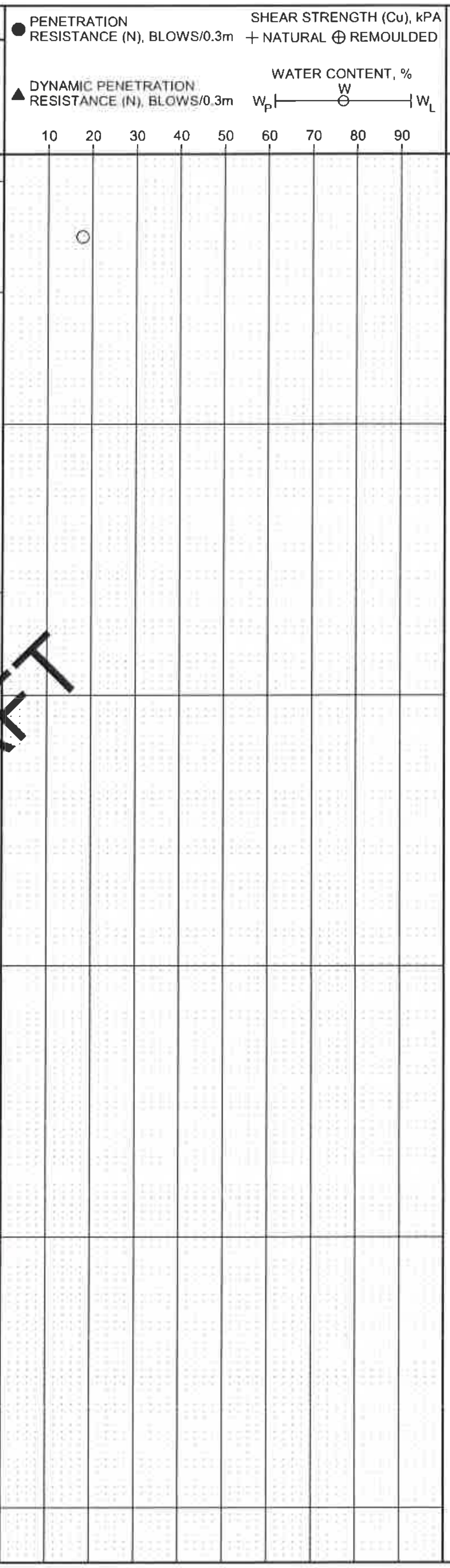
CHECKED: BTB

RECORD OF BOREHOLE 18-1

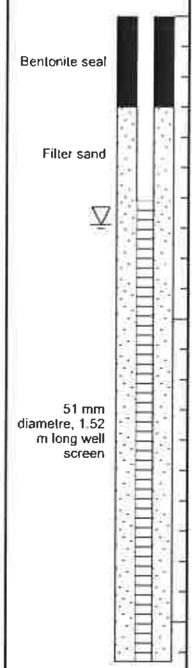
CLIENT: Cavanagh Developments
PROJECT: 2596 Carp Road
JOB#: 61318.20
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Aug 8 2018

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES				ADDITIONAL LAB. TESTING
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		112.90					
		TOPSOIL		0.05					
		Brown SAND, trace silt		112.49 0.41	1	GS			M
1		Grey SILTY SAND, trace clay		110.77 2.13	2	GS			
2		End of borehole							
3									
4									
5									



PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18/08/17	0.69 ∇	112.21

GEMTEC
Consulting Engineers and Scientists

LOGGED: K.H.
CHECKED: B.W.

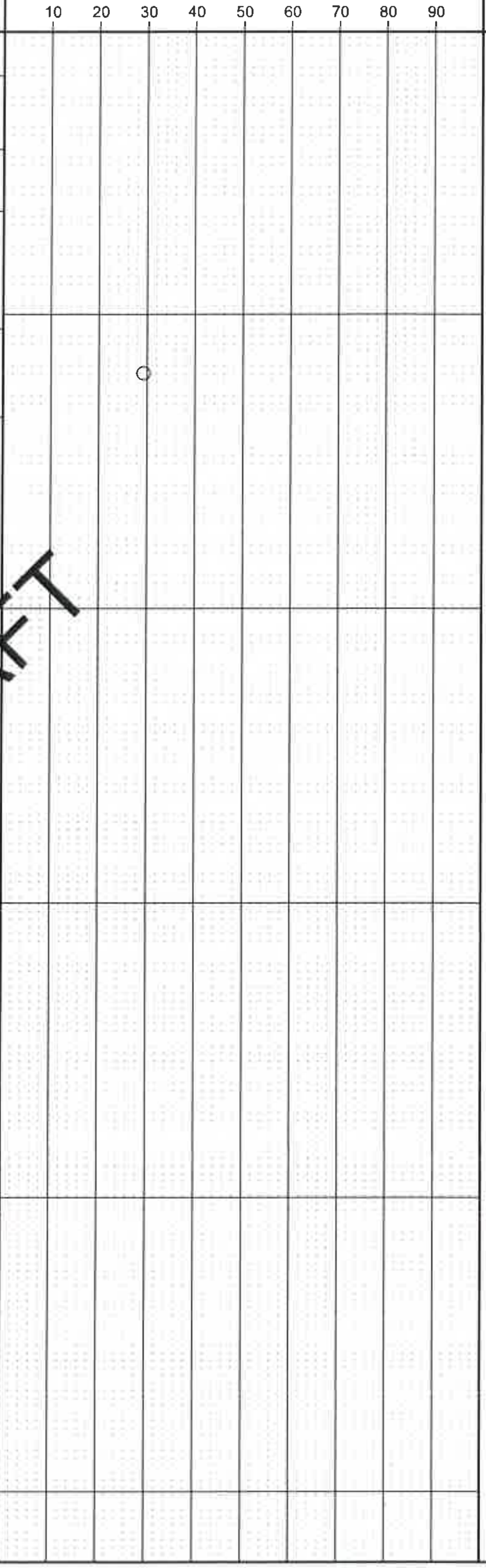
RECORD OF BOREHOLE 18-6

CLIENT: Cavanagh Developments
PROJECT: 2596 Carp Road
JOB#: 61318.20
LOCATION: See Borehole Location Plan, Figure 2

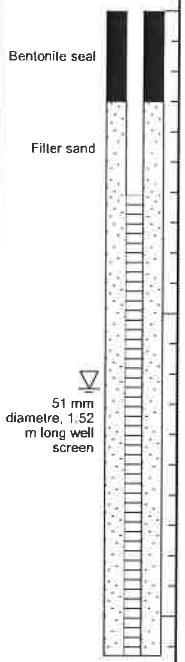
SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Aug 8 2018

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		110.86					
		TOPSOIL		0.05					
		Dark brown SILTY SAND		110.56 0.30	1	GS			
		Brown SAND, trace silt and gravel		110.35 0.51	2	GS			
1		Grey brown SILTY SAND			3	GS			M
2				108.73 2.13					
		End of borehole							
3									
4									
5									

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE (N), BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P ⊢ W ○ ⊣ W_L



PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18/08/17	1.25 ▽	109.61

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

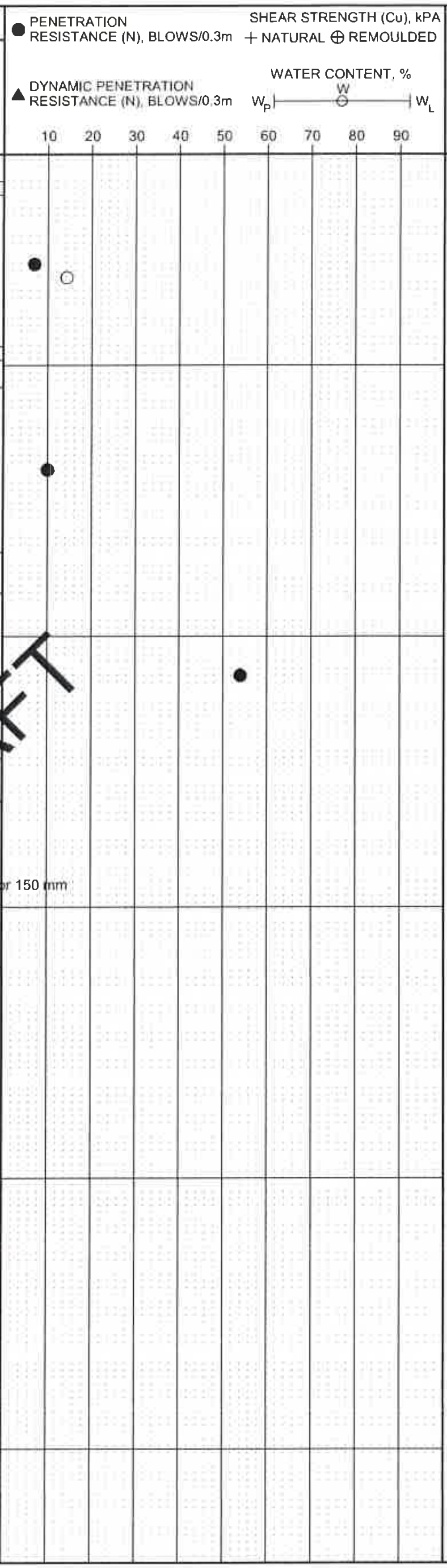
LOGGED: K.H.
CHECKED: B.W.

