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STORMWATER MANAGEMENT REPORT

PROPOSED COMMERCIAL DEVELOPMENT
3904 MARCH ROAD
CARP, ONTARIO

Prepared For:
Dog World Bedrock Kennels

PROJECT #: 190622

DISTRIBUTION
5 copies – City of Ottawa
1 copy – Dog World Bedrock Kennels
1 copy – Kollaard Associates Inc.

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1 INTRODUCTION

Kollaard Associates was retained by the Dog World Bedrock Kennels to complete a Site Grading Plan and Stormwater Management Report for the proposed site works. The subject site is located at 3904 March Road. (See location of property on the key plan included in the grading plan). For the purposes of this report, March Road is considered to be oriented along an east west axis. The subject property is fronting onto the south side of March Road and is about 300 metres east of Upper Dwyer Hill road.

This report will summarize the stormwater management (SWM) design requirements and proposed works that will address the stormwater flows arising from the site under post-development conditions for both a quantity and quality perspective.

The site is part of a property within the City of Ottawa which has a total area of 9.6 hectares. The gravel driveways and buildings occupy about 2% of the property. The land cover of the property currently consists of about 44% grass and 54% woodland. The majority of the area that is affected by the existing and proposed development is within the grass covered portion of the property.

The portion of the property considered to be potentially affected by the existing and proposed developments will be referred to as the Site. The site has an area of 4.206 hectares and is currently occupied by the main dwelling with a foot print of about 229 m^2. The site also contains various dog kennels, outbuildings and storage sheds, which have a combined area of about 1441 m^2, and is used as a dog boarding, training centre, and grooming facility. The buildings occupy 0.2% of the lot area. The buildings are serviced by existing gravel surfaced driveways that have a combined surface area of about 2638 m^2.

1.1 Proposed Development

The project consists of the construction of two additional commercial buildings for the dog boarding and training facility. The buildings are to be constructed in phases. The phase 1 building is to consist of a 445 m^2 Indoor Dog Gym/Play Area. The phase 2 building is to consist of a 153 m^2 Dog Kennel. The driveway will be expanded to provide fire truck access to the proposed new development. Both phases of the development are being considered in this report.

Both of the proposed buildings will be constructed in the gravel and grass surfaced yard area south of the existing buildings currently used by Dog World. Due to the presence of the existing buildings and roadway network, there are no significant grade changes proposed within the area of development.

2 STORMWATER DESIGN

2.1 Stormwater Management Design Criteria

Design of the storm sewer system was completed in conformance with the City of Ottawa Design Guidelines (October 2012 as amended).

2.1.1 Quantity Control Design Criteria

In accordance with the SWM design criteria provided by the City of Ottawa (CoO), the following stormwater management conditions are to be followed:

- The consultant should determine a stormwater management regime for the application and generally maintain post-development flows to pre-development levels by way of providing storage to offset increased impervious area.
- The pre-development conditions will consider the existing dwelling, and driveway as the existing impervious surfaces. All other hard landscaping surfaces shall be considered soft landscaping/grass for pre-development conditions.
- The stormwater management system should be designed for the 5-year and 100-year storm events.
- Overland flows should be directed to a legal outlet or watercourse.
- Any existing stormwater runoff from adjacent site(s) that crosses the property must be accommodated by the proposed stormwater management design.
- The post-development flow rates from the site must not exceed pre-development runoff rates for storm events up to and including 100 year events.

2.1.2 Quality Control Design Criteria

- The Mississippi Valley Conservation Authority (MVCA) requires an enhanced level of treatment for the site. An enhanced level of treatment corresponds to 80 percent total suspended solids removal.
- The City of Ottawa requires that all outdoor open areas for canines shall ensure sanitary waste does not run-off site during storm events. If stormwater management ponds are provided the ponds should be free of contamination prior to discharging.

2.2 Stormwater Quantity Control Methodology

The peak flow and runoff rates for quantity control purposes during both Pre-Development and Post-Development stages of the project were calculated using The hydrologic modeling software, Visual OTTHYMO (V2.6.3) as well as the modified rational method for comparison.

The rational method is a common and straightforward calculation, which assumes that the entire drainage area is subject to uniformly distributed rainfall. The formula is:

Q = 2.78 C * I * A

Where Q = Peak runoff measured in *L/s*
C = Runof Coefficient
I = Rainfall intensity (mm/hr)
A = catchment area (ha)

All values for intensity, i, for this project were derived from IDF curves provided by the City of Ottawa for data collected at the Ottawa International airport. For this project two return periods were considered, 5 and 100-year events. The formulas for each are:

5-Year Event

$$i = \frac{998.071}{(t_c + 6.053)^{0.814}}$$

100-Year Event

$$i = \frac{1735.688}{(t_c + 6.014)^{0.82}}$$

Where t_c is time of concentration

The hydrologic modeling software, Visual OTTHYMO (V2.6.3) was used to assess pre- and post-development stormwater conditions at the site using the NASHYD watershed command as the average impervious ratio for the proposed development is less than 20 percent.

The NASHYD hydrograph method uses the Nash instantaneous unit hydrograph which is made of a cascade of 'N' linear reservoirs and is used to model rural areas.

Both the Pre and Post-development conditions were modeled for quantity control purposes utilizing SCS Type II Storm Distributions of various duration and magnitude. The SCS Type II storms are generally applicable to undeveloped or rural basins where peak flow rates are largely influenced by the total volume of rainfall. The SCS Type II storm distribution is generally preferred for both large and small rural areas.

The pre- and post-development conditions were also modeled using the 25 mm 4 hour Chicago storm for quality control purposes.

The resulting pre and post-development models contain the storm events as follows:

Simulation Number 1 – 25 mm 4 hour Chicago
Simulation Number 2 – 6 hour 5 year SCS Type II
Simulation Number 3 – 12 hour 5 year SCS Type II

Simulation Number 5 – 6 hour 100 year SCS Type II
Simulation Number 5 – 12 hour 100 year SCS Type II

Rainfall data from Intensity-Duration-Frequency curves obtained from the Ottawa International Airport as provided in the CofO Guidelines were utilized to provide the rainfall data used in the SCS Type II storm distribution models for the site.

The IDF formulae utilized are as follows:

5 year Intensity = 998.071 / (Time in min + 6.053)$^{0.814}$

100 year Intensity = 1735.688 / (Time in min + 6.014)$^{0.820}$

The volume of rain fall in terms of depth for each event was determined as shown in the following example.

6 hour 5 year SCS Type II

998.071 / (6 hr x 60min/hr) + 6.053)$^{0.814}$ = 8.17 mm/hr

8.17 mm/hr x 6 hrs = 49 mm.

2.3 OTTHYMO and Rational Method Storm Analysis Variables

The NASHYD command uses the following inputs:

DT – Simulation time step increment (min) – must be shorter than TP
Area – Watershed or catchment area (hectares)
DWF – A constant Dry Weather Flow or Baseflow (m3/s) assumed to be 0 (doesn't change from pre to post development)
CN – SCS Modified Curve Number
IA – Initial Abstraction (mm)
N – Number of Linear reservoirs used for derivation of the Nash Unit Hydrograph and is three for most normal cases including this development.
TP – Unit hydrograph time to peak (hr)

The Rational Method uses the following inputs:

C is the Runoff Coefficient, Dimensionless
A is the watershed or catchment area in *hectares*
i is the storm intensity measure in *mm/hr*

2.3.1 Curve Numbers and Runoff Coefficient

The NasHyd hydrograph method which uses the SCS loss method for pervious areas was used to model both the pre- and post development conditions of the proposed development. Runoff

Curve Numbers (CN) are utilized in the SCS hydrology method. The Curve Number is a function of soil type, ground cover, and antecedent moisture conditions. The runoff coefficient is a function of the soil type and ground cover. The soil type was chosen to be Group B, considering the sand underlying the topsoil at the site. Calculations of the weighted average CN values and the C values for both the pre- and post-development conditions are presented in Appendix A. The CN and C values used for each catchment area consist of a weighted average value based on the conditions and cover of the ground surface in the catchment area. For the purposes of analysis presented in this report, the surface cover was considered to be: Woodland in good condition – CN = 55, C = 0.25; Gravel – CN = 85, C = 0.6; Grass – CN = 69, C = 0.3; and Impervious (roof tops and asphaltic concrete pavement) – CN = 98, C = 0.9. The CN values were taken from the CofO Guidelines Table 5.9 and from the United States Department of Agriculture Urban Hydrology for Small Watersheds Technical Release 55 (USDA TR55). The C values were taken from the CofO Guidelines.

A 25% increase for the post-development 100-year runoff coefficients was used as per City of Ottawa guidelines.

2.3.2 Initial Abstraction And Potential Storage

The initial abstraction includes all losses before runoff begins, and includes water retained in surface depressions, water taken up by vegetation, evaporation, and infiltration. This value is related to characteristics of the soil and the soil cover. Initial abstraction is a function of the potential storage and is generally assumed to be equal to 0.2 S where S is the potential storage.

It is considered that for lower CN values, the relationship IA = 0.2S tends to overestimate the initial abstraction resulting in underestimated peak runoff. Suggested guidelines are as follows:

CN ≤ 80	IA = 0.10S
CN > 80 ≤ 90	IA = 0.15S
CN > 90	IA = 0.2S

Since the weighted average CN numbers for the site range from 66 to 73, a relationship of IA = 0.10S was used.

The potential storage S is related to the runoff coefficient as follows:

$S = (25400/CN) - 254$

2.3.3 Time of Concentration and Time to Peak

The time to peak is typically considered to be 2/3rds of the time of concentration of a catchment area. The time of concentration of each catchment was determined using the Velocity method. The velocity method assumes that the time of concentration is the sum of travel times for segments along the hydraulically most distant flow path. The segments used in the velocity method may be of three types: sheet flow T_s, shallow concentrated flow T_{sc}, and open channel flow T_c. Since the receiver for the runoff from the area of the site within the limit of development is the undeveloped area of the site beyond the limit of development, open channel flow was not considered in the analysis.

It is noted that the proposed development does not affect the length of the flow path within the area of development. It is further noted that the weighted average runoff coefficient C for pre-development conditions is equal to C = 31 and for post-development conditions is equal to C = 33. Since there is no significant difference between the runoff coefficients modelling pre- and post- development conditions and the length of the flow path remains the same, the time of concentration is considered to be the same for both pre- and post- development conditions.

The Manning's roughness coefficient for sheet flow for the proposed development across the short grass in the developed portion of the site was taken as n = 0.15.

$$T_s = \frac{0.091(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Where T_s = travel time, h
n = Manning's roughness coefficient sheet flow = 0.15
l = sheet flow length, 30 m
P_2 = 2-year 24-hour rainfall, = 48.4 mm
S = Slope of land surface m/m = 0.01
T_s = 0.27 hours

Shallow concentrated flow was assumed to occur after a maximum of 30 metres. The rainfall quantity P_2 was determined using the IDF curve obtained from the Ottawa International Airport as provided in the CofO Guidelines.

Travel time for shallow concentrated flow pre-development site:

The flow velocity used to calculate the time of travel for shallow concentrated flow was determined using Table 15-3 of Chapter 15 of the USDA handbook. This table can be used to calculate the velocity when the slope and ground cover are known. The ground cover used in reading Table 15-3 for the site area subject to shallow concentrated flow was short grass pasture. The existing ground surface subject to shallow concentrated flow is considered to be range from maintained and unmaintained grass land to wood land and light underbrush. From Table 15-3 of the USDA Handbook, the flow velocity across this surface can be calculated using the relation $V = 5.032(s)^{0.5}$. The slope was calculated to be on average 1.1% based on the existing topography. The velocity was calculated to be $V = 5.032 \times s^{0.5}$ = 0.52 ft/s or 0.16 m/s. The distance of shallow concentrated flow was the distance between the point at which sheet flow ended and the limit of development.

$$T_{sc} = \frac{l}{3600\,V}$$

Where T_{sc} = travel time, h
l = distance of shallow concentrated flow = 154 m

V = average velocity = 0.16 m/s
T_{sc} = 0.27 hrs

As previously stated, the total time of concentration is equal to the time of concentration for sheet flow plus the time of concentration for shallow concentrated flow.

Tt = Ts + Tsc = 0.27 hrs + 0.27 hrs = 0.54 hrs or 32 min.

The time to peak would be equal to 0.54 hrs x 2/3 = 0.36 hrs.

2.4 Site Conditions

2.4.1 Pre-development Site Conditions

As previously indicated, the site is part of a property located on March Road in the City of Ottawa. The site is currently occupied by assorted buildings and a gravel surfaced roadway for the dog training and boarding facility (known as Dog World). The City Ottawa criteria states that the pre-development conditions will consider the existing dwelling and driveway as the existing impervious surfaces. Therefore any existing assorted buildings and associated gravel surfaced areas related to the assorted buildings on the site with the exception of the dwelling were not considered in the pre-development calculation.

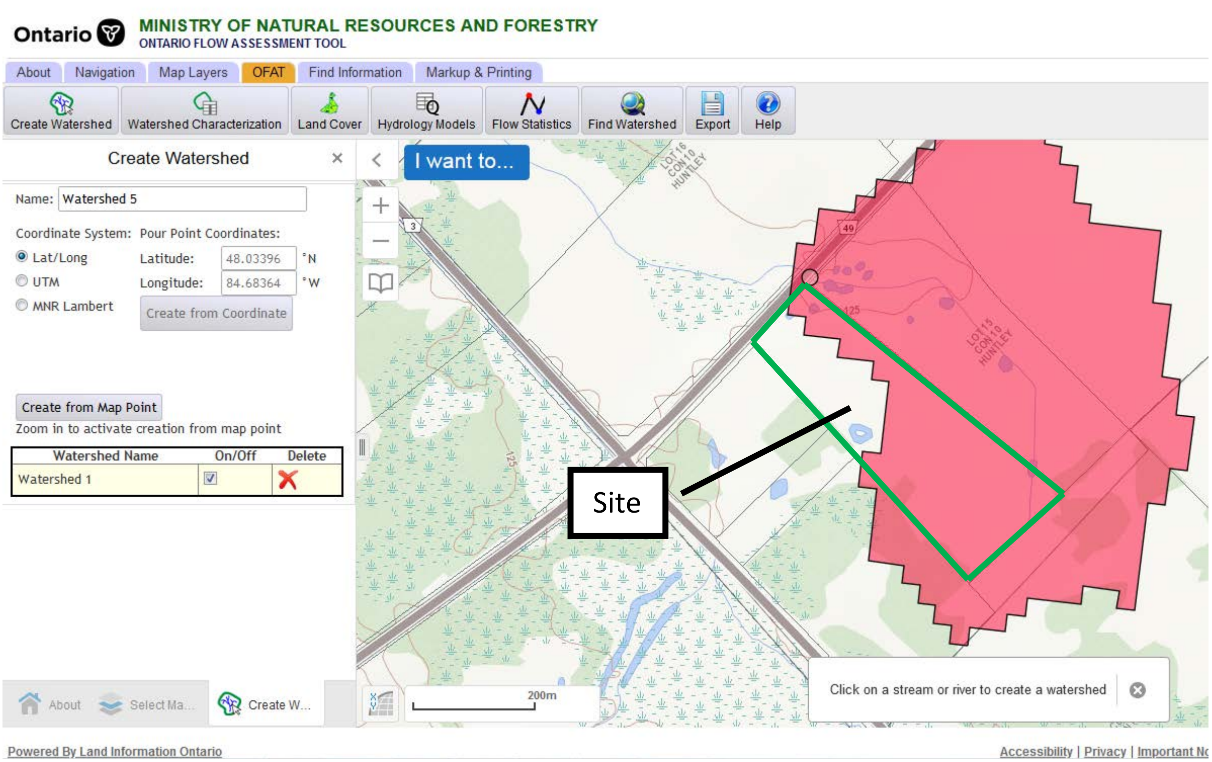
Pre-development site conditions are summarised for the site in the following Table 2-1.

Table 2-1 – Summary of Pre-Development Site Conditions

PRE-DEVELOPMENT

Description	Runoff Coefficient C		Curve Number CN	Area (ha)
	5-year	100-year		
Total Area				4.206
Roof	0.90	1.00	98	0.023
Gravel	0.60	0.75	85	0.176
Grass	0.30	0.38	69	3.318
Woodland	0.25	0.31	55	0.689
Controlled Area Weighted Average C and CN	*0.31*	*0.38*	68	
Additional Parameters	**Potential Storage**	**IA**	**Time to Peak**	
	122	*12.2*	0.36	

The Ministry of Natural Resources and Forestry, Ontario Flow Assessment Tool (OFAT) was used to analyse the watersheds in the vicinity of the Dog World site. It was identified that one watershed begins over the portion of the site subject to the proposed development assuming that the gravel driveway forms the western limit of the watershed at the front of the site. The use of the watershed tool in OFAT is illustrated in the figure below. While it is acknowledged that the OFAT model can be inaccurate in terms of delineating watersheds and flow rates for small areas, it is considered sufficiently accurate to indicate the overall flow patterns in the area. The figure below indicates that the proposed Dog World development is within a watershed that directs flow away from the wetland south and west of the site and towards the shallow watercourses and tributaries to Cody Creek north of the site. It is noted that the existing ground surface elevations at the limit of development at the south end of the site, in proximity to the limit of regulation area from the adjacent wetland, are in the order of 2 metres higher than the ground surface elevation at the northeast corner of the site verifying the limit of the watershed and watershed flow direction.



2.4.2 Post-Development Site Conditions

As previously stated, the proposed development consists of the construction of two additional commercial buildings for the dog boarding and training facility. The buildings are to be constructed in phases. The phase 1 building is to consist of a 445m^2 Indoor Dog Gym/Play Area. The phase 2 building is to consist of a 153m^2 Dog Kennel. Both phases of the development are being considered in this report. The driveway will be expanded to provide fire truck access to the proposed new development. Also considered in the post-development conditions for the site are the existing gravel surfaced areas not previously considered within the pre-development conditions due to the criteria provided by the City of Ottawa. The post-development conditions can be summarized as indicated in the following Tables 2-2a to 2-2c

Table 2-2a – Summary of Post-Development Site Conditions

POST-DEVELOPMENT – TOTAL AREA

Description	**Runoff Coefficient C**		**Curve Number CN**	**Area (ha)**
	5-year	100-year		
Total Area				4.206
Roof	0.90	1.00	98	0.144
Gravel	0.60	0.75	85	0.264
Grass	0.30	0.38	69	3.170
Woodland	0.25	0.31	55	0.629
Controlled Area Weighted Average C and CN	*0.33*	*0.41*	*69*	
Additional Parameters	**Potential Storage**	**IA**	**Time to Peak**	
	115	*11.5*	*0.36*	

Table 2-2b– Summary of Post-Development Uncontrolled Area

POST-DEVELOPMENT – UNCONTROLLED AREA

Description	**Runoff Coefficient C**		**Curve Number CN**	**Area (ha)**
	5-year	100-year		
Total Area				2.123
Roof	0.90	1.00	98	0
Gravel	0.60	0.75	85	0.057
Grass	0.30	0.38	69	1.437
Woodland	0.25	0.31	55	0.629
Controlled Area Weighted Average C and CN	*0.29*	*0.37*	65	
Additional Parameters	**Potential Storage**	**IA**	**Time to Peak**	
	135	*13.5*	0.36	

Table 2-2c– Summary of Post-Development Controlled Area

POST-DEVELOPMENT – CONTROLLED AREA

Description	Runoff Coefficient C 5-year	Runoff Coefficient C 100-year	Curve Number CN	Area (ha)
Total Area				2.083
Roof	0.90	1.00	98	0.144
Gravel	0.60	0.75	85	0.207
Grass	0.30	0.38	69	1.732
Woodland	0.25	0.31	55	0
Controlled Area Weighted Average C and CN	*0.37*	*0.46*	73	
Additional Parameters	**Potential Storage**	**IA**	**Time to Peak**	
	96	*9.6*	0.36	

3 STORMWATER QUANTITY CONTROL

3.1 Pre-development Flow Rate

3.1.1 Rational Method

Using the previously calculated runoff coefficients and the storm intensities, the pre-development runoff rate for the 5-year storm and 100- year storms are as follows:

5 year $^{\text{pre-development}}$= 186 L/sec
100 year $^{\text{pre-development}}$ = 394 L/sec

3.1.2 OTTHYMO SWM model

Table 2-3 summarizes the pre-development peak release rate and runoff volumes for the above storm events. Appendix B contains the detailed pre-development OTTHYMO output data. The detailed output data provides the program output for the pre-development outflow from the proposed development.

