



Toronto Zoo Anaerobic Digester Project

STORMWATER MANAGEMENT REPORT

Prepared for:

Riepma Consultants Inc.

Prepared by:

MGM Consulting Inc.
400 Bronte Street South
Suite 201
Milton, Ontario
L9T 0H7

Revised July 8, 2015

File No. 2013-046

1.0 PROJECT AND SITE DESCRIPTION

Riepma Consultants Inc. is proposing the construction of an anaerobic digester plant (biogas plant) on the Toronto Zoo property in Scarborough, Ontario. The proposed facility consists of two 21m diameter vessels, a 38m diameter, open storage vessel and an engine / control building housing the initial 500kW engine as well as a series of smaller input and processing tanks.

The proposed site development is indicated in Figure No. 1.

2.0 EXISTING CONDITIONS

The site of the Biogas plant is located on the lands currently used for the Zoo's composting operation. It is flat and devoid of vegetation cover and has been modified to accommodate the composting operation. The site is surrounded by a 2 meter high berm that was constructed as part of the compost operation. The area slopes slightly to the south and east and is over 200 metres from the water's edge of the Little Rouge River. Elevations within the perimeter berms range from 132.4 m. in the south west corner of the site down to 131.7 m in the north west corner of the site. A ponding area currently exists in the low area in the north east corner of the site which occupies an area in the order of 500 sq.m. which will remain but not be impacted during construction and not utilized for any stormwater management function, post construction.

The majority of the site has been lined with clay in order to prevent infiltration from the composting operation.

The existing site is indicated in Figure No.2.

2.1 Existing Perimeter Berming and Drainage

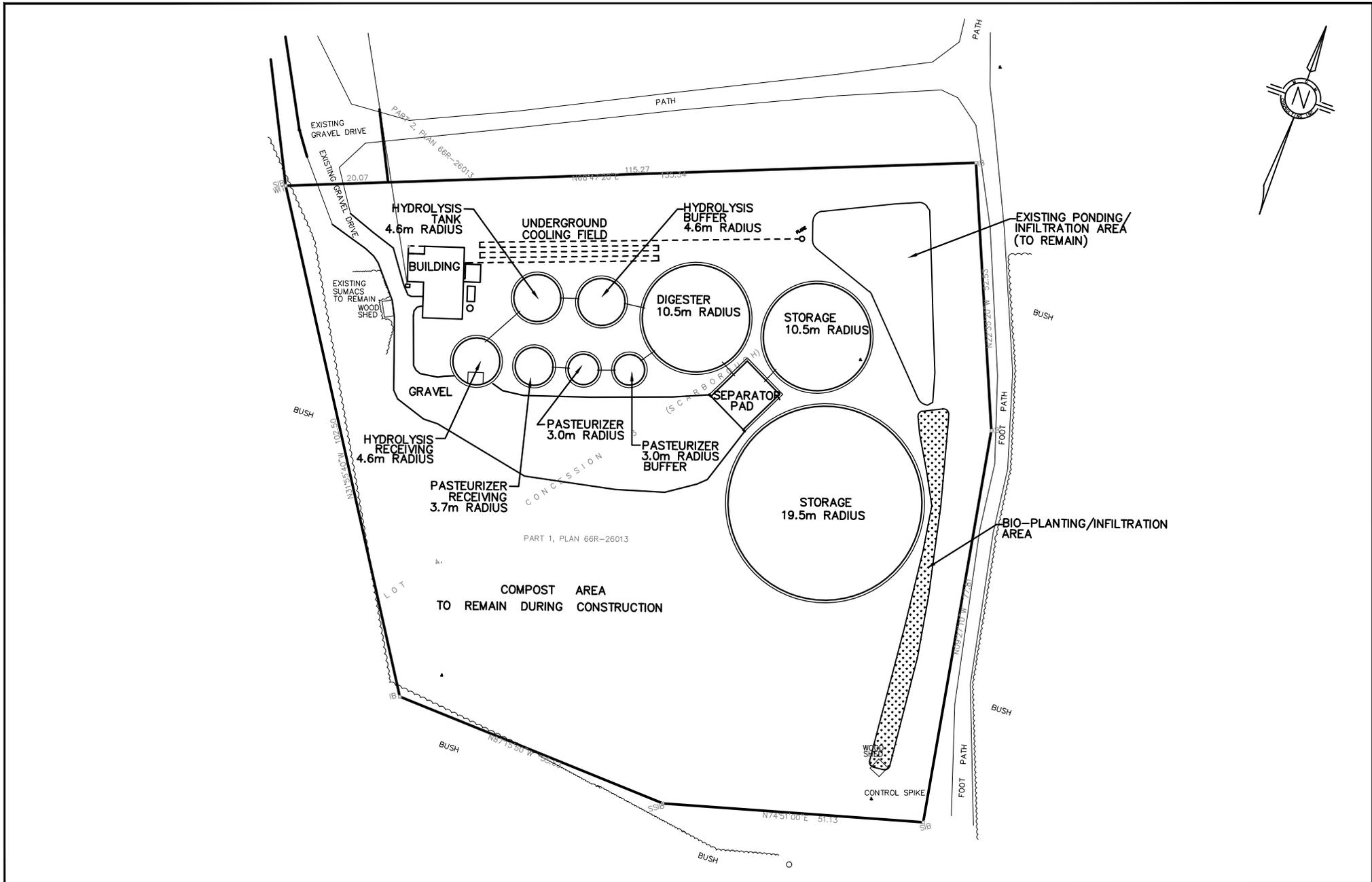
The existing berming which surrounds the north, east and south sides of the site is to remain after the proposed construction. The existing berming serves to contain all storm runoff from the site area prior to it exiting the site in the north-west corner at an elevation in the order of 131.7 metres.