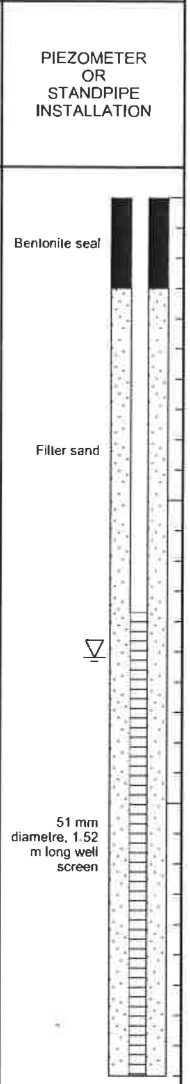
RECORD OF BOREHOLE 18-7

CLIENT: Cavanagh Developments
PROJECT: 2596 Carp Road
JOB#: 61318.20
LOCATION: See Borehole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Aug 8 2018

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
Power Auger Hollow Stem Auger (210mm OD)	Ground Surface	112.68					
	TOPSOIL	0.05					
	Loose, brown SILTY SAND, trace gravel		1 1B	SS SS	430	7	M
	very dense, grey brown silty sand, trace to some gravel with possible cobbles and boulders (GLACIAL TILL)	111.61 1.07	2	SS	480	10	
			3	SS	610	54	
			4	SS	410	>50 for 150 mm	
	End of borehole Auger refusal on inferred bedrock	109.78 2.90					





GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
18/08/17	1.52 ▽	111.16

GEMTEC
Consulting Engineers and Scientists

LOGGED: K.H.
CHECKED: B.W.

GOLDER

TECHNICAL MEMORANDUM

DATE December 18, 2018

Project No. 1543767-2001

TO Ben Houle, P.Eng.
Cavanagh Developments

FROM Brian Byerley, P.Eng.

EMAIL bbyerley@golder.com

RESPONSE TO CITY COMMENTS ON ROBINSON LAND DEVELOPMENT LID DESIGN 2596 CARP ROAD, OTTAWA, ONTARIO

Golder Associates Ltd. (Golder), under contract with Cavanagh Developments (Cavanagh), undertook an assessment of the infiltration characteristics of the soils at eleven locations within the footprint of a proposed stormwater management system. The tests were completed at 2596 Carp Road in Ottawa, Ontario, in order to support the stormwater management (SWM) facility design, based on current Low Impact Development (LID) guidance, by Robinson Land Development Inc. (Robinson).

Following submission of the design to the City of Ottawa (City), the City provided comments related to the hydrogeological aspects of the design. Following are the City comments (*in italics*) and Golder's responses.

> *Both the MOE SWMP and the LID manual state that the bottom of the Bioretention basin or infiltration trench should be separated from the seasonally high water table by a minimum of one (1) metre. I understand that water tables fluctuate over time, and I further understand that the CA have offered to be flexible on this distance. However as the water table level was established on a warm day in August - during an admitted dry spell - it is suggested that the value obtained currently be taken as the seasonally LOW level. Please provide a value of an annual average high groundwater elevation.*

Groundwater elevations have been measured at a number of groundwater monitoring wells on four occasions (see attached table). The measurements in August 2018 may be considered representative of the seasonal low level while the measurements in April 2017 and December 2018 may be considered representative of the seasonal high level. The April 2017 measurements are the highest values and indicate that the expected pre-development maximum seasonal fluctuation of the water table at this site is approximately 1.1 metres (i.e. the maximum observed difference between seasonal low and seasonal high water table elevation). The post-development water table elevation would be expected to decline if LID is not implemented.

The water table elevations indicated on the Robinson Stormwater Management Plan drawing number 18047-SWM1 were obtained from the Golder memorandum dated September 5, 2018. However, these elevations are not water table elevations, but are in fact the elevations of the infiltration testing, which in all cases were above the water table. Comparison of the bottom elevations of the SWM facilities to the water table elevations at the nearest groundwater monitoring wells indicates that, in all cases, the SWM facilities are located above the seasonal high water table elevations and/or are located more than 1.1 meters above the seasonal low water table elevations. Following are the interpreted seasonal high water table elevations at the SWM facilities.

SWM Facility	Groundwater Monitor	Water Table Elevation (masl)
SWM1	BH15-4	108.8
SWM2	BH18-13	108.5

Note: masl = metres above sea level

> *Groundwater mounding occurs when the water table is shallow, and water soaks into the soil faster than it can percolate away. Will this be an issue here?*

Groundwater mounding is not anticipated to be an issue because the SWM facilities were designed in accordance with current LID guidance using the site-specific design infiltration rates determined by Golder, as reported in Golder's memorandum dated September 5, 2018.

> *The bio-retention trench is very close to the existing septic system leaching bed. Will it interfere with the functioning of the septic bed?*

The infiltration testing completed by Golder in the area close to the septic system leaching bed (testing location GP-05), encountered the water table at a depth of 1.35 metres below ground surface in August 2018. The SWM facility at this location is designed to be a vegetated swale that will direct surface flow to the east, towards the SWM 1 bioretention treatment facility. The swale is not designed to retain or infiltrate surface water, but is designed to convey surface water to the treatment facility. The elevation of the swale in the area of the existing septic system leaching bed is approximately the same as the existing ground surface elevation, and as such will be approximately 1.3 meters above the water table elevation measured at GP-05. Therefore, we do not anticipate that the proposed swale will interfere with the functioning of the septic bed.

Closure

We trust the information included meets your current needs. Should you require clarification, please do not hesitate to contact us.

Yours truly,

Golder Associates Ltd.

Loren Bekeris

Loren Bekeris, M.Sc., P.Eng.
Environmental Engineer

Brian Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Principal

LICENSED PROFESSIONAL ENGINEER
B. T. BYERLEY
Dec 18/18
PROVINCE OF ONTARIO

BTB/LEB/sg
n:\active\2015\3 proj\1543767 cavanagh industrial subdivision carp\04_reporting\hydrogeology\stormwater infiltration\1543767-tm- lid comments_18dec2018.docx

Attachments: Table 1: Groundwater Level Measurements

Table 1
Groundwater Level Measurements

Well ID	Ground Surface Elevation	Top of Casing Elevation	Geologic Unit of Screened Interval	Depth of Screened Interval	Groundwater Levels							
					22-Dec-15		26-Apr-17		22-Aug-18		14-Dec-18	
	(masl)	(masl)		(mbgs)	Depth (mbgs)	Elevation (masl)	Depth (mbgs)	Elevation (masl)	Depth (mbgs)	Elevation (masl)	Depth (mbgs)	Elevation (masl)
15-1	114.57	115.45	Silty Sand over Silty Sand and Gravel	5.8 – 7.4	1.44	113.13	0.22	114.35		-		
15-2	114.99	115.79	Glacial Till	4.6 – 6.1	>6.38	<108.61	5.26	109.73		-		
15-4	110.31	111.24	Glacial Till	3.7 – 5.3	2.67	107.64	1.52	108.79	2.50	107.81	2.20	108.11
15-5	109.50	110.33	Silty Clay over Glacial Till	4.6 – 6.1	1.72	107.78	0.88	108.62	1.86	107.64		
15-6	109.54	110.34	Layers of Silty Sand and Silty Clay	4.1 – 5.6	3.36	106.18	3.13	106.41		-		
Gemtec 18-7	112.68	113.63	Glacial Till	1.4 - 2.9		-		-	1.85	110.84	1.11	111.57
Gemtec 18-11	110.87	111.82	Glacial Till	1.4 - 2.9		-		-	1.62	109.25		
18-13	111.59	112.32	Glacial Till	2.7 - 4.2					>4.19	<107.40	3.35	108.24
Gemtec 18-6	110.86	111.79	Silty Sand	0.6 - 2.1					1.25	109.61	0.88	109.98

Notes:

mbgs = metres below ground surface

masl = metres above sea level

Treatment Facility Stormwater Flow Calculations

Given:

Area (ha) = 3.27 (SWM1 + SWM2)