Table 2-3 – Summary of Pre-Development Runoff Rates and Runoff Volumes using OTTHYMO

Design Storm Event		Pre-Development Runoff Rate	Runoff Volume
		(L/s)	(mm)
Sim 1	25 mm 4 hour Chicago	6	1.24
Sim 2	6 hour 5 year SCS Type II	62	8.67
Sim 3	12 hour 5 year SCS Type II	77	11.84
Sim 4	6 hour 100 year SCS Type II	200	25.91
Sim 5	12 hour 100 year SCS Type II	237	33.17

3.2 Post-development Flow Rate – Uncontrolled Areas

3.2.1 Rational Method

Using the previously calculated runoff coefficients and the storm intensities, the post-development runoff rate from the uncontrolled areas for the 5-year storm and 100- year storms are as follows:

$$Q = 2.78\ C * I * A$$

5 year ^{uncontrolled} = 2.78 * 0.29 * 51.61 * 2.123 = 89 L/sec
100 year ^{uncontrolled} = 2.78 * 0.37 * 87.89 * 2.123 = 190 L/sec

3.2.2 OTTHYMO SWM model

Table 2-4 summarizes the post-development peak release rate and runoff volumes for the above storm events from the uncontrolled area. Appendix C contains the detailed post-development OTTHYMO output data. The detailed output data provides the program output for the post-development outflow from the proposed development.

Table 2-4 – Summary of Uncontrolled Post-Development Runoff Rates and Runoff Volumes using OTTHYMO

Design Storm Event		Pre-Development Runoff Rate	Runoff Volume
		(L/s)	(mm)
Sim 1	25 mm 4 hour Chicago	2	0.89
Sim 2	6 hour 5 year SCS Type II	26	7.32

Sim 3	12 hour 5 year SCS Type II	32	10.16
Sim 4	6 hour 100 year SCS Type II	88	23.02
Sim 5	12 hour 100 year SCS Type II	106	29.76

3.3 Allowable Release Rate

Based on the quantity control criteria, the allowable release rate from the controlled area of the development is equal to the total pre-development runoff rate from the site less the runoff rate from the uncontrolled areas of the site.

3.3.1 Rational Method

Using the previously determined pre-development runoff rate and runoff rate from the uncontrolled areas calculated using the rational method, the allowable release rate from the controlled area during post-development conditions is as follows:

5 year ^{allowable} = 186 - 89 = 97 L/sec
100 year ^{allowable} = 394- 190 = 204 L/sec

3.3.2 OTTHYMO SWM model

Using the previously determined pre-development runoff rate and runoff rate from the uncontrolled areas calculated using the OTTHYMO SWM model, the allowable release rate from the controlled area during post-development conditions is as follows:

Table 2-5 – Allowable Release Rate using OTTHYMO

Design Storm Event		**Pre-Dev Runoff Rate**	**Uncontrolled Runoff Rate**	**Allowable Release Rate**
		(L/s)	**(L/s)**	**(L/s)**
Sim 1	25 mm 4 hour Chicago	6	2	4
Sim 2	6 hour 5 year SCS Type II	62	26	36
Sim 3	12 hour 5 year SCS Type II	77	32	45
Sim 4	6 hour 100 year SCS Type II	200	88	112
Sim 5	12 hour 100 year SCS Type II	237	106	131

3.4 Post-Development Controlled Area Stormwater Management

As previously indicated, the post-development flow rate from the controlled area will be restricted such that the maximum runoff rate from the proposed development will be less than or equal to the pre-development flow rate from the proposed development area during corresponding storm events up to and including the 100 year storm event. Runoff in excess of the pre-development runoff rate will be detained on the controlled area to be released at a controlled rate during and following a storm event.

3.4.1 Controlled Area Stormwater Storage and Discharge

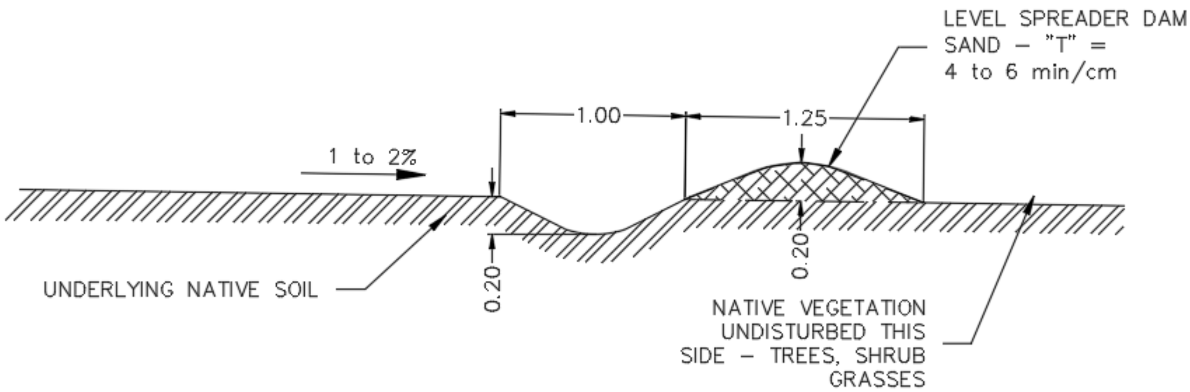
Details for the proposed stormwater management storage are provided on drawing 190622-GR. Stormwater storage will be provided behind a series of level spreader dams which will be located all around the proposed area of development. The level spreader dams will be constructed parallel to the existing contours of the ground surface at the limit of the proposed development. Where the level spreader dams are discontinuous, they will slightly overlap to ensure that all runoff from the development area will directed through and over the level spreaders. The level spreader dams are intended to reduce the runoff rate and runoff volume by promoting infiltration and redistributing any concentrated runoff from the development area to match existing runoff patterns. The level spreader dams will ensure that the post-development runoff conditions will match the pre-development runoff conditions.

As previously indicated, the upper subsurface conditions at the site consist of soils within the Hydrological Soil Group B. That is: Soils having a moderate infiltration rate when thoroughly wetted.

Guidance for the design of the level spreader dams is provided in the Ministry of Environment Stormwater Management Planning and Design Manual (the manual) Section 4.5.12. Vegetated Filter Strips. From the manual, a vegetated filter strip generally consists of a level spreader and planted vegetation. The level spreader ensures uniform flow over the vegetation which filters out pollutants and promotes infiltration of the stormwater. It is noted that the design guidance in Section 4.5.12 indicates that the drainage area should be limited to less than 2 hectares.

The controlled catchment area of 2.08 hectares slightly exceeds this upper limit. It is however noted that the runoff from the controlled area will be directed outwards from the developed portion of the site to level spreader dams constructed all around the developed area. As such each section of level spreader dam and associated vegetated filter strip will receive runoff from an area much less than 2 hectares.

The level spreader dams will be constructed in keeping with Figure 4.16 of the manual as illustrated in the figure below.



Stormwater will be stored upstream of the level spreader dams and will be discharged by infiltration through the underlying native soil and by filtration through the level spreader dam. The level spreader dams as indicated on drawing 190622-GEC have a total combined length of 610 metres. For calculation purposes, it is assumed that stormwater storage will occur behind half of the total length of the level spreaders. Due to the length of the level spreaders and natural undulation of the land it is considered that it will be difficult to ensure all of the spreader sections are level. The ends of each section will serve to direct the runoff towards the centre of the section. Each level spreader will have a height of 0.2 metres before overflow. The total calculated storage before overflow is 291 cubic metres.

The storage capacity behind the level spreader dams was calculated using an excel spreadsheet included in Appendix A following the text of this letter. This spreadsheet was used in conjunction with the Required Storage vs Release Rate to determine the storage requirements using the rational method. The storage capacity behind the level spreader dams in modeled in OTTHYMO using a reservoir.

An outlet rating curve is entered into the reservoir model in the form of an allowable release rate as a function of available storage. The outlet rating curve was obtained in two steps. The first step consisted of calculating the available storage volume behind the level spreader at elevation increments using Auto Cad Civil 3D modeling software in combination with an excel spreadsheet. The second step consisted of determining the outlet release rate by means of infiltration through the native soils and by means of filtration through the level spreader dams.

The following Table 2-6 Storage Swale Volume and Release rate provides a summary of the available storage volume and release rate with respect to depth of stored water behind the level spreader.

Table 2-6: Storage Swale Volume and Release Rate

Storage Depth (m)	Total Discharge (L/s)	Total Discharge (m^3/s)	Cumulative Volume (ha*m)	Cumulative Volume (m^3)
0.240	833	0.833	0.0389	388.9
0.220	349	0.349	0.0340	340.1
0.210	176	0.176	0.0316	315.7
0.205	114	0.114	0.0303	303.5
0.200	78	0.078	0.0291	291.3
0.160	54	0.054	0.0194	193.7
0.120	31	0.031	0.0108	108.3
0.080	14	0.014	0.0047	47.4
0.040	4	0.004	0.0011	11.0
0.020	1	0.001	0.0002	2.0

3.4.2 Post Development Runoff Rate – Rational Method

In order to meet the stormwater quantity control restriction, the post development runoff rate from the controlled areas of the site cannot exceed the allowable release rate previously calculated. Runoff in excess of the allowable release rate will be detained and temporarily stored on the site to be released a controlled rate during and following a storm event.

The stormwater management calculation sheets included in Appendix A were generated to determine the maximum storage requirement for each catchment area:

- On the required storage vs release rate calculation sheet: The storage requirement for a series of design storms was determined as a function of the release rate from the catchment area for each return period. As an Example: For the purposes of this sheet, each duration of the 5 year storm is considered to be an individual design storm. When considering a storm event with a 5 year return period for the controlled area CA1, the maximum storage requirement for a release rate of 20 L/s will occur for a design storm with a duration of 55 minutes and for a release rate of 80 L/s will occur for a design storm with a duration of 15 minutes.
- On the outlet control design sheet: The available storage volume behind the level spreader dam is calculated with respect to the ponding depth behind the level spreader dam in the storage pond. Since the discharge rate by infiltration and filtration is a function of the head

on across the spreader dam and over the native soils, the discharge rate from the storage is also calculated with respect to the ponding depth.

- The storage discharge curve chart was generated to overlay the maximum storage requirement vs discharge rate curve for each return period (calculated on the required storage vs release rate sheet) on the available storage volume vs discharge rate curve (calculated on the outlet control design sheet). The point where the curves cross provides the maximum storage volume and discharge rate for each return period considered.

The calculation tables included in Appendix A provide the maximum discharge rates and storage requirements and ponding depths for the design storms as summarized in the following Table 2-7

Table 2-7 – Summary of Maximum Discharge Rate, Storage Requirement and Ponding Depth

Return period	Allowable Release Rate	Actual Release rate	Required Storage	Available Storage	Required Storage Depth	Available Storage Depth
(years)	(L/s)	(L/s)	(m3)	(m3)	(m)	(m)
2.083 ha Catchment - Controlled Area						
5	97	38	138	316	0.13	0.21
100	204	82	293	316	0.20	0.21

Since the actual release rate is much less than the allowable release rate for both design storms the post-development runoff will be less than or equal to the pre-development runoff for the proposed development area.

3.4.3 Post Development Runoff Rate – OTTHYMO

In order to meet the stormwater quantity control restriction, the post development runoff rate from the controlled areas of the site cannot exceed the allowable release rate previously

The above indicated stage-storage curve was added to a reservoir model included in the OTTHYMO analysis. The following table 2-8 provides a summary of the analysis results obtained using the OTTHYMO model.

Table 2-8 – Post-Development Release Rate using OTTHYMO

Design Storm Event		Allowable Release Rate	Actual Release Rate	Difference Post-Dev – Allowable
		(L/s)	(L/s)	(L/s)
2.083 ha Catchment - Controlled Area				
Sim 1	25 mm 4 hour Chicago	4	4	0
Sim 2	6 hour 5 year SCS Type II	36	24	-12
Sim 3	12 hour 5 year SCS Type II	45	28	-17
Sim 4	6 hour 100 year SCS Type II	112	67	-45
Sim 5	12 hour 100 year SCS Type II	131	73	-58

Since the actual release rate is less than the allowable release rate for all design storms the post-development runoff will be less than or equal to the pre-development runoff for the proposed development area.

3.4.4 Post Development Runoff Volume – OTTHYMO

In order to ensure that the proposed development had no negative impact on the surrounding area the change in runoff volume as a result of the increased impervious area due to the proposed development was also considered.

The OTTHYMO stormwater management model provides a volume of runoff in terms of mm of depth. The volume of runoff is the difference between the total amount of rainfall in mm and the amount rainfall that is stored or absorbed also measured in mm. The total runoff volume can be determined by multiplying the depth by the catchment area. It is noted that the runoff volume calculations completed by the program do not take into account the volume of runoff stored and infiltrated as the reservoir model assumes this runoff is being released from site.

The pre- and post- development runoff volumes as calculated using OTTHYMO are summarized in the following Table 2-9.

Table 2-9 Runoff Volume – Comparison of Pre-Development to Post-Development

Design Storm Event	Pre-Dev Runoff Volume		Post-Dev Runoff Volume					Excess Post Runoff Volume	
	Total (4.206 ha)		Uncon (2.123 ha)		Con (2.083 ha)		(4.206 ha)	Total (4.206 ha)	
	mm	mm*ha	mm	mm*ha	mm	mm*ha	mm*ha	mm*ha	m^3
25 mm 4 hr Chi	1.24	5.22	0.89	1.90	2.13	4.44	6.34	1.12	11.2
6 hr 5 yr SCS Type II	8.67	36.47	7.32	15.64	11.61	24.18	39.82	3.35	33.5

12 hr 5 yr SCS Type II	11.84	49.80	10.13	21.64	15.42	32.12	53.76	3.96	39.6
6 hr 100 yr SCS Type II	25.91	108.98	23.02	49.17	31.68	65.99	115.16	6.18	61.8
12 hr 100 yr SCS Type II	33.17	139.51	29.76	63.57	39.83	82.97	146.53	7.02	70.2

Sample calculation: 6 hr 5 yr SCS Type II storm event

The total volume of runoff during pre-development conditions is equal to:
8.67 mm x 4.206 ha = 36.47 mm*ha.

The total volume of runoff from the uncontrolled area during post-development conditions is equal to:
7.32 mm x 2.123 ha = 15.64 mm*ha.

The total volume of runoff from the controlled area during post-development conditions is equal to:
11.61 mm x 2.083 ha = 24.18 mm*ha.

Total runoff volume during post-development conditions for the developed area is equal to:
15.64 mm*ha + 24.18 mm* ha = 39.82 mm* ha.

Volume of excess runoff generated during post-development conditions is equal to:
39.82 mm* ha - 36.47 mm*ha = 3.35 mm*ha = 33.5 m^3.

From table 2-9 above, the maximum excess runoff volume generated during post-development conditions occurs during a 100 year design storm event and is equal to 70.2 m^3. As discussed above, there is a total storage capacity of about 291 m^3 behind the level spreader dams before overflow. Since all of the stored water behind the level spreaders is infiltrated, the available storage for infiltration is in excess of the surplus runoff volume generated during post development conditions. As such, the total post-development runoff volume leaving the site under post-development conditions will be less than the runoff volume leaving the site under pre-development conditions and the proposed development will have no negative impact to the surrounding area.

4 STORMWATER QUALITY DESIGN CRITERIA

MVCA requires an enhanced level of treatment for the site. An enhanced level of treatment corresponds to 80 percent total suspended solids removal.

The City of Ottawa requires that all outdoor open areas for canines shall ensure sanitary waste does not run-off site during storm events. If stormwater management ponds are provided the ponds should be free of contamination prior to discharging.

As indicated in the Stormwater Management Planning and Design Manual published by the Ontario Ministry of the Environment (The Manual), the recommended strategy for stormwater management is to provide an integrated treatment train approach to water management. In general, best management practices for stormwater management quality control are divided into three categories: source control, conveyance control and end-of-pipe control.

4.1 Total Suspended Solids Removal - Enhanced Level of Treatment

4.1.1 Runoff Pollutant Source Control

Based on the quality control criteria, there are two significant pollutants of concern with respect to surface water contamination. The first pollutant consists of suspended solids. The second pollutant consists of canine sanitary waste.

The primary source of total suspended solids and associated runoff pollution under post-development conditions in a commercial facility such as present at the site is considered to be the areas of the site subject to vehicle traffic and surfaced with granular material. In general, vegetated landscaped areas and roof areas are not considered to be a major source of runoff pollution following the completion of the development and establishment of the vegetation in the landscaped areas.

The primary sources of pollution in runoff from canine sanitary waste is failure to clean up the feces after it has been deposited by the dog and poor kennel cleaning practices where solid waste is placed in a location prone to runoff.

The application of de-icing chemicals including salts can be reduced with a best management plan for the application of these products. BMPs with respect to de-icing chemicals include such measures as timing of application, targeted application, and clearing of snow cover before application.

Best management practices with respect to cleaning up after each dog will be implemented by the facilities both to maintain a clean facilities and to maintain the health of the dogs within the facilities. Solid waste from the kennels is placed at a location distance from sensitive receptors and at a location not prone to significant runoff.

4.1.2 Conveyance Control – Flow over Grassed Surfaces

The primary mode of treatment, following reduction of potential pollutants by source control, is by means of conveyance control. All of the runoff at the site will be directed by sheet flow and shallow swales towards the limits of the development. There are no storm sewers or directly connected impervious areas. Runoff from the gravel surfaced roadway and parking areas will be directed to the adjacent grassed areas. The runoff will be conveyed over the grass covered surfaces prior to encountering the level spreaders.

4.1.3 End-of-Pipe Control – Level Spreader, Filtration and Vegetated Filter Strips

All of the runoff generated on the developed portion of the site will be intersected by the level spreaders and be dispersed to the natural vegetation following the level spreader prior to flowing beyond the limit of development.

Guidance for the design of the level spreader dams is provided in the Ministry of Environment Stormwater Management Planning and Design Manual (the manual) Section 4.5.12. Vegetated Filter Strips. From the manual, a vegetated filter strip generally consists of a level spreader and planted vegetation. In the case of the proposed development, the planted vegetation will be limited to that required to re-vegetate the areas where the vegetation was disturbed during construction.

The following Table 2.10 provides a summary of the design conformance for the vegetative filter strip and level spreader. A column has been added to indicate how the proposed design conforms to the Criteria.

