Activa Conservation Drive Stage III, Post-Construction Monitoring Report – 2016 City of Waterloo



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Sign-off Sheet

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1.0 Introduction

As shown in Figure 1, the 21 ha Conservation Drive Subdivision is located in the northwest region of the City of Waterloo (City), within the Laurel Creek and Martin Creek watersheds. The property is bounded by Conservation Drive to the south, Conservation Meadows, Stage 5 to the east, the Township of Woolwich municipal boundary to the north, and Roy Schmidt Road to the west.

The Subdivision is comprised of two stages with drainage from Stage I in the northern part of the site directed to Martin Creek and drainage from Stage II in the south being directed to Laurel Creek. Stage I, the focus of this monitoring report, is approximately 13.1 ha, and includes the construction of 144 single-family lots, 19 townhouse lots, 4 roadways, a park area, 2 stormwater management (SWM) ponds and an existing natural wetland. Stage II, which is not yet Draft Plan Approved, will include the construction of additional residential lots.

As outlined in the *Activa Conservation Drive Lands Stormwater Management Report* (Stantec Consulting Ltd., 2005), a SWM strategy was prepared for Stage I to include two constructed wetlands working in series with an existing natural wetland to provide the required stormwater controls. The constructed wetlands were designed to provide Normal (formerly Level 2) water quality control while the natural wetland provides water quantity control prior to discharge to Martin Creek, which has been classified by the Ministry of Natural Resources (MNR) as a warm water stream.

A number of reports have been referenced in the preparation of this report, including:

- Activa Conservation Drive – Stage III, Post-Construction Monitoring Report 2015, Stantec Consulting Ltd., 2015.
- Activa Conservation Drive – Stage II Monitoring Reports 2006 – 2014, Stantec Consulting Ltd., 2007- 2015.
- Activa Conservation Drive Lands Stormwater Management Report, Stantec Consulting Ltd., August 2005.
- Scoped Environmental Impact Study, Ecoplans, July 2003.
- *Geotechnical Investigation Report*, Naylor Engineering Associates Ltd., February 2003.

The following report has been prepared to summarize the 2016 Stage III (post-construction) Monitoring Program for the Activa Conservation Drive lands. The Monitoring Program is conducted jointly by Stantec Consulting Ltd. (Stantec) and MMM Group Ltd. (formerly Ecoplans Ltd.).



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ORIGINAL SHEET - ANSI A

January 2014
603-08671

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CONSERVATION DRIVE
WATERLOO, ON

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SITE LOCATION PLAN

1.1 CONSTRUCTION ACTIVITY

Construction in the Conservation Drive Subdivision was initiated in 2006 with various activities continuing through 2016. The major activity in Stage I in 2016 was ongoing house construction with all lots being completed by the end of 2016. A build-out assessment for the subdivision was conducted in December 2016 and the limit of development is noted in Table 1, below, and in Figure 2.

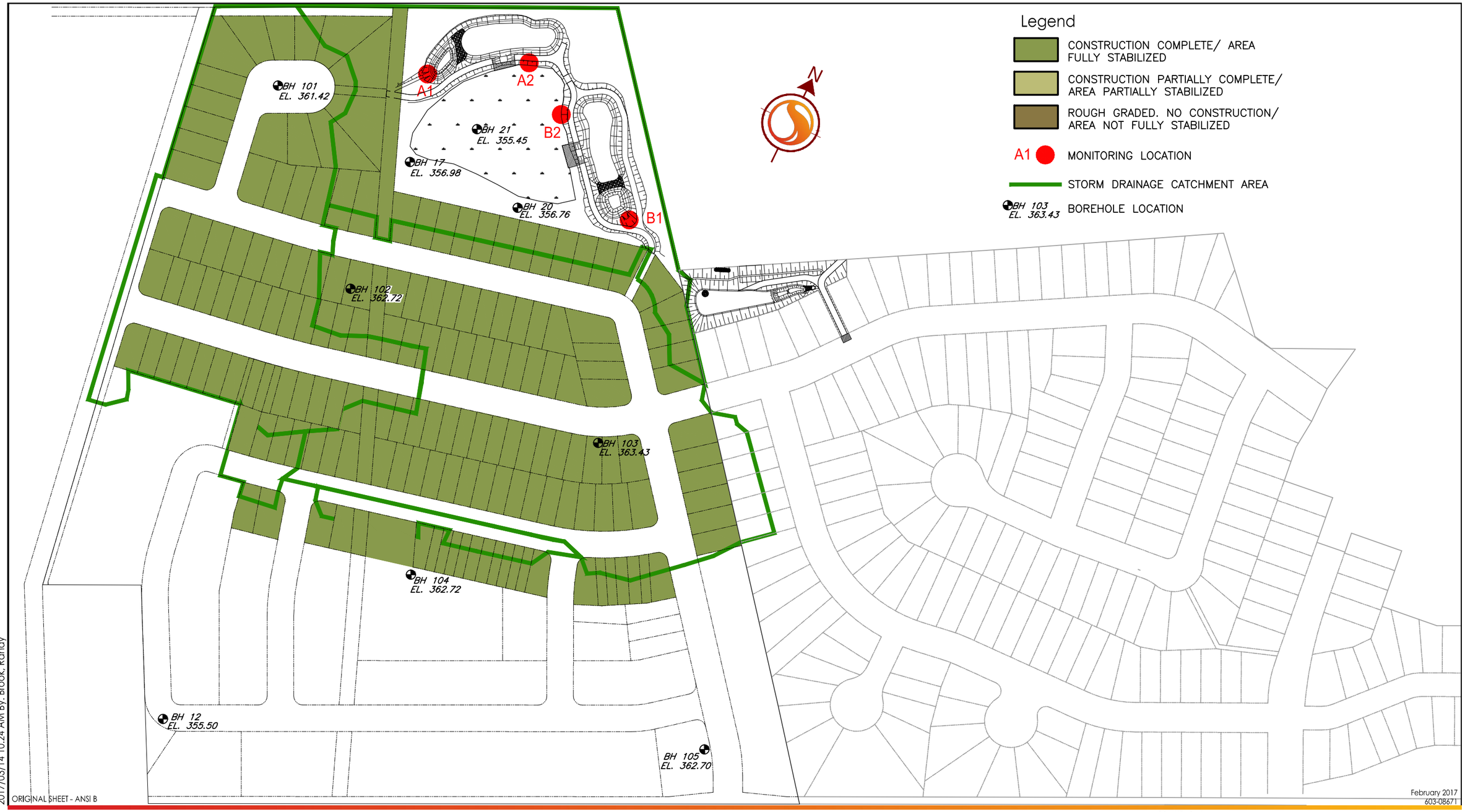
Table 1: Catchment Build-Out Status for Basins A and B

Tributary Lands	Total Number of Units	Fully Developed Lots	Partially Developed Lots	Vacant Lots	Current % Build-Out
Basin A	59	59	0	0	100%
Basin B	106	106	0	0	100%
Stage I	165	165	0	0	100%

The two-year period of post-construction monitoring, which focused largely on the maintenance and operation of the SWMF, concluded in 2016 and a City inspection of the SWMF is required. Conditions and results for 2016 are discussed in subsequent sections of this report.

1.2 ENVIRONMENTAL DATA AND PRECIPITATION

Weather data used in conjunction with this study has been obtained from a station located at the University of Waterloo. The University of Waterloo Weather Station is operated by the University of Waterloo and is a reliable source of weather information in the area. Precipitation and temperature data recorded at this station during 2016 can be found on Figure 3. Precipitation for the year totaled 891 mm, which is slightly below the average of 916 mm, while the above average temperatures made 2016 one of the warmest years on record in the region. For more detailed weather data and discussion, refer to the University of Waterloo Weather Station Website (weather.uwaterloo.ca).



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February 2017
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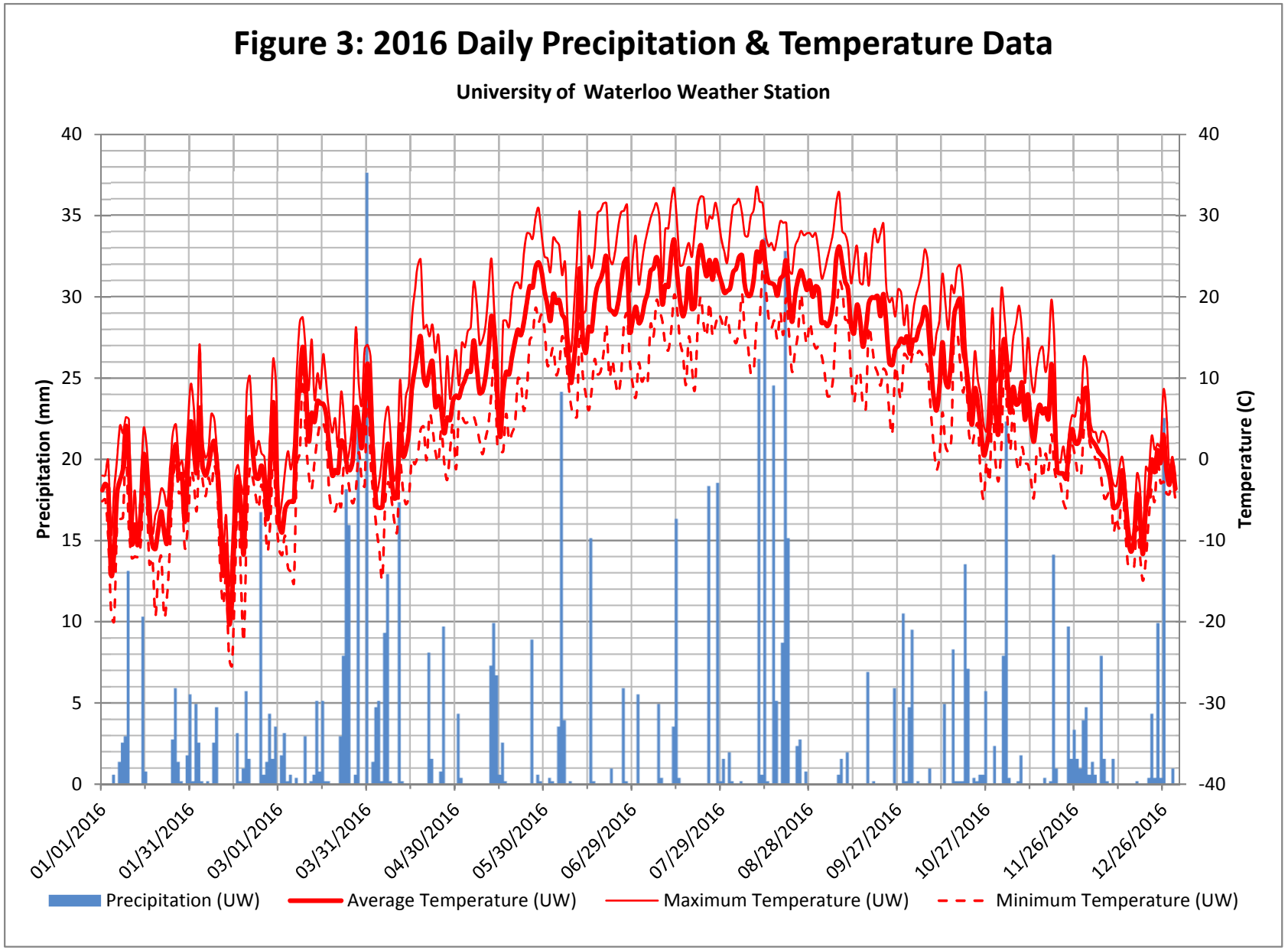
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LIMIT OF DEVELOPMENT ACTIVITY (DECEMBER 2016)

Figure 3: 2016 Daily Precipitation & Temperature Data



2.0 Monitoring Program

As per the City of Waterloo requirements, a Monitoring Program is required for all new development projects. Monitoring and maintenance activities are an important part of a SWM Plan to ensure that the designed features operate as intended. The Stage II (during-construction) Monitoring Program for the site was initiated in 2006 with the construction of the two SWM basins, Basin A and Basin B and concluded in 2014. The Stage III (post-construction) Monitoring Program for the site was initiated during 2015 and concluded in 2016.