C = 0.74

C (100 YR) = 0.92

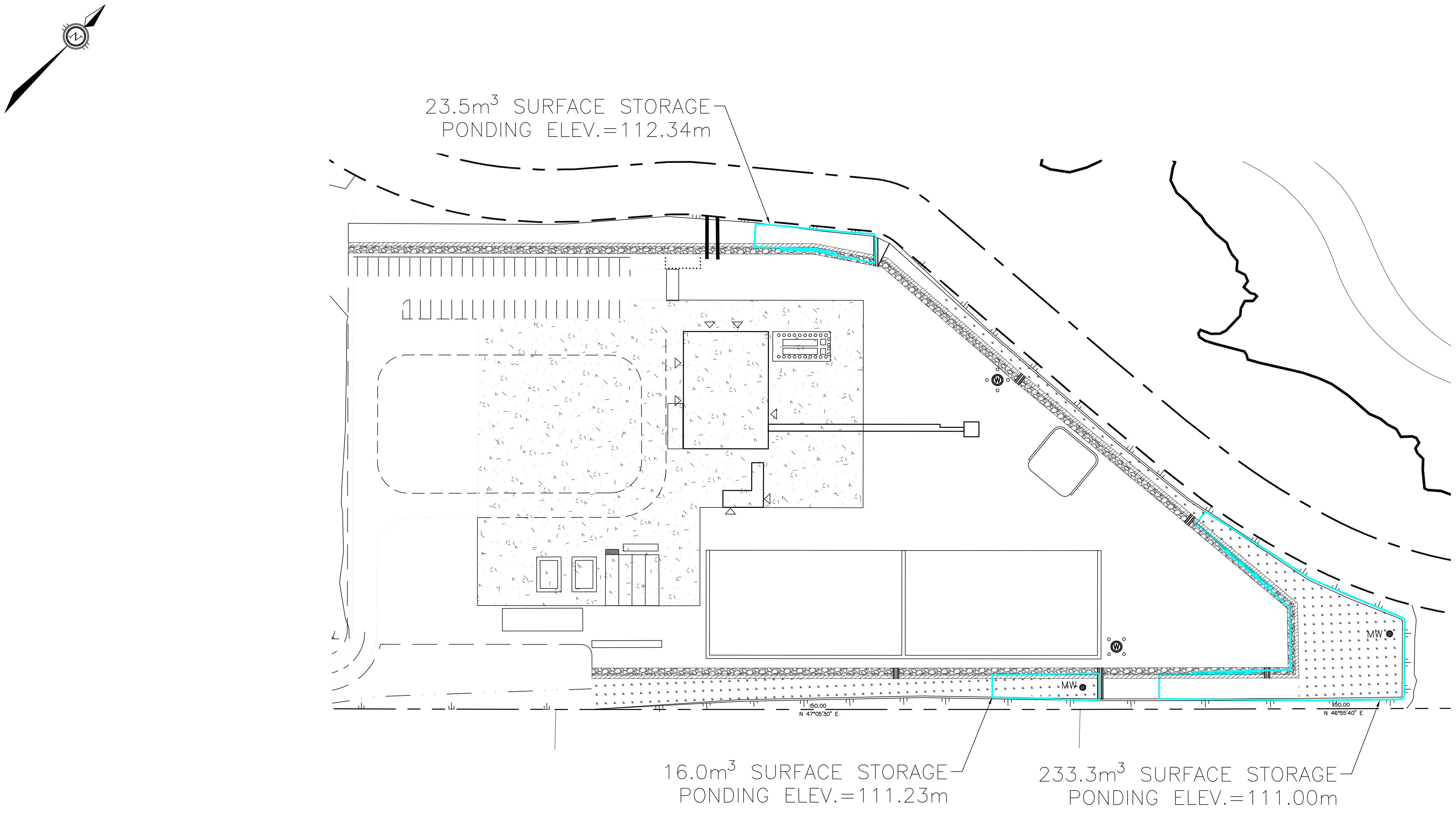
Return Period	Time (min)	Intensity (mm/hr)	Flow (L/s)[*1,2]	Allowable Release Rate (L/s)	Net Runoff to be Stored (L/s)	Storage Required (m^3)
100 Year	5	242.7	2037.7	0.0	2037.7	611.3
	10	178.6	1499.2	0.0	1499.2	899.5
	16	**137.5**	**1154.8**	**0.0**	**1154.8**	**1108.7**
	20	120.0	1007.1	0.0	1007.1	1208.5
	25	103.8	871.9	0.0	871.9	1307.8
	30	91.9	771.3	0.0	771.3	1388.4
5 Year	5	141.2	948.3	0.0	948.3	284.5
	10	104.2	699.8	0.0	699.8	419.9
	16	**80.5**	**540.4**	**0.0**	**540.4**	**518.8**
	20	70.3	471.9	0.0	471.9	566.2
	25	60.9	409.0	0.0	409.0	613.5
	30	53.9	362.2	0.0	362.2	652.0
2 Year	5	103.6	695.7	0.0	695.7	208.7
	10	76.8	515.9	0.0	515.9	309.5
	16	**59.5**	**399.7**	**0.0**	**399.7**	**383.7**
	20	52.0	349.5	0.0	349.5	419.4
	25	45.2	303.4	0.0	303.4	455.1
	30	40.0	269.0	0.0	269.0	484.1

Notes:
1. Q = 2.78 CiA
2. 100 Year flow calculation uses C-Value + 25%.

Time of Concentration Calculations

Drainage Area	Average Slope (m/m)	Length (m)	$V/S^{0.5}$ (m/s)[*1]	Velocity (m/s)	Tc (min.)[*2,*3]
SWM1/SWM2	0.009	417.0	4.6	0.43	16.0

Notes:
1. $V/S^{0.5}$ value from Table 3.9 of Uplands Method for "grassed waterway" land cover. Refer to **Appendix B**.
2. Time of Concentration = Length / Velocity
3. Final values are calculated using non-rounded numbers. Discrepencies may occur with manual computations.