Table 2.10 – Design Conformance of the Vegetative Filter Strip and Level Spreader

Vegetative Filter Strip			
Design Element	Design Objective	Minimum Criteria	Design Conformance / Comment
Drainage Area	Limit Peak Flow Rate and Velocity below Flow Criteria	< 2 hectares	< 1 ha. 2.08 hectares total divided to all four sides of the development.
Ground Slope	promote sheet drainage	< 10% ideal <5%	Varies 1 to 2%
Strip Length	promote sedimentation and vegetative filtration	10m to 15m	varies ~10m to greater than 20m
Strip width	reduce flow depth to provide sufficient water quality enhancement	minimum 10 to 20 metres	total of 305 metres considered

Flow Rate	Sedimentation and prevent re-suspension	≤ 0.15 m^3/s during quality event	< 0.08 m^3/s during 100 year storm event
Peak Flow Velocity	Facilitate Sedimentation and vegetative filtration	< 0.5 m/s during quality event	0.18 m/s during 100 year storm event

Level Spreader			
Design Element	Design Objective	Minimum Criteria	Design Conformance / Comment
Orientation	distribute flow evenly over vegetated surface	perpendicular to flow	perpendicular to flow
Height	Provide Storage	illustrated as 200 mm	200 mm
Flow depth over filter	limit peak flow depth during quality storm event	less than 50 to 100 mm	no flow over spreader during quality storm
Storage	Maintain desired flow depth through vegetative filter	Store excess storm water from quality storm	Storage greater than 5 year storm event.
Construction	Concrete, wood, or natural material with outlet for water trapped behind spreader		Medium to coarse grained sand with outlet by overflow or filtration.

The level spreaders have been designed to be constructed with medium to coarse sand and as such will act as a sand filter. Flow over the spreaders will be distributed as sheet flow through the vegetation following the spreaders. Runoff less than the storage capacity behind the level spreader will be discharged from the site by filtration through the level spreader only.

MOE Manual indicates that the size of a filter be designed to ensure a specified volume is discharged within a specified time period using the Darcy Equation. The size of the filter and storage volume must be sufficient to ensure that no overflow or by-pass occurs below the 4 hr 15 mm design storm. This guidance for the design of a filter has been used to ensure there is sufficient storage volume behind the level spreader to achieve the desired level of quality control. Since there is sufficient volume to ensure that there will be no overflow during a 5 year storm event, the proposed design will meet the quality control criteria. It is noted that the runoff rate from the controlled area during the 25 mm 4hr Chicago quality storm event is 4 L/s and during a 5 year event is 28 L/s.

4.1.4 Best Management Practices

Best Management Practices shall be implemented as follows to reduce transport of sediments.

- Discharge roof leaders to yards for natural infiltration / evaporation. Roof leaders will discharge onto the ground and travel through low gradient grassed swales. Discharge of roof leaders to the granular surfaced roadways or parking areas should be avoided if at all possible.
- The grassed swales will have reduced gradients to reduce the flow velocity and to promote sedimentation and prevent resuspension of sediment. Grass swales should terminate before the level spreaders.
- Construction works are to be timed in order to reduce the length of time between the beginning of construction and the establishment of vegetative cover.

The runoff from the uncontrolled areas consists of runoff from predominately grassed surfaced areas and will not be subject to any significant sediment or pollutant loading.

4.2 Management of Canine Waste

As previously discussed, the kennel implements best management practices with respect to canine waste management to ensure a clean facilities and healthy dogs. The dog feces deposited outdoors is collected after it is deposited and placed in a transport container. Solid Canine waste from the kennels and the collected dog feces is transported to a solid manure storage location.

It is noted that Solid, in relation to prescribed materials or nutrients [manure], is: '... having a dry matter content of 18 per cent, or more, or a slump of 150 mm, or less, using the (slump test) set out in Schedule 9 to Regulation 347 made under the Environmental Protection Act... '

'Solid prescribed materials' is generally inferred as 'solid manure' that contains bedding such as straw, peat moss, shavings, sawdust or other materials that binds it so it can be stacked and handled with equipment.

From the geotechnical report, the subsurface soil conditions at the site consist of topsoil overlying a 1.2 to 1.5 metre thick layer of sand followed by silt then silty clay. The silty clay was encountered at depths varying between 1.5 and 2.3 metres below the existing ground surface. Bedrock was encountered at depths ranging from 3.6 to 4.5 metres below the existing ground surface.

Perched groundwater was encountered in the sand and silt above the silty clay at 0.9 metres below the existing ground surface. This groundwater does not represent a groundwater aquifer but is the result of the relatively slower infiltration rate of the underlying silty clay.

The proposed solid manure storage location is shown on Kollaard drawing. The manure storage location is surrounded by a berm which will prevent all stormwater originating on the area of the manure storage location from running off the site. The following Table 2.11 provides a summary of the design conformance of the solid manure storage location to site requirements under the NMA regulations.

Table 2.11 Conformance of Solid Manure Storage to Regulations

Design Element	Design Objective	Minimum Criteria	Design Conformance
Minimum depth of Soil to Bedrock	minimum potential for runoff to reach bedrock	3.0 m of un-consolidated (not compacted) soil	3.6 m At least 1 m of silty clay above bedrock
Minimum depth to water table	minimum potential for runoff to reach water table	0.9 m	0.9 m to perched groundwater. Permanent ground water below surface of bedrock
Soil Type	minimize potential for nutrient flow into the bedrock	Cannot be Soil Group A	Soil Group B
Storage location	minimize potential for flooding	Cannot be in the floodplain	Is not in the floodplain.
Site slope	minimize runoff rate	< 3%	Relatively flat in proposed storage area <1%
Distance to Surface Water	minimize potential for surface water contamination	50 m	94 m to the regulation limit surrounding the adjacent wetland
Separations	minimize risk to drinking water and provide separation to the residence	45 m to drilled well	133
		90 m to dug well	N/A
		100 m to municipal well	N/A
		125 m to single residence	127 m

As shown in the above table, the solid waste from the facilities will be placed at a location in keeping with the requirements for the storage of solid manure. As such, the proposed practices with respect to the management of the canine feces will ensure that contamination from canine feces is not carried off of the site by stormwater runoff. There are no stormwater management ponds proposed on site.

5 STORMWATER SYSTEM OPERATION AND MAINTENANCE

The level spreaders and vegetation should be inspected on a weekly basis and after any rain fall event during and after construction until vegetation is well established. Once the vegetation is well established, the storage areas should be visually inspected on a bi-monthly basis and following significant storm events. For inspection purposes, a rain fall event of more than 15 mm in 4 hours or more than 25 mm in 24 hours would be considered to be a significant event.

The inspection should consist of an intentional visual examination of the condition of the vegetation, and level spreader. If noxious or invasive vegetative growth is observed, it should be removed. If the level spreaders have settled or is not evenly distributing the runoff over the vegetation, they should be leveled and reshaped.

The vegetation along the level spreader can be left natural or be maintained by mowing. If mowed, the grass should be cared for as required to maintain a normal healthy appearance. Minimum recommended grass height is 75 mm.

If there is the appearance of long term ponding behind the level spreader as evidenced by standing water more than 2 days after a storm event or by distress in the vegetation, the sand in the level spreader should be replaced. Disturbed areas should be revegetated.

6 EROSION AND SEDIMENT CONTROL

The owner (and/or contractor) agrees to prepare and implement an erosion and sediment control plan at least equal to the stated minimum requirements and to the satisfaction of the City of Ottawa and the Conservation Authority, appropriate to the site conditions, prior to undertaking any site alterations (filling, grading, removal of vegetation, etc.) and during all phases of site preparation and construction in accordance with the current best management practices for erosion and sediment control. It is considered to be the owners and/or contractors responsibility to ensure that the erosion control measures are implemented and maintained.

In order to limit the amount of sediment carried in stormwater runoff from the site during construction, it is recommended to install a silt fence along the limit of development. The silt fence may be polypropylene, nylon, and polyester or ethylene yarn.

If a standard filter fabric is used, it must be backed by a wire fence supported on posts not over 2.0 m apart. Extra strength filter fabric may be used without a wire fence backing if posts are not over 1.0 m apart. Fabric joints should be lapped at least 150 mm (6") and stapled. The bottom edge of the filter fabric should be anchored in a 300 mm (1 ft) deep trench, to prevent flow under the fence. Sections of fence should be cleaned, if blocked with sediment and replaced if torn.

The proposed landscaping works should be completed as soon as possible. The proposed granular and asphaltic concrete surfaced areas should be surfaced as soon as possible.

The silt fences should only be removed once the site is stabilized and landscaping is completed.

7 CONCLUSIONS

This report addresses stormwater management (SWM) design requirements and proposed works that will address stormwater flows arising from the site under post-development conditions for the proposed expansion of the existing dog training and boarding facility. Based on the analysis provided in this report, the conclusions are as follows:

Stormwater runoff will be managed by a series of level spreaders constructed around the proposed development.

The level spreaders will provide sufficient storage to ensure the post-development runoff is less than or equal to the pre-development runoff for all storm events from both a runoff rate and a runoff volume perspective.

The proposed development will have no negative effect to the adjacent lands outside the limit of development.

The stormwater management design will ensure that an enhanced level of treatment corresponding to 80 percent total suspended solid removal is attained for all runoff by means of sedimentation and filtration.

Canine sanitary waste will be managed and disposed of in a manner which will ensure that stormwater runoff from the site will not convey contamination related to canine sanitary waste off the site.

We trust that this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we can be of any further assistance to you on this project, please do not hesitate to contact our office.

Sincerely,
Kollaard Associates, Inc.

Steven deWit, P.Eng.

Appendix A: Drawings

- Pre-development Area and Flow Summary
- Rational Method - Post-Development Flow and SWM Summary
- Otthymo - Post-Development Flow and SWM Summary
- Required Storage Vs. Release Rate
- Outlet Control Structure Design Sheet - Level Spreaders
- Storage-Discharge Curve
- Stage-Storage Curve.

APPENDIX A: STORMWATER MANAGEMENT MODEL

PRE-DEVELOPMENT AREA AND FLOW SUMMARY

Client: Dog World Bedrock Kennels
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022

PRE-DEVELOPMENT AREA (limit of development)

Runoff Coefficient Equation

$C = (A_{hard} \times 0.9 + A_{soft} \times 0.2)/A_{tot}$

Pre- Dev run-off Coefficient "C"

Area	Surface	Ha	"C"	5 yr C_{avg}
Total	Roof	0.023	0.90	**0.31**
4.206	Gravel	0.176	0.60	
	Grass	3.318	0.30	
	Woodland	0.689	0.25	

5 Year Event

Pre Dev.	C	Intensity	Area
5 Year	0.31	51.61	4.206
2.78CIA= 185.64			

**Use a 32 minute time of concentration for 5 year

Total Runoff Rate: 186 L/s

Area	Surface	Ha	"C"	100 yr C_{avg}
Total	Roof	0.023	1.00	**0.38**
4.206	Gravel	0.176	0.75	
	Grass	3.318	0.38	
	Woodland	0.689	0.31	

100 Year Event

Pre Dev.	C	Intensity	Area
100 Year	0.38	87.89	4.206
2.78CIA= 394.45			

**Use a 32 minute time of concentration for 100 year

Total Runoff Rate: 394 L/s

Pre- Dev run-off Coefficient "CN" Soil Group B

Area	Surface	Ha	"CN"	CN_{avg}	Potential Storage	Initial Abstraction	Time to Peak
Total	Roof	0.023	98	**68**	122	12.2	0.36
4.206	Gravel	0.176	85				
	Grass	3.318	69				
	Woodland	0.689	55				

Storm Event	Pre-Dev 4.206 ha L/s
25mm 4hr Chi	6
6hr 5 yr	62
12hr 5yr	77
6hr 100yr	200
12hr 100yr	237

APPENDIX A: STORMWATER MANAGEMENT MODEL
RATIONAL METHOD - POST-DEVELOPMENT FLOW AND SWM SUMMARY

Client: Dog World Bedrock Kennels
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022

POST-DEVELOPMENT AREA (limit of development)

Runoff Coefficient Equation
$C = (A_{hard} \times 0.9 + A_{soft} \times 0.2)/A_{tot}$

Post- Development Run-off Coefficient C - Total Area

Area	Surface	Ha	"C"	5 yr C_{avg}
Total	Roof	0.144	0.90	**0.33**
4.206	Gravel	0.264	0.60	
	Grass	3.170	0.30	
	Woodland	0.629	0.25	

5 Year Event			
Post Dev.	**C**	**Intensity**	**Area**
5 Year	0.33	51.61	4.206
2.78CIA= 200.29			

**Use a 32 minute time of concentration for 5 year
Total Runoff Rate: **200 L/s**

Area	Surface	Ha	"C"	100 yr C_{avg}
Total	Roof	0.144	1.00	**0.41**
4.206	Gravel	0.264	0.75	
	Grass	3.170	0.38	
	Woodland	0.629	0.31	

100 Year Event			
Post Dev.	**C**	**Intensity**	**Area**
100 Year	0.41	87.89	4.206
2.78CIA= 421.94			

**Use a 32 minute time of concentration for 100 year
Total Runoff Rate: **422 L/s**

Post- Development Run-off Coefficient C - Uncontrolled Area

Area	Surface	Ha	"C"	5 yr C_{avg}
Total	Roof	0.000	0.90	**0.29**
2.123	Gravel	0.057	0.60	
	Grass	1.437	0.30	
	Woodland	0.629	0.25	

5 Year Event			
Pre Dev.	**C**	**Intensity**	**Area**
5 Year	0.29	51.61	2.123
2.78CIA= 89.29			

**Use a 32 minute time of concentration for 5 year
Total Runoff Rate: **89 L/s**

Area	Surface	Ha	"C"	100 yr C_{avg}
Total	Roof	0.000	1.00	**0.37**
2.123	Gravel	0.057	0.75	
	Grass	1.437	0.38	
	Woodland	0.629	0.31	

100 Year Event			
Pre Dev.	**C**	**Intensity**	**Area**
100 Year	0.37	87.89	2.123
2.78CIA= 190.07			

**Use a 32 minute time of concentration for 100 year
Total Runoff Rate: **190 L/s**

Post- Development Run-off Coefficient C - Cntrolled Area - Unrestricted

Area	Surface	Ha	"C"	5 yr C_{avg}
Total	Roof	0.144	0.90	**0.37**
2.083	Gravel	0.207	0.60	
	Grass	1.732	0.30	
	Woodland	0.000	0.25	

5 Year Event			
Pre Dev.	**C**	**Intensity**	**Area**
5 Year	0.37	51.61	2.083
2.78CIA= 110.99			

**Use a 32 minute time of concentration for 5 year
Total Runoff Rate: **111 L/s**

Area	Surface	Ha	"C"	100 yr C_{avg}
Total	Roof	0.144	1.00	**0.46**
2.083	Gravel	0.207	0.75	
	Grass	1.732	0.38	
	Woodland	0.000	0.31	

100 Year Event			
Pre Dev.	**C**	**Intensity**	**Area**
100 Year	0.46	87.89	2.083
2.78CIA= 231.87			

**Use a 32 minute time of concentration for 100 year
Total Runoff Rate: **232 L/s**

Summary

Flow Rate Rational Method

Storm Event	Pre-Dev (4.206 ha) L/s	Post-Development Unrestricted (4.206 ha) L/s	Difference L/s	Uncontrolled (2.123 ha) L/s	Unrestricted Controlled (2.083 ha) L/s
5 year	186	200	15	89	111
100 year	394	422	27	190	232

Flow Rate Rational Method

Storm Event	Pre-Dev (4.206 ha) L/s	Uncontrolled (2.123 ha) L/s	Allowable Controlled L/s	Actual Controlled L/s
5 year	186	89	97	38
100 year	394	190	204	82

APPENDIX A: STORMWATER MANAGEMENT MODEL
OTTHYMO - POST-DEVELOPMENT FLOW AND SWM SUMMARY

Client: Dog World Bedrock Kennels
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022

POST-DEVELOPMENT AREA (limit of development)

Post- Dev run-off Coefficient "CN" - Total Area Soil Group B

Area	Surface	Ha	"CN"	CN_{avg}	Potential Storage	Initial Abstraction	Time to Peak
Total	Roof	0.144	98	**69**	115	11.5	0.36
4.206	Gravel	0.264	85				
	Grass	3.170	69				
	Woodland	0.629	55				

Post- Dev run-off Coefficient "CN" - UnControlled Soil Group B

Area	Surface	Ha	"CN"	CN_{avg}	Potential Storage	Initial Abstraction	Time to Peak
Total	Roof	0	98	**65**	135	13.5	0.36
2.123	Gravel	0.057	85				
	Grass	1.437	69				
	Woodland	0.629	55				

Post- Dev run-off Coefficient "CN" - Controlled Soil Group B

Area	Surface	Ha	"CN"	CN_{avg}	Potential Storage	Initial Abstraction	Time to Peak
Total	Roof	0.144	98	**73**	96	9.6	0.39
2.083	Gravel	0.207	85				
	Grass	1.732	69				
	Woodland	0	55				

Summary

Storm Event	Flow Rate OTTHYMO Pre-Dev 4.206 ha L/s	Flow Rate OTTHYMO Unrestricted Post-Dev 4.206 ha L/s	Difference L/s	Runoff Volume OTTHYMO Pre-Dev 4.206 ha (mm)	Runoff Volume OTTHYMO Unrestricted[1] Post-Dev 4.206 ha (mm)	Difference 4.206 ha (mm)
25mm 4hr Chi	6	7	1	1.24	1.43	0.19
6hr 5 yr	62	67	5	8.67	9.28	0.61
12hr 5yr	77	83	6	11.84	12.58	0.74
6hr 100yr	200	210	10	25.91	27.10	1.19
12hr 100yr	237	248	11	33.17	34.55	1.38

1) Analysis completed assuming no stormwater management control. Since the difference in Flow Rate and Volume are Positive Stormwater Management is required

Storm Event	Flow Rate OTTHYMO Pre-Dev 4.206 ha L/s	Uncontrolled Post-Dev 2.123 ha L/s	Allowable 2.083 ha L/s	Runoff Volume OTTHYMO Uncontrolled Post-Dev (2.123 ha) depth[2] (mm)	Volume[3] mm*ha
25mm 4hr Chi	6	2	4	0.89	1.90
6hr 5 yr	62	26	36	7.32	15.64
12hr 5yr	77	32	45	10.13	21.64
6hr 100yr	200	88	112	23.02	49.17
12hr 100yr	237	106	131	29.76	63.57

2) The Otthymo Program calculates excess runoff in terms of depth of rainfall which is not trapped or infiltrated (runs off).
3) The depth of rainfall running off of the site can be converted to a volume by multiplying by the catchment area. 1 mm*ha = 10 m^3.

Flow Rate OTTHYMO - FLOW RATE FROM CONTROLLED AREA RESTRICTED BY SPREADER DAMS

Storm Event	Pre-Dev 4.206 ha L/s	Controlled Post-Dev 2.083 ha L/s	Uncontrolled Post-Dev 2.123 ha L/s	Total Combined Post-Dev 4.206 ha L/s	Difference[4] Post less Pre 4.206 ha L/s
25mm 4hr Chi	6	4	2	6	0
6hr 5 yr	62	24	26	50	-12
12hr 5yr	77	28	32	60	-17
6hr 100yr	200	67	88	155	-45
12hr 100yr	237	73	106	179	-58

4) Since the difference between the post-development flow and the pre-development flow is 0 or negative the post-dev flow is < or = the pre-dev flow.