The objectives of the program are to monitor the effectiveness of the erosion and sedimentation control measures during-construction and to evaluate the operation of the SWMF. Vegetation health and proliferation and groundwater conditions were monitored in the pre-construction phase and will continue to be monitored through all stages of development to ensure that impacts to the surrounding environment are minimized.

2.1 SCOPE OF WORK

Post-construction monitoring initiated in 2015 for SWM Basins A and B concluded in 2016, for a total post-construction monitoring period of two years. Consistent with the Laurel Creek Watershed Development Monitoring Program (Stantec Consulting Ltd and Planning and Engineering Initiatives Ltd., 1999), the following post-construction monitoring work was completed between March and November, 2016:

- Surface Water Monitoring (Stantec):
    - Discrete, monthly water quality sampling from March to November at the inlet and outlet of each SWM basin for a total of four sample stations. Each sample was analyzed for the concentration of Total Phosphorus (TP), Dissolved Oxygen (DO), bacteria (E. coli), and total suspended solids (TSS) as well as temperature.
    - Semi-annual sediment accumulation monitoring in each of the facility forebays.
- Groundwater Monitoring (Stantec):
    - Monthly groundwater level measurements at six boreholes (BH) from January to December, 2016.
- Biological Monitoring (MMM Group):
    - Semi-annual surveys and data collection conducted at two previously installed, permanently marked plots within the natural wetland area to assess species presence and abundance.

3.0 Surface Water Quality Monitoring

The intent of the water quality monitoring is to assess the performance and potential impact of the SWM facilities on adjacent environments by comparing results with the Laurel Creek Watershed Study (LCWS) performance targets and historical monitoring results. Since Martin Creek ultimately discharges into the Conestoga River, stormwater discharge is not directly governed by instream flow targets established in the LCWS; however, they have been included for comparison purposes. As noted previously, Martin Creek has been designated as a warm water stream by the MNR and, as such, the LCWS targets for a warm water stream are summarized below.

The following targets have been identified as the parameters of interest for the Post-Construction Monitoring Program:

i) **Temperature** – maintain or reduce instream surface water temperatures to ≤29°C from June 1 to July 31 and ≤26°C for the remainder of the year

ii) **Dissolved Oxygen (DO)** – maintain a minimum DO level of 5.0 mg/L.

iii) **Total Suspended Solids (TSS)** – maintain an average concentration during rainfall events of less than 25 mg/L for the effluent from SWM facilities to the downstream watercourse. No instream target was identified within the LCWS

iv) **Total Phosphorus (TP)** – Maintain a phosphorus concentration within the range of 0.05 to 0.08 mg/L. Although a specific phosphorus limit for SWMF discharge was not established, removal of 90% of the phosphorus from development runoff is targeted.

v) **Bacteria (*E.coli*)** – Although specific bacteria targets for development runoff were not established, the target of 200 CFU/100 mL has been adopted as a guideline.

Sampling locations within the monitoring network include:

- Station A1: Concrete headwall inlet to Basin A from the storm sewer network
- Station A2: Basin A outlet; with sample taken in Corrugated Steel Pipe (CSP) riser or from overflow outlet pipe (if flowing)
- Station B1: Concrete headwall inlet to Basin B from the storm sewer network
- Station B2: Basin B outlet; with sample taken in CSP riser or from overflow outlet pipe (if flowing)

Water quality monitoring results are presented in Table 2 and discussed below with historic results located in Appendix C.

Table 2: Activa Conservation Drive
2016 Monitoring Results

Date	Precipitation (mm)				Air Temperature (°C)			Depth (m)				Water Temp (°C)				DO (mg/L)				TSS (mg/L)				TP (mg/L)				E. Coli (CFU/100mL)			
	Day of Sample	24 Hr	48 Hr	5 Day	Min	Avg	Max	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2
March 28, 2016	22.4	0.6	0.6	42.8	0.9	4.6	9.2	NF	NF	NM	0.08	NF	NF	NM	9.4	NF	NF	NM	11.64	NF	NF	NM	22	NF	NF	NM	0.100	NF	NF	NM	150
April 26, 2016	9.8	0.8	0.8	10.6	-0.4	3.2	5.3	0.04	NM	0.07	0.01	7.5	10.9	8.6	11.7	10.96	9.99	11.42	16.80	46	12	<10	11	0.083	0.035	0.037	0.027	500	620	20	<10
May 26, 2016	9.0	0.0	0.0	0.0	15.3	21.2	27.2	NF	NF	0.04	0.02	NF	NF	13.9	21.0	NF	NF	10.52	11.30	NF	NF	<10	140	NF	NF	0.160	0.130	NF	NF	320	100
June 16, 2016	0.2	15.2	15.2	15.2	12.3	19.4	25.7	0.10	NF	0.24	0.08	18.6	NF	17.5	22.7	10.31	NF	9.50	8.12	15	NF	<10	<10	NM	NF	NM	NM	NM	NF	NM	NM
July 25, 2016	18.4	0.0	0.0	0.0	19.3	24.5	29.9	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
August 16, 2016	24.6	0.0	0.2	60.6	17.1	21.4	25.8	0.15	NF	0.24	0.04	23.0	NF	23.2	23.8	8.05	NF	7.95	6.21	<10	NF	<10	<10	0.120	NF	0.130	0.041	9600	NF	1600	880
October 3, 2016	0.0	9.6	14.4	25.2	12.6	14.7	20.1	NF	NF	0.10	NF	NF	NF	18.1	NF	NF	NF	9.37	NF	NF	NF	<10	NF	NF	NF	<0.020	NF	NF	NF	300	NF
October 20, 2016	13.6	0.2	0.4	9.0	9.9	11.6	13.5	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
November 3, 2016	22.4	8.0	8.0	10.4	5.4	10.3	13.4	NF	NF	NF	0.01	NF	NF	NF	14.0	NF	NF	NF	10.12	NF	NF	NF	10	NF	NF	NF	0.200	NF	NF	NF	2100
2016 Maximum	24.6	15.2	15.2	60.6	19.3	24.5	29.9	0.15	NM	0.24	0.08	23.0	10.9	23.2	23.8	10.96	9.99	11.42	16.80	46	12	10	140	0.120	0.035	0.160	0.200	9600	620	1600	2100
2016 Average	13.4	3.8	4.4	19.3	10.3	14.5	18.9	0.10	NM	0.14	0.04	16.4	10.9	16.3	17.1	9.77	9.99	9.75	10.70	24	12	10	34	0.102	0.035	0.087	0.100	5050	620	560	608
2016 Minimum	0.0	0.0	0.0	0.0	-0.4	3.2	5.3	0.04	NM	0.04	0.01	7.5	10.9	8.6	9.4	8.05	9.99	7.95	6.21	10	12	10	10	0.083	0.035	0.020	0.027	500	620	20	10
Laurel Creek Watershed Study Targets												<26°C* / <29°C**				>5.0 mg/L				<25 mg/L				<0.08 mg/L				<200 CFU/100 mL			
Number of Target Exceedances												0	0	0	0	0	0	0	0	1	0	0	1	2	0	2	3	2	1	3	2
Number of Successful Samples												3	1	5	6	3	1	5	6	3	1	5	6	2	1	4	5	2	1	4	5
% Exceed												0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	0%	17%	100%	0%	50%	60%	100%	100%	75%	40%

NOTES:

1) The LCWS targets presented for temperature and TSS are presented for comparative purposes only.

2) Rainfall amounts based on the University of Waterloo Station
   a) Day of Sample: Total precip recorded on the day of sample collection
   b) 24 Hour: Precip recorded one day prior the sample collection day
   b) 48 Hour: Precip recorded 2 days prior the sample collection day
   d) 5 day: Precip recorded 5 days prior to the sample collection day

* Target temperature between June and July
** Target temperature for August

NM Indicates water at site but parameter not measured for reasons including:
   a) Standing water at site
   b) Existing flow not measureable due to configuration
   c) Safety
NF Indicates no water at site
ND Parameter not detected
NA Indicates equipment malfunction
4.8 LCWS Target Exceeded
8.3 LCWS Target Met

3.1 GENERAL OBSERVATIONS

The site was visited 9 times in 2016 with samples collected from one or more stations in the monitoring network during all of these sessions. The 2016 sampling year included:

- 5 sessions with >10 mm of precipitation on day of sample.
- 2 sessions with between 5 and 10 mm of precipitation on day of sample.
- 2 sessions with <5 mm of precipitation on day of sample.

Key monitoring sessions included:

- June 16, 2016: Experienced the greatest amount of rainfall (15.2 mm) in the 24-hour period prior to sampling.
- March 28, April 26, May 26, August 16, October 20, and November 3, 2016: Experienced significant amounts of precipitation during sampling (22.4 mm, 9.8 mm, 9.0 mm, 24.6 mm, 13.6 mm, and 22.4 mm respectively).

No flow conditions were observed at the inlets of Basin A and Basin B during the March 28, October 30, and November 3, 2016 monitoring sessions. In addition, the inlet of Basin A had no flow during the May 26 and October 3, 2016 monitoring sessions.

Samples from the outlet of Basin A were only obtained during one sampling session in the 2016 monitoring season and from Basin B six times during the 2016 monitoring season. The low number of samples from Basin A is due to the initiation of the upwelling trench in 2015 that has been designed to convey flows from the SWM Basins to the wetland by mimicking lateral shallow groundwater interflow, similar to original conditions. This helps to reduce point-source discharge and also helps promote stormwater cooling prior to discharge to the downstream systems. However, since the upwelling trench is designed to mimic groundwater discharge to the wetland, samples cannot be taken at the outlet of the trench. It was recommended in 2015 to take samples within the outlet riser in each basin as the overflow pipe and weir are only operational under high flows; however, the outlet riser in Basin A was sealed for the 2016 monitoring season. In addition, the drainage area to Basin A is smaller than Basin B and will drain more rapidly, so therefore, fewer opportunities existed to sample from the overflow pipe outlet of Basin A.

As illustrated in the photographic inventory in Appendix A, vegetation growth in and around the wetlands was generally good. Waterfowl and other aquatic species were observed around the facilities during most of the 2016 monitoring sessions. The fence around the inlet headwall in Basin B (station B1) is broken and requires repair.

3.2 BASIN A MONITORING RESULTS

Constructed in 2006, Basin A receives runoff from approximately 3.8 ha in the northwestern part of the site. In 2007, the outlet pipe leading to the upwelling trench was plugged to reduce the potential for fouling from the higher sediment loads generally observed during construction. As mentioned above, in 2015, this outlet pipe leading to the upwelling trench was unplugged as most of the sediment loading from construction has subsided. Basin discharge is now directed to the wetland through the upwelling trench, and to the overflow outlet pipe and weir during high events.