LEGEND

━ SURFACE PONDING LIMITS

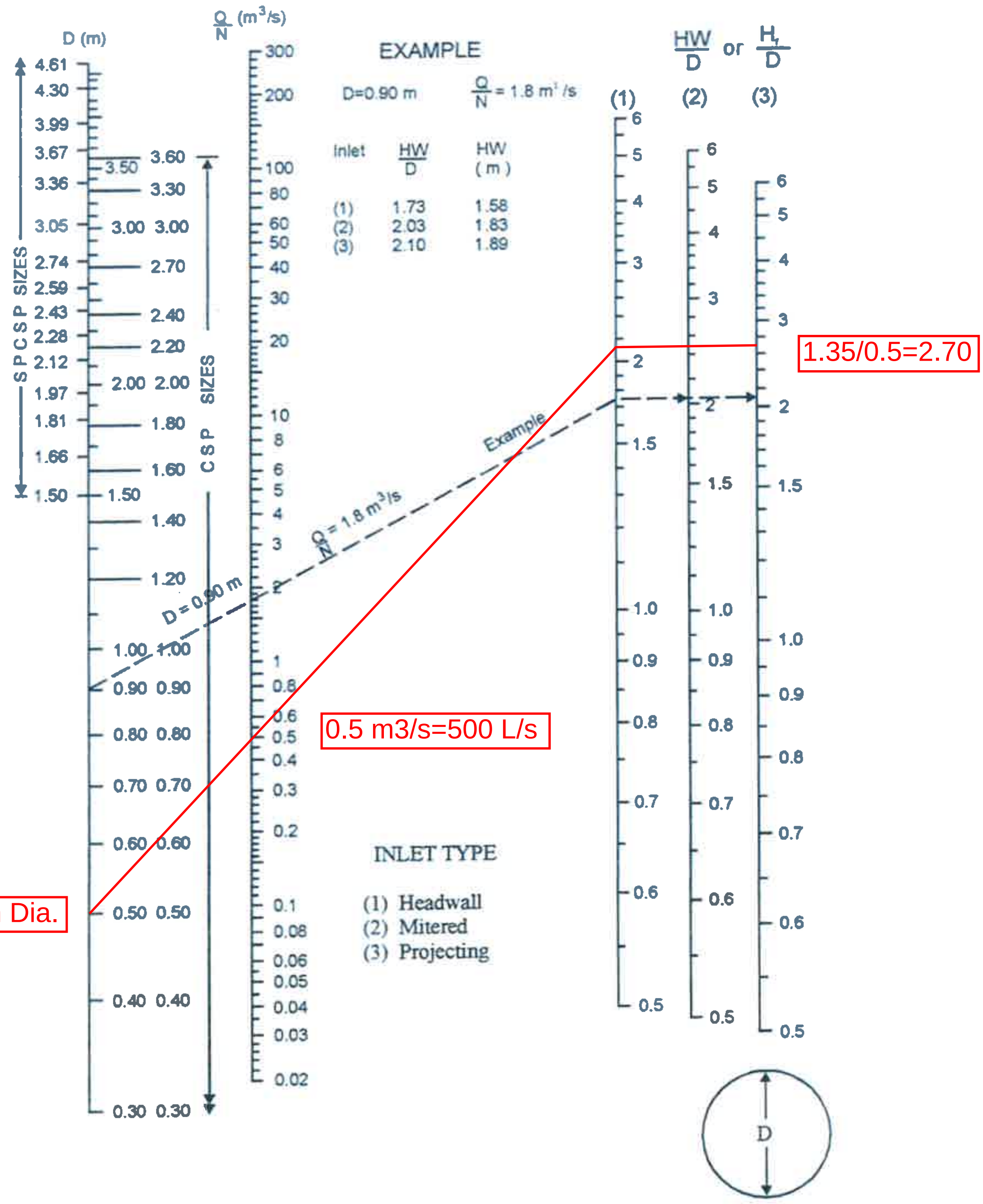
Robinson
Land Development

scale 1:2000	2596 CARP ROAD	project no. 18047
date 07/11/18	TITLE: AVAILABLE SURFACE STORAGE PLAN	FIG 3
drawn by BLM		

MAXIMUM CAPACITY

STA. 0+105.64

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts

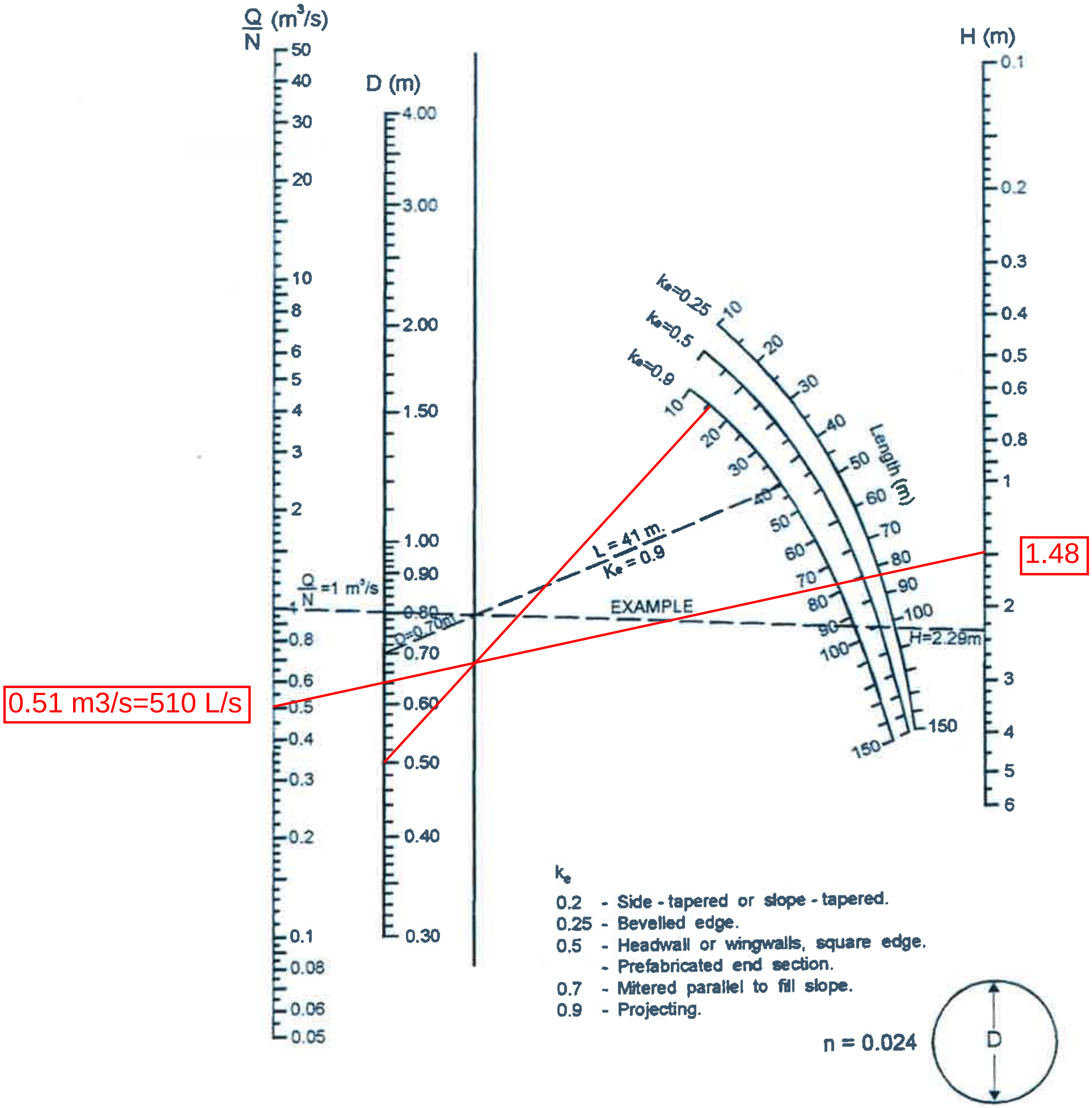


Source: Herr (1977)

MAXIMUM CAPACITY

STA. 0+105.64

Design Chart 2.35: Outlet Control: CSP Culvert - Flowing Full



k_e

0.2 - Side - tapered or slope - tapered.

0.25 - Bevelled edge.

0.5 - Headwall or wingwalls, square edge.

- Prefabricated end section.

0.7 - Mitered parallel to fill slope.

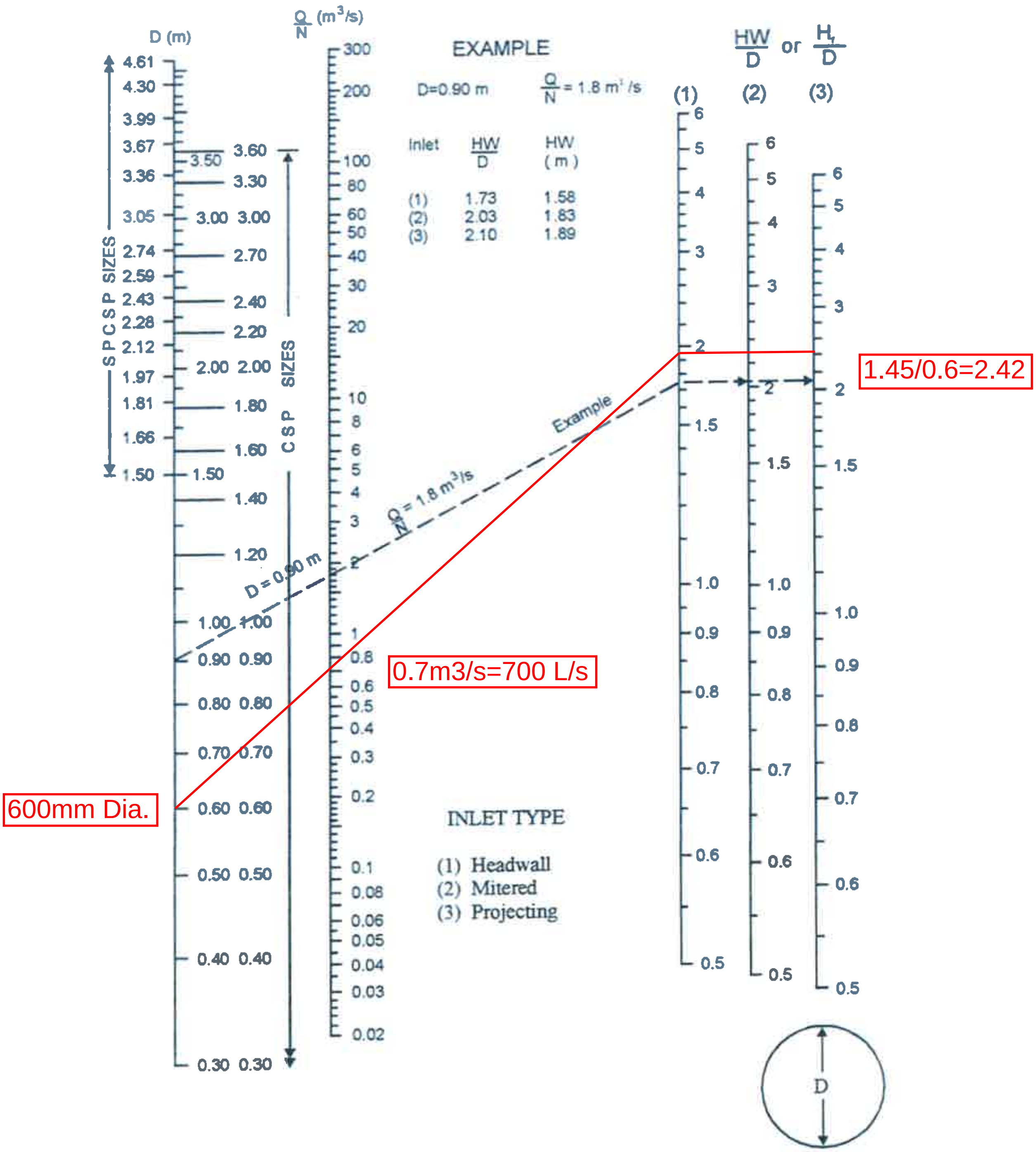
0.9 - Projecting.