Runoff Volume OTTHYMO - Comparison of Pre-Development to Post-Development Conditions

Storm Event	Pre-Dev (4.206 ha) depth[3] (mm)	Pre-Dev (4.206 ha) Volume[4] mm*ha	Controlled Area Post-Dev (2.083 ha) depth[3] (mm)	Controlled Area Post-Dev (2.083 ha) Volume[4] mm*ha	Combined 4.206 ha volume mm*ha	Post-Dev Excess volume m^3
25mm 4hr Chi	1.24	5.22	2.13	4.44	6.34	11.2
6hr 5 yr	8.67	36.47	11.61	24.18	39.82	33.5
12hr 5yr	11.84	49.80	15.42	32.12	53.76	39.6
6hr 100yr	25.91	108.98	31.68	65.99	115.16	61.8
12hr 100yr	33.17	139.51	39.83	82.97	146.53	70.2

APPENDIX A: STORMWATER MANAGEMENT MODEL

REQUIRED STORAGE VS. RELEASE RATE

Client: Dog World Bedrock Kennels
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022

Post Dev run-off Coefficient "C" - CA2

			5 Year Event		100 Year Event	
Area (ha)	**Surface**	**Area (ha)**	**"C"**	**C_{avg}**	**"C" x 1.25**	**$C_{100\ avg}$**
Total	Roof	0.144	0.90	**0.37**	1.00	**0.46**
	Gravel	0.207	0.60		0.75	
2.083	Grass	1.732	0.30		0.38	
	Woodland	0.0	0.30		0.38	

TABLE 3 - REQUIRED STORAGE VERSUS RELEASE RATE FOR 5 YEAR STORM

Runoff Coeffcient, C =	**0.37**	Duration Interval (min) =	**5**
Drainage Area (ha) =	**2.083**	Release Rate Start (L/s) =	**0**
Return Period (yrs) =	**5**	Release Rate Interval (L/s) =	**20**

		Release Rate -->	**0**	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**
Duration (min)	Rainfall Intensity (mm/hr)	Peak Flow (L/sec)	**Storage Required (m^3)**									
0	230.5	493.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	141.2	302.6	90.8	84.8	78.8	72.8	66.8	60.8	54.8	48.8	42.8	36.8
10	104.2	223.3	134.0	122.0	110.0	98.0	86.0	74.0	62.0	50.0	38.0	26.0
15	83.6	179.1	161.2	143.2	125.2	107.2	89.2	71.2	53.2	35.2	17.2	-0.8
20	70.3	150.6	180.7	156.7	132.7	108.7	84.7	60.7	36.7	12.7	-11.3	-35.3
25	60.9	130.5	195.8	165.8	135.8	105.8	75.8	45.8	15.8	-14.2	-44.2	-74.2
30	53.9	115.6	208.0	172.0	136.0	100.0	64.0	28.0	-8.0	-44.0	-80.0	-116.0
35	48.5	104.0	218.4	176.4	134.4	92.4	50.4	8.4	-33.6	-75.6	-117.6	-159.6
40	44.2	94.7	227.3	179.3	131.3	83.3	35.3	-12.7	-60.7	-108.7	-156.7	-204.7
45	40.6	87.1	235.1	181.1	127.1	73.1	19.1	-34.9	-88.9	-142.9	-196.9	-250.9
50	37.7	80.7	242.1	182.1	122.1	62.1	2.1	-57.9	-117.9	-177.9	-237.9	-297.9
55	35.1	75.3	248.4	182.4	116.4	50.4	-15.6	-81.6	-147.6	-213.6	-279.6	-345.6
60	32.9	70.6	254.2	182.2	110.2	38.2	-33.8	-105.8	-177.8	-249.8	-321.8	-393.8
65	31.0	66.5	259.5	181.5	103.5	25.5	-52.5	-130.5	-208.5	-286.5	-364.5	-442.5
70	29.4	62.9	264.4	180.4	96.4	12.4	-71.6	-155.6	-239.6	-323.6	-407.6	-491.6
75	27.9	59.8	269.0	179.0	89.0	-1.0	-91.0	-181.0	-271.0	-361.0	-451.0	-541.0
80	26.6	56.9	273.2	177.2	81.2	-14.8	-110.8	-206.8	-302.8	-398.8	-494.8	-590.8
85	25.4	54.4	277.3	175.3	73.3	-28.7	-130.7	-232.7	-334.7	-436.7	-538.7	-640.7
90	24.3	52.1	281.1	173.1	65.1	-42.9	-150.9	-258.9	-366.9	-474.9	-582.9	-690.9
95	23.3	49.9	284.7	170.7	56.7	-57.3	-171.3	-285.3	-399.3	-513.3	-627.3	-741.3
Maximum Storage Rate =			284.7	182.4	136.0	108.7	89.2	74.0	62.0	50.0	42.8	36.8

TABLE 4 - REQUIRED STORAGE VERSUS RELEASE RATE FOR 100 YEAR STORM

Runoff Coeffcient, C =	**0.46**	Duration Interval (min) =	**5**
Drainage Area (ha) =	**2.083**	Release Rate Start (L/s) =	**0**
Return Period (yrs) =	**100**	Release Rate Interval (L/s) =	**25**

		Release Rate -->	**0**	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**
Duration (min)	Rainfall Intensity (mm/hr)	Peak Flow (L/sec)	**Storage Required (m^3)**									
0	398.6	1062.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	242.7	646.6	194.0	186.5	179.0	171.5	164.0	156.5	149.0	141.5	134.0	126.5
10	178.6	475.7	285.4	270.4	255.4	240.4	225.4	210.4	195.4	180.4	165.4	150.4
15	142.9	380.7	342.6	320.1	297.6	275.1	252.6	230.1	207.6	185.1	162.6	140.1
20	120.0	319.6	383.5	353.5	323.5	293.5	263.5	233.5	203.5	173.5	143.5	113.5
25	103.8	276.7	415.0	377.5	340.0	302.5	265.0	227.5	190.0	152.5	115.0	77.5
30	91.9	244.8	440.6	395.6	350.6	305.6	260.6	215.6	170.6	125.6	80.6	35.6
35	82.6	220.0	462.0	409.5	357.0	304.5	252.0	199.5	147.0	94.5	42.0	-10.5
40	75.1	200.2	480.5	420.5	360.5	300.5	240.5	180.5	120.5	60.5	0.5	-59.5
45	69.1	184.0	496.7	429.2	361.7	294.2	226.7	159.2	91.7	24.2	-43.3	-110.8
50	64.0	170.4	511.2	436.2	361.2	286.2	211.2	136.2	61.2	-13.8	-88.8	-163.8
55	59.6	158.9	524.2	441.7	359.2	276.7	194.2	111.7	29.2	-53.3	-135.8	-218.3
60	55.9	148.9	536.1	446.1	356.1	266.1	176.1	86.1	-3.9	-93.9	-183.9	-273.9
65	52.6	140.3	547.0	449.5	352.0	254.5	157.0	59.5	-38.0	-135.5	-233.0	-330.5
70	49.8	132.7	557.2	452.2	347.2	242.2	137.2	32.2	-72.8	-177.8	-282.8	-387.8
75	47.3	125.9	566.6	454.1	341.6	229.1	116.6	4.1	-108.4	-220.9	-333.4	-445.9
80	45.0	119.9	575.4	455.4	335.4	215.4	95.4	-24.6	-144.6	-264.6	-384.6	-504.6
85	43.0	114.4	583.7	456.2	328.7	201.2	73.7	-53.8	-181.3	-308.8	-436.3	-563.8
90	41.1	109.5	591.5	456.5	321.5	186.5	51.5	-83.5	-218.5	-353.5	-488.5	-623.5
95	39.4	105.1	598.9	456.4	313.9	171.4	28.9	-113.6	-256.1	-398.6	-541.1	-683.6
100	37.9	101.0	605.9	455.9	305.9	155.9	5.9	-144.1	-294.1	-444.1	-594.1	-744.1
Maximum Storage Rate =			605.9	456.5	361.7	305.6	265.0	233.5	207.6	185.1	165.4	150.4

APPENDIX A: STORMWATER MANAGEMENT MODEL

OUTLET CONTROL STRUCTURE DESIGN SHEET - LEVEL SPREADERS

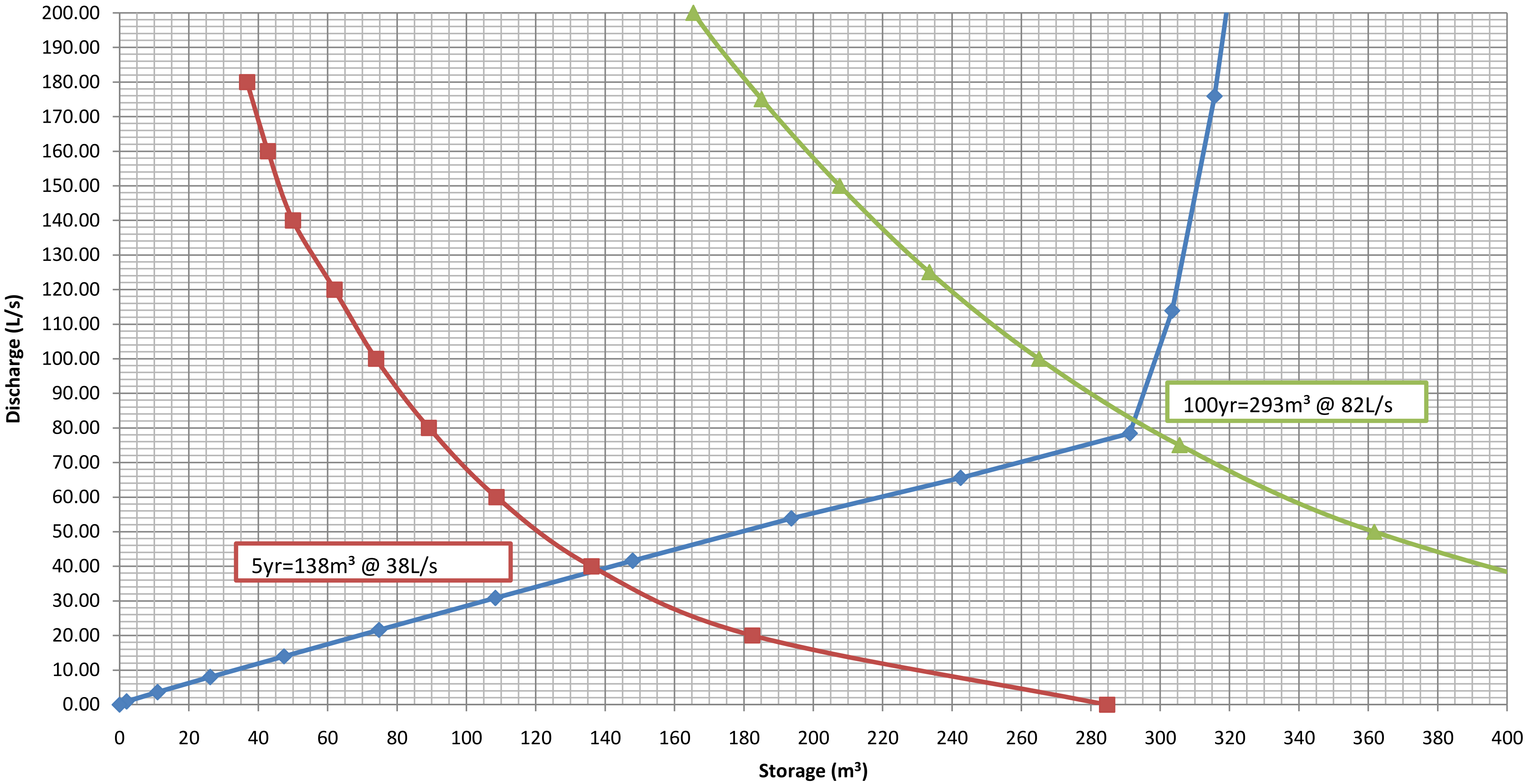
Client: **Dog World Bedrock Kennels**
Job No.: **190622**
Location: **3904 March Road, Ottawa**
Date: **August 29, 2022**

InfiltrationThrough Spreader Dam		InfiltrationThrough Bottom			Level Spreader or Weir	
Percolation Time T =	4	Percolation Time T =	15	min/cm	Weir Width (m):	50.00
Percolation Rate =	36000	Percolation Rate =	360	mm/hr	Weir Coefficient:	0.62
Permeability k =	0.010	Permeability k =	0.0001	cm/s	Weir Invert (m):	99.95
Depth of Layer =	0.5	Depth of Layer =	0.5			

Comments	Layer Thickness (m)	Cumulative depth	Layer Volume (m^3)	Cummulative Storage Volume (m^3)	Head on Weir (m)	Weir Flow (L/sec)	Outflow Infiltration (L/sec)	Total Outflow (L/sec)	Draw Down Incremental (hrs)	Draw Down Cummulative (hrs)
	0.020	0.240	48.8	388.86	0.04	725.0	107.62	832.64	0.13	4.09
	0.010	0.220	24.4	340.06	0.02	256.3	92.45	348.78	0.07	3.97
	0.005	0.210	12.2	315.66	0.01	90.6	85.29	175.92	0.04	3.89
	0.005	0.205	12.2	303.46	0.00	32.0	81.83	113.87	0.04	3.85
Top of Level Spreader	0.020	0.200	48.8	291.26	0.00	0.0	78.43	78.43	0.17	3.81
	0.020	0.180	48.8	242.46	0.00	0.0	65.56	65.56	0.21	3.64
	0.020	0.160	45.7	193.66		0.0	53.83	53.83	0.24	3.43
	0.020	0.140	39.6	147.94		0.0	41.57	41.57	0.26	3.20
	0.020	0.120	33.5	108.33		0.0	30.81	30.81	0.30	2.93
	0.020	0.100	27.4	74.83		0.0	21.60	21.60	0.35	2.63
	0.020	0.080	21.3	47.43		0.0	13.97	13.97	0.42	2.28
	0.020	0.060	15.1	26.16		0.0	7.94	7.94	0.53	1.85
	0.020	0.040	9.0	11.01		0.0	3.57	3.57	0.70	1.32
	0.020	0.020	2.0	2.03		0.0	0.90	0.90	0.63	0.63
Bottom of Storage	0.000	0.000	0.0	0.00		0.0	0.00	0.00	0.00	0.00

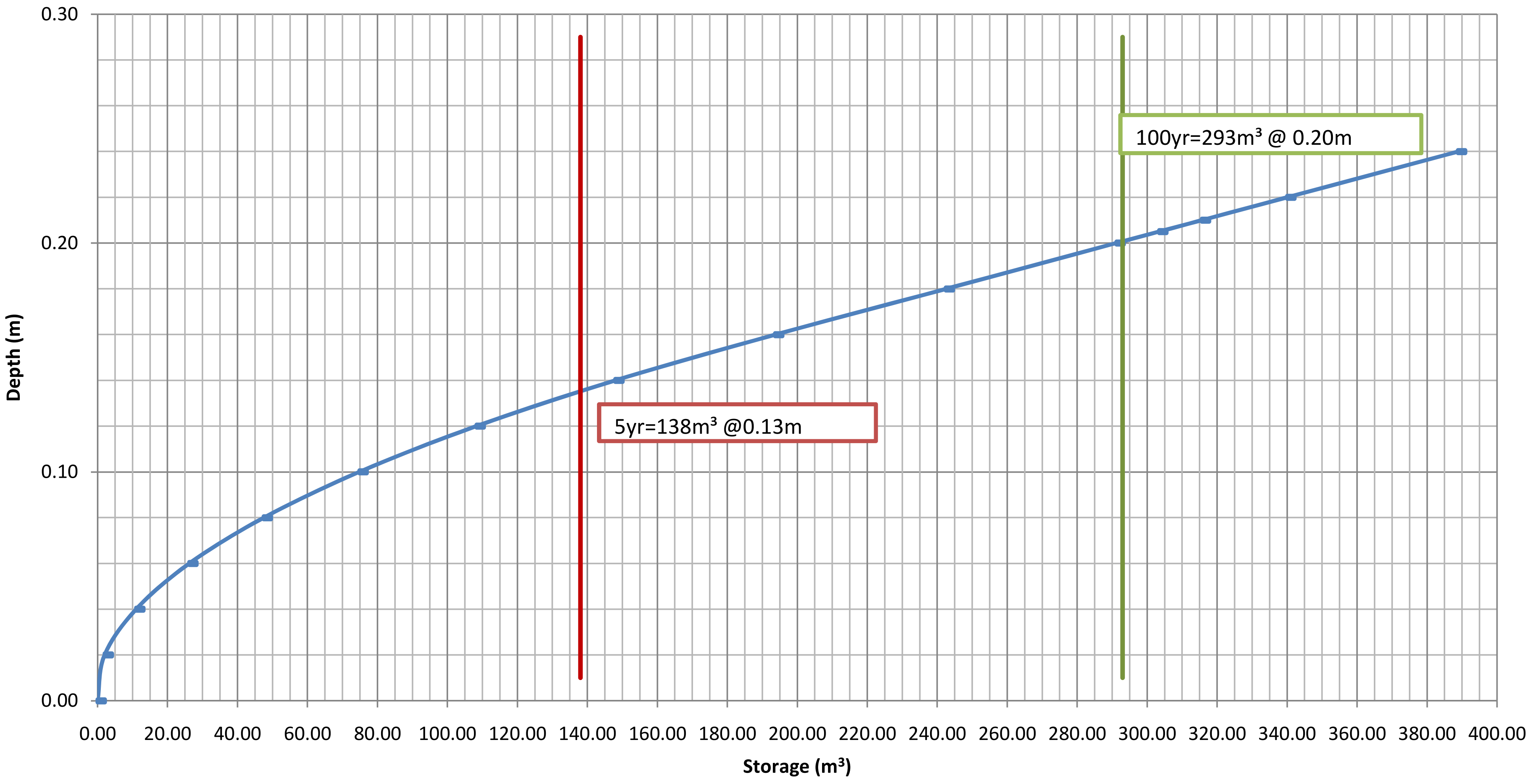
APPENDIX A: STORMWATER MANAGEMENT MODEL
Storage-Discharge Curve

Client: Dog World Bedrock Kennels.
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022



APPENDIX A: STORMWATER MANAGEMENT MODEL
Stage-Storage Curve

Client: Dog World Bedrock Kennels
Job No.: 190622
Location: 3904 March Road, Ottawa
Date: August 29, 2022



Appendix B: Pre-Development - OTTHYMO

- Pre-development OTTHYMO Model Schematic
- Pre-development Schematic Summary Table
- Pre-development Detailed Output

1

Schematic Summary Table

Hydrograph No.	Model Type	Item Represented	Comment
1	NASHYD	Sub-Catchment PRE-CA	Catchment Representing Developable Portion of the site

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

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

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



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


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


 --------------------
 |    READ STORM    |    Filename: G:\Projects\2019\
 |                  |              190622 - Dog World - 3904 March Road - SPC, G
 |                  |              \Storm\Design Storm Text Files\25mm4hrChicago
 | Ptotal= 25.00 mm |    Comments: twentyfive mm 4 hr chicago storm
 --------------------
                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                   .17    2.07 |  1.17    5.70 |  2.17    5.19 |  3.17    2.80
                   .33    2.27 |  1.33   10.78 |  2.33    4.47 |  3.33    2.62
                   .50    2.52 |  1.50   50.21 |  2.50    3.95 |  3.50    2.48
                   .67    2.88 |  1.67   13.37 |  2.67    3.56 |  3.67    2.35
                   .83    3.38 |  1.83    8.29 |  2.83    3.25 |  3.83    2.23
                  1.00    4.18 |  2.00    6.30 |  3.00    3.01 |  4.00    2.14

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 --------------------
 | CALIB            |
 | NASHYD    (0001) |   Area    (ha)=   4.21   Curve Number   (CN)= 68.0
 |ID= 1 DT= 5.0 min |   Ia      (mm)=  12.20   # of Linear Res.(N)= 3.00
 --------------------   U.H. Tp(hrs)=    .36