Sediment measurements were taken twice during the 2016 monitoring season. On June 1, 2016 sediment depths in Basin A were measured and ranged from 0.19 m to 0.29 m with an average depth of approximately 0.25 m. No sediment was observed at the forebay berm. On December 1, 2016 sediment depths in Basin A were measured again and averaged a depth of approximately 0.10 m with no sediment observed at the forebay berm. The sediment plume was localized to an area about 1 m wide by 2 m long. Based on these results and the fairly recent pond cleanout in summer 2013, a forebay cleanout is not recommended at this time.

3.2.1 Water Temperature

All water temperatures recorded since 2006, including those in 2016, have met the LCWS temperature targets of ≤29°C in June and July, and ≤26°C the rest of the year with fluctuations generally proportional to ambient air temperatures. In 2016, temperatures within the basin ranged from 7.5 to 23.0°C. Historically, water temperatures in Basin A have ranged from -2.5 to 29°C. Historical monitoring results are attached in Appendix C.

Although a very small sample size, in 2016, temperatures at the outlet were greater than or equal to those at the inlet during the only monitoring session where data was collected at both locations. There has been a continuing a trend observed since 2010 of higher outlet temperatures than inlet temperatures and continued with the limited available data in 2016. Contributing factors to this trend may be the impact of solar radiation warming water in the basin and the lack of riparian cover to shade these areas. It is expected that as more wetland vegetation becomes established throughout the wetland portion of the basin thermal and solar impacts will be reduced. In addition, the upwelling trench will provide some further cooling benefit that is not recorded with outlet samples.

3.2.2 Dissolved Oxygen (DO)

The 2016 sampling year did not have any samples with a DO less than the LCWS target of >5mg/L. DO concentrations were fairly consistent between the inlet and outlet of the SWM basins. The average DO concentration within Basin A at the inlet was 9.8 mg/L and 10.0 mg/L at the outlet.

This was the second year that DO was measured at Conservation Drive, with similar results to those recorded in 2015.

3.2.3 Total Suspended Solids (TSS)

From 2006 to 2015, TSS concentrations at Stations A1 and A2 have ranged from <10 to 1,300 mg/L and <10 to 160 mg/L, respectively. During 2016, a total of 4 samples (at both stations A1 and A2) were collected from Basin A. The 2016 concentrations at A1 showed average TSS concentrations lower than 2015 and most other previous monitoring years, but comparable with 2014 historical results. The average TSS concentration from A1 was 24 mg/L with one of the three samples collected during the 2016 monitoring session exceeding the target of 25 mg/L.

The TSS concentrations in the lone sample collected at Station A2 in 2016 showed generally a lower result in compared to historic results. However, since only one sample was able to be collected at station A2, the sample size is very small and hard to establish any trends based on the results. Although no outflow samples were obtained during the other events where an inlet sample was available, it is likely that the TSS concentration at the outlet were low based on the very low inlet concentrations. Most of the site has been built out and therefore the TSS concentrations in the influent runoff is much lower.

3.2.4 Total Phosphorus (TP)

Target concentrations were exceeded on the two inlet samples, but within the target range in the outlet sample within Basin A in 2016. TP concentrations ranged from 0.035 mg/L to 0.12 mg/L in 2016. During the sampling session in which both inlet and outlet samples were obtained, TP decreased from the inlet to the outlet, which was consistent with TSS results. The results from 2016 are slightly lower than those obtained in 2015.

3.2.5 Bacteria (*E.coli*)

E.coli concentration in 2016 in Basin A ranged from 500 CFU/100mL to 9,600 CFU/100mL and exceeded the target concentration in all three samples collected. The largest measured sample also occurred during a hot summer period. The results from 2016 are slightly higher than those obtained in 2015; however, it was a warmer summer and dryer than previous.

3.3 BASIN B MONITORING RESULTS

Also constructed in 2006, Basin B receives runoff from 5.12 ha in the east and central areas of the property. Similar to Basin A, the outlet pipe leading to the Basin B upwelling trench was blocked early in 2007 to prevent sediment from clogging the feature. As mentioned above, in 2015, this outlet pipe leading to the upwelling trench was unplugged as most of the sediment loading from construction has subsided. Basin discharge is now directed to the wetland through the upwelling trench, and to the overflow outlet pipe and weir during high events.

Sediment measurements were taken twice during the 2016 monitoring season. On June 1, 2016, sediment depths in Basin B were measured and ranged from 0.13 m to 0.24 m, with an average depth of 0.18 m. On December 1, 2016 sediment depths in Basin B were measured again and ranged from 0.05 m to 0.30 m with an average depth of approximately 0.15 m. A sediment plume roughly 8 m wide by 3 m long was noted at the inlet. Based on these results and the fairly recent pond cleanout in summer 2013, a forebay cleanout is not recommended at this time.

3.3.1 Water Temperature

In 2016, the temperatures measured in Basin B ranged from 8.6 to 23.8°C with no target exceedances, similar to historical data. During all four sessions where temperatures were recorded at both inlet and outlet stations, temperatures at the outlet were greater than or equal to those at the inlet, continuing trends observed in historical data for Basin B. Increases in water temperature across a facility such as Basin B are common due to the shallow water depths and often minimal vegetative cover to absorb solar radiation. The upwelling trench will provide some cooling benefit that is not recorded with outlet samples.

Water temperatures in Basin B continue to be generally proportional to ambient air temperatures.

3.3.2 Dissolved Oxygen (DO)

The 2016 sampling year did not have any samples with a DO less than the LCWS target of >5 mg/L. DO concentrations were fairly consistent between the inlet and outlet of the SWM basins. The average DO concentration within Basin B was 9.8 mg/L at the inlet and 10.7 mg/L at the outlet.

This was the second year that DO was measured at Conservation Drive, with similar results to those recorded in 2015.

3.3.3 Total Suspended Solids (TSS)

Historically, TSS concentrations at Stations B1 and B2 have ranged from non-detectable to 7,400 mg/L and 1 to 520 mg/L, respectively. During 2016, a total of 11 samples (at both stations B1 and B2) were collected from Basin B. The 2016 concentrations at B1 showed the lowest historical average TSS concentrations to date. The average TSS concentration from B1 was <10 mg/L with none of the five samples collected during the 2016 monitoring session exceeding the target of 25 mg/L.

TSS concentrations in samples collected at Station B2 were generally consistent with historic results, ranging from <10 to 140 mg/L. Only one sample exceeded the target of 25 mg/L. In two of the four samples taken where both inlet and outlet samples were obtained, the outlet concentration was higher than the corresponding inlet concentration; however, the inlet

concentrations were very low making it difficult to achieve a reduction. The lone high outlet concentration of 140 mg/L could also be attributed to missing the first flush flow at the inlet to the SWMF.

3.3.4 Total Phosphorus (TP)

Target concentrations were exceeded on five of nine samples within Basin B in 2016. TP concentrations ranged from <0.02 mg/L to 0.20 mg/L in 2016. During the three sampling sessions in which both inlet and outlet samples were taken, TP decreased from the inlet to the outlet on all occasions. This shows that the Basin is functioning as designed by decreasing the TP across the basin. The results from 2016 are slightly lower than those obtained in 2015.

3.3.5 Bacteria (*E.coli*)

E.coli concentration for 2016 in Basin B ranged from <10 CFU/100mL to 2,100 CFU/100mL and exceeded the target concentration in five of the nine samples collected. The samples that exceeded the target concentration generally corresponded to samples taken during large rainfall events . The results from 2016 are slightly lower than those obtained in 2015.

4.0 Groundwater Monitoring

Groundwater measurements were taken monthly from 2006 through 2016 as a continuation of the pre-construction (Stage I) Monitoring Program. Although many of the original monitoring wells were destroyed, during-construction and post-construction monitoring continued at the remaining wells with five additional wells installed onsite by LVM (formerly Naylor Engineering Associates Ltd.) in early 2007 as detailed in their Report No. 4500H1.R01. Groundwater monitoring was undertaken by Stantec from 2008 to 2016. Groundwater level monitoring results are provided in Table 3 and are illustrated in Appendix D.

As illustrated in Appendix D, groundwater elevations varied throughout the year. As expected, historical groundwater levels typically show trends where measurements during March and April are higher than during the summer months.

BH101 (upper) and BH103 experienced the highest measured groundwater levels. Increased groundwater levels in spring 2016 are likely attributable to the combination of the late spring freshet and spring precipitation. Groundwater levels dipped in late spring before increasing then slowly declining throughout 2016. BH103 and BH 104 experienced the greatest variability, which is generally consistent with historical results for this location. The results from this study and general groundwater conditions have been incorporated into the attached Biological Monitoring Report, completed by WSP/MMM Group.

The standpipes at BH 17 in the wetland had become completely blocked/clogged during the 2016 monitoring year and therefore limited data is available for this location for 2016. This location usually shows a downward vertical gradient, particularly through the summer months, indicating a trend of groundwater recharge in this area while the standpipes at BH20 typically generally demonstrate equilibrium through this same period.

Table 3: 2016 Groundwater Monitoring Results

Date	BH 12	BH 17		BH 20		BH 101		BH 103	BH 104	BH 105
		BH 17 (Upper)	BH 17 (Lower)	BH 20 (Upper)	BH 20 (Lower)	BH 101 (Upper)	BH 101 (Lower)			
11-Feb-16	Clogged @ 0.10			356.390	356.760	359.472	354.895	could not open	354.31	lock rusted shut
25-Feb-16	Clogged @0.99			356.485	356.825	359.472	355.015	360.99	354.34	full of ice
28-Mar-16	Clogged @0.99		356.645	356.060	356.590	360.090	355.145	Full of water	354.62	
27-May-16	354.72	Clogged/dry at 0.48	Clogged/Dry at 1.49	356.395	356.400	359.080	354.180	360.99	353.20	358.69
16-Jun-16	Clogged @0.99	Completely blocked	Blocked at 0.07m	356.415	356.430	359.280	355.170	360.79	354.11	358.59
25-Jul-16	353.57	Completely blocked	Completely blocked	356.305	356.310	359.080	355.000	360.47	353.87	358.33
16-Aug-16	353.70	Completely blocked	Completely blocked		356.650		354.830	360.69	353.70	358.31
3-Oct-16	353.80	Completely blocked	Completely blocked	356.315			354.720	360.48	353.65	358.17
2-Nov-16	353.92	Completely blocked	Completely blocked	356.255			354.600	358.22	352.57	357.11

5.0 Biological Monitoring

The Stage I (pre-construction) monitoring (2003-2005) and Stage II (during-construction) monitoring (2006-2014) provide baseline data against which Stage III (post-construction) results at the study site have been evaluated. Stage III monitoring at the site commenced in 2015 and concluded in 2016.

Monitoring over the course of 14 years (2003-2016) has shown that this is a dynamic wetland system, driven by natural cycles of water level variation. This hydrologic variation, in turn, influences vegetation. The vegetation composition at Plot 1 has been relatively constant. At Plot 2 (the central wetland area), vegetation composition has varied, likely in response to environmental conditions, particularly water levels. In general, the marsh has been dominated by obligate and facultative wetland species during the 2003 to 2016 monitoring period, and no clear and consistent vegetation trends have been observed.