Source: Herr (1977)

MAXIMUM CAPACITY

STA. 0+222.49

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



1.45/0.6=2.42

0.7m3/s=700 L/s

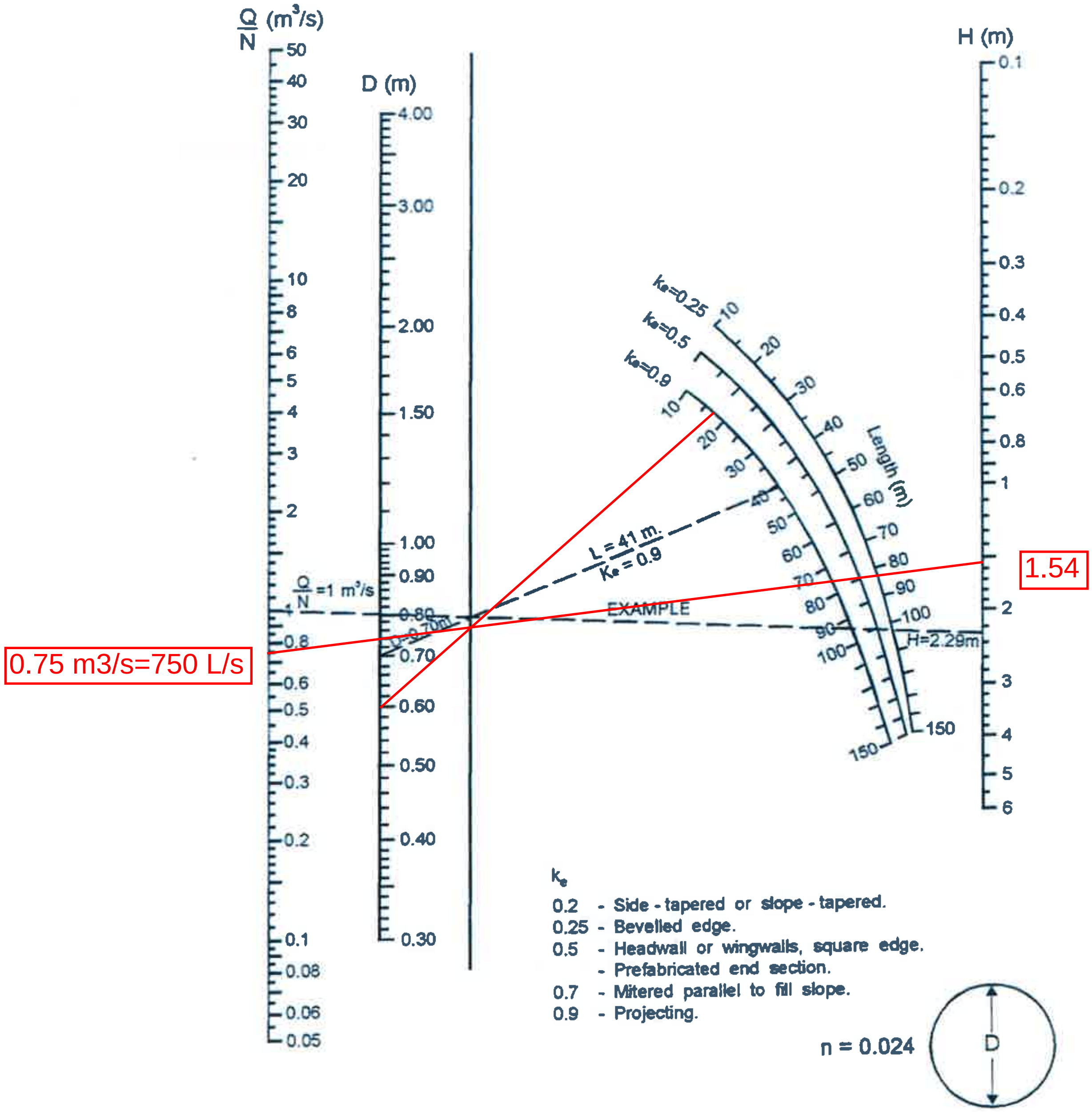
600mm Dia.

Source: Herr (1977)

MAXIMUM CAPACITY

STA. 0+222.49

Design Chart 2.35: Outlet Control: CSP Culvert - Flowing Full

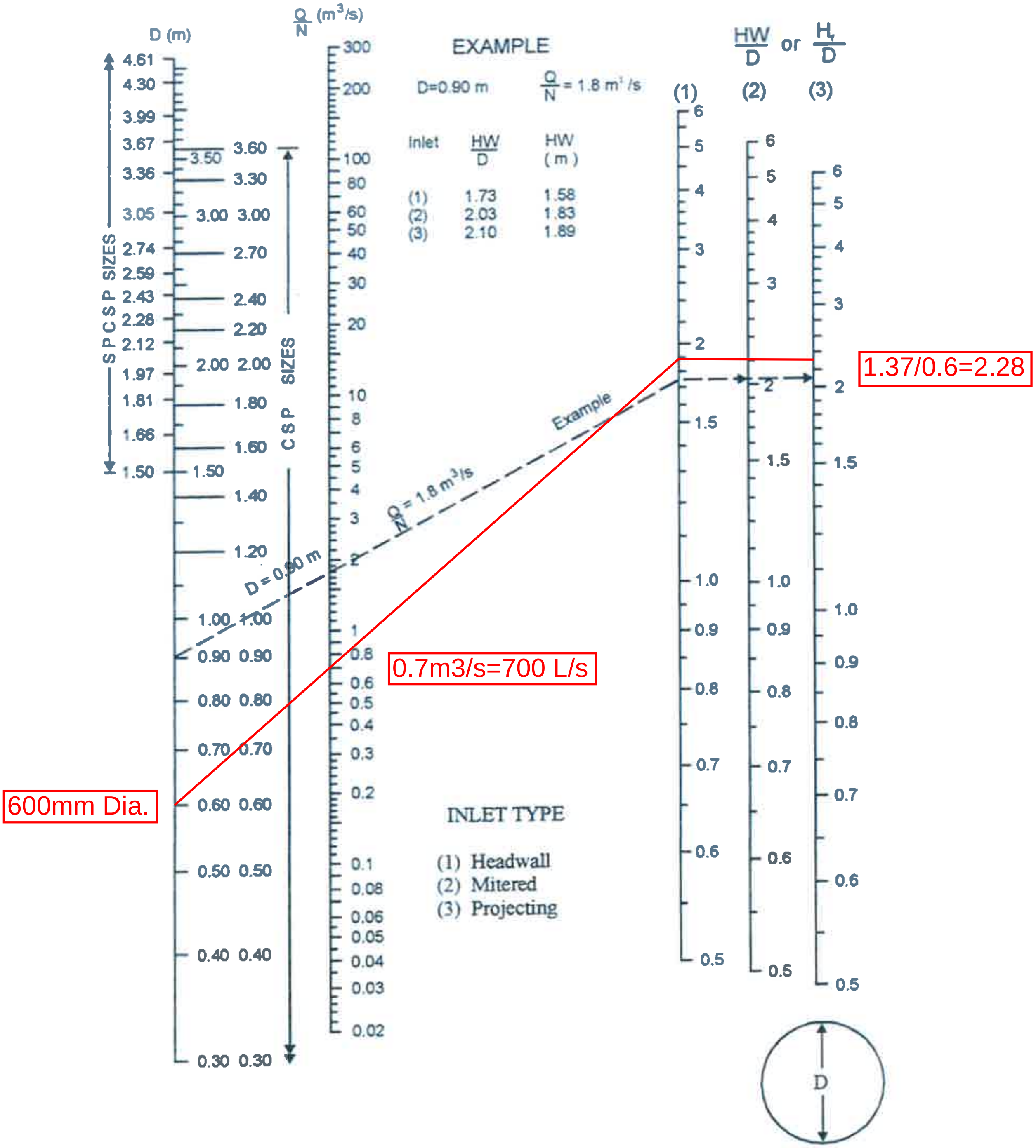


Source: Herr (1977)