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


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
```

```
                 hrs    mm/hr |   hrs    mm/hr |   hrs    mm/hr |   hrs    mm/hr
                .083     2.07 | 1.083     5.70 | 2.083     5.19 |  3.08     2.80
                .167     2.07 | 1.167     5.70 | 2.167     5.19 |  3.17     2.80
                .250     2.27 | 1.250    10.78 | 2.250     4.47 |  3.25     2.62
                .333     2.27 | 1.333    10.78 | 2.333     4.47 |  3.33     2.62
                .417     2.52 | 1.417    50.21 | 2.417     3.95 |  3.42     2.48
                .500     2.52 | 1.500    50.21 | 2.500     3.95 |  3.50     2.48
                .583     2.88 | 1.583    13.37 | 2.583     3.56 |  3.58     2.35
                .667     2.88 | 1.667    13.37 | 2.667     3.56 |  3.67     2.35
                .750     3.38 | 1.750     8.29 | 2.750     3.25 |  3.75     2.23
                .833     3.38 | 1.833     8.29 | 2.833     3.25 |  3.83     2.23
                .917     4.17 | 1.917     6.30 | 2.917     3.01 |  3.92     2.14
               1.000     4.18 | 2.000     6.29 | 3.000     3.01 |  4.00     2.14

     Unit Hyd Qpeak  (cms)=    .446

     PEAK FLOW       (cms)=    .006 (i)
     TIME TO PEAK    (hrs)=   2.500
     RUNOFF VOLUME    (mm)=   1.237
     TOTAL RAINFALL   (mm)=  24.996
     RUNOFF COEFFICIENT   =    .049

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

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************


--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 6hr 5yr
| Ptotal= 49.01 mm |    Comments: SCS II 6hr 5yr Dog World
--------------------
                TIME     RAIN |  TIME     RAIN |  TIME     RAIN |  TIME     RAIN
                 hrs    mm/hr |   hrs    mm/hr |   hrs    mm/hr |   hrs    mm/hr
                 .50     2.16 |  2.00     3.92 |  3.50    15.39 |  5.00     2.65
                1.00     2.55 |  2.50     5.98 |  4.00     5.88 |  5.50     2.74
                1.50     3.14 |  3.00    47.24 |  4.50     4.41 |  6.00     1.96

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


--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   4.21   Curve Number   (CN)= 68.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  12.20   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME     RAIN |  TIME     RAIN |  TIME     RAIN |  TIME     RAIN
```

hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
.083	2.16	1.583	3.92	3.083	15.39	4.58	2.65
.167	2.16	1.667	3.92	3.167	15.39	4.67	2.65
.250	2.16	1.750	3.92	3.250	15.39	4.75	2.65
.333	2.16	1.833	3.92	3.333	15.39	4.83	2.65
.417	2.16	1.917	3.92	3.417	15.39	4.92	2.65
.500	2.16	2.000	3.92	3.500	15.39	5.00	2.65
.583	2.55	2.083	5.98	3.583	5.88	5.08	2.74
.667	2.55	2.167	5.98	3.667	5.88	5.17	2.74
.750	2.55	2.250	5.98	3.750	5.88	5.25	2.74
.833	2.55	2.333	5.98	3.833	5.88	5.33	2.74
.917	2.55	2.417	5.98	3.917	5.88	5.42	2.74
1.000	2.55	2.500	5.98	4.000	5.88	5.50	2.74
1.083	3.14	2.583	47.24	4.083	4.41	5.58	1.96
1.167	3.14	2.667	47.24	4.167	4.41	5.67	1.96
1.250	3.14	2.750	47.24	4.250	4.41	5.75	1.96
1.333	3.14	2.833	47.24	4.333	4.41	5.83	1.96
1.417	3.14	2.917	47.24	4.417	4.41	5.92	1.96
1.500	3.14	3.000	47.24	4.500	4.41	6.00	1.96

```
    Unit Hyd Qpeak  (cms)=    .446

    PEAK FLOW       (cms)=    .062 (i)
    TIME TO PEAK    (hrs)=   3.500
    RUNOFF VOLUME    (mm)=   8.665
    TOTAL RAINFALL   (mm)=  49.010
    RUNOFF COEFFICIENT   =    .177

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

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  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************


--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 12hr 5y
| Ptotal= 56.21 mm |    Comments: SCS II 12hr 5yr Dog World
--------------------
```

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
.50	1.69	3.50	2.25	6.50	12.25	9.50	1.69
1.00	.79	4.00	2.25	7.00	5.40	10.00	1.35
1.50	1.46	4.50	3.03	7.50	3.60	10.50	1.91
2.00	1.46	5.00	3.82	8.00	3.15	11.00	1.24
2.50	1.91	5.50	6.07	8.50	2.47	11.50	1.12
3.00	1.69	6.00	48.11	9.00	2.59	12.00	1.12

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

--------------------
| CALIB            |
```

```
| NASHYD    (0001) |   Area    (ha)=   4.21   Curve Number   (CN)= 68.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  12.20   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	1.69	3.083	2.25	6.083	12.25	9.08	1.69
.167	1.69	3.167	2.25	6.167	12.25	9.17	1.69
.250	1.69	3.250	2.25	6.250	12.25	9.25	1.69
.333	1.69	3.333	2.25	6.333	12.25	9.33	1.69
.417	1.69	3.417	2.25	6.417	12.25	9.42	1.69
.500	1.69	3.500	2.25	6.500	12.25	9.50	1.69
.583	.79	3.583	2.25	6.583	5.40	9.58	1.35
.667	.79	3.667	2.25	6.667	5.40	9.67	1.35
.750	.79	3.750	2.25	6.750	5.40	9.75	1.35
.833	.79	3.833	2.25	6.833	5.40	9.83	1.35
.917	.79	3.917	2.25	6.917	5.40	9.92	1.35
1.000	.79	4.000	2.25	7.000	5.40	10.00	1.35
1.083	1.46	4.083	3.03	7.083	3.60	10.08	1.91
1.167	1.46	4.167	3.03	7.167	3.60	10.17	1.91
1.250	1.46	4.250	3.03	7.250	3.60	10.25	1.91
1.333	1.46	4.333	3.03	7.333	3.60	10.33	1.91
1.417	1.46	4.417	3.03	7.417	3.60	10.42	1.91
1.500	1.46	4.500	3.03	7.500	3.60	10.50	1.91
1.583	1.46	4.583	3.82	7.583	3.15	10.58	1.24
1.667	1.46	4.667	3.82	7.667	3.15	10.67	1.24
1.750	1.46	4.750	3.82	7.750	3.15	10.75	1.24
1.833	1.46	4.833	3.82	7.833	3.15	10.83	1.24
1.917	1.46	4.917	3.82	7.917	3.15	10.92	1.24
2.000	1.46	5.000	3.82	8.000	3.15	11.00	1.24
2.083	1.91	5.083	6.07	8.083	2.47	11.08	1.12
2.167	1.91	5.167	6.07	8.167	2.47	11.17	1.12
2.250	1.91	5.250	6.07	8.250	2.47	11.25	1.12
2.333	1.91	5.333	6.07	8.333	2.47	11.33	1.12
2.417	1.91	5.417	6.07	8.417	2.47	11.42	1.12
2.500	1.91	5.500	6.07	8.500	2.47	11.50	1.12
2.583	1.69	5.583	48.11	8.583	2.59	11.58	1.12
2.667	1.69	5.667	48.11	8.667	2.59	11.67	1.12
2.750	1.69	5.750	48.11	8.750	2.59	11.75	1.12
2.833	1.69	5.833	48.11	8.833	2.59	11.83	1.12
2.917	1.69	5.917	48.11	8.917	2.59	11.92	1.12
3.000	1.69	6.000	48.11	9.000	2.59	12.00	1.12

```
     Unit Hyd Qpeak  (cms)=    .446

     PEAK FLOW       (cms)=    .077 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  11.841
     TOTAL RAINFALL   (mm)=  56.210
     RUNOFF COEFFICIENT   =    .211
```

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

--------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************


--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 6hr 100
| Ptotal= 82.30 mm |    Comments: SCS II 6hr 100yr Dog World
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .50    3.62 |  2.00    6.58 |  3.50   25.84 |  5.00    4.44
                 1.00    4.28 |  2.50   10.04 |  4.00    9.88 |  5.50    4.61
                 1.50    5.27 |  3.00   79.34 |  4.50    7.41 |  6.00    3.29

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

--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   4.21   Curve Number   (CN)= 68.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  12.20   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    3.62 | 1.583    6.58 | 3.083   25.84 |  4.58    4.44
                 .167    3.62 | 1.667    6.58 | 3.167   25.84 |  4.67    4.44
                 .250    3.62 | 1.750    6.58 | 3.250   25.84 |  4.75    4.44
                 .333    3.62 | 1.833    6.58 | 3.333   25.84 |  4.83    4.44
                 .417    3.62 | 1.917    6.58 | 3.417   25.84 |  4.92    4.44
                 .500    3.62 | 2.000    6.58 | 3.500   25.84 |  5.00    4.44
                 .583    4.28 | 2.083   10.04 | 3.583    9.88 |  5.08    4.61
                 .667    4.28 | 2.167   10.04 | 3.667    9.88 |  5.17    4.61
                 .750    4.28 | 2.250   10.04 | 3.750    9.88 |  5.25    4.61
                 .833    4.28 | 2.333   10.04 | 3.833    9.88 |  5.33    4.61
                 .917    4.28 | 2.417   10.04 | 3.917    9.88 |  5.42    4.61
                1.000    4.28 | 2.500   10.04 | 4.000    9.88 |  5.50    4.61
                1.083    5.27 | 2.583   79.34 | 4.083    7.41 |  5.58    3.29
                1.167    5.27 | 2.667   79.34 | 4.167    7.41 |  5.67    3.29
                1.250    5.27 | 2.750   79.34 | 4.250    7.41 |  5.75    3.29
                1.333    5.27 | 2.833   79.34 | 4.333    7.41 |  5.83    3.29
                1.417    5.27 | 2.917   79.34 | 4.417    7.41 |  5.92    3.29
                1.500    5.27 | 3.000   79.34 | 4.500    7.41 |  6.00    3.29

    Unit Hyd Qpeak  (cms)=    .446
```

```
    PEAK FLOW       (cms)=    .200 (i)
    TIME TO PEAK    (hrs)=   3.333
    RUNOFF VOLUME    (mm)=  25.909
    TOTAL RAINFALL   (mm)=  82.300
    RUNOFF COEFFICIENT   =    .315

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

--------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************


--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 12hr 10
| Ptotal= 93.90 mm |    Comments: SCS II 12hr 100yr Dog World
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .50    2.82 |  3.50    3.76 |  6.50   20.47 |  9.50    2.82
                 1.00    1.31 |  4.00    3.76 |  7.00    9.01 | 10.00    2.25
                 1.50    2.44 |  4.50    5.07 |  7.50    6.01 | 10.50    3.19
                 2.00    2.44 |  5.00    6.39 |  8.00    5.26 | 11.00    2.07
                 2.50    3.19 |  5.50   10.14 |  8.50    4.13 | 11.50    1.88
                 3.00    2.82 |  6.00   80.38 |  9.00    4.32 | 12.00    1.88

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

--------------------
| CALIB            |
| NASHYD    (0001) |   Area    (ha)=   4.21   Curve Number   (CN)= 68.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  12.20   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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


                                 ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    2.82 | 3.083    3.76 | 6.083   20.47 |  9.08    2.82
                 .167    2.82 | 3.167    3.76 | 6.167   20.47 |  9.17    2.82
                 .250    2.82 | 3.250    3.76 | 6.250   20.47 |  9.25    2.82
                 .333    2.82 | 3.333    3.76 | 6.333   20.47 |  9.33    2.82
                 .417    2.82 | 3.417    3.76 | 6.417   20.47 |  9.42    2.82
                 .500    2.82 | 3.500    3.76 | 6.500   20.47 |  9.50    2.82
                 .583    1.31 | 3.583    3.76 | 6.583    9.01 |  9.58    2.25
                 .667    1.31 | 3.667    3.76 | 6.667    9.01 |  9.67    2.25
                 .750    1.31 | 3.750    3.76 | 6.750    9.01 |  9.75    2.25
                 .833    1.31 | 3.833    3.76 | 6.833    9.01 |  9.83    2.25
                 .917    1.31 | 3.917    3.76 | 6.917    9.01 |  9.92    2.25
                1.000    1.31 | 4.000    3.76 | 7.000    9.01 | 10.00    2.25
```

```
                 1.083    2.44 | 4.083    5.07 | 7.083    6.01 | 10.08    3.19
                 1.167    2.44 | 4.167    5.07 | 7.167    6.01 | 10.17    3.19
                 1.250    2.44 | 4.250    5.07 | 7.250    6.01 | 10.25    3.19
                 1.333    2.44 | 4.333    5.07 | 7.333    6.01 | 10.33    3.19
                 1.417    2.44 | 4.417    5.07 | 7.417    6.01 | 10.42    3.19
                 1.500    2.44 | 4.500    5.07 | 7.500    6.01 | 10.50    3.19
                 1.583    2.44 | 4.583    6.39 | 7.583    5.26 | 10.58    2.07
                 1.667    2.44 | 4.667    6.39 | 7.667    5.26 | 10.67    2.07
                 1.750    2.44 | 4.750    6.39 | 7.750    5.26 | 10.75    2.07
                 1.833    2.44 | 4.833    6.39 | 7.833    5.26 | 10.83    2.07
                 1.917    2.44 | 4.917    6.39 | 7.917    5.26 | 10.92    2.07
                 2.000    2.44 | 5.000    6.39 | 8.000    5.26 | 11.00    2.07
                 2.083    3.19 | 5.083   10.14 | 8.083    4.13 | 11.08    1.88
                 2.167    3.19 | 5.167   10.14 | 8.167    4.13 | 11.17    1.88
                 2.250    3.19 | 5.250   10.14 | 8.250    4.13 | 11.25    1.88
                 2.333    3.19 | 5.333   10.14 | 8.333    4.13 | 11.33    1.88
                 2.417    3.19 | 5.417   10.14 | 8.417    4.13 | 11.42    1.88
                 2.500    3.19 | 5.500   10.14 | 8.500    4.13 | 11.50    1.88
                 2.583    2.82 | 5.583   80.38 | 8.583    4.32 | 11.58    1.88
                 2.667    2.82 | 5.667   80.38 | 8.667    4.32 | 11.67    1.88
                 2.750    2.82 | 5.750   80.38 | 8.750    4.32 | 11.75    1.88
                 2.833    2.82 | 5.833   80.38 | 8.833    4.32 | 11.83    1.88
                 2.917    2.82 | 5.917   80.38 | 8.917    4.32 | 11.92    1.88
                 3.000    2.82 | 6.000   80.38 | 9.000    4.32 | 12.00    1.88

     Unit Hyd Qpeak  (cms)=    .446

     PEAK FLOW       (cms)=    .237 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  33.167
     TOTAL RAINFALL   (mm)=  93.905
     RUNOFF COEFFICIENT   =    .353

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

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```
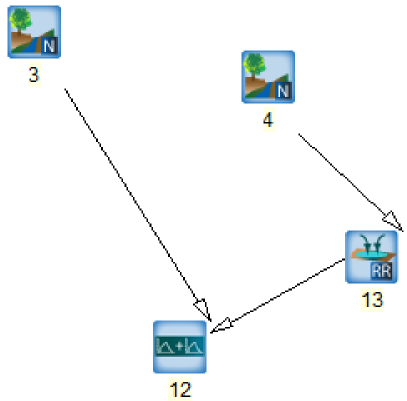

Appendix C: Post-Development – OTTHYMO

- Post-development OTTHYMO Model Schematic
- Post-development Schematic Summary Table
- Post-development Detailed Output



Schematic Summary Table

Hydrograph No.	Model Type	Item Represented	Comment
3	NASHYD	Sub-Catchment UnControlled	Catchment represents the uncontrolled areas of the site
4	NASHYD	Sub-Catchment Controlled	Catchment represents the controlled areas of the site
13	Route Reservoir	Storage Behind Level Spreaders	The combined storage behind all of the level spreaders is represented as a reservoir which contains the stage storage curve
12	ADD HYD	Add Hydrograph	Link used to add two hydrographs in the routing

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

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

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


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

POST-DEVELOPMENT

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


--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\25mm4hrChicago
| Ptotal= 25.00 mm |    Comments: twentyfive mm 4 hr chicago storm
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    2.07 |  1.17    5.70 |  2.17    5.19 |  3.17    2.80
                  .33    2.27 |  1.33   10.78 |  2.33    4.47 |  3.33    2.62
                  .50    2.52 |  1.50   50.21 |  2.50    3.95 |  3.50    2.48
                  .67    2.88 |  1.67   13.37 |  2.67    3.56 |  3.67    2.35
                  .83    3.38 |  1.83    8.29 |  2.83    3.25 |  3.83    2.23
                 1.00    4.18 |  2.00    6.30 |  3.00    3.01 |  4.00    2.14

---------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0004) |   Area    (ha)=   2.08   Curve Number   (CN)= 73.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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

                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    2.07 | 1.083    5.70 | 2.083    5.19 |  3.08    2.80
                 .167    2.07 | 1.167    5.70 | 2.167    5.19 |  3.17    2.80
                 .250    2.27 | 1.250   10.78 | 2.250    4.47 |  3.25    2.62
                 .333    2.27 | 1.333   10.78 | 2.333    4.47 |  3.33    2.62
```

```
                 .417     2.52 | 1.417   50.21 | 2.417     3.95 |  3.42    2.48
                 .500     2.52 | 1.500   50.21 | 2.500     3.95 |  3.50    2.48
                 .583     2.88 | 1.583   13.37 | 2.583     3.56 |  3.58    2.35
                 .667     2.88 | 1.667   13.37 | 2.667     3.56 |  3.67    2.35
                 .750     3.38 | 1.750    8.29 | 2.750     3.25 |  3.75    2.23
                 .833     3.38 | 1.833    8.29 | 2.833     3.25 |  3.83    2.23
                 .917     4.17 | 1.917    6.30 | 2.917     3.01 |  3.92    2.14
                1.000     4.18 | 2.000    6.29 | 3.000     3.01 |  4.00    2.14

     Unit Hyd Qpeak  (cms)=    .221

     PEAK FLOW       (cms)=    .006 (i)
     TIME TO PEAK    (hrs)=   2.167
     RUNOFF VOLUME    (mm)=   2.167
     TOTAL RAINFALL   (mm)=  24.996
     RUNOFF COEFFICIENT   =    .087

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

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=   2.12   Curve Number   (CN)= 65.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  13.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

     Unit Hyd Qpeak  (cms)=    .225

     PEAK FLOW       (cms)=    .002 (i)
     TIME TO PEAK    (hrs)=   2.750
     RUNOFF VOLUME    (mm)=    .891
     TOTAL RAINFALL   (mm)=  24.996
     RUNOFF COEFFICIENT   =    .036

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

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0013) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0780       .0291
                           .0010      .0002   |    .1240       .0303
                           .0040      .0011   |    .1870       .0316
                           .0140      .0047   |    .3560       .0340
                           .0310      .0108   |    .8330       .0389
                           .0540      .0194   |    .0000       .0000

                                 AREA      QPEAK        TPEAK        R.V.
                                 (ha)      (cms)        (hrs)        (mm)
     INFLOW : ID= 2 (0004)      2.083       .006         2.17         2.17
     OUTFLOW: ID= 1 (0013)      2.083       .004         3.25         2.15

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 71.97
```

```
                   TIME SHIFT OF PEAK FLOW         (min)= 65.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0012

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


--------------------
| ADD HYD   (0012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0013):     2.08    .004     3.25     2.15
        + ID2= 2 (0003):     2.12    .002     2.75      .89
          ==================================================
          ID = 3 (0012):     4.21    .006     3.08     1.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************
--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 6hr 5yr
| Ptotal= 49.01 mm |    Comments: SCS II 6hr 5yr Dog World
--------------------
                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                   .50    2.16 |  2.00    3.92 |  3.50   15.39 |  5.00    2.65
                  1.00    2.55 |  2.50    5.98 |  4.00    5.88 |  5.50    2.74
                  1.50    3.14 |  3.00   47.24 |  4.50    4.41 |  6.00    1.96

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0004) |   Area    (ha)=   2.08   Curve Number   (CN)= 73.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .083    2.16 | 1.583    3.92 | 3.083   15.39 |  4.58    2.65
                  .167    2.16 | 1.667    3.92 | 3.167   15.39 |  4.67    2.65
                  .250    2.16 | 1.750    3.92 | 3.250   15.39 |  4.75    2.65
                  .333    2.16 | 1.833    3.92 | 3.333   15.39 |  4.83    2.65
                  .417    2.16 | 1.917    3.92 | 3.417   15.39 |  4.92    2.65
                  .500    2.16 | 2.000    3.92 | 3.500   15.39 |  5.00    2.65
                  .583    2.55 | 2.083    5.98 | 3.583    5.88 |  5.08    2.74
                  .667    2.55 | 2.167    5.98 | 3.667    5.88 |  5.17    2.74
                  .750    2.55 | 2.250    5.98 | 3.750    5.88 |  5.25    2.74
                  .833    2.55 | 2.333    5.98 | 3.833    5.88 |  5.33    2.74
```

```
              .917    2.55 | 2.417    5.98 | 3.917    5.88 |  5.42    2.74
             1.000    2.55 | 2.500    5.98 | 4.000    5.88 |  5.50    2.74
             1.083    3.14 | 2.583   47.24 | 4.083    4.41 |  5.58    1.96
             1.167    3.14 | 2.667   47.24 | 4.167    4.41 |  5.67    1.96
             1.250    3.14 | 2.750   47.24 | 4.250    4.41 |  5.75    1.96
             1.333    3.14 | 2.833   47.24 | 4.333    4.41 |  5.83    1.96
             1.417    3.14 | 2.917   47.24 | 4.417    4.41 |  5.92    1.96
             1.500    3.14 | 3.000   47.24 | 4.500    4.41 |  6.00    1.96

     Unit Hyd Qpeak  (cms)=    .221

     PEAK FLOW       (cms)=    .043 (i)
     TIME TO PEAK    (hrs)=   3.333
     RUNOFF VOLUME    (mm)=  11.644
     TOTAL RAINFALL   (mm)=  49.010
     RUNOFF COEFFICIENT   =    .238

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

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD    (0003) |   Area    (ha)=   2.12   Curve Number   (CN)= 65.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  13.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

     Unit Hyd Qpeak  (cms)=    .225

     PEAK FLOW       (cms)=    .026 (i)
     TIME TO PEAK    (hrs)=   3.500
     RUNOFF VOLUME    (mm)=   7.318
     TOTAL RAINFALL   (mm)=  49.010
     RUNOFF COEFFICIENT   =    .149

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

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0013) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0780       .0291
                           .0010      .0002   |    .1240       .0303
                           .0040      .0011   |    .1870       .0316
                           .0140      .0047   |    .3560       .0340
                           .0310      .0108   |    .8330       .0389
                           .0540      .0194   |    .0000       .0000

                                 AREA      QPEAK       TPEAK       R.V.
                                 (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0004)      2.083       .043        3.33       11.64
     OUTFLOW: ID= 1 (0013)      2.083       .024        4.00       11.62

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 56.69
```

```
                   TIME SHIFT OF PEAK FLOW         (min)= 40.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0084

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

--------------------
| ADD HYD   (0012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0013):     2.08    .024     4.00    11.62
        + ID2= 2 (0003):     2.12    .026     3.50     7.32
          ==================================================
          ID = 3 (0012):     4.21    .046     3.67     9.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************
--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 12hr 5y
| Ptotal= 56.21 mm |    Comments: SCS II 12hr 5yr Dog World
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .50    1.69 |  3.50    2.25 |  6.50   12.25 |  9.50    1.69
                 1.00     .79 |  4.00    2.25 |  7.00    5.40 | 10.00    1.35
                 1.50    1.46 |  4.50    3.03 |  7.50    3.60 | 10.50    1.91
                 2.00    1.46 |  5.00    3.82 |  8.00    3.15 | 11.00    1.24
                 2.50    1.91 |  5.50    6.07 |  8.50    2.47 | 11.50    1.12
                 3.00    1.69 |  6.00   48.11 |  9.00    2.59 | 12.00    1.12

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0004) |   Area    (ha)=   2.08   Curve Number   (CN)= 73.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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

                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    1.69 | 3.083    2.25 | 6.083   12.25 |  9.08    1.69
                 .167    1.69 | 3.167    2.25 | 6.167   12.25 |  9.17    1.69
                 .250    1.69 | 3.250    2.25 | 6.250   12.25 |  9.25    1.69
                 .333    1.69 | 3.333    2.25 | 6.333   12.25 |  9.33    1.69
                 .417    1.69 | 3.417    2.25 | 6.417   12.25 |  9.42    1.69
                 .500    1.69 | 3.500    2.25 | 6.500   12.25 |  9.50    1.69
                 .583     .79 | 3.583    2.25 | 6.583    5.40 |  9.58    1.35
                 .667     .79 | 3.667    2.25 | 6.667    5.40 |  9.67    1.35
```

```
                .750     .79 | 3.750    2.25 | 6.750    5.40 |  9.75    1.35
                .833     .79 | 3.833    2.25 | 6.833    5.40 |  9.83    1.35
                .917     .79 | 3.917    2.25 | 6.917    5.40 |  9.92    1.35
               1.000     .79 | 4.000    2.25 | 7.000    5.40 | 10.00    1.35
               1.083    1.46 | 4.083    3.03 | 7.083    3.60 | 10.08    1.91
               1.167    1.46 | 4.167    3.03 | 7.167    3.60 | 10.17    1.91
               1.250    1.46 | 4.250    3.03 | 7.250    3.60 | 10.25    1.91
               1.333    1.46 | 4.333    3.03 | 7.333    3.60 | 10.33    1.91
               1.417    1.46 | 4.417    3.03 | 7.417    3.60 | 10.42    1.91
               1.500    1.46 | 4.500    3.03 | 7.500    3.60 | 10.50    1.91
               1.583    1.46 | 4.583    3.82 | 7.583    3.15 | 10.58    1.24
               1.667    1.46 | 4.667    3.82 | 7.667    3.15 | 10.67    1.24
               1.750    1.46 | 4.750    3.82 | 7.750    3.15 | 10.75    1.24
               1.833    1.46 | 4.833    3.82 | 7.833    3.15 | 10.83    1.24
               1.917    1.46 | 4.917    3.82 | 7.917    3.15 | 10.92    1.24
               2.000    1.46 | 5.000    3.82 | 8.000    3.15 | 11.00    1.24
               2.083    1.91 | 5.083    6.07 | 8.083    2.47 | 11.08    1.12
               2.167    1.91 | 5.167    6.07 | 8.167    2.47 | 11.17    1.12
               2.250    1.91 | 5.250    6.07 | 8.250    2.47 | 11.25    1.12
               2.333    1.91 | 5.333    6.07 | 8.333    2.47 | 11.33    1.12
               2.417    1.91 | 5.417    6.07 | 8.417    2.47 | 11.42    1.12
               2.500    1.91 | 5.500    6.07 | 8.500    2.47 | 11.50    1.12
               2.583    1.69 | 5.583   48.11 | 8.583    2.59 | 11.58    1.12
               2.667    1.69 | 5.667   48.11 | 8.667    2.59 | 11.67    1.12
               2.750    1.69 | 5.750   48.11 | 8.750    2.59 | 11.75    1.12
               2.833    1.69 | 5.833   48.11 | 8.833    2.59 | 11.83    1.12
               2.917    1.69 | 5.917   48.11 | 8.917    2.59 | 11.92    1.12
               3.000    1.69 | 6.000   48.11 | 9.000    2.59 | 12.00    1.12

     Unit Hyd Qpeak  (cms)=    .221

     PEAK FLOW       (cms)=    .053 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  15.453
     TOTAL RAINFALL   (mm)=  56.210
     RUNOFF COEFFICIENT   =    .275

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD    (0003) |   Area    (ha)=   2.12   Curve Number   (CN)= 65.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  13.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

     Unit Hyd Qpeak  (cms)=    .225

     PEAK FLOW       (cms)=    .032 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  10.161
     TOTAL RAINFALL   (mm)=  56.210
     RUNOFF COEFFICIENT   =    .181

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