Further comments on the function of existing berming, and the direction of overland flows off site, after construction is completed, are provided in Section 3.2 of this report.

3.0 PROPOSED STORMWATER MANAGEMENT

3.1 Proposed Stormwater Rate Controls

The proposed site redevelopment will include for the construction of buildings, storage and processing tanks, a gravel access road and soft landscaping between facility components in the north portion of the site. The drainage characteristics of the existing and proposed site are included in the detailed SWM calculations included in Appendix A. These calculations have been made using the "Modified Rational Method". The Modified Rational Method is suitable for small sites such as this and generates a triangular hydrograph with the peak of the triangle being the peak flow. Required storage volumes during each time step are then approximated as the difference between the total attenuated flow and the allowable controlled flow times the time difference. The estimated time to concentration used for the subject site is 10



ZOOSHARE BIOGAS COOPERATIVE INC.
 MEADOWVALE ROAD, TORONTO

PROPOSED DEVELOPMENT

MGM
CONSULTING INC
 Consulting Engineering & Project Management
 400 Bronte Street South Tel: (905) 567-8678
 Suite 201 Fax: (905) 875-1339
 Milton, Ontario Email: mgm@mgm.on.ca
 L9T 0H7 www.mgm.on.ca

FIGURE 1

APRIL 16, 2015
 1:1000
 2013-046-C3

minutes. Rainfall intensities used in these calculations are as provided by the City of Toronto in the Design Criteria for Sewers and Watermains.

As indicated, the proposed site redevelopment will cause a net decrease in the site imperviousness, primarily due to the removal of the clay surface material from a major portion of the site, and the introduction of grassed areas between facility components. Calculations are provided in Appendix A for the pre and post development peak flows during the 2 to 100 year storm events. As indicated, in all instances, peak storm flows will be lowered as a result of the proposed site redevelopment.

Given the above, no formal stormwater rate controls are proposed related to the proposed facility.

3.2 Perimeter Berming and Emergency Overflow

The existing perimeter berming encompasses the north, east and south sides of the site and serves to contain site drainage during all storm events. During severe storm events, overland flow from the site will occur in the northwest corner of the site at an elevation of 131.7 metres which is consistent with the existing condition. Areas beyond this overflow location are currently bush. As indicated in the appended drainage calculations, the volume of runoff from the site during all storm events will be reduced as a result of an increase in the site's perviousness. Given this, the existing berming which is to remain serves to contain and direct major flows off site in a direction consistent with the existing condition, but at reduced rates.

Site grading as required to convey minor storm flows within the site to the infiltration and treatment features in the east portion of the site, and to safely convey water around the proposed facility components is indicated on the Site Grading Plan, Drawings CV-1.