Non-native / invasive species are not widespread or abundant in the wetland; these species are generally restricted to the wetland periphery / development envelope interface. Even at the periphery, these species are not prevalent and no noticeable increase in distribution or abundance was evident in 2016 or the previous 13 years of monitoring. Invasive species control measures are not required or recommended, consistent with previous years.

The monitoring program undertaken at this site was appropriate in scale and content to elucidate changes / trends in vegetation. Changes were recorded in vegetation composition and abundance over the course of 14 years of monitoring, but no consistent trends that were attributable to development or occupancy within the adjacent Activa residential subdivision.

The detailed 2016 Biological Monitoring Report is included in Appendix B for reference.

6.0 Conclusions and Recommendations

Based on the results and observations of the 2016 Monitoring Program, the following conclusions are made:

- Water temperatures in both basins in 2016 met the targets, were proportional to air temperature, were consistent with historical records and generally warmed from inlet to outlet.
- In both basins, inlet concentrations of TSS were generally lower than historical results. The very low inlet concentrations led to poor or even negative removal efficiencies; however, outlet concentrations were also generally very low with only one outlet sample exceeding the LCWS target of 25 mg/L.
- Following the cleanouts of both Basins in the summer of 2013, negligible sediment accumulation was measured within Basin A and Basin B.
- Groundwater levels throughout the year are generally responsive to the amount of local precipitation and remain consistent with historical fluctuations.
- 2016 groundwater measurements adjacent to the wetland continue to suggest seasonal recharge conditions in this area.
- Biological monitoring continued to show a dynamic wetland system, driven by natural cycles of water level variation.
- Non-native / invasive species are not widespread or abundant in the wetland.

Based on the findings of this report, the following recommendations are provided:

- Repair broken fence at inlet headwall to Basin B (Station B1)
- No control measures for invasive species or other environmental measures are needed or recommended.
- The Developer should complete the final rectifications of the basin and coordinate a meeting with City staff so the City can assume ownership of this facility. The OMM report will be submitted under separate cover.

APPENDIX A

Photographic Inventory



Photo 1: B1 headwall (note broken fence) (April 2016)



Photo 2: Outlet from Basin B to Wetland (March 2016)



Photo 3: Twin CSP culverts at the outlet of wetland area (March 2016)



Photo 4: Basin A and spillway (March 2016)



Photo 5: A1 headwall (March 2016)

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APPENDIX
A

TITLE
PHOTOGRAPHIC RECORD

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SURVEY DATE
2016



Photo 6: Basin B looking towards B1 (May 2016)



Photo 7: B2 outlet riser (May 2016)



Photo 8: Basin A looking towards A1 (May 2016)



Photo 9: A2 outlet riser (June 2016)



Photo 10: PVC outlet from Basin A (May 2016)

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TITLE
PHOTOGRAPHIC RECORD

SURVEY DATE
2016



Photo 11: A1 headwall (November 2016)



Photo 12: PVC outlet from Basin A (November 2016)



Photo 13: Basin B forebay and B1 headwall (November 2016)



Photo 14: PVC outlet from Basin B (November 2016)



Photo 15: Looking south towards existing wetland (November 2016)

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2016

APPENDIX B

Biological Monitoring Report (WSP/MMM Group Ltd., 2016)





MMM GROUP

Prepared for: Activa Group

2016 BIOLOGICAL MONITORING REPORT

CONSERVATION DRIVE SUBDIVISION DEVELOPMENT

PART OF LOT 28, GERMAN COMPANY TRACT, WATERLOO, ONTARIO

3324690 | March 2017

WSP | MMM GROUP

Conservation Drive
Subdivision Development

Part of Lot 28, German Company Tract,
Waterloo, Ontario

2016 BIOLOGICAL MONITORING REPORT

Prepared for:
Activa Group

March 2017

Prepared by:

WSP | MMM GROUP

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1.0 INTRODUCTION

This report describes results from the Stage III biological monitoring of a small wetland located on the Activa - Conservation Drive subdivision lands, undertaken by MMM Group Limited, a WSP Company.

The two-year, post-construction monitoring phase commenced in 2015. This report represents the second (final) year of Stage III (post-construction) monitoring of the wetland, which took place in 2016. Prior to the post-construction phase, nine years (2006 to 2014) of Stage II (during-construction) monitoring and three years (2003 to 2005) of Stage I (pre-construction) monitoring were completed for this development. Stage III biological monitoring results will be evaluated against the baseline data that were collected during the Stage I and Stage II monitoring. The biological monitoring program within the wetland, in conjunction with hydrological monitoring conducted by Stantec, has been used to quantify the extent of any disturbance or impact to the wetland, and where possible, identify the cause of these disturbances.

1.1 Site Location and Context

The subject property is a 21 ha parcel of land located at the northwest edge of the City of Waterloo (Figure 1). The property is a residential development (previously active agricultural land), with a small wetland in the northeast corner and a farmstead at the west-central border (Appendix A, Photo 1 and Photo 2). It is bordered by Conservation Drive to the south, future residential lands to the west, the City of Waterloo / Township of Woolwich boundary to the north and a developing subdivision and woodlot to the east. There is a hydro-electric power corridor (HEPC) that extends north-south through the site.

The surrounding landscape is predominantly farmland to the north, interim agriculture to the west and residential lands to the east. Laurel Creek Conservation Area is located south of Conservation Drive. The property is located within two watersheds: Laurel Creek to the south and Martin Creek to the north.

At the time of the 2016 monitoring visits, the residential homes adjacent to the wetland were completed and the area was stabilized. Grading and road construction were generally completed in 2008. Two stormwater management (SWM) ponds and an associated service road / trail were installed in 2006.

L:\Projects\Ecoplans\2400-2599\2469-Conservation Drive\Maps\3324690_Figure1_Location2016Dec.mxd 12/20/2016



WSP | MMM GROUP

CONSERVATION DRIVE SUBDIVISION
2016 Biological Monitoring Report
Site Context & Monitoring Plot Locations

0 50 100 M
1:6,000
N

Date: December 2016
Project No: 3324690
Figure No: 1

1.2 Rationale

This monitoring program was designed to evaluate the potential impacts of subdivision development on the wetland at the northeast corner of the property. There is potential for negative impact to wetland function due to changes to the existing hydrological regime (i.e., more or less water) and physical disturbance or intrusion (e.g., increased recreational usage, proliferation of invasive non-native species, etc.). Such impacts can differ from year to year in this intrinsically dynamic system due to responses to environmental and climatic conditions.

This monitoring program focuses on the vegetation communities and flora in the wetland, including an assessment of invasive non-native species proliferation and changes to component flora (i.e., substantive and consistent shifts in vegetation type). We also provide general comments on surrounding habitats and identify any remedial actions that may be required (e.g., removal or control of non-native species). The monitoring is undertaken during twice-annual surveys to address the City of Waterloo's development monitoring requirements.

2.0 APPROACH

Habitats were previously characterized during the Scoped Environmental Impact Study (Ecoplans Limited 2003) using the Ecological Land Classification for Southern Ontario (ELC) (Lee et. al. 1998).

The 2016 biological monitoring was conducted on June 29 and September 23.

2.1 Quantitative Photo Monitoring

A technique described by Van Horn and Van Horn (1996), known as "quantitative photo monitoring" was utilized to sample the monitoring plots. Two permanent photo monitoring plots were established within the wetland in 2003, with approximate locations shown in Figure 1.

- Each plot consists of two stakes spaced 10 m apart. One stake is the photo reference point, which provides a consistent location for a standard photo monitoring board (a 2.5 m board with alternating 0.5 m white / black sections).
    - The photo monitoring board is used to assess percent coverage (i.e., density) of different vegetation layers.
    - Additional measurements and observations were made, including the identification of the dominant vegetation between the photo and reference points, and the depth and location of any standing water between the photo and reference points. General notes on community health and site disturbance were also recorded.
- Four 0.5 m square quadrats were surveyed along the plot line (at 1 m, 3 m, 5 m and 8 m). Each quadrat consists of nine sub-plots. Each quadrat was inventoried for plant species (i.e., presence

/ absence and frequency of occurrence). A surface water depth was taken along the transect (where applicable). In addition, the amount of standing water along the transect was estimated (i.e., as percent cover of the transect line). Vegetation community characteristics were recorded and photographed.

Inventoried plant species were characterized by their *Coefficient of Conservatism and Coefficient of Wetness.* The Coefficient of Conservatism (CC) is a measure of habitat specificity / tolerance, and ranges in value from 0 (tolerant of a wide range of habitats) to 10 (very habitat specific), as shown in Table 1. The Coefficient of Wetness (CW) is an indicator of wetland or upland affinity, ranging in value from +5 (upland) to –5 (obligate wetland), as shown in Table 2. Mean CC and CW values are calculated based on sampling data and are compared within and between monitoring years in section 3.3. These data can provide indications of wetland condition changes in association with surface and groundwater levels, and climatic data.

Table 1 Coefficient of Conservatism (Adapted from Oldham et al. 1995).

Coefficient of Conservatism	Rank	Description
0 to 3	Tolerant	Found in a wide variety of plant communities, including disturbed sites.
4 to 6	Moderately Conservative	Typically associated with a specific plant community, but tolerate moderate disturbance.
7 to 8	Conservative	Typically associated with a plant community in an advanced successional stage that has undergone minor disturbance.
9 to 10	Highly Conservative	Typically displaying a high degree of fidelity to a specific plant community or a narrow range of synecological parameters.

Table 2 Wetness Index Categories (Oldham et al. 1995).

OBL	**- 5**	Obligate Wetland	Occurs almost always in wetlands under natural conditions (99% probability)
FACW+	**- 4**		
FACW	**- 3**	Facultative Wetland	Usually occurs in wetlands, but occasionally found in non-wetlands (67-99%)
FACW-	**- 2**		
FAC +	**- 1**		
FAC	**0**	Facultative	Equally likely to occur in wetlands or non-wetlands (34-66%)
FAC -	**1**		
FACU+	**2**		
FACU	**3**	Facultative Upland	Occasionally occurs in wetlands, but usually occurs in non-wetlands (1-33%)
FACU-	**4**		
UPL	**5**	Upland	Occurs almost never in wetlands under natural conditions (<1%)

3.0 VEGETATION OVERVIEW AND MONITORING RESULTS

3.1 Habitat Classification and Description

The wetland feature was initially characterized by a central low lying area of *Forb Organic Shallow Marsh* (MAS3-10). This central area had limited vegetation cover in 2003 and 2004, but during the 2005, 2006, 2007, 2008 and 2009 monitoring events, it was again dominated by forbs and graminoids. In 2010, 2011, 2012, 2013, 2014, 2015, and 2016 the central area had limited vegetation cover, and was more accurately classified as *Submerged Shallow Aquatic* (SAS1) with some *Duckweed Floating-leaved Shallow Aquatic* (SAF1-3). The central area is surrounded by a mosaic of *Reed-canary Grass Organic Meadow Marsh* (MAM3-2) and *Cattail Organic Shallow Marsh* (MAS3-1). The marsh is characterized by organic soils, with an overlying layer of mineral soils in some areas, possibly the result of erosion from surrounding slopes and deposition in the wetland.