```
--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0013) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0780      .0291
                           .0010      .0002   |    .1240      .0303
                           .0040      .0011   |    .1870      .0316
                           .0140      .0047   |    .3560      .0340
                           .0310      .0108   |    .8330      .0389
                           .0540      .0194   |    .0000      .0000

                                 AREA      QPEAK       TPEAK       R.V.
                                 (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0004)      2.083       .053        6.25      15.45
     OUTFLOW: ID= 1 (0013)      2.083       .028        6.92      15.43

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 52.83
                   TIME SHIFT OF PEAK FLOW         (min)= 40.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0097

--------------------------------------------------------------------------------
--------------------
| ADD HYD   (0012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0013):     2.08    .028     6.92    15.43
        + ID2= 2 (0003):     2.12    .032     6.25    10.16
          ==================================================
          ID = 3 (0012):     4.21    .053     6.50    12.77

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   4 **
  ****************************
--------------------
|    READ STORM    |    Filename: G:\Projects\2019\
|                  |              190622 - Dog World - 3904 March Road - SPC, G
|                  |              \Storm\Design Storm Text Files\SCS II 6hr 100
| Ptotal= 82.30 mm |    Comments: SCS II 6hr 100yr Dog World
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .50    3.62 |  2.00    6.58 |  3.50   25.84 |  5.00    4.44
                 1.00    4.28 |  2.50   10.04 |  4.00    9.88 |  5.50    4.61
                 1.50    5.27 |  3.00   79.34 |  4.50    7.41 |  6.00    3.29

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0004) |   Area    (ha)=   2.08   Curve Number   (CN)= 73.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.60   # of Linear Res.(N)= 3.00
```

```
--------------------   U.H. Tp(hrs)=    .36

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

                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    3.62 | 1.583    6.58 | 3.083   25.84 |  4.58    4.44
                 .167    3.62 | 1.667    6.58 | 3.167   25.84 |  4.67    4.44
                 .250    3.62 | 1.750    6.58 | 3.250   25.84 |  4.75    4.44
                 .333    3.62 | 1.833    6.58 | 3.333   25.84 |  4.83    4.44
                 .417    3.62 | 1.917    6.58 | 3.417   25.84 |  4.92    4.44
                 .500    3.62 | 2.000    6.58 | 3.500   25.84 |  5.00    4.44
                 .583    4.28 | 2.083   10.04 | 3.583    9.88 |  5.08    4.61
                 .667    4.28 | 2.167   10.04 | 3.667    9.88 |  5.17    4.61
                 .750    4.28 | 2.250   10.04 | 3.750    9.88 |  5.25    4.61
                 .833    4.28 | 2.333   10.04 | 3.833    9.88 |  5.33    4.61
                 .917    4.28 | 2.417   10.04 | 3.917    9.88 |  5.42    4.61
                1.000    4.28 | 2.500   10.04 | 4.000    9.88 |  5.50    4.61
                1.083    5.27 | 2.583   79.34 | 4.083    7.41 |  5.58    3.29
                1.167    5.27 | 2.667   79.34 | 4.167    7.41 |  5.67    3.29
                1.250    5.27 | 2.750   79.34 | 4.250    7.41 |  5.75    3.29
                1.333    5.27 | 2.833   79.34 | 4.333    7.41 |  5.83    3.29
                1.417    5.27 | 2.917   79.34 | 4.417    7.41 |  5.92    3.29
                1.500    5.27 | 3.000   79.34 | 4.500    7.41 |  6.00    3.29

     Unit Hyd Qpeak  (cms)=    .221

     PEAK FLOW       (cms)=    .125 (i)
     TIME TO PEAK    (hrs)=   3.250
     RUNOFF VOLUME    (mm)=  31.710
     TOTAL RAINFALL   (mm)=  82.300
     RUNOFF COEFFICIENT   =    .385

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

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0003) |   Area    (ha)=   2.12   Curve Number   (CN)= 65.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  13.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

     Unit Hyd Qpeak  (cms)=    .225

     PEAK FLOW       (cms)=    .088 (i)
     TIME TO PEAK    (hrs)=   3.333
     RUNOFF VOLUME    (mm)=  23.021
     TOTAL RAINFALL   (mm)=  82.300
     RUNOFF COEFFICIENT   =    .280

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

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

```
| RESERVOIR (0013) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0780      .0291
                           .0010      .0002   |    .1240      .0303
                           .0040      .0011   |    .1870      .0316
                           .0140      .0047   |    .3560      .0340
                           .0310      .0108   |    .8330      .0389
                           .0540      .0194   |    .0000      .0000

                                 AREA      QPEAK       TPEAK       R.V.
                                 (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0004)      2.083       .125        3.25       31.71
     OUTFLOW: ID= 1 (0013)      2.083       .067        4.00       31.69

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 53.39
                   TIME SHIFT OF PEAK FLOW         (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0246

-------------------------------------------------------------------------------
--------------------
| ADD HYD   (0012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0013):     2.08    .067     4.00    31.69
        + ID2= 2 (0003):     2.12    .088     3.33    23.02
          ==================================================
          ID = 3 (0012):     4.21    .140     3.58    27.31

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   5 **
  ****************************
--------------------
|    READ STORM    |     Filename: G:\Projects\2019\
|                  |               190622 - Dog World - 3904 March Road - SPC, G
|                  |               \Storm\Design Storm Text Files\SCS II 12hr 10
| Ptotal= 93.90 mm |     Comments: SCS II 12hr 100yr Dog World
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .50    2.82 |  3.50    3.76 |  6.50   20.47 |  9.50    2.82
                 1.00    1.31 |  4.00    3.76 |  7.00    9.01 | 10.00    2.25
                 1.50    2.44 |  4.50    5.07 |  7.50    6.01 | 10.50    3.19
                 2.00    2.44 |  5.00    6.39 |  8.00    5.26 | 11.00    2.07
                 2.50    3.19 |  5.50   10.14 |  8.50    4.13 | 11.50    1.88
                 3.00    2.82 |  6.00   80.38 |  9.00    4.32 | 12.00    1.88

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD    (0004) |   Area    (ha)=   2.08   Curve Number   (CN)= 73.0
```

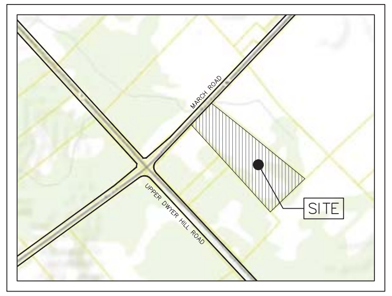
```
|ID= 1 DT= 5.0 min |   Ia      (mm)=   9.60   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

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

                            ---- TRANSFORMED HYETOGRAPH ----
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.083	2.82	3.083	3.76	6.083	20.47	9.08	2.82
.167	2.82	3.167	3.76	6.167	20.47	9.17	2.82
.250	2.82	3.250	3.76	6.250	20.47	9.25	2.82
.333	2.82	3.333	3.76	6.333	20.47	9.33	2.82
.417	2.82	3.417	3.76	6.417	20.47	9.42	2.82
.500	2.82	3.500	3.76	6.500	20.47	9.50	2.82
.583	1.31	3.583	3.76	6.583	9.01	9.58	2.25
.667	1.31	3.667	3.76	6.667	9.01	9.67	2.25
.750	1.31	3.750	3.76	6.750	9.01	9.75	2.25
.833	1.31	3.833	3.76	6.833	9.01	9.83	2.25
.917	1.31	3.917	3.76	6.917	9.01	9.92	2.25
1.000	1.31	4.000	3.76	7.000	9.01	10.00	2.25
1.083	2.44	4.083	5.07	7.083	6.01	10.08	3.19
1.167	2.44	4.167	5.07	7.167	6.01	10.17	3.19
1.250	2.44	4.250	5.07	7.250	6.01	10.25	3.19
1.333	2.44	4.333	5.07	7.333	6.01	10.33	3.19
1.417	2.44	4.417	5.07	7.417	6.01	10.42	3.19
1.500	2.44	4.500	5.07	7.500	6.01	10.50	3.19
1.583	2.44	4.583	6.39	7.583	5.26	10.58	2.07
1.667	2.44	4.667	6.39	7.667	5.26	10.67	2.07
1.750	2.44	4.750	6.39	7.750	5.26	10.75	2.07
1.833	2.44	4.833	6.39	7.833	5.26	10.83	2.07
1.917	2.44	4.917	6.39	7.917	5.26	10.92	2.07
2.000	2.44	5.000	6.39	8.000	5.26	11.00	2.07
2.083	3.19	5.083	10.14	8.083	4.13	11.08	1.88
2.167	3.19	5.167	10.14	8.167	4.13	11.17	1.88
2.250	3.19	5.250	10.14	8.250	4.13	11.25	1.88
2.333	3.19	5.333	10.14	8.333	4.13	11.33	1.88
2.417	3.19	5.417	10.14	8.417	4.13	11.42	1.88
2.500	3.19	5.500	10.14	8.500	4.13	11.50	1.88
2.583	2.82	5.583	80.38	8.583	4.32	11.58	1.88
2.667	2.82	5.667	80.38	8.667	4.32	11.67	1.88
2.750	2.82	5.750	80.38	8.750	4.32	11.75	1.88
2.833	2.82	5.833	80.38	8.833	4.32	11.83	1.88
2.917	2.82	5.917	80.38	8.917	4.32	11.92	1.88
3.000	2.82	6.000	80.38	9.000	4.32	12.00	1.88

```
     Unit Hyd Qpeak  (cms)=    .221

     PEAK FLOW       (cms)=    .144 (i)
     TIME TO PEAK    (hrs)=   6.167
     RUNOFF VOLUME    (mm)=  39.865
     TOTAL RAINFALL   (mm)=  93.905
     RUNOFF COEFFICIENT   =    .425

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

```
--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD    (0003) |   Area    (ha)=   2.12   Curve Number   (CN)= 65.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=  13.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

     Unit Hyd Qpeak  (cms)=    .225

     PEAK FLOW       (cms)=    .106 (i)
     TIME TO PEAK    (hrs)=   6.250
     RUNOFF VOLUME    (mm)=  29.762
     TOTAL RAINFALL   (mm)=  93.905
     RUNOFF COEFFICIENT   =    .317

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

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0013) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0780       .0291
                           .0010      .0002   |    .1240       .0303
                           .0040      .0011   |    .1870       .0316
                           .0140      .0047   |    .3560       .0340
                           .0310      .0108   |    .8330       .0389
                           .0540      .0194   |    .0000       .0000

                                 AREA      QPEAK       TPEAK       R.V.
                                 (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0004)      2.083       .144        6.17       39.86
     OUTFLOW: ID= 1 (0013)      2.083       .073        6.83       39.84

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 50.66
                   TIME SHIFT OF PEAK FLOW         (min)= 40.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0271

--------------------------------------------------------------------------------
--------------------
| ADD HYD   (0012) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0013):     2.08    .073     6.83    39.84
        + ID2= 2 (0003):     2.12    .106     6.25    29.76
          ==================================================
          ID = 3 (0012):     4.21    .157     6.42    34.75

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
FINISH
================================================================================
===========================
```