3.3 Proposed Stormwater Quality Controls for Site Operation

Stormwater quality controls for the site once it is operable are to be provided with the construction of an infiltration feature located along the east side of the site. Calculations for the required sizing of the proposed infiltration feature has been based on the water quality sizing criteria as provided in the MOE SWM Planning & Design Manual Table 3.2. A summary of considerations in selecting this method of treatment, follows:

- The site area is 1.45 ha which is consistent with the recommendation in the MOE manual that the contributing drainage area should not exceed 2.0 ha,
- The MOE manual indicates that infiltration features are typically not appropriate for industrial uses, given the risk of groundwater contamination due to spills. In order to alleviate these concerns a spill contingency plan has been provided by ZooShare will be implemented as included in Appendix C. In addition, the proposed location of the infiltration feature is remote from the processing area of the site such that any spills would need to traverse a minimum distance of 23 metres overland before reaching this feature.
- Based on borehole information provided by Terraprobe Limited, groundwater in the area of the proposed infiltration feature is in the order of The bottom elevation of the infiltration feature bottom is proposed at an elevation of 130.25 which is 1.0 metres above the estimated groundwater elevation (129.10 m) as consistent with the MOE recommendation,

- Bedrock was not encountered in boreholes and as such, will be > 1.0 metre below the bottom of the infiltration feature as recommended in the MOE Manual,
- Terraprobe Limited has classified existing sub soils as “silty sands” with an estimated percolation rate of 20 min/cm which translates to 30 mm/hr which exceeds the minimum 15 mm/hr indicated in the MOE manual,
- Based on the estimated percolation rate and infiltration feature dimensions, the estimated drawdown time is 27 hrs. which is between the recommended 24 to 48 hour drawdown time indicated in the MOE Manual,
- The shape and orientation of the proposed feature is such that its dimension perpendicular to the direction of flow is maximized.
- 50 mm clear stone is proposed for the storage media with a non-woven filter fabric surround. A

As indicated in the attached calculations, the storage volume required to provide an “enhanced” level of treatment is in the order of 31 cu.m. per ha, or 45 cu.m.. of available storage.

An infiltration feature proposed in the south east corner of the site which will provide an estimated 80 cu.m. of water storage to be infiltrated into surrounding soils and as such, provides sufficient storage volume as required to achieve “enhanced” treatment of runoff.

A cross section through the bio-treatment and infiltration trench area is included on the Site Grading Plan, Drawing CV-1. This feature is to be constructed upon completion of all construction.

3.4 Water Balance

The City of Toronto Wet Weather Flow Management Guideline Section 2.2.1.1, Figure 1a, provides a requirement for water balance such that a minimum of 50% of the annual rainfall volume is captured on site, which is typically equivalent to a 5 mm depth of rainfall over the site area. The proposed clear stone trench to be constructed along the east limit of the property provides for the capture of approximately 80 cu.m. of stormwater which can be held in the trench and infiltrated into the ground. This volume of stormwater is equivalent to 5.5 mm depth of water over the site area which is equivalent to approximately 54% of the total average annual rainfall depth.

Based on an estimated soil percolation rate of 40 min/cm, water contained in the proposed clear stone trench will infiltrate into the ground within a 53 hour timeframe.

3.5 Stream Erosion Mitigation

Stream erosion mitigation is to be provided based on detaining a 25 mm rainfall for a minimum of 48 hours. Proposed stream erosion mitigation is to be provided by the retention of water within the bio-treatment area, the infiltration feature and through site grading which will provide a depressed area overtop the bio-treatment area.

As indicated in the appended calculations, water retained within the bio-treatment area and infiltration feature based on an estimated 40% available voids is approximately 200 cu.m. which exceeds the estimated volume of runoff from the site during a 25 mm storm event based on the

proposed site imperviousness of 0.57.

3.6 Construction De-watering

Sediment and erosion controls during construction are proposed consistent with the recommendations included in the Erosion and Sediment Control Guideline for Urban Construction, December 2006, as published by the Greater Golden Horseshoe Area Conservation Authorities. The topography of the site is such that all drainage is directed towards perimeter berming along the north, east and south limits which will contain all storm flows pre and post construction. Given this, the installation of perimeter silt control fencing, which is typical for most construction projects, would have little value.

Proposed sediment and erosion controls features to be employed include temporary sediment trap intended to contain any sediments generated from construction. Sizing for the temporary sediment trap is in accordance with the information included in Appendix C, "Sediment Traps".

Notes relating to the required sediment and erosion controls have been included Drawing No. CV-2.