MAXIMUM CAPACITY

STA. 0+687.11

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts

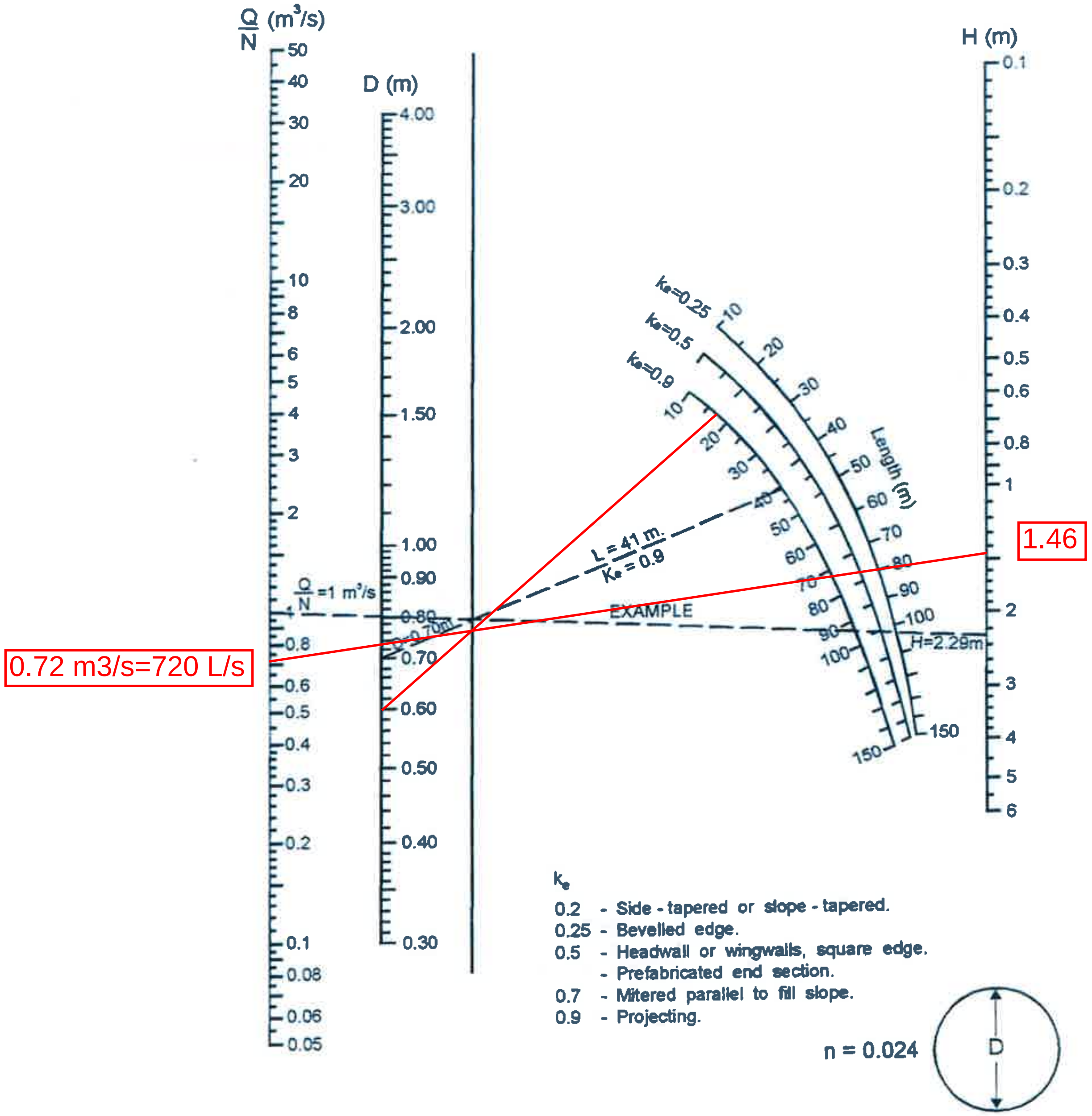


Source: Herr (1977)

MAXIMUM CAPACITY

STA. 0+687.11

Design Chart 2.35: Outlet Control: CSP Culvert - Flowing Full



k_e

0.2 - Side - tapered or slope - tapered.
0.25 - Bevelled edge.
0.5 - Headwall or wingwalls, square edge.
- Prefabricated end section.
0.7 - Mitered parallel to fill slope.
0.9 - Projecting.

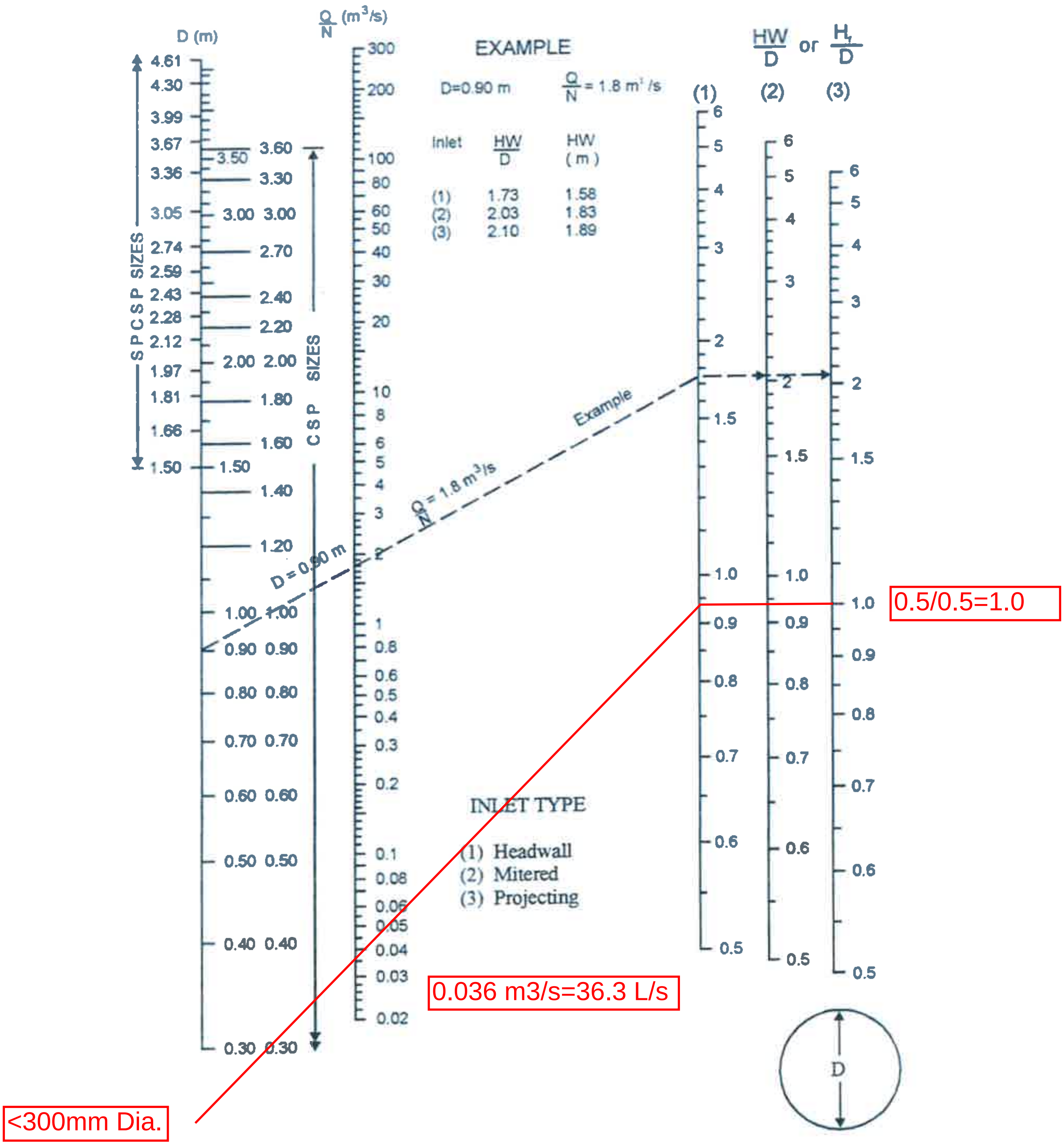
n = 0.024

Source: Herr (1977)