Appendix D: DRAWINGS

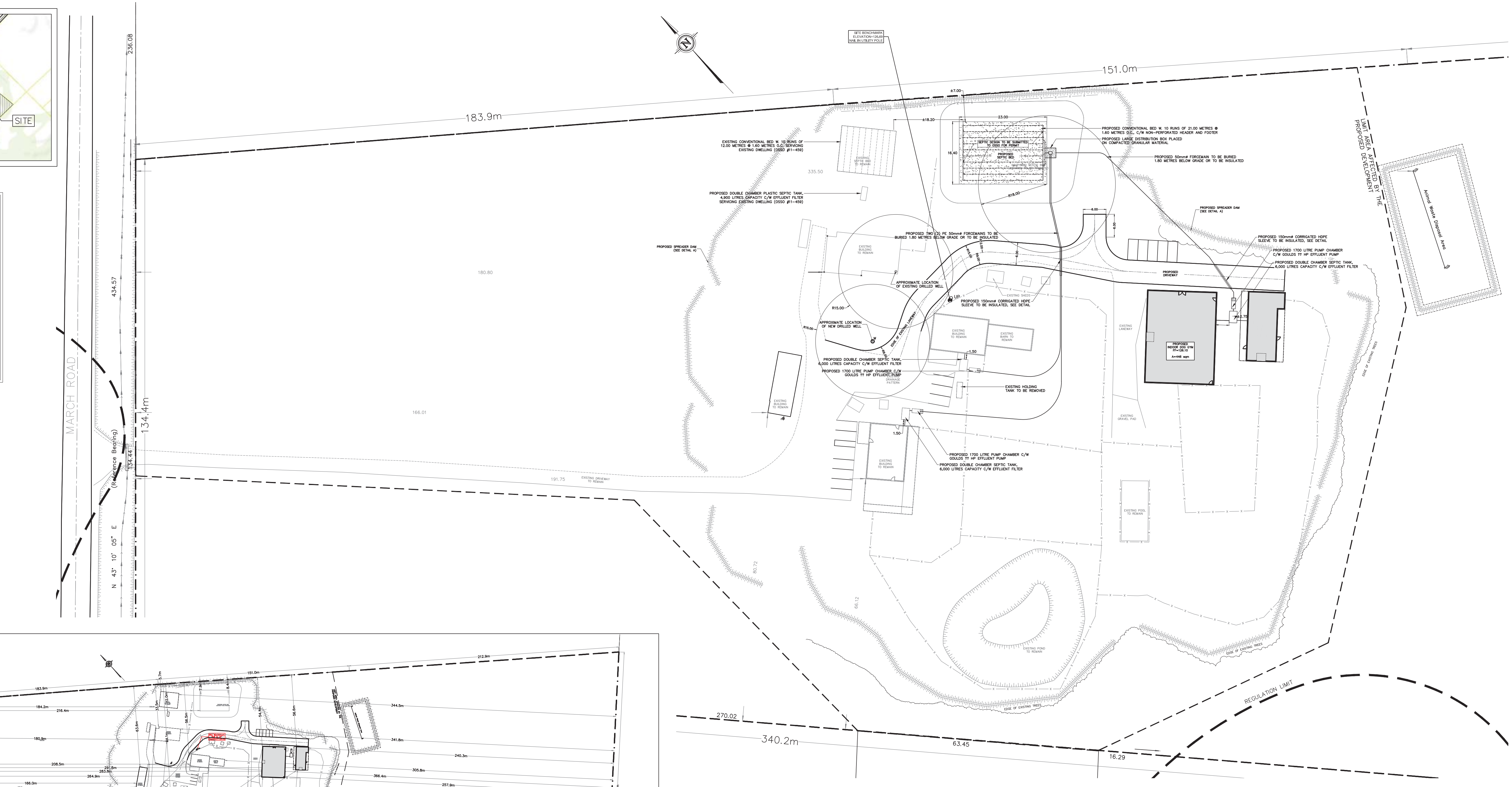


KEY PLAN

NOT TO SCALE

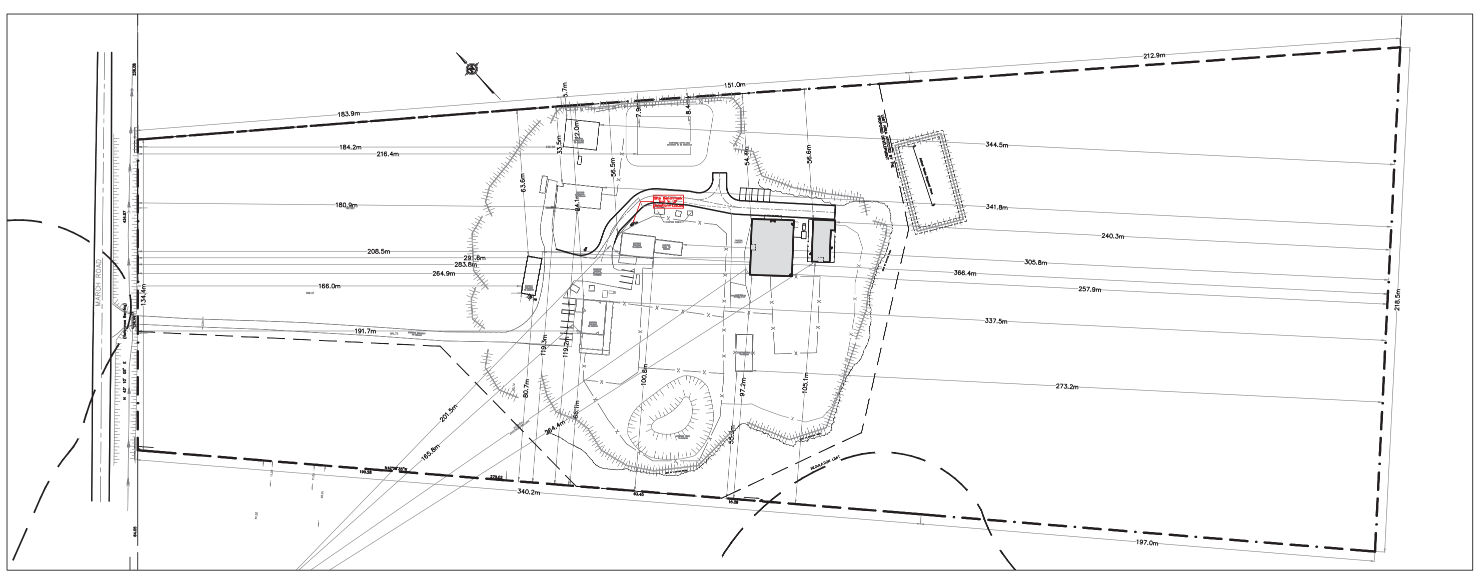
LEGEND

- EXISTING ELEVATION
- PROPOSED/EXISTING ELEVATIONS
- PROPOSED ELEVATION
- DRAINAGE SLOPE
- EXISTING DRAINAGE
- CENTRELINE OF ROAD
- EDGE OF ROAD
- TOP OF SLOPE
- PROPERTY LINE
- EXISTING FENCE
- SILT FENCE
- OVERLAND FLOW ROUTE
- EXISTING UTILITY POLE
- EXISTING HYDRO GUY WIRE ANCHOR
- TEMPORARY BENCHMARK



SITE SERVICING PLAN (DEVELOPMENT)

SCALE = 1:500



SITE PLAN (OVERALL)

SCALE = 1:1250

NOTES:

1. ALL DIMENSIONS ARE IN METRES, UNLESS OTHERWISE SPECIFIED; ALL ELEVATIONS ARE IN METRES AND ARE GEODETIC.
2. THIS IS NOT A LEGAL SURVEY.
3. BOUNDARY INFORMATION WAS DERIVED FROM ANNIS, O-SULLIVAN, VOLLEBEKK LTD. JOB NO. 20074-19
4. EXISTING SERVICES INFORMATION SHOWN ARE BASED ON BEST CURRENT INFORMATION. CONTRACTOR TO VERIFY EXACT LOCATION AND REPORT ANY DISCREPANCIES TO KOLLAARD ASSOCIATES INC.
5. CLIENT IS RESPONSIBLE FOR ACQUIRING ALL NECESSARY PERMITS.
6. CONTRACTOR TO VERIFY THAT APPROPRIATE PERMITS HAVE BEEN ACQUIRED PRIOR TO ANY CONSTRUCTION.
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CONSULTANTS

Kollaard Associates Engineers

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210 PRESCOTT STREET
KEMPTVILLE, ONTARIO
K0G 1J0
FACSIMILE (613) 258-0475

(613) 860-0923

DESIGN	SD
DRAWN	ML
CHECKED	SD
APPROVED	SD

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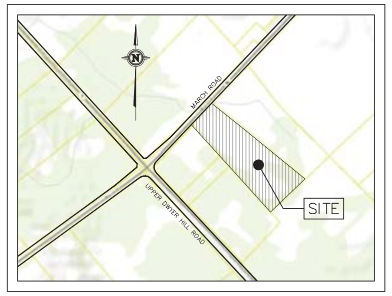
CLIENT NAME	DOG WORLD (TRACY KIM HOLDEN) 3904 MARCH ROAD, CARP, ON K0A 1L0	PROJECT No.	190622
PROJECT NAME	PROPOSED KENNEL ADDITION	DATE	NOV. 19, 2019
PROJECT LOCATION	3904 MARCH ROAD, CARP, ON K0A 1L0	SCALE	AS NOTED
DRAWING	SITE SERVICING PLAN	DRAWING No.	190622-SER

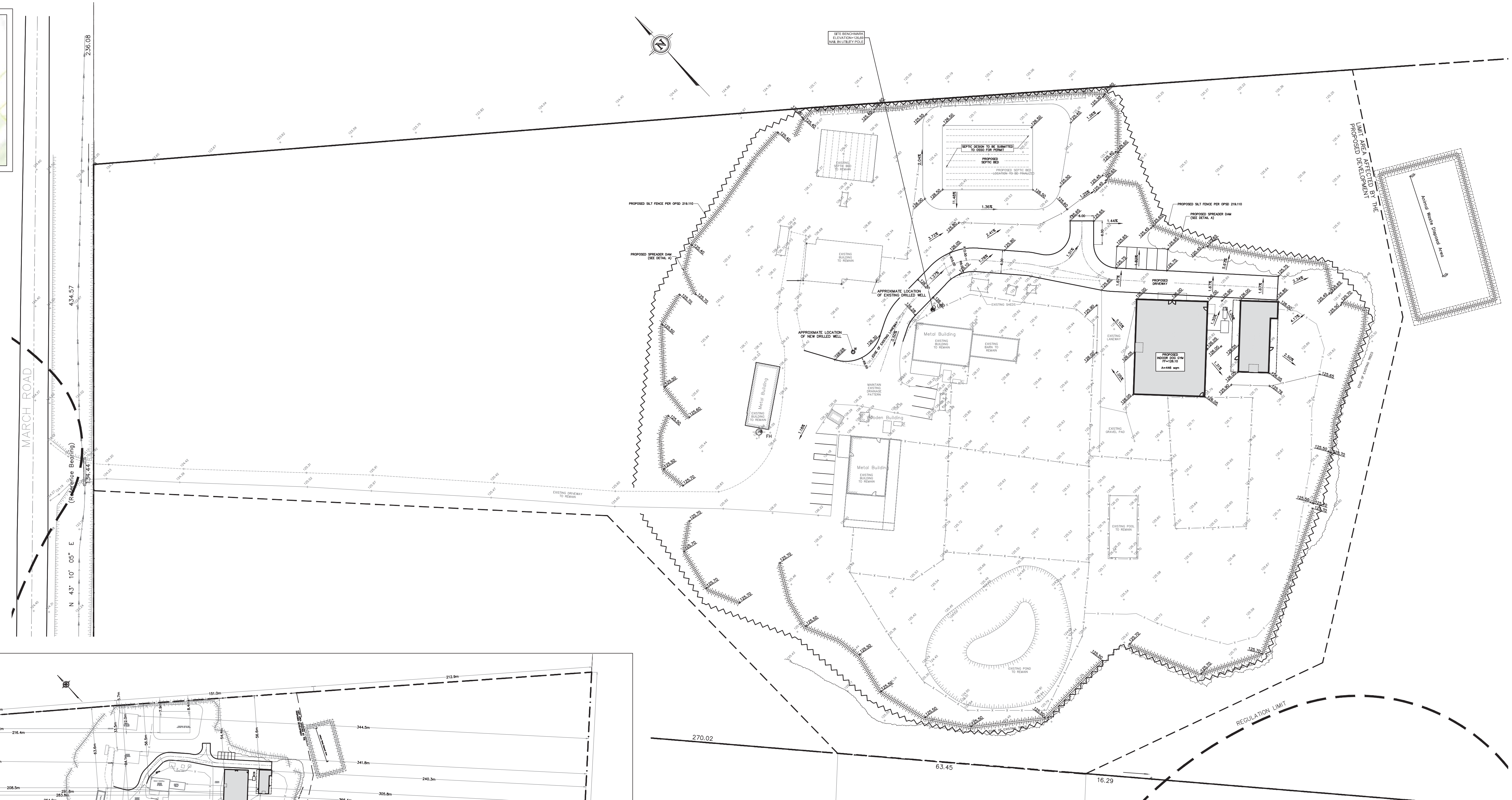


KEY PLAN

NOT TO SCALE

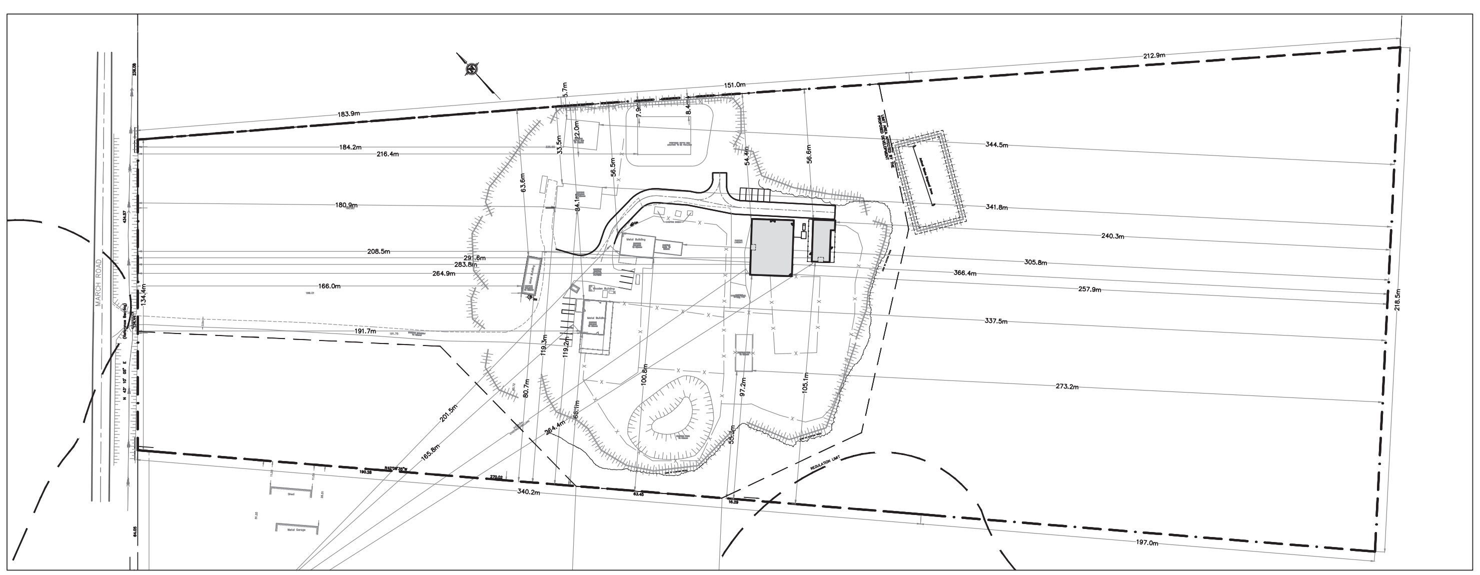
LEGEND

- EXISTING ELEVATION
- PROPOSED/EXISTING ELEVATIONS
- PROPOSED ELEVATION
- DRAINAGE SLOPE
- EXISTING DRAINAGE
- CENTRELINE OF ROAD
- EDGE OF ROAD
- TOP OF SLOPE
- PROPERTY LINE
- EXISTING FENCE
- SILT FENCE
- OVERLAND FLOW ROUTE
- EXISTING UTILITY POLE
- EXISTING HYDRO GUY WIRE ANCHOR
- TEMPORARY BENCHMARK



SITE GRADING PLAN (DEVELOPMENT)

SCALE = 1:500



SITE PLAN (OVERALL)

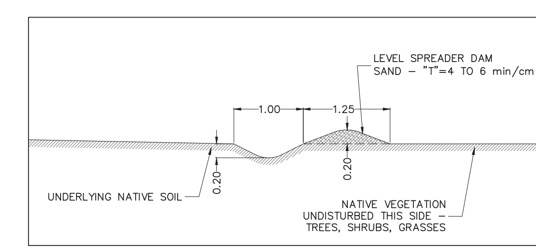
SCALE = 1:1250

EROSION AND SEDIMENT CONTROL NOTES:

1. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES, TO PROVIDE FOR PROTECTION OF THE AREA DRAINAGE SYSTEM AND THE RECEIVING WATERCOURSE, 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.
2. THE OWNER (AND/OR CONTRACTOR) AGREES TO PREPARE AND IMPLEMENT AN EROSION AND SEDIMENT CONTROL PLAN AT LEAST EQUAL TO THE STATED MINIMUM REQUIREMENTS AND TO THE SATISFACTION OF THE CITY OF OTTAWA, APPROPRIATE TO THE SITE CONDITIONS, PRIOR TO UNDERTAKING ANY SITE ALTERATIONS (FILLING, GRADING, REMOVAL OF VEGETATION, ETC.) AND DURING ALL PHASES OF SITE PREPARATION AND CONSTRUCTION IN ACCORDANCE WITH THE CURRENT BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENT CONTROL.
3. THE CONTRACTOR IS TO ENSURE THAT THE SITE ACCESS POINTS AND ADJACENT STREETS TO THE ACCESS POINTS ARE MAINTAINED AND KEPT CLEAN OF CONSTRUCTION MATERIALS SUCH AS, BUT NOT LIMITED TO MUD, DIRT, CLAY AND GRANULARS ON A DAILY BASIS OR AS NECESSARY, TO THE SATISFACTION OF THE CITY OF OTTAWA.
4. EVERY EFFORT WILL BE MADE TO ENSURE THAT ALL DISTURBED AREAS ARE TOPSOILED AND SEEDED AS SOON AS REASONABLY POSSIBLE.
5. THE SEDIMENT AND EROSION CONTROL PLAN IS A LIVING DOCUMENT WHICH MAY BE AMENDED BY ONSITE REQUIREMENTS AT THE APPROVAL OF THE MUNICIPALITY AND THE CONSERVATION AUTHORITY.