A proposed de-watering and contingency plan for managing groundwater encountered during construction, provided by Terraprobe Limited, is included in Appendix B. In general, the plan outlines recommended procedures for required dewatering of excavations as required for the construction of proposed buildings and tanks. The plan recommends discharging water pumped from excavations to the existing infiltration/ponding area in the north east corner of the site as the primary location for containing water generated from de-watering during construction.

A secondary sediment trap is also proposed. In addition, as a contingency measure, a temporary overflow basin is also recommended that would accommodate up to 200,000 litres of de-watering discharge in the event the infiltration basin capacity is exceeded. A calculation for the sizing of the temporary sediment trap and for the estimated times for the de-watering volumes to percolate into the ground beneath both features is indicated in the calculations included in Appendix A.

Temporary site measures required during construction as recommended in the appended report are indicated on Drawing No. CV-2.

4.0 SUMMARY

The proposed facility will require that existing impervious areas of the site be replaced with pervious site features such that the net imperviousness of the site will be reduced from what currently exists. Given this, no stormwater rate controls are proposed.

Water quality controls as required to provide an "enhanced" level of treatment will be provided with the construction of an infiltration feature in the south east portion of the site. A sufficient volume of water as required to achieve an enhanced level of treatment, has been provided.

Water balance objectives are provided through infiltration as provided by the pervious areas of the site and the infiltration feature, located along the east side of the site.

Stream erosion mitigation is provided with the retention of an additional 200 cu.m of runoff within the bio-treatment and infiltration features which exceeds the volume of runoff during a 25 mm storm event over the site area based on the proposed imperviousness of 0.57.

Temporary measures required during construction include directing de-watering discharge to a sediment trap located in the south east portion of the site. A secondary or contingency sediment trap is also provided in the instance the primary sediment trap volume is exceeded. Both sediment traps have been designed to accommodate up to 200,000 litres of effluent, which is consistent with the recommendations indicated in the Terraprobe Report included in Appendix B.

Prepared by:
MGM CONSULTING INC.



M.L.Stairs, P.Eng.

APPENDIX A
STORMWATER MANAGEMENT CALCULATIONS

**Appendix A
Detailed Stormwater Management Calculations**

1.0 DRAINAGE CHARACTERISTICS

1.1 Existing Drainage Areas: (see Figure No. 3)

	"c"	Area (ha)
Soft Landscaping	0.25	0.366
Gravel	0.60	0.003
Building/Structure	0.95	0.000
Clay Lined Areas	0.95	1.031
Pond	1.00	0.050
Total		1.450
Average Site Imperviousness		0.77

1.2 Proposed Drainage Areas (see Figure No. 4)

	"c"	Area (ha)
Soft Landscaping	0.25	0.713
Gravel	0.60	0.113
Building/Structure	0.95	0.137
Clay Lined Areas	0.95	0.412
Bio-Treatment Area	0.25	0.025
Pond	1.00	0.050
Total		1.450
Average Site Imperviousness		0.57

2.0 Pre and Post Development Peak Flows

Pre and post development peak storm flows during the 2 to 100 year storm events are calculated using the "Modified Rational Method.

Rainfall intensities indicated below are as per the IDF curves and equations provided by the City of Toronto in the Design Criteria for Sewers and Watermains, based on a initial time of concentration of 10 minutes.

Rainfall intensity = $A \times (T)^c$, $T_c = 10$ minutes

Flow Q - $ciA/360$

where c = runoff coefficient
I = rainfall intensity
A = area in hectares

Storm Event	A	Tc (min)	c	Peak Intensity (mm/hr)	Existing Peak flow (cms)	Post Development Peak flow (cms)
2 year	21.8	10	-0.78	88.2	0.275	0.202
5 year	32.0	10	-0.79	131.8	0.411	0.302
10 year	38.7	10	-0.80	162.3	0.506	0.371
25 year	45.2	10	-0.80	189.5	0.591	0.434
50 year	53.5	10	-0.80	224.3	0.700	0.514
100 year	59.7	10	-0.80	250.3	0.781	0.573

As indicated, peak storm flows during all storm events are reduced as a result of the proposed site re-development.

3.0 Water Quality Treatment

Water quality treatment is proposed with the construction of an infiltration feature as required to provide an "enhanced" (80% TSS removal) level of treatment

Water quality sizing criteria have been taken from the MOE SWM Planning & Design Manual Section 3.3.2, Table 3.2 which provide the required storage for various stormwater management features and various impervious levels.