MINIMUM DIAMETER FOR NO OVERTOPPING

STA. 0+105.64

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



0.5/0.5=1.0

0.036 m3/s=36.3 L/s

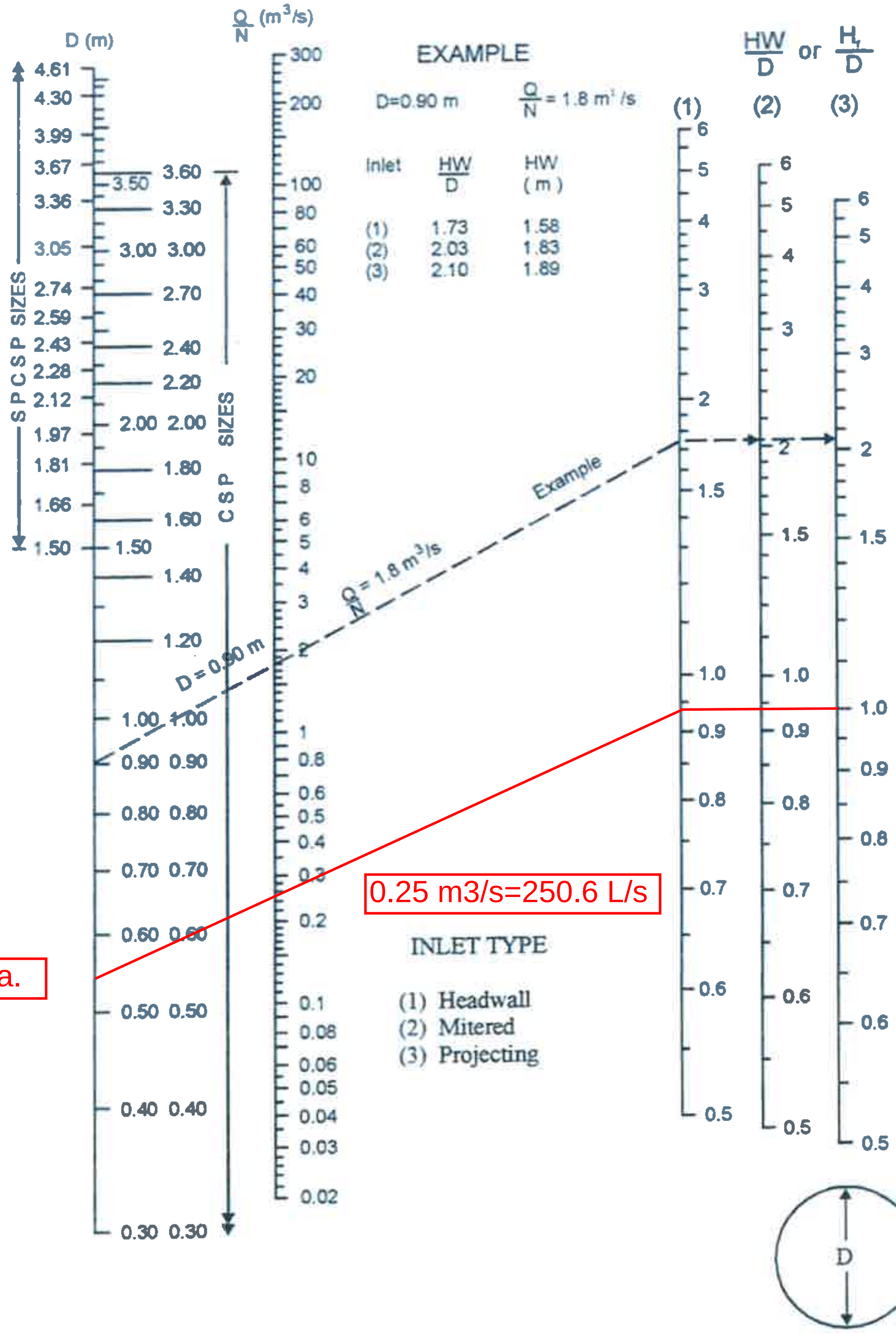
<300mm Dia.

Source: Herr (1977)

MINIMUM DIAMETER FOR NO OVERTOPPING

STA. 0+222.49

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



0.6/0.6=1.0

0.25 m3/s=250.6 L/s

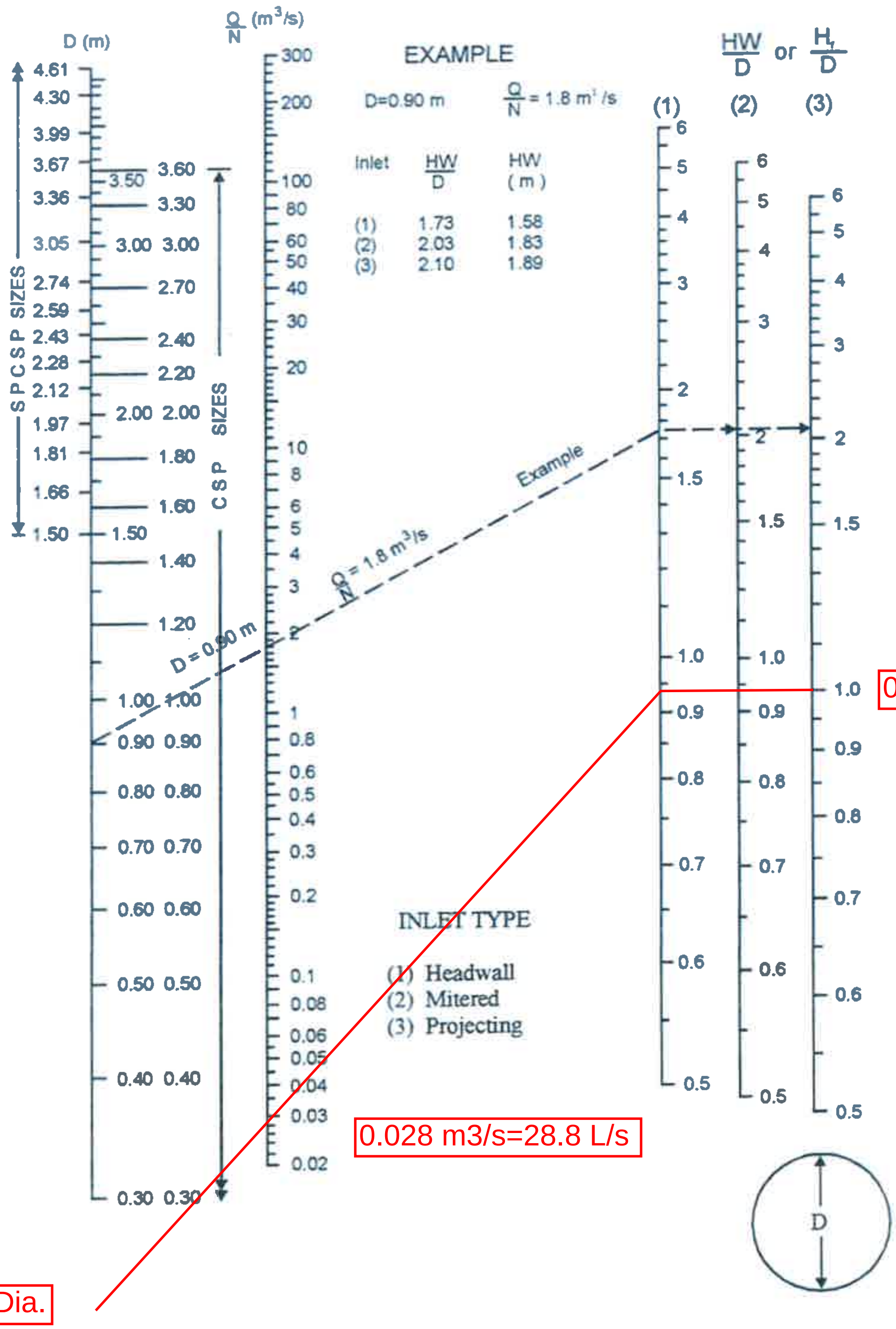
550mm Dia.

Source: Herr (1977)

MINIMUM DIAMETER FOR NO OVERTOPPING

STA. 0+687.11

Design Chart 2.32: Inlet Control: Circular CSP and SPCSP Culverts



0.6/0.6=1.0

0.028 m3/s=28.8 L/s

<300mm Dia.