Most of the cultural meadow fringe / fallow agricultural areas adjacent to the wetland present during early monitoring years were removed for the construction of two stormwater management ponds, to the north and east of the wetland area (Appendix A, Photo 4 and Photo 5).

As in previous years, in 2016, the remaining wetland outer fringe area was characterized by a mix of upland, facultative, facultative wetland and obligates wetland species. The shrub layer consists of occasional Pussy Willow (*Salix discolor*) and Red-osier Dogwood (*Cornus stolonifera*). The ground layer includes Reed Canary Grass (*Phalaris arudinacea*), Broad-leaf Cattail (*Typha latifolia*), Climbing Nightshade (*Solanum dulcamara*), Cottongrass Bulrush (*Scirpus cyperinus*), Common Milkweed (*Asclepias syriaca*), Sensitive Fern (*Onoclea sensibilis*), Canada Goldenrod (*Solidago canadensis*), asters (*Aster sp.*), Soft Rush (*Juncus effuses var. solutus*) and Stalk-grain Sedge (*Carex stipata*). No changes to the vegetation in the outer fringe were observed during the 2016 monitoring.

The wetland is a dynamic system with seasonal and year-to-year variability in water levels that can impact the extent of each of the marsh communities described above. In 2016, as in several previous years, the central portion of the wetland, which is represented by Plot 2 (Appendix A, Photo 8 and Photo 9), was dominated by green algae (*Chara sp.*). The species composition in this area has been quite variable from 2010 to 2015, with dominant vegetation changing between emergent, submergent and floating-leaved species each spring. In September 2010, 2012 and 2013, the central wetland area was devoid of vegetation. Reed Canary-grass, which declined in this area in 2008 and 2009, was not observed in the central open area from 2010 to 2016, likely due to sustained high water levels over the 2008-2016 growing seasons.

The outer marsh band, as represented by Plot 1 (Appendix A, Photo 6 and Photo 7), was characterized by a dense growth of Reed Canary-grass and Broad-leaf Cattail, with abundant Lesser Duckweed on the water surface beneath the dense graminoid canopy in 2006. This area expanded slightly from 2006 to 2007, but declined from 2008 to 2012, as the emergent vegetation receded further towards the wetland edge. In 2011 and 2012, this area was dominated by floating-leaved obligate wetland species. In 2013

and 2014, emergent vegetation, including Reed Canary-grass, Broad-leaved Water Plantain, Soft Rush and Broad-leaf Cattail was once again present in Plot 1. In 2015 and 2016, some Reed Canary-grass and Broad-leaved Cattail were present. However, floating-leaved and emergent species including Lesser Duckweed, Star Duckweed, Water-flaxseed (*Spirodela polyrrhiza*), and Canada Waterweed (*Elodea canadensis*), were also prominent in Plot 1 from 2013 to 2016.

3.2 General Overview

3.2.1 Water Levels and Vegetation within the Wetland

During the pre-construction monitoring phase (2003-2005), water levels ranged from 0 cm (no standing water) to 60 cm, with no standing water observed on any of the fall monitoring dates. In 2006, water levels were higher, ranging from 30-80 cm. In 2007, the water levels recorded were once again in the lower end of the range observed (0-15 cm). Since 2007, water levels have been somewhat higher overall (maximum depths of 65 cm in 2008, 75 cm in 2009, 70 cm in 2010, 75 cm in 2011, 65 cm in 2012 and 2013, 75 cm in 2014, 75 cm in 2015, and 62 cm in 2016). Since 2007, there has been less variation in water depths between the spring and fall monitoring dates and the persistent presence of standing water. Water levels in 2016 were very similar to previous years (2008-2015). The relatively deeper and more seasonally consistent water levels appear to represent a change within the wetland system. See Figure 2.

Prior to 2003 biological monitoring, the central core of the wetland was characterized by a higher proportion of forbs / herbs (e.g., *Polygonum sp*.) and a very limited presence of Reed Canary Grass. There was a reduction in forb density in 2003 that continued in 2004, with very little vegetation noted in the central marsh area in June or September of 2004. From 2005 to 2007 however, the central core was again dominated by forb and graminoid species. In 2008, forb and graminoid density in the central marsh area was less than in 2007, but higher than in 2004. In 2009, emergent graminoids and floating-leaved aquatics covered approximately 40% of the central core, with open water areas lacking vegetation cover comprising the remaining 60%. From 2010 to 2013, there was a great deal of annual variation in the composition of the wetland vegetation communities; from floating-leaved species, to forbs and graminoids, to areas with no vegetation present. In 2014, 2015 and 2016, the vegetation in the inner wetland area (Plot 2) was restricted to submergent species, while the outer wetland edge (Plot 1) included both emergent and aquatic species. The overall composition in 2016 remained similar to previous years (2011-2015). See Figure 3.

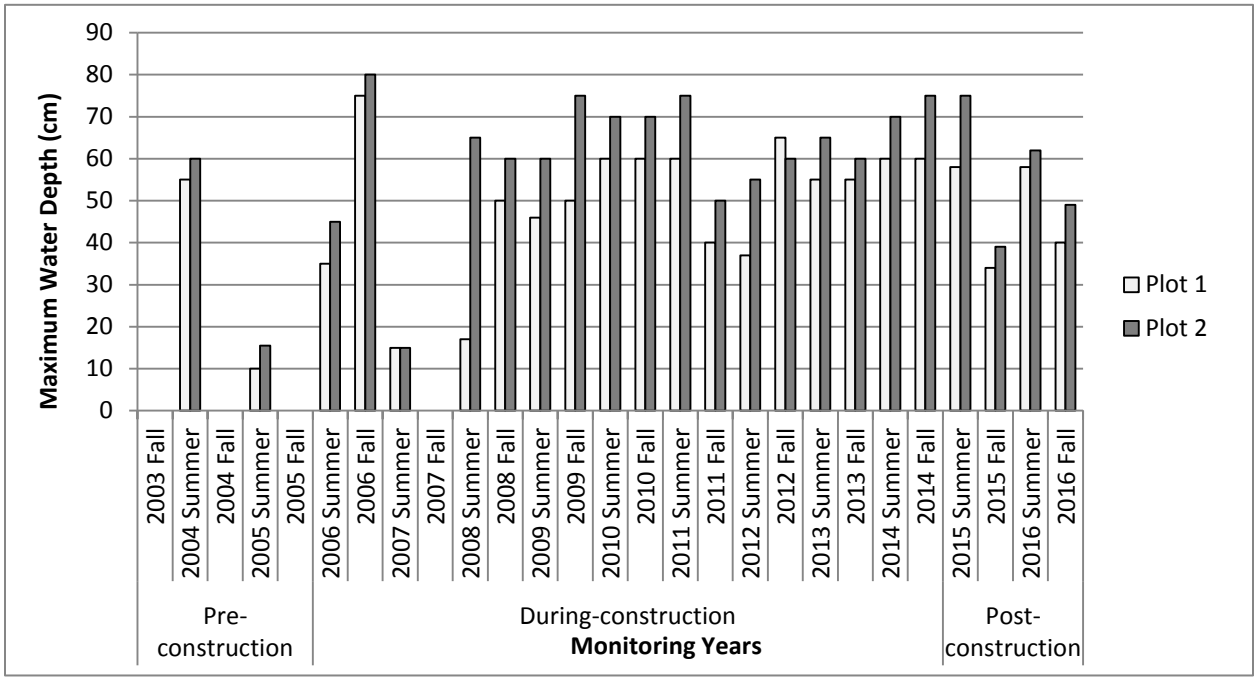


Figure 2: Maximum Water Depths on Monitoring Dates from 2003-2016

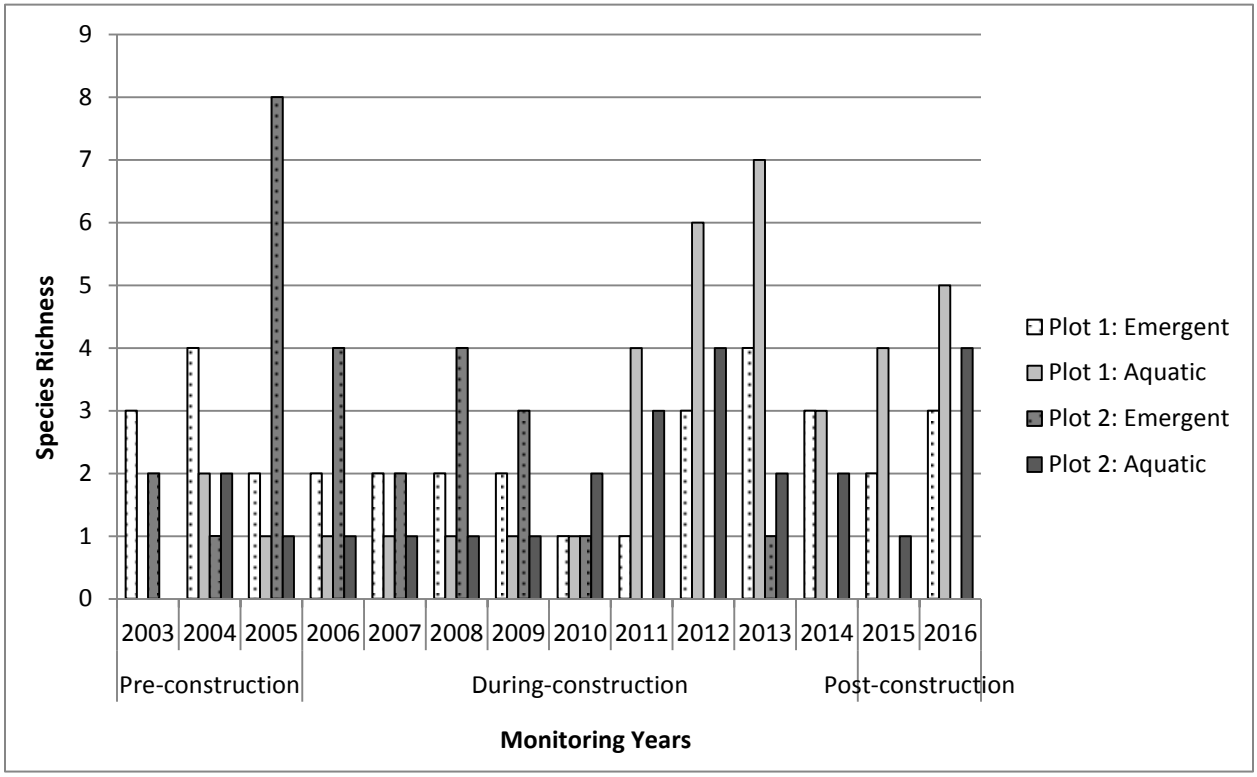


Figure 3: Emergent and Aquatic Vegetation Species Recorded in Each Plot from 2003-2016

Cause for these shifts in vegetation is unknown, but may be due to changes in hydrology as a result of year to year environmental variation, and is not directly attributable to development in the general area. Precipitation data from a local weather station and reported by The Weather Network (2016) show fluctuating precipitation levels recorded both seasonally and annually throughout the monitoring period from 2007 to 2016, which likely influences the water depths recorded in the wetland in each year. However, there does not appear to be any direct correlation between precipitation and wetland water levels; year to year variability may be the norm.

There has been no change in the amount of shrub willow dieback at the east side of the wetland since 2004. However, some successional shrub regeneration has occurred in this area since 2004.