Appendix A
Detailed Stormwater Management Calculations

Site area =	1.45	ha
Site imperviousness	0.57	
Required volume per ha for enhanced treatment =	31	cu.m/ ha (interpolated using Table 3.2 values)
Volume required for enhanced treatment =	45	cu.m.
Depth of Clear Stone =	800	mm.
Area of Proposed Trench =	250	sq. m.
Volume of Stone =	200	cu.m.
Storage Vol. (based on 40% voids) =	80	cu.m.

Based on the above, the proposed infiltration feature will provide the required enhanced water quality treatment level.

Additional "pre-treatment" is provided by the bio-treatment planting proposed above the infiltration feature.

4.0 Water Balance Calculation

The target water balance volume is the retain 50% of the average annual rainfall depths on site, which is equivalent to a 5 mm depth of water over the site area as identified in the City of Toronto Wet Weather Flow Management Guidelines, Section 2.2.1.1 Figure 1a.

An infiltration trench is proposed as required to contain stormwater and promote infiltration into the surrounding soils

Depth of Clear Stone =	800	mm.
Area of Proposed Trench =	250	sq. m.
Volume of Stone =	200	cu.m.
Storage Vol. (based on 40% voids) =	80	cu.m.
Total Site Area =	1.450	ha
Infiltration Volume / Site Area =	5.5	mm.

5.0 Estimated Retention Time

Estimated times for percolation in a proposed subsurface feature is calculated from Equation 4.3 in the MOE SWM Planning & Design Manual as follows:

$A = 1,000 \times V / (P \times n \times t)$ where,

A =	bottom area of feature (sq.m.)
V =	volume to be infiltrated (cu.m.)
P =	percolation rate of surrounding native material (mm/hr)
n =	porosity of the storage media (0.4 for clear stone)
t =	retention time (hrs)

A =	250	sq.m.
V =	80	cu.m. (stream erosion mitigation volume from Section 6.0)
P =	30.0	mm/hr (est. percolation rate = 40 min/cm)
n =	0.400	clear stone trench
Solving for "t" =	27	hours

6.0 De-Watering Operation During Construction

During construction, de-watering of excavations may be required in order to construct building and other structure foundations. Proposed areas for receiving water pumped from excavations include a primary sediment trap located in the south east portion of the site, and a contingency sediment trap located in the south east corner of the site.

6.1.1 Primary Sediment Trap

The primary sediment trap performance based on dimensions and the estimated percolation rate is as follows:

Estimated de-watering volume =	100000	l/day	(see Appendix B)
Ponding bottom contact area =	500	sq.m.	
Estimated percolation rate =	40	min/cm =	36 cm./day
Est. vol percolated/ day =	180	cu.m. =	180000 l/day

Based on the above, the estimate volume of de-watering would percolate into existing soils is in the

Appendix A
Detailed Stormwater Management Calculations

order of 13.3 hours

6.1.2 Contingency Sediment Trap

The contingency sediment trap performance based on dimensions and the estimated percolation rate is as follows:

Basin bottom contact area =	100000	l/day	(see Appendix B)		
Estimated percolation rate =	500	sq.m.			
Est. vol percolated/ day =	40	min/cm =	36	cm./day	
	180	cu.m. =	180000	l/day	