Source: Herr (1977)

Table 3.9 $V/S^{0.5}$ relationship for various land covers

Land Cover	$V/S^{0.5}$ (m/s)
Forest with heavy ground litter, hay meadow (overland flow)	0.6
Trash fallow or minimum tillage cultivation, contour, strip cropped woodland (overland flow)	1.5
Short grass pasture (overland flow)	2.3
Cultivated, straight row (overland flow)	2.7
Nearly bare and untilled (overland flow) or alluvial fans in Western mountain regions	3.0
Grassed waterway	4.6
Paved areas (sheet flow); small upland gullies	6.1

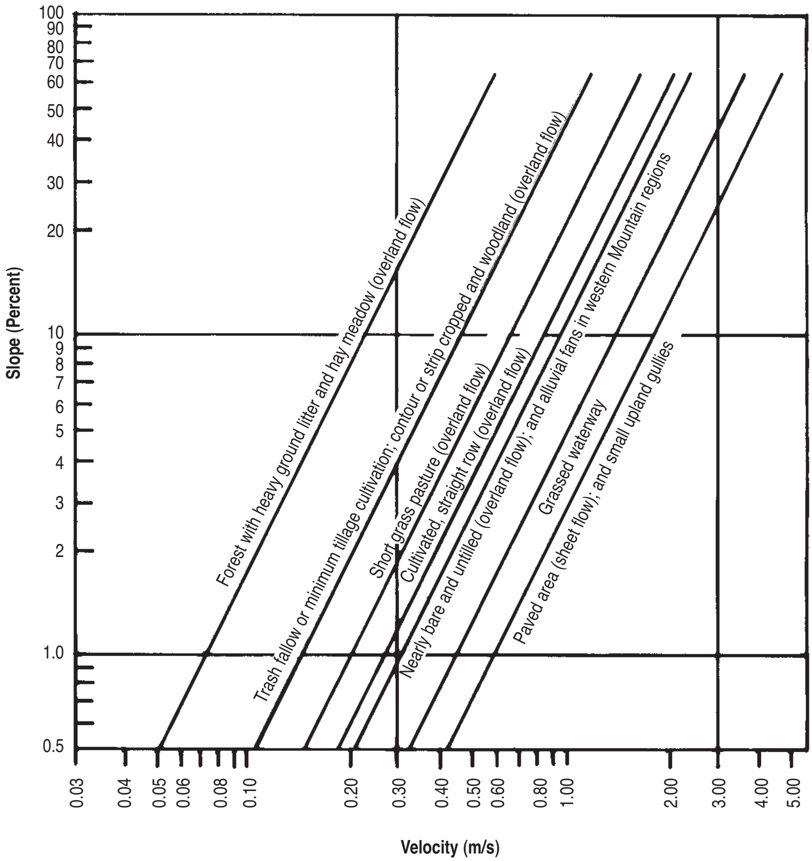


Figure 3.12 Velocities for Upland method for estimating travel time for overland flow.

Runoff Coefficient Calculations

Drainage Area	Impervious Area (ha)	Pervious Area (ha)	Gravel Area (ha)	Total Area (ha)	C^{*2}
A1	0.208	3.942	0.089	4.24	0.25
A2	0.031	0.095	0.016	0.14	0.42
A3	0.034	0.130	0.015	0.18	0.38

Notes:

1. $C_{impervious}$ = 0.90, $C_{pervious}$=0.20, C_{gravel}=0.80
2. Final values are calculated using non-rounded numbers. Discrepencies may occur with manual computations.

Time of Concentration Calculations

Drainage Area	Average Slope (m/m)	Length (m)	$V/S^{0.5}$ (m/s)^{*1}	Velocity (m/s)	Tc (min.)^{*2,*3}
A1	0.0056	383.95	4.6	0.34	18.59
A2	0.0052	87.20	4.6	0.33	4.38
A3	0.0109	94.60	4.6	0.48	3.28

Notes:

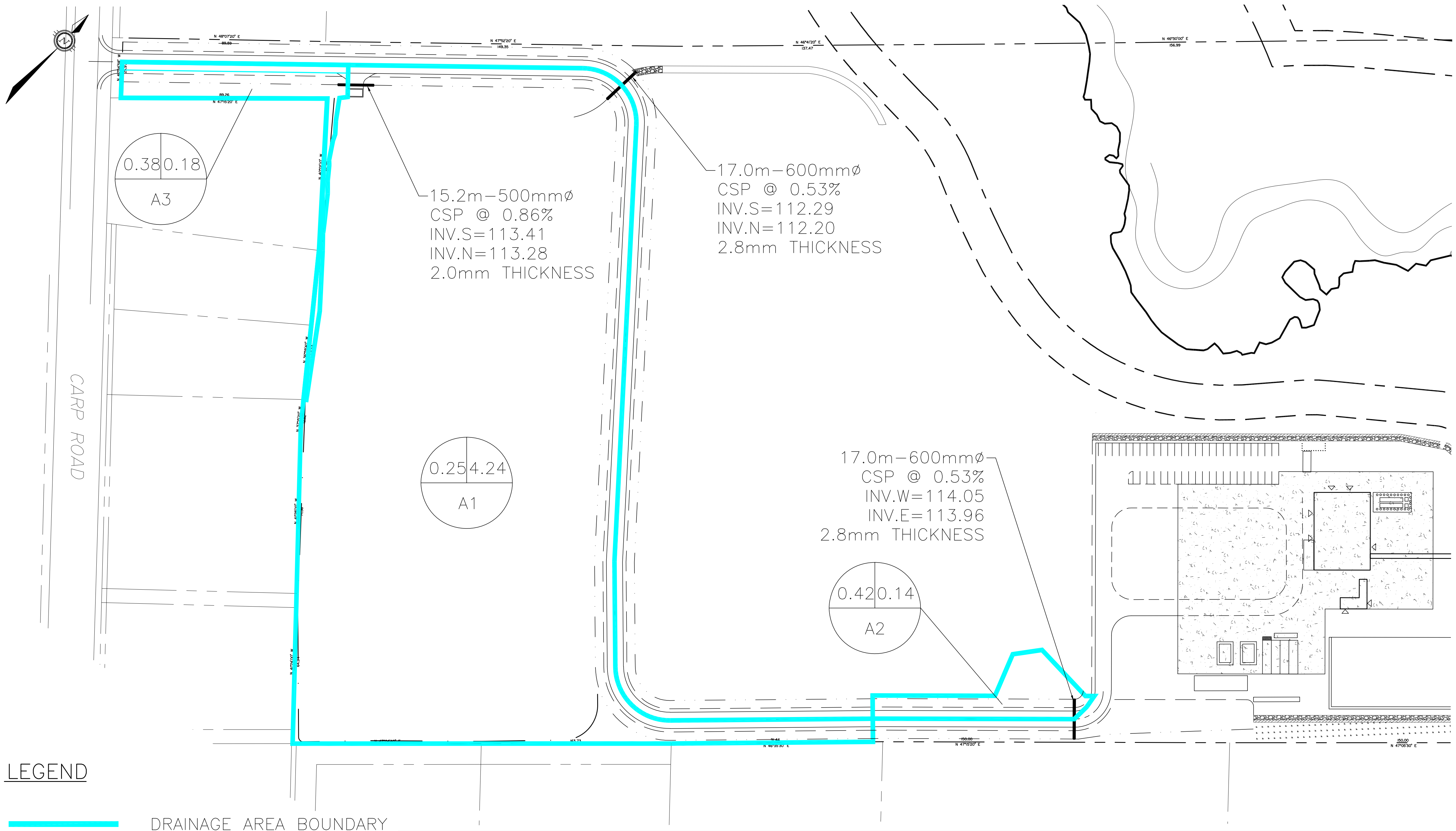
1. $V/S^{0.5}$ value from Table 3.9 of Uplands Method for "grassed waterway" land cover. Refer to **Appendix B**.
2. Time of Concentration = Length / Velocity
3. Final values are calculated using non-rounded numbers. Discrepencies may occur with manual computations.

Culvert Design (10 Year Design Storm)

Station	Contributing Drainage Area	Area (ha)	Time of Concentration (min)^{*2}	10 YR Intensity (mm/hr)^{*3}	Runoff Coefficient	10 Year Peak Flow (L/s)^{*4}	Proposed Culvert Diameter (mm)	Culvert Capacity (L/s)^{*1}
0+222.49	A1	4.24	18.59	86.04	0.25	250.6	600	700
0+687.11	A2	0.14	4.38	173.78	0.42	28.8	600	700
0+105.64	A3	0.18	3.28	190.36	0.38	36.3	500	500

Notes:

1. Culvert capacity determined using MTO culvert design charts. Refer to **Appendix B**.
2. Time of Concentration estimated using the Uplands Method. Refer to **Appendix B**.
3. Rainfall intensity calculated using City of Ottawa IDF Curves.
4. Peak Flow calculated using the Rational Method.



LEGEND

▬ DRAINAGE AREA BOUNDARY

RUNOFF COEFFICIENT

0.50 0.28 ← AREA (ha)

201

DRAINAGE AREA ID

Robinson
Land Development

scale	1:2500
date	08/04/19
drawn by	BLM

2596 CARP ROAD

TITLE: CULVERT DRAINAGE AREA PLAN

project no. 18047