MINIMUM EROSION AND SEDIMENT CONTROL PLAN REQUIREMENTS:

- TIME THE DEMOLITION AND EXCAVATION ACTIVITIES SO THAT THEY OCCUR NO SOONER THAN IS NECESSARY FOR SUBSEQUENT CONSTRUCTION ACTIVITIES.
- LANDSCAPE THE SITE AS SOON AS PRACTICALLY POSSIBLE.
- USE SILT FENCES AROUND ANY STOCKPILES OF SOIL.
- PRIOR TO CONSTRUCTION, SILT FENCE BARRIERS (OPSD 219.110) WILL BE PLACED ALONG THE PROPERTY LINES AS ON THE DRAWING.
- THE SILT FENCE SHOULD BE REMOVED ONLY WHEN THE SITE IS STABILIZED.



SPREADER DAM TYPICAL SECTION

N.T.S.

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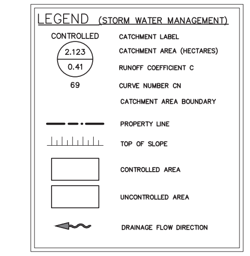
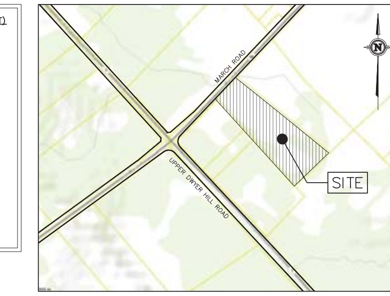
PROJECT LOCATION	3904 MARCH ROAD, CARP, ON K0A 1L0
DRAWING	SITE GRADING AND EROSION CONTROL
PROJECT No.	190622
DATE	NOV. 19, 2019
SCALE	AS NOTED
DRAWING No.	190622-GEC





KEY PLAN

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PRE-DEVELOPMENT DRAINAGE PLAN

SCALE = 1:500

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Engineers

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PROJECT No.	190622
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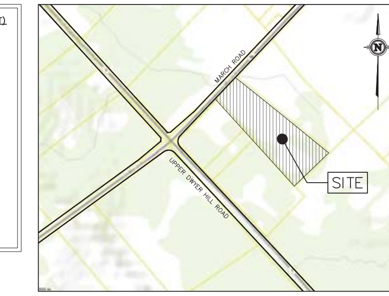
DRAWING No.	190622-PRE

LEGEND (STORM WATER MANAGEMENT)

CONTROLLED	CATCHMENT LABEL
2.123	CATCHMENT AREA (HECTARES)
0.41	RUNOFF COEFFICIENT C
69	CURVE NUMBER CN
	CATCHMENT AREA BOUNDARY
	PROPERTY LINE
	TOP OF SLOPE
	CONTROLLED AREA
	UNCONTROLLED AREA
	DRAINAGE FLOW DIRECTION



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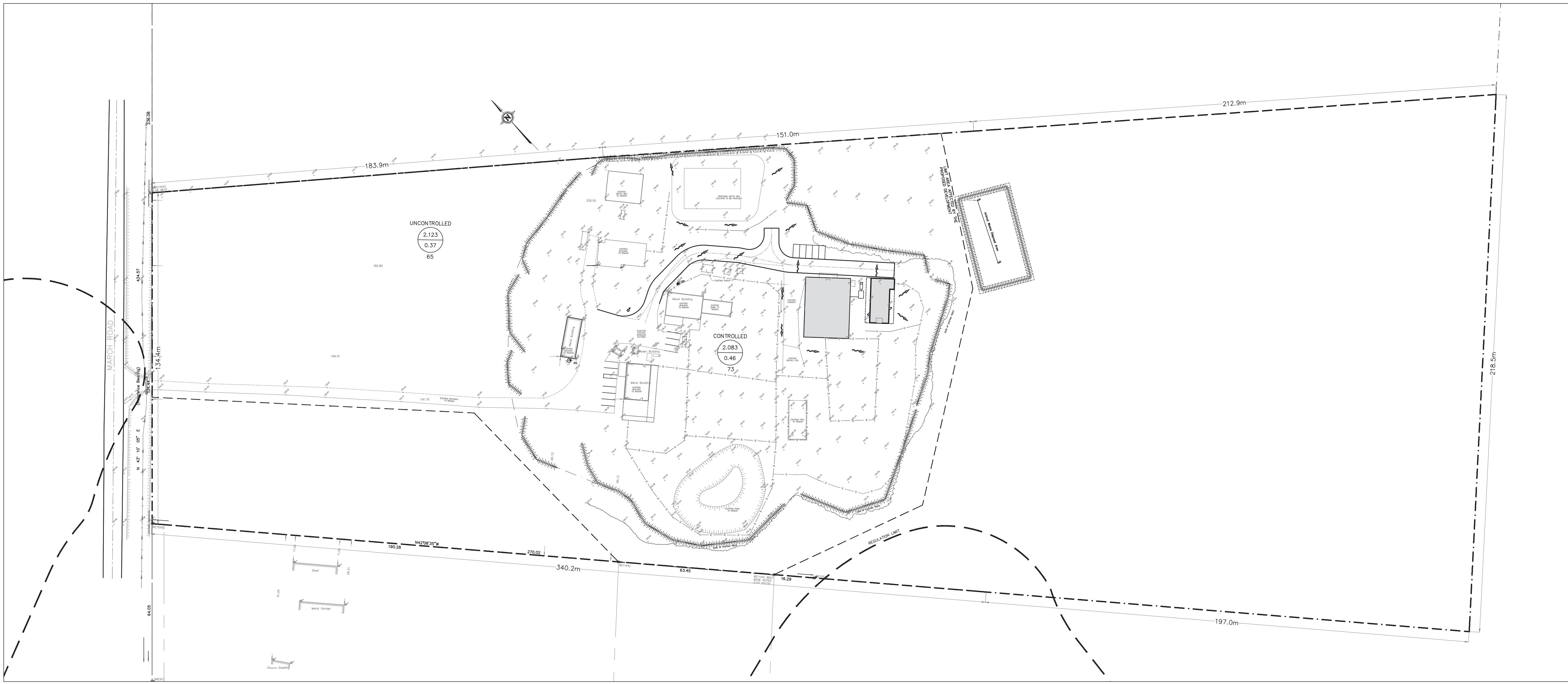

POST–DEVELOPMENT DRAINAGE PLAN

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PROJECT No.	190622
DATE	NOV. 19, 2019
SCALE	AS NOTED
DRAWING No.	190622–POST

Appendix E: Communications and Additional Information

Site Plan Control Pre-consultation

Meeting Date: April 9, 2019

3904 March Road

Applicant:	Chris Clarke	**Consultant:**	N/A
Ward	5	**Councillor**	Eli El-Chantiry

Proposal Summary: Site Plan Control application required for a proposed kennel expansion.

Attendees:
Chris Clarke, Planning Technician, ZanderPlan Inc.
Sami Rehman, Environmental Planner, PIEDD, City of Ottawa
Rubina Rasool, EIT, PIEDD, City of Ottawa
Seana Turkington, Planner, PIEDD, City of Ottawa
Maria Kaczmarek, Assistant Planner, PIEDD, City of Ottawa

Meeting Minutes

Proposal Details

- The site currently has 4 existing structures, a kennel and office, a personal workshop, a barn, and a house, along with 5 accessory structures such as sheds and garbage enclosures.
- The site is enclosed by a 6-8ft chain-link fence which is expected to remain and be modified to permit new development.
- The proposed development is expected to take place in two phases. The first phase will include a proposed in-ground pool and indoor gym/playground for dogs. The second phase will include a new 8 run kennel as well as the removal of the existing barn.
- The proposed 8 dog runs are to be open-air runs with cover over top.
- The proposed indoor gym/playground will be an open space for dogs to exercise.
- The kennel currently has a capacity of 100 dogs and would like to increase this capacity to over 150 dogs.
- The kennel is expecting to have one employee per every 8-10 dogs.
- No minor variances are expected.

Planning (Provided by Seana Turkington)

- The site is zoned Rural Countryside zone, RU, which permits a kennel and therefore a Zoning By-law amendment will not be required.
- Please include all dimensions for driveways, setbacks, parking spaces, etc. as required by the Zoning By-law.
- Please ensure parking requirements of Part 4 (sections 100-114) of the Zoning By-law are met.
- Please refer to Section 84 of the Zoning By-law for all requirements for kennels.
- The Planning Rationale should speak to the site's General Rural Area designation within the Official Plan, the Bedrock Resource Area designation within 500m of the subject site, and the applicable Zoning By-law sections.

Environment Comments (Provided by Sami Rehman)

- The proposed location of the in-ground pool is not desirable due to its close proximity to the unevaluated wetland. A more desirable location would be further north of the site, further away from the wetland, perhaps closer to the existing kennel.
- The existing barn and surrounding fields have potential significant habitat for threatened or endangered species. This will require a scoped Environmental Impact Statement (EIS) or Species at Risk Assessment to be completed closer to the proposed removal of the existing barn to support the application. Refer to section 4.7.4 and 4.7.8 of the Official Plan or the EIS guidelines for further details. https://documents.ottawa.ca/sites/default/files/documents/eis_guidelines2015_en.pdf
- If any trees over 10 centimetres are to be removed, a Tree Conservation Report is required. Please see section 4.7.2 of the Official Plan or the Tree Conservation Report Guidelines for more information on protection of

vegetation cover. https://ottawa.ca/en/residents/water-and-environment/trees-and-community-forests/protection#tree-conservation-report-guidelines

Engineering Comments (Provided by Rubina Rasool)

- Please identify the location of the existing well and septic system on the submitted plans.
- Please identify if an additional well is being proposed.
- The site is identified as a thin soils area which requires a minimum of 30cm between the bedrock and septic system. The terrain analysis (septic) and septic permit as well as the stormwater management brief should speak to this.
- The required stormwater management brief should speak to the grading of the site as well as the placement of the proposed stormwater management pond.
- The site is within 500m from a designated Bedrock Resource Area which will require a Mineral Resource Impact Assessment (MRIA).

ADDITIONAL COMMENTS

Planning Comments

Official Plan: General Rural Area

Secondary Plan and/or Community Design Plan: N/A

Zoning By-law: Rural Countryside Zone (RU)

1. Parking:
   All parking and driveways/ drive aisles must comply with Part 4 (Sections 100-114) of the Zoning By-law.

2. Garbage Enclosure:
   Any outdoor refuse collection areas must comply with Section 110(3) of the Zoning By-law.

3. Kennel:
   Under the Zoning By-law, kennels must comply with the provisions of Section 84. Under the Zoning By-law, the definition of a dog run is defined as "*an enclosed outdoor extension of one or more dogs' individual indoor living space in association with a kennel."* As such, the in-ground pool and the small pools on the property that are used by dogs are considered additional runs.

Other: Site Plan Control information

- During the pre-consultation meeting, constructing the proposed kennel expansion in two phases was discussed. For Site Plan purposes please show the entirety of the proposed expansion. The proposal can be done through the Site Plan process at the same time and any construction (and required building permits) may be considered in a phased manner. This will eliminate the need for a second Site Plan application and any associated additional fees.

Current Site Plan By-law, Types and Fees (effective up until May 31, 2019):

	Proposal has a gross floor area under 350 square metres	**Proposal has a gross floor area of 350 square meters or more**
Type of Application	Manager Approval, No Public Consultation Site Plan	Manager Approval, Public Consultation Site Plan
Costs	$6,691.36 Plus engineering design and review fee of: $1,000 (includes HST) (value of Hard and Soft Servicing <$50,000) or $5,000 (includes HST) (value of Hard and Soft Servicing $50,000-$300,000) or $10,000 (includes HST) (value of Hard and Soft Servicing >$300,000) Plus Conservation Authority Fee of: $110 (if within Wards 7, 8, 9, 12, 13, 14, 15, 16,17, 18) or $995 (remainder of the City)	$21, 508.66 Plus engineering design and review fee of: $1,000 (includes HST) (value of Hard and Soft Servicing <$50,000) or $5,000 (includes HST) (value of Hard and Soft Servicing $50,000-$300,000) or $10,000 (includes HST) (value of Hard and Soft Servicing >$300,000) Plus Conservation Authority Fee of: $110 (if within Wards 7, 8, 9, 12, 13, 14, 15, 16,17, 18) or $995 (remainder of the City)

Site Plan By-law, Types and Fees Applicable as of June 1, 2019:

	Proposed structure is between 300-600 square meters and under 10 parking spaces	**Proposed structure is over 600 square meters OR over 10 parking spaces**
Type of Application	Rural Small Site Plan (staff approval, no public consultation)	Standard, Rural Site Plan (staff approval, no public consultation)
Cost	$723.00	$7,995.00

For a full report on the new Site Plan Control By-law, please visit Service Ottawa's E-Agenda. The February 14, 2019 meeting of Planning Committee has a full report available to view by members of the public.

Transportation Comments

- Please show the fire truck route on the submitted site plan.

Hydrogeological Comments

- A hydrogeological report should be prepared to support the application. It is understood that there is already a well and septic that service the lot.
- The report should discuss if there are changes in the water quantity requirements, if there is an increased need (significant), then the supply well should be tested for water quantity (pump test). If a new well is being installed, then the new well should be tested as per the yield requirements. Water quantity should also be confirmed from the supply well.
- If there is a change in wastewater (i.e. a larger septic system), then the report should provide an assessment of the potential impact.

Engineering Comments

Water/Sanitary/Storm Servicing

Water:

- No municipal services are adjacent/near the proposed development and the site will be serviced with an on-site well.

Sanitary:

- No municipal sanitary pipes are adjacent/near the proposed development and instead the site will need to be provided an on-site septic system. A Groundwater Impact Study will be required for design flows exceeding 10,000 L/day.
- Sanitary waste from canines shall be managed on site as per Mississippi Valley Conservation Authority (MVCA), and Ministry of Environment, Conservation, and Parks (MECP), Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) requirements.
- Sanitary waste from canines directed to the septic system shall obtain approval from the Ottawa Septic System Office.

Storm Water Management:

- The consultant should determine a stormwater management regime for the application and, generally, maintain post-development flows to pre-development levels by way of providing storage to offset increased impervious areas.
- The pre-development conditions will consider the existing dwelling and driveway as existing impervious surfaces. All other structures and hard landscaping surfaces shall be considered soft landscaping/grass for the pre-development conditions.
- The stormwater management system should be designed for the 5-year and the 100-year storm events.
- Overland flows should be directed to a legal outlet or watercourse.
- Any existing stormwater runoff from adjacent site(s) that crosses the property must be accommodated by the proposed stormwater management design.
- Water quality design requirements will be determined by the Mississippi Conservation Authority (MVCA). Stormwater quality control is required for the site. The site must ensure enhanced TSS removal of 80% is achieved.
- Outdoor open areas for canines shall ensure sanitary waste does not run-off site during storm events. If stormwater management ponds are provided the ponds shall be free on contamination prior to discharging.
- All stormwater management determinations shall have supporting rationale.

Fire Protection:

- The applicant should have their consultant contact Ottawa Fire Services to determine if fire protection is required.

  Contact Information:
  Allan Evans
  Engineer, Fire Protection
  City of Ottawa
  613-580-2424 x24119
  Allan.Evans@ottawa.ca

Snow Storage:

- Any portion of the subject property which is intended to be used for permanent or temporary snow storage shall be as shown on the approved site plan and grading plan. Snow storage shall not interfere with approved grading and drainage patterns or servicing. Snow storage areas shall be setback from the property lines, foundations, fencing or landscaping a minimum of 1.5m. Snow storage areas shall not occupy driveways, aisles, required parking spaces or any portion of a road allowance.

Permits and Approvals:

- Please contact the Ministry of the Environment, Conservation, and Parks (MECP) and the Mississippi Conservation Authority (MVCA), amongst other federal and/or provincial departments/agencies, to identify all the necessary permits and approvals required to facilitate the development: responsibility rests with the developer and their consultant for obtaining all external agency approvals. The address shall be in good standing with all approval agencies, for example the MVCA, prior to approval. Copies of confirmation of correspondence will be required by the City of Ottawa from all approval agencies that a form of assent is given. An amendment to the

MECP ECA application is not submitted until after Site Plan Approval. No construction shall commence until after a commence work notification is given.

Ministry of the Environment, Conservation, and Parks	Mississippi Valley Conservation Authority
Contact Information: moeccottawasewage@ontario.ca	Contact Information: Niall Oddie Environmental Planner 613-253-0006 ext. 229 noddie@mvc.on.ca www.mvc.on.ca

Site Plan submission requirements for engineering drawings:

- Geotechnical Report
    - Earthquake and liquefaction analysis is now required in the report.
    - Please note that the area is likely to contain sensitive marine clays. Atterberg limits, consolidation testing, shear strength testing, grade raise restriction, sieve analysis, and discussion thereof, amongst other data, will be required in if sensitive marine clay, or similar conditions are found.
    - The geotechnical consultant will need to provide full copies of any published and peer reviewed papers relied on to determine results and conclusions.
- Hydrogeology and Terrain Analysis
    - The report shall demonstrate the quality of drinking water by performing a minimum of two water sample tests.
    - The hydrogeology analysis should provide a pump test in accordance to MECP requirements.
    - The terrain analysis shall clearly demonstrate the suitability of the soils to adequate support a septic system at this location and the capacity of dilution.
- Servicing Report
- Stormwater Management Report
- Mineral Resource Impact Assessment
- Phase 1 Environmental Site Assessment
    - The Phase 1 Environmental Site Assessment (ESA) must be prepared as per O.Reg. 153/04. Phase 1 ESA documents performed to CSA standards are not acceptable. Please note the report "Screening Level Risk Assessment" provided following the meeting would not be admissible.
    - The Phase 1 ESA will demonstrate sources of potential contamination and other concerns impacting the development of the site. The Phase 2 ESA will provide further investigation and recommendations.
    - Please ensure all ESAs are prepared for the purpose of land development for the specific property.

Report Submission Requirements[1]:

- Grading and Drainage Plan
- Servicing Plan
- Sediment and Erosion Control Plan
    - The Erosion and Sediment Control Plan should manage all loose material from being transporting into adjacent properties and waterways. The Conservation Authority should be consulted to determine any additional measures that may be required.

Footnote [1] - All required plans & reports are to be provided on a CD in *.pdf format (at application submission and for any, and all, re-submissions)

Comments from MVCA

- A permit from MVCA will not be required provided the work remains beyond the MVCA regulation limit and does not involve altering any existing watercourses.
- Total Suspended Solids removal should be at 70%.
- If the Applicant is proposing digging another pond on the property, given the proximity to wetlands in the surrounding area, an EIS is recommended to review the area and provide a determination if the lands exhibit wetland characteristics.

Application Submission Information

Application Type: **Site Plan Control**

Depending on when an application is submitted, the application type and fees may differ. As of June 1, 2019 a new Site Plan Control By-law and new applicable fees will take effect.

For information on Applications, including fees, please visit: https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/fees-and-funding-programs/development-application-fees

The application processing timeline generally depends on the quality of the submission. For more information on standard processing timelines, please visit: https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/development-application-forms#site-plan-control

Prior to submitting a formal application, it is recommended that you pre-consult with the Ward Councillor.

Application Submission Requirements

For information on the preparation of Studies and Plans and the City's Planning and Engineering requirements, please visit: https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans

For information on the guidelines for preparation of Servicing Studies, please visit http://ottawa.ca/en/development-application-review-process-0/servicing-study-guidelines-development-applications

To request any City of Ottawa plan(s) or report information please contact the City of Ottawa Information Centre at: informationcentre@ottawa.ca or (613) 580-2424 ext. 44455

Please provide electronic copy (PDF) of all plans and studies required.

All plans and drawings must be produced on A1-sized paper and folded to 21.6 cm x 27.9 cm (8½"x 11").

Note that many of the plans and studies collected with this application must be signed, sealed and dated by a qualified engineer, architect, surveyor, planner or designated specialist.