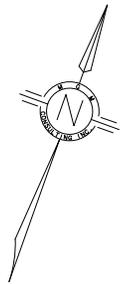
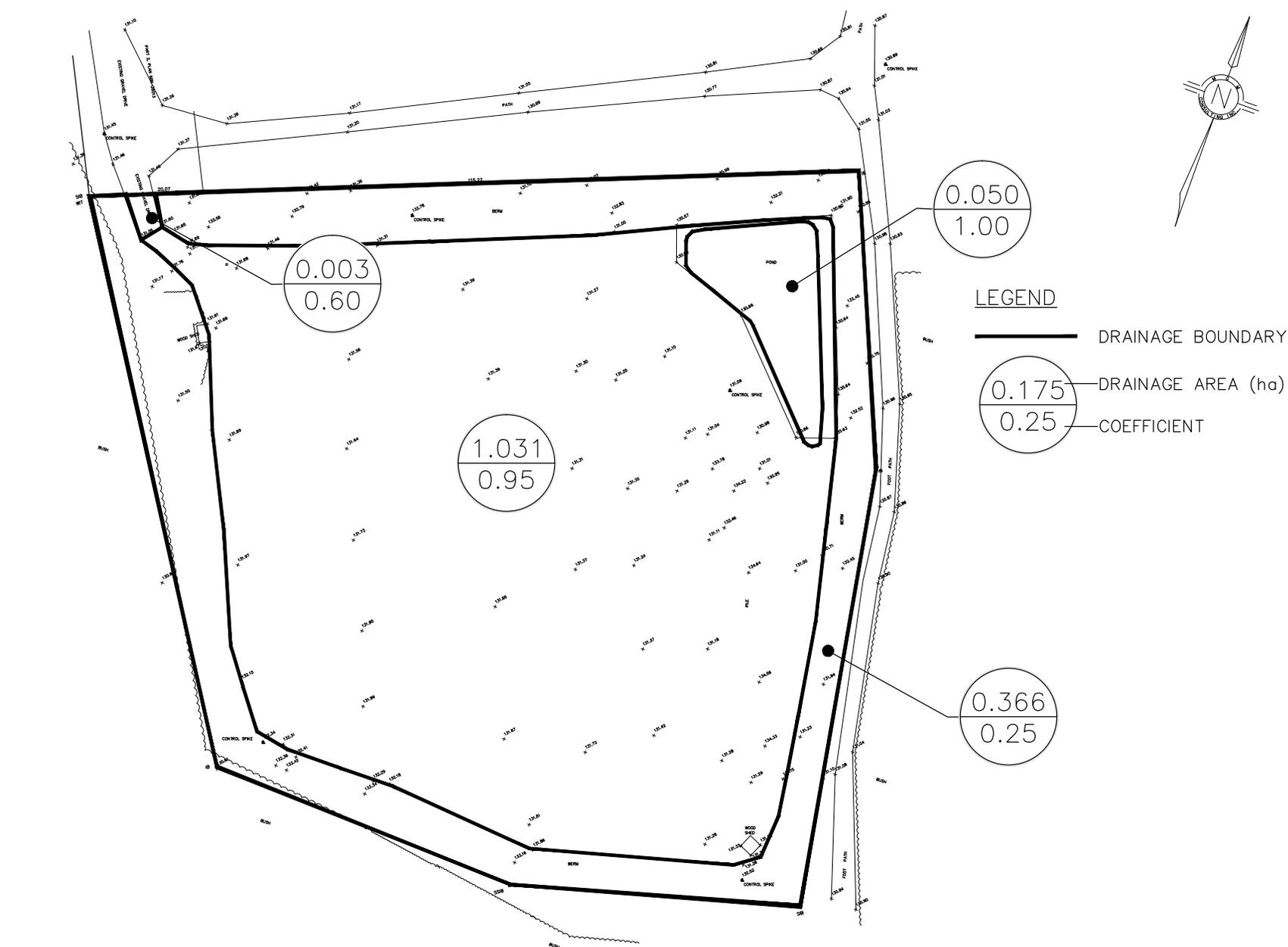
Based on the above, the estimate volume of de-watering would percolate into existing soils is in the order of 13.3 hours hours

7.0 Contingency Sediment Trap Sizing Calculations for Erosion and Sediment Control

The sediment traps have been sized to provide a minimum of 125 cu.m. /hectare of contributing drainage area as indicated in Appendix C, of the Erosion and Sediment Control Guideline for Urban Construction;

Contributing drainage area =	1.450 ha
Sizing requirement =	125 cu.m/ha
Total storage volume req'd =	181 cu.m.

The contingency sediment trap has been sized to accommodate 200 cu.m. of runoff.