3.2.2 Adjacent Vegetation

During the 2003 and 2004 monitoring, cultural meadow habitat was limited to a fringe around the marsh that varied in width depending on soil moisture and plowing limits. In 2005 the cultural meadow expanded to include all land that was previously farmed on the site and left fallow. As noted in Section 3.1, most of this early successional meadow was removed for construction of two stormwater management ponds in 2006.

Since 2008, a fringe of wetland vegetation has developed around the perimeter of the SWM ponds north and east of the wetland. This area includes species such as Broad-leaf Cattail, Woolgrass Bulrush (*Scirpus atrovirens*) and Soft Rush. SWM pond maintenance required removal of some of this vegetation in the summer of 2013. The disturbed areas were replanted with similar species in 2014 (pers. comm. Stantec Dec. 11, 2013). The natural wetland area was not affected. No changes to the vegetation around the SWM ponds were observed in 2015 or 2016.

3.2.3 Outlet Channel

Shrub and herbaceous vegetation growth has continued to mature around the outlet channel since the construction of the SWM ponds and associated trails; this vegetation is now well-established and stable. As in previous years, in 2016, this area was densely vegetated with a mix of facultative species. The water is generally clear and contains signs of groundwater influx, including oily sheen and presence of iron floc. In June 2012, 2013, and 2014, and September 2015, Northern Leopard Frogs were abundant in and around the channel.

Prior to 2009, flow in the channel had been minimal or absent at the time of the surveys, except for 2006 when there was water present during both monitoring visits (and moderate flow in September). During construction of the stormwater management ponds in 2006, a paved access road / pedestrian trail was constructed over the outlet channel. Flows are now conveyed under the trail, and the channel is connected to the wetland via a double corrugated steel pipe culvert.

Standing water was present in the channel during all monitoring visits from 2009 to 2016, including where it entered the woodlot (Appendix A, Photo 3). Since 2009, water in the channel has generally been

stagnant, excluding flow attributed to recent storm events that took place prior to several monitoring dates No changes to the channel, water clarity, or flow were noted in 2016.

No notable sediment accumulation was observed in the wetland during any of the monitoring visits from 2009 to 2016. The water in the SWM ponds is clear and no new sediment deposition was observed in the wetland in 2016.

Erosion and sediment control measures continue to be monitored by Stantec, with supplemental observations by MMM during biological monitoring visits. Remedial measures will be identified and completed, as required.

3.2.4 Hydrology

The following summary of hydrological conditions on the subject property was provided by Stantec (March 2017):

"Groundwater measurements were taken approximately monthly from 2006 through 2016 as a continuation of the Pre-Construction (Stage I) Monitoring Program. Although many of the original monitoring wells were destroyed, during-construction and post-construction monitoring was continued at the remaining wells with five additional wells installed onsite by LVM (formerly Naylor Engineering Associates Ltd.) in early 2007 as detailed in their Report No. 4500H1.R01. Groundwater monitoring was undertaken by Stantec from 2008 to 2016. Groundwater level monitoring results are provided in Table 4 and illustrated in Appendix D.

As illustrated in Appendix D, groundwater elevations varied throughout the year. As expected, historical groundwater levels typically show trends where measurements during March and April are higher than during the summer months.

BH101 (upper) and BH103 experienced the highest measured groundwater levels. Increased groundwater levels in spring 2016 are likely attributable to the combination of the late spring freshet and spring precipitation. Groundwater levels dipped in late spring before increasing then slowly declining throughout 2016. BH103 and BH 104 experienced the greatest variability, which is generally consistent with historical results for this location. The results from this study and general groundwater conditions have been incorporated into the attached Biological Monitoring Report, completed by WSP/MMM Group.

The standpipes at BH 17 in the wetland had become completely blocked/clogged during the 2016 monitoring year and therefore limited data is available for this location for 2016. This location usually shows a downward vertical gradient, particularly through the summer months, indicating a trend of groundwater recharge in this area while the standpipes at BH20 typically generally demonstrate equilibrium through this same period."

3.2.5 Exotic and Invasive Species

In 2005 a non-native species, Lady's Thumb (*Polygonum persicaria*), was abundant in Plot 2. This species has not been observed in the wetland since 2005. Presence and abundance of Lady's Thumb is likely related to changes in water levels. More prolific and difficult to eradicate species like Garlic Mustard (*Alliaria petiolata*) and Common Buckthorn (*Rhamnus cathartica*) have not been noted in either of the plots during any of the monitoring surveys to date. In 2016, there was no noticeable increase in invasive or exotic species distribution or abundance within the wetland (assessed qualitatively).

3.2.6 Wildlife Observations

Incidental wildlife observations were recorded during monitoring surveys and are noted in Appendix B. Virginia Rail, a wetland dependent bird species considered significant in Waterloo Region, was observed in the wetland in 2005, but was not recorded again from 2006-2016. Other bird species observed are common, expected species, such as Red-winged Blackbird, Blue Jay, Canada Goose, Mallard, Great Blue Heron and American Robin.

In 2006, Muskrats were active in the wetland, with four individuals and three 'push-ups' (homes) observed. In 2007, no Muskrats were observed, although recent 'tunnels' in the mud were evident. In 2008, a single individual was observed in the north SWM pond, and 'tunnels' were noted during each monitoring visit. In September 2009 a Muskrat and several associated "push-ups" were again observed, this time just outside of Plot 2. From 2010 to 2016, no overt evidence of Muskrat was observed, but they may still be active within the area.

In July 2007, approximately 10 dead frogs (species unknown) were observed floating in the wetland in both Plots and between the plots. No cause was ascertainable. No dead frogs were recorded from 2008 to 2016. Green Frogs and Northern Leopard Frogs were first recorded in and around the wetland in 2008. In 2009, a number of Green Frogs were heard calling and a Grey Treefrog was observed on the pathway southeast of the wetland. In 2010, Northern Leopard Frogs were observed near Plot 1. In 2011, Green Frogs were again heard calling and Northern Leopard Frogs were observed. In addition, two Midland Painted Turtles were observed basking in the wetland in 2011. In 2012, there were observations of Northern Leopard Frog and Green Frog in the wetland. Northern Leopard frogs were also noted as being abundant in the vicinity of the outlet channel. In 2013, Green Frogs were heard calling in the wetland, and Northern Leopard Frogs were abundant in and around the outlet channel. A Grey Treefrog was also observed in woody vegetation along the outlet channel. In 2014 and 2015, Green Frogs and Northern Leopard Frogs were recorded in the central wetland area (i.e., near Plot 2). In 2016, Green Frogs were heard calling from the SWM pond north of the wetland and Northern Leopard Frogs were recorded along the outlet channel.

3.3 Quantitative and Photo monitoring Results

Results for quantitative photo-monitoring are provided in Appendix B. In 2016, average species richness at Plot 1 (seven species) was within the range recorded in previous years (six species in 2014, 11

species in 2013, and two to nine species each year from 2003-2012), and characterized by a mix of floating-leaved aquatic, submergent, and emergent species, as in previous years (Appendix A, Photo 6 and Photo 7). Species richness at Plot 2 was low (three species in June, one species in September), dominated by a green algae, and a pondweed, both submergent aquatic species, similar to previous years, (Appendix A, Photo 8 and Photo 9).

A decrease in emergent vegetation within the wetland has been evident since 2008, and is likely associated with the sustained annual high water levels that have been recorded in recent years (discussed further below, and shown in Table 4). Species composition in the two monitoring plots in 2016 was similar to that found from 2010 to 2015. As discussed in section 3.2.1, cause for this shift in vegetation is unknown, but may be due to changes in hydrology or other year to year environmental variation.

The species richness, mean CC values and mean CW values for each plot from 2003 to 2016 is presented in Table 3. Species richness, CC and CW values have only varied slightly between years, and generally suggest a 'tolerant' community type with facultative and obligate wetland species. When averaged over each monitoring phase, there are no discernible differences between pre-construction and during-construction results. The 2016 (post-construction) results for Plot 1 are comparable to the results from the previous phases. However, the results for Plot 2 shifted in 2015, when the vegetation in the central wetland area was limited to a green algae (*Chara sp.*), which does not have associated CC and CW values, leading to the calculation being null. In 2016, green algae continued to dominate the central wetland in June; however, none was present in September 2016. In addition to green algae, three other aquatic vegetation species were recorded in the central wetland area (i.e., Plot 2) in 2016.

Maximum water depths recorded in the monitoring plots on each date are presented in Table 4. Water level has varied seasonally and year to year in the wetland over the course of the monitoring program, as described above. No standing water was observed during the fall monitoring visits during the pre-construction monitoring period from 2003 to 2005. However, in the during-construction monitoring period from 2006 to 2013, excluding 2007, less seasonal variation in water depth was measured within the wetland. Maximum water depths measured in the during construction period have been fairly close to the range of depths recorded pre-construction. The water levels observed in 2015 and 2016 (i.e., post-construction) were very similar to those observed from 2008 to 2014. The relatively more static (and higher) water depths observed in 2006 and 2008-2016 may explain vegetation shifts within the wetland (from abundant emergent vegetation to more floating-leaved and submergent aquatic species), and the lack of vegetation observed in Plot 2 in September 2010, September 2012 and September 2013.

Table 3 Mean Species Richness, CC and CW Values (2003-2016).

PHASE	YEAR	PLOT 1			PLOT 2		
		Species Richness	CC	CW	Species Richness	CC	CW
Pre-construction	2003	3	0.5	-3.9	2	0.4	-4.1
	2004	4	2.1	-4.8	2	2.0	-4.9
	2005	3	1.3	-4.5	6	2.2	-4.6
	2003-2005 Average	3	1.5	-4.5	3	1.8	-4.6
During-construction	2006	3	1.6	-4.7	4	1.8	-4.7
	2007	3	1.5	-4.6	3	1.2	-4.5
	2008	3	1.6	-4.7	5	1.5	-4.6
	2009	3	1.9	-4.8	4	2.3	-4.9
	2010[1]	2	1.7	-4.9	2	2.0	-5.0
	2011	4	2.6	-4.9	3	2.0	-5.0
	2012	5	2.9	-5.0	2	3.3	-5.0
	2013	6	3.6	-5.0	2	3.3	-5.0
	2014	5	3.5	-4.4	1	4.0	-5.0
	2006-2014 Average	4	2.3	-4.7	3	2.1	-4.8
Post-construction	2015	5	1.8	-4.6	1	N/A[2]	N/A
	2016	7	3.0	-5.0	2	3.1[3]	-5.0
	2015-2016 Average	6	2	-5	2	N/A	N/A

Density board coverage for each plot from 2003 to 2016 is shown in Table 5. Given the marsh / shallow aquatic nature of this particular wetland system, the density board coverage reflects both shifts in herbaceous vegetation composition and changes in water levels. Minor variation in density board coverage has been observed in both plots both seasonally and annually. These results are not unusual, given the dynamic nature of this wetland.

1 Mean CC and CW values for Plot 2 are only representative of vegetation observed during the July visit, since no vegetation was observed in Plot 2 in September 2010. The same is true for September 2012 and September 2013.

2 No CC or CW values are available for Plot 2 in 2015, due to vegetation being limited to one species of green algae (Chara sp.), which lacks these values.

3 Value provided as mean CC for Plot 2 in 2016, is only representative of June findings (no CC data available for species recorded in September 2016).