ZOOSHARE BIOGAS COOPERATIVE INC.
MEADOWVALE ROAD, TORONTO

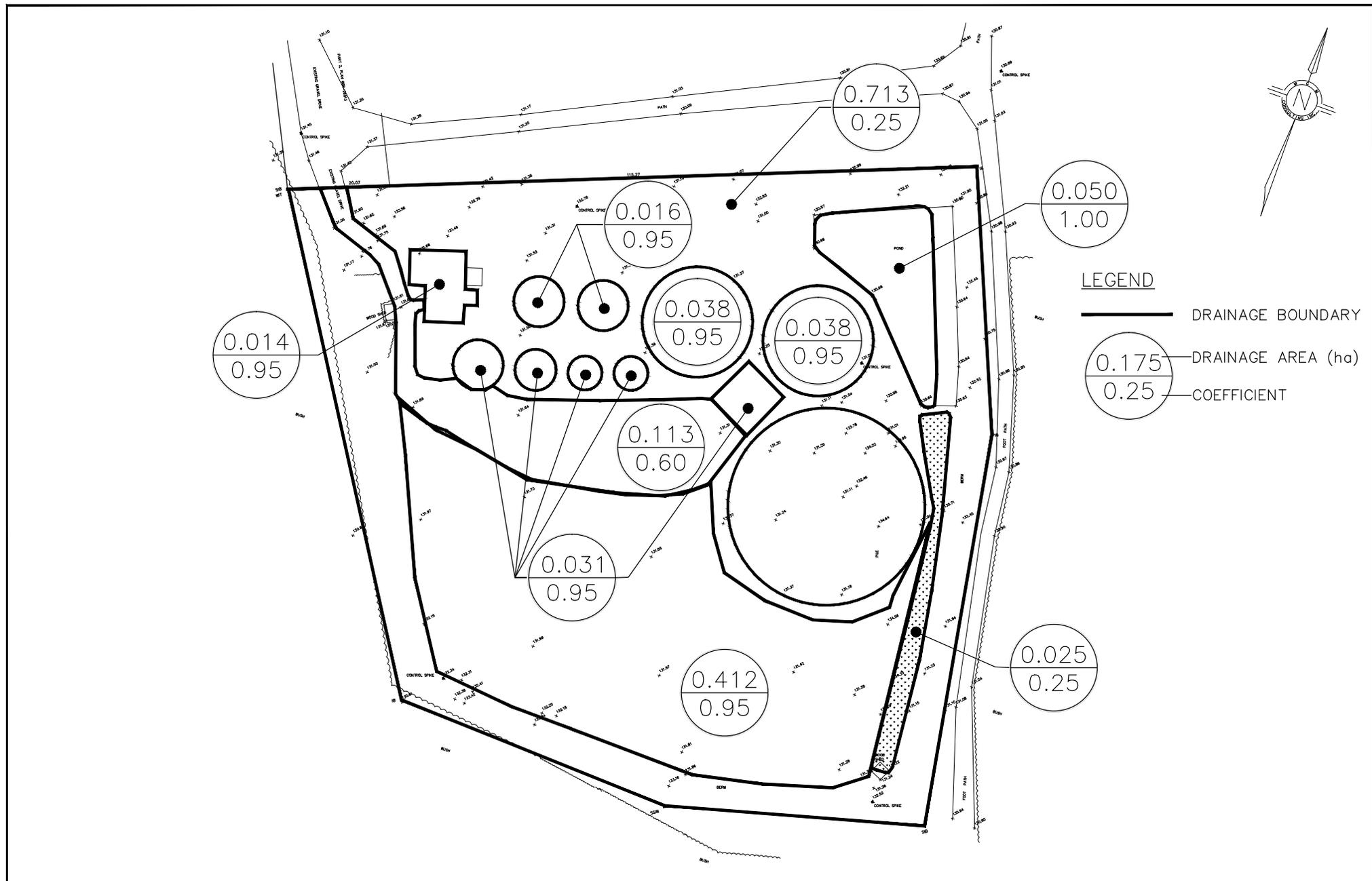
EXISTING DRAINAGE AREAS

MGM
CONSULTING INC

Consulting Engineering & Project Management
400 Bronte Street South Tel: (905) 567-8678
Suite 201 Fax: (905) 875-1339
Milton, Ontario Email: mgm@mgm.on.ca
L9T 0H7 www.mgm.on.ca

FIGURE 3

OCT-29-2013
1:1000
2013-046-C2



ZOOSHARE BIOGAS COOPERATIVE INC.
MEADOWVALE ROAD, TORONTO

PROPOSED DRAINAGE AREAS

MGM
CONSULTING INC

Consulting Engineering & Project Management
400 Bronte Street South
Suite 201
Milton, Ontario
L9T 0H7

Tel: (905) 567-8678
Fax: (905) 875-1339
Email: mgm@mgm.on.ca
www.mgm.on.ca

FIGURE 4

REV ARP 16, 2015
OCT-29-2013
1:1000
2013-046-C2

APPENDIX B
DEWATERING AND CONTINGENCY PLAN
PREPARED BY TERRAPROBE LIMITED



Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

April 30, 2015

File No. 13-13-3142

Brampton Office

Zooshare Biogas Cooperative Inc.
c/o Riepma Consultants Inc.
220 Kempenfelt Drive
Barrie, Ontario
L4M 1C4

Attention: Mr. Clare Riepma, P.Eng., R.P.P.

**RE: DEWATERING AND CONTINGENCY PLAN
PROPOSED DIGESTER AND BIOGAS FACILITY
TORONTO ZOO
SCARBOROUGH, ONTARIO**

Dear Sir:

This letter presents additional details concerning the ground water dewatering plan and associated monitoring and contingency plan as discussed during the recent April 20, 2015 teleconference with the MOECC. This letter is in follow up to the Terraprobe letter dated March 20, 2015.

PROPOSED DEWATERING PLAN

Excavations for the construction of tanks forming the biogas facility are proposed at a depth of 1.5 m below grade. Two receiving tanks have footing depths proposed at approximately 3.0 m below grade. It is anticipated that shallow excavations (i.e. 1.5 m depth) will not encounter significant ground water, and that excavations for the receiving tanks will require active dewatering to maintain a dry excavation base to allow for construction. The radius of the two receiving tanks is approximately 4.6 m and 3.7 m.

It is anticipated that rates of dewatering may exceed the limit requiring a Permit to Take Water (PTTW) (i.e. 50,000 L/day). Dewatering is anticipated to be required for to construction of receiving tanks and to a lesser degree for tanks completed to a shallower depth. Dewatering for tank excavations may be conducted simultaneously, in addition of the potential for surface runoff entering open excavations. A maximum rate of water taking of approximately 100,000 L/day is requested. Rates of dewatering were previously determined in the hydrogeologic report dated December 2014. It is expected that rates of dewatering up to 100,000 L/day would be required to achieve initial drawdown of ground water in excavations, along with potential surface water runoff to excavations. Rates of dewatering to maintain

Terraprobe Inc.

Greater Toronto

11 Indell Lane
Brampton, Ontario L6T 3Y3
(905) 796-2650 Fax: 796-2250

Hamilton – Niagara

903 Barton Street, Unit 22
Stoney Creek, Ontario L8E
(905) 643-7560 Fax: 643-7559

Central Ontario

220 Bayview Drive, Unit 25
Barrie, Ontario L4N 4Y8
(705) 739-8355 Fax: 739-8369

Northern Ontario

1012 Kelly Lake Rd., Unit 1
Sudbury, Ontario P3E 5P4
(705) 670-0460 Fax: 670-0558

www.terraprobe.ca

ground water levels below the proposed depth of open excavations are expected at rates of approximately 50,000 L/day or less.

MONITORING AND CONTINGENCY PLAN

Based on water quality sampling reported in the letter dated March 20, 2015, it is expected that dewatering discharge will not meet the Provincial Water Quality Objectives (PWQO), and as such will not be directed off-site. The primary objective of the monitoring and contingency plan is to ensure dewatering discharge remains on-site, and infiltration basins are performing satisfactorily. The following plan is proposed:

- Discharge is to be directed to the existing infiltration basin located to the northwest corner of the site. Discharge will be directed to ground water infiltration.
- The discharge point will be equipped with measures to prevent the movement of sediment and fines. Measures should be implemented such as filter bags, hay bales or temporary sedimentation pools to remove fines from discharge. Daily monitoring should be completed to confirm discharge to the infiltration basin is free of suspended sediments.
- The perimeter of the infiltration basin should be inspected daily to confirm capacity of the feature has not been exceeded and discharge is maintained on-site. A temporary overflow basin should be constructed that will receive dewatering discharge in the event that the infiltration basin capacity is exceeded. The temporary overflow basin should be designed to receive a capacity of 200,000 L (maximum pumping capacity over a two day period).
- In the event that capacity has been reached in both the infiltration basin and the temporary overflow basin rates of dewatering should be reduced so that capacity is not exceeded resulting in discharge of ground water from these features. It is anticipated that in the event infiltration capacity is reached at the site that construction can be staged to reduce rates of dewatering preventing the discharge of ground water from the site.
- Records should be maintained by the contractor including a current record of the location and extent (depth and approximate dimensions) of all excavations on the site and maintaining a current record of water taking including location, rates and times in which dewatering was required.

We trust this information is sufficient for your present purposes. Should you have any questions concerning the above, please do not hesitate to contact the undersigned.

Yours truly,
Terraprobe Inc.



Paul L. Raeppe, P.Geo



Paul W. Bowen, P.Geo., P.Eng., QP_{ESA}
Principal

Stoney Creek Office