Table 4. Wetland Maximum Water Depth (cm) as measured on monitoring dates (2003-2016).

Phase	Year	Date	Plot 1		Plot 2	
			Low (cm)	High (cm)	Low (cm)	High (cm)
Pre-Construction	2003	Oct 2	0	0	0	0
	2004	June 21	40	55	40	60
		Sept 28	0	0	0	0
	2005	July 4	0	10	12.5	16
		Sept 22	0	0	0	0
	2003-2005 Spring	AVERAGE	20	33	26	38
	2003-2005 Fall	AVERAGE	0	0	0	0
During-construction	2006	June 28	30	35	40	45
		Sept 21/26	70	75	60	80
	2007	July 5	0	15	5	15
		Sept 21	0	0	0	0
	2008	July 2	17	17	55	65
		Sept 24	25	50	50	60
	2009	June 29	19	46	60	60
		Sept 30	25	50	75	75
	2010	July 6	25	60	60	70
		Sept 29	25	60	50	70
	2011	June 30	30	60	75	75
		Sept 21	15	40	50	50
	2012	June 27	5	37	45	55
		Sept 21	30	65	50	60
	2013	June 20	26	55	60	65
		Sept 25	35	55	50	60
	2014	June 26	45	60	65	70
		Sept 23	28	60	68	75
	2006-2014 Spring	AVERAGE	22	43	52	58
	2006-2014 Fall	AVERAGE	28	51	50	59
Post-construction	2015	June 24	30	58	65	75
		Sept 22	26	34	36	39
	2016	29-Jun	21	58	54	62
		23-Sep	0	40	44	49
	2015-2016 Spring	AVERAGE	22	43	52	58
	2015-2016 Fall	AVERAGE	28	51	50	59

Table 5. Density Board Coverage (2003-2016).

Phase	Year	Plot 1					Plot 2				
		0-0.5	0.5-1	1-1.5	1.5-2	2-2.5	0-0.5	0.5-1	1-1.5	1.5-2	2-2.5
Pre-construction	2003	100	85	70	55	30	55	0	0	0	0
	2004	100	92	82	52	22	52	0	0	0	0
	2005	100	99	93	55	5	50	10	3	0	0
	2003-2005	100	95	86	53	15	51	4	1	0	0
During-construction	2006	100	100	88	25	0	100	95	8	0	0
	2007	100	97	63	50	0	65	30	0	0	0
	2008	100	85	48	35	3	100	30	0	0	0
	2009	90	90	70	48	20	100	35	0	0	0
	2010	45	10	5	0	0	100	28	0	0	0
	2011	35	0	0	0	0	80	25	0	0	0
	2012	50	3	0	0	0	100	15	0	0	0
	2013	93	50	38	20	0	100	30	0	0	0
	2014	80	38	23	13	0	100	33	0	0	0
	2006-2014	77	52	37	21	3	94	36	1	0	0
Post-construction	2015	93	25	5	3	0	85	3	0	0	0
	2016	95	88	58	50	20	95	5	0	0	0
	2015-2016	94	56	31	26	10	90	4	0	0	0

4.0 CONCLUSIONS

The Stage I (pre-construction) monitoring (2003-2005) and Stage II (during-construction) monitoring (2006-2014) provide baseline data against which Stage III (post-construction) results at the study site have been evaluated. Stage III monitoring at the site commenced in 2015 and concluded in 2016.

Monitoring over the course of 14 years (2003-2016) has shown that this is a dynamic wetland system, driven by natural cycles of water level variation. This hydrologic variation, in turn, influences vegetation. The vegetation composition at Plot 1 has been relatively constant. At Plot 2 (the central wetland area), vegetation composition has varied, likely in response to environmental conditions, particularly water levels. In general, the marsh has been dominated by obligate and facultative wetland species during the 2003 to 2016 monitoring period, and no clear and consistent vegetation trends have been observed.

Non-native / invasive species are not widespread or abundant in the wetland; these species are generally restricted to the wetland periphery / development envelope interface. Even at the periphery, these species are not prevalent and no noticeable increase in distribution or abundance was evident in 2016 or the previous 13 years of monitoring. Invasive species control measures are not required or recommended, consistent with previous years.

In our opinion, the monitoring program undertaken at this site was appropriate in scale and content to elucidate changes / trends in vegetation. We did record changes in vegetation composition and

abundance over the course of 14 years of monitoring, but no consistent trends that were attributable to development or occupancy within the adjacent Activa residential subdivision.

5.0 RECOMMENDATIONS

The required monitoring at this site concluded with the second year of post-construction monitoring in 2016, as presented herein. No environmental management measures or remedial actions are recommended.

No future monitoring (by the proponent) is proposed.

All of which is respectfully submitted by,

MMM Group Limited, a WSP Company



Kristina Domsic, B.E.S.
Ecologist - Botany

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APPENDIX A

Site Photographs

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Photo 1: Wetland overview facing north, September 2016



Photo 2: Wetland overview facing south, September 2016



Photo 3: Outlet channel, September 2016



Photo 4: SWM pond north of the wetland, September 2016



Photo 5: SWM pond east of the wetland, September 2016



Photo 6: Plot 1, June 2016



Photo 7: Plot 1, September 2016



Photo 8: Plot 2, June 2016

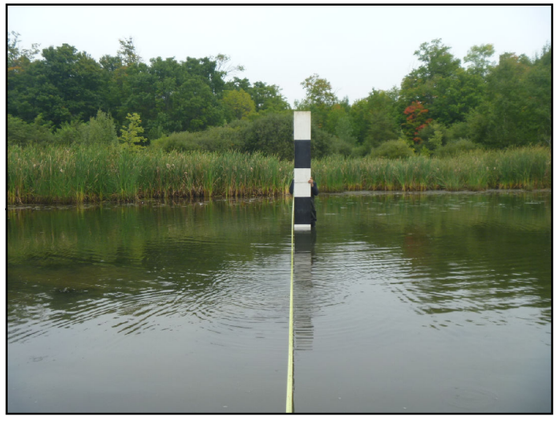


Photo 9: Plot 2, September 2016

WSP | MMM GROUP

CONSERVATION DRIVE SUBDIVISION
2016 Biological Monitoring Site Photographs

Date: December 2016

Project No: 3324690

Appendix A

APPENDIX B

Plot Monitoring Results

Vegetation / Wetland Monitoring

MMM GROUP

Activa Conservation Drive
Project No.: 01-2469-____

Plot #: 1
Monitoring Date: June 29, 2016

Dominant Plant Species (General Area) | **Density Board** | **%Cover**

Canopy/Subcanopy

N/A

0.0-0.5 m	90%	H_2O + cat
0.5-1.0 m	75%	
1.0-1.5 m	15%	
1.5-2.0 m	<5%	- cattail
2.0-2.5 m	0%	

Shrub

N/A

Ground Layer

Water Depth: @ 0: 58cm @5m: 32cm at 10m: 21cm

Scientific Name	Common Name	1m	3 m	5 m	8 m	CC	CW	Wetness
CHAR		9	9	9	9			
LEMN MIN		9	9	9				
WOLF COL	small dots	9	9	9				
TYPH LAT					9			
PHAL ARU					5			
SPIR POL					4			

(can note plants in plot but not necessarily in quadrats)

** Non-native species

Notes:

Additional Plant Species (General Area)

R - LEMN TRI
O - JUNC EFF

Incidental Wildlife Observations:

MALL, AMCR, RWBL, AMRO

Vegetation / Wetland Monitoring

MMM GROUP

Activa Conservation Drive
Project No.: 01-2469-____

Plot #: 2
Monitoring Date: June 29, 2016

Dominant Plant Species (General Area)	Density Board	%Cover
Canopy/Subcanopy	0.0-0.5 m	100% (H_2O)
	0.5-1.0 m	10% (H_2O)
N/A	1.0-1.5 m	0%
	1.5-2.0 m	0%
	2.0-2.5 m	0%
Shrub		
N/A		

Ground Layer
No additional sp.

Water Depth: 0m - 62cm 10m - 54cm

Scientific Name	Common Name	1m	3 m	5 m	8 m	CC	CW	Wetness	
Chara		9	9	9	9				A
LEMN MIN		3	9	9	9				A
WOLF COL	tiniest green dots	9	9	9	9				A

(can note plants in plot but not necessarily in quadrats)

** Non-native species

Notes: - chara is dominant cover
- Lemna is very scattered, minor cover component

Additional Plant Species (General Area)

Incidental Wildlife Observations:
MALL - 3, GRFR calling from N SWM pond

Vegetation / Wetland Monitoring

Activa Conservation Drive
Project No.: 01-2469-____

MMM GROUP

Plot #: 1
Monitoring Date: Sept. 23, 2016

102-107

	Dominant Plant Species (General Area)	Density Board	%Cover
Canopy/Subcanopy	N/A	0.0-0.5 m	100% (saturated)
		0.5-1.0 m	100%
		1.0-1.5 m	100%
		1.5-2.0 m	95%
		2.0-2.5 m	40%
Shrub	N/A		~70% of transect has standing H_2O
Ground Layer	JUNC EFF		

Water Depth: 40cm @ 0m 22cm @ 5m peters out at 7m

Scientific Name	Common Name	1m	3 m	5 m	8 m	CC	CW	Wetness
	Chara	9	9					
LEMN MIN		9	9	5	9			
SPIR POLY		7	7	5	6			
WOLF COL		5	4	5	9			
1* POTA			7					
TYPH LAT				9				
PHAL ARU					2			
[illegible]	[illegible]				1			
ALIS PLAN					1			

AAAAEEE

(can note plants in plot but not necessarily in quadrats)

** Non-native species

Notes: * found metal rebar at main stake location

Additional Plant Species (General Area)

Incidental Wildlife Observations: MALL WODU RACC scat, duck nest, tadpoles

tation / Wetland Monitoring

va Conservation Drive
ject No.: 01-2469-____

MMM GROUP

p. 100-101

lot #: 2
Monitoring Date: Sept 23, 2016

	Dominant Plant Species (General Area)	Density Board	%Cover
Canopy/Subcanopy	N/A	0.0-0.5 m	90% (H_2O)
		0.5-1.0 m	—
		1.0-1.5 m	—
		1.5-2.0 m	—
		2.0-2.5 m	—
Shrub	N/A		
Ground Layer			

Water Depth: at 0m 44 cm 45 at 5m 49 at 10m

Scientific Name	Common Name	1m	3 m	5 m	8 m	CC	CW	Wetness
	narrow pondweed	9	9	9	9			A

(can note plants in plot but not necessarily in quadrats)

** Non-native species

Notes:

Additional Plant Species (General Area)

Incidental Wildlife Observations:

APPENDIX C

Historic Monitoring Data

Table C1: Historic Monitoring Results for Activa Conservation Drive

Date	Precipitation (mm)				Air Temp (°C)			Water Temp (°C)				TSS (mg/L)				DO (mg/L)				TP (mg/L)				E. Coli (CFU/100mL)			
	During Sample	24 Hour	48 Hour	5 Day	Min	Avg	Max	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2	A1	A2	B1	B2
June 22, 2006	0.0	0.0	0.2	3.8	17.5	22.8	27.8	NF	NF	NF	NF	NF	NF	NF	NF												
June 29, 2006	1.2	10.0	11.0	11.2	13.7	17.1	21.1	NF	NF	NF	NF	NF	NF	NF	NF												
July 10, 2006	4.2	19.8	19.8	19.8	17.2	19.1	22.9	18.0	NF	18.0	NF	620	NF	7400	NF												
July 28, 2006	0.4	10.2	18.2	36.8	19.9	23.5	27.5	20.5	NF	21.0	NF	66	NF	120	NF	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 21, 2006	0.2	0.0	0.2	5.0	10.4	17.8	24.6	NF	NF	17.0	NF	NF	NF	5	NF												
September 13, 2006	1.2	29.0	29.0	30.2	14.9	18.0	22.8	18.0	19.0	20.0	18.0	78	31	130	84												
October 27, 2006	1.8	0.0	0.0	7.8	0.0	2.9	4.2	NF	NF	5.0	2.0	NF	NF	0	1												
November 16, 2006	4.8	20.8	20.8	22.6	4.3	8.0	12.0	8.0	7.5	8.0	8.0	240	120	1100	26												
2006 Maximum	4.8	29.0	29.0	36.8	19.9	23.5	27.8	20.5	19.0	21.0	18.0	620	120	7400	84												
2006 Average	1.7	11.2	12.4	17.2	12.2	16.2	20.3	16.1	13.3	14.8	9.3	251	76	1459	37												
2006 Minimum	0.0	0.0	0.0	3.8	0.0	2.9	4.2	8.0	7.5	5.0	2.0	66	31	0	1												
April 3, 2007	0.4	18.0	18.0	22.4	5.1	2.5	6.9	NF	NF	7.0	5.0	NF	NF	3	4												
May 28, 2007	0.0	6.0	6.4	6.4	7.8	14.1	19.2	NF	NF	19.0	NF	NF	NF	53	NF												
June 4, 2007	4.8	3.2	3.2	3.2	16.0	17.7	21.6	NF	NF	NF	NF	NF	NF	NF	NF												
June 28, 2007	0.2	2.4	2.4	2.4	12.5	19.6	23.4	NF	NF	NM	NF	NF	NF	23	NF												
July 4, 2007	4.4	1.0	1.0	1.0	14.6	16.8	18.5	20.0	NF	20.0	NF	30	NF	140	NF	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 8, 2007	0.0	32.2	32.2	32.4	17.1	22.9	27.6	NF	NF	NF	NF	NF	NF	NF	NF												
September 26, 2007	0.2	8.8	8.8	8.8	12.9	17.3	19.8	NF	NF	19.0	20.0	NF	NF	410	110												
October 23, 2007	3.0	8.6	8.6	10.0	4.7	9.6	16.6	13.0	NF	13.5	15.0	12	NF	160	10												
November 13, 2007	0.0	3.4	4.2	8.2	0.6	6.8	12.0	NF	NF	7.5	6.0	NF	NF	190	35												
2007 Maximum	4.8	32.2	32.2	32.4	17.1	22.9	27.6	20.0	NF	20.0	20.0	30	NF	410	110												
2007 Average	1.4	9.3	9.4	10.5	9.0	14.1	18.4	16.5	NF	14.3	11.5	21	NF	140	40												
2007 Minimum	0.0	1.0	1.0	1.0	0.1	2.5	6.9	13.0	NF	7.0	5.0	12	NF	3	4												
March 26, 2008	0.0	0.0	0.0	1.2	-1.9	1.0	3.5	2	NM	2	1	430	NM	610	<10												
April 28, 2008	0.6	8.6	8.8	9.4	0.5	4.6	9.3	7	NM	8	12	310	NM	190	22												
May 22, 2008	0.0	1.6	1.6	10.0	5.0	8.1	12.0	8	11	10	10	220	<10	13	10												
June 10, 2008	4.4	10.4	16.0	16.8	16.3	18.9	21.1	17	NM	17	22	210	NM	3100	10												
July 23, 2008	1.0	40.2	40.2	73.0	15.6	17.2	18.8	19	20	19.5	20	650	160	270	160	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
September 4, 2008	0	7.4	7.4	7.6	14.9	19.9	25.7	NF	NF	19	21	NM	NM	270	94												
September 30, 2008	0.0	6.0	6.0	8.6	11.3	13.5	17.9	15	NF	16	16	59	NM	83	<10												
October 27, 2008	2.2	4.6	5.2	11.8	1.3	3.9	7.6	9	7	10	7	500	14	1700	58												
December 3, 2008	5	0.6	8	12	-3.52	0.79	2.8	1.5	-2.5	1	-3	11	<10	16	<10												
2008 Maximum	5.0	40.2	40.2	73.0	16.3	19.9	25.7	19.0	20.0	19.5	22.0	650	160	3100	160												
2008 Average	1.5	8.8	10.4	16.7	6.6	9.8	13.2	9.8	8.9	11.4	11.8	303	49	695	42												
2008 Minimum	0.0	0.0	0.0	1.2	-3.5	0.8	2.8	1.5	-2.5	1.0	-3.0	11	10	13	10												
March 11, 2009	0.0	17.0	17.4	52.4	-6.0	0.2	9.4	2	2	NM	2	130	140	NM	520												
April 3, 2009	12.8	9.6	10.2	18.4	0.8	6.8	10.3	10	10	10	11	1300	140	830	43												
May 1, 2009	0.0	25.8	25.8	35.8	4.8	12.7	16.3	12	16	NM	15	110	68	NM	300												
June 12, 2009	0.0	8.4	8.4	23.4	10.1	16.8	22.7	19	23	24	29	110	<10	42	57												
July 23, 2009	0.4	5.0	5.4	5.8	16.5	18.8	23.0	14	NF	15	15.5	71	NF	94	26	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
September 11, 2009	0	0	0	0.2	8.6	13.6	18.4	NF	NF	NF	NF	NF	NF	NF	NF												
September 29, 2009	0.2	11.6	36.0	39.0	6.9	10.6	13.6	10	10	10.5	10	48	100	140	420												
October 23, 2009	4.2	1.4	2.2	2.2	2.9	4.7	8.2	8	NF	7.5	9	81	NF	140	23												
November 20, 2009	0	2	9.4	9.4	4.79	6.03	7.16	NM	NM	7	7	NM	NM	150	29												
2009 Maximum	12.8	25.8	36.0	52.4	16.5	18.8	23.0	19.0	23.0	24.0	29.0	1300	160	830	520												
2009 Average	2.0	9.0	12.8	20.7	5.5	10.0	14.3	10.6	12.2	12.3	12.3	265	96	233	177												
2009 Minimum	0.0	0.0	0.0	0.2	-6.0	0.2	7.2	2.0	2.0	2.0	2.0	48	10	42	23												
March 15, 2010	0.2	0.6	20.0	26.6	-0.9	5.2	10.6	5	4	3	5	68	68	67	78												
April 6, 2010	2.8	13.4	13.8	14.0	7.7	9.9	11.8	8	12	8	12	1000	30	160	110												
May 6, 2010	–	12.9	12.9	31.9	9.0	16.8	24.5	11	NF	10	16	440	NM	300	30												
June 3, 2010	0.0	10.6	11.4	16.4	15.1	18.6	24.5	NF	NF	16	15	NM	NM	NM	NM												
July 9, 2010	3.7	30.6	30.6	30.6	20.0	24.2	33.1	22	24.5	NM	23.5	460	14	NM	520	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 23, 2010	0.0	2.6	13.4	13.8	17.3	19.6	23.5	NF	NF	20	21	NM	NM	NM	NM												
September 28, 2010	33.8	7.5	7.5	8.6	10.4	12.9	14.8	13.5	13.5	14	13.5	1000	1000	1000	520												
October 14, 2010	0.0	6.3	6.3	8.3	3.9	11.3	16.0	11	12	11	12	1000	1000	1000	1000												
November 18, 2010	0.8	0.2	21.6	21.7	3.2	4.8	7.6	6	4	6	4	1000	1000	570	170												
2010 Maximum	33.8	30.6	30.6	31.9	20.0	24.2	33.1	22.0	24.5	20.0	23.5	1000	1000	1000	520												
2010 Average	5.2	9.4	13.3	19.1	9.5	13.0	17.8	10.1	11.1	10.9	13.6	559	386	586	150												
2010 Minimum	0.0	0.2	6.3	8.3	-0.9	4.8	7.6	5.0	4.0	3.0	4.0	53	10	10	10												
March 16, 2011	0.9	5.8	5.9	16.2	-3.9	2.4	5.7	4	4	4	4	160	80	100	30												
April 5, 2011	0.9	6.7	21.7	22.0	0.1	6.0	15.7	2	3	2	2	78	10	300	74												
May 18, 2011	0.1	5.2	6.9	44.7	7.7	10.7	12.6	14	12	13	14	78	10	300	74												
June 23, 2011	1.0	27.9	30.0	30.0	16.9	20.4	25.7	20.5	22	21	22	1000	1000	1000	1000												
July 28, 2011	0.9	3.1	3.1	3.8	19.6	23.3	27.4	NF	NF	21	NF	NM	NM	NM	NM	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 9, 2011	8.6	22.7	25.6	29.2	18.5	22.5	27.5	NM	NM	NM	NM	1000	1000	1000	1000												
September 20, 2011	0.0	21.9	21.9	23.1	10.3	14.1	16.5	N/A	21.3	N/A	21.1	NM	NM	NM	NM												
October 3, 2011	0.1	8.2	8.2	16.7	4.1	7.5	9.6	N/A	11.1	N/A	10.9	NM	19	NM	15												
November 23, 2011	2.9	13.2	13.2	14.0	-2.2	-0.1	1.1	7	7	8	8	NM	32	84	20												
2011 Maximum	8.6	27.9	30.0	44.7	19.6	23.3	27.5	20.5	22.0	21.0	21.5	240	75	390	500												
2011 Average	1.7	12.7	15.2	22.2	7.9	11.8	15.8	9.5	11.4	11.5	11.6	98	33	177	133												
2011 Minimum	0.0	3.1	3.1	3.8	-3.9	-0.1	1.1	2.0	3.0	2.0	2.0	22	10	18	14												
March 13, 2012	0.0	11.9	11.9	16.6	1.0	10.6	15.0	6.4	10	7.2	10.1	33	30	820	87												
April 25, 2012	0.0	2.6	4.6	13.9	-1.0	6.7	14.1	NM	NM	8	8.5	NM	NM	120	19												
June 1, 2012	0.0	8.6	9.2	11.9	10.7	12.0	14.0	14.1	NF	14	14	330	NF	400	100												
June 29, 2012	0.0	0.0	0.5	6.1	18.3	24.1	29.1	NF	NF	NF	NF	NF	NF	NF	NF												
July 16, 2012	0.9	10.8	12.2	12.9	18.2	25.0	31.3	NF	NF	NF	NF	NF	NF	NF	NF	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 10, 2012	7.1	12.8	13.3	24.9	16.7	18.7	23.7	20.5	20.5	20.5	20.5	380	14	430	<10												
September 25, 2012	0.0	0.0	0.0	9.2	9.7	14.9	20.1	NF	NF	NF	NF	NF	NF	NF	NF												
October 23, 2012	10.7	23.3	23.4	30.9	8.2	10.4	12.3	12	12.5	13	13	100	78	99	63												
November 13, 2012	0.0	12.3	12.5	13.3	-0.7	0.1	1.2	NF	4	4	4	NF	32	84	20												
2012 Maximum	10.7	23.3	23.4	30.9	18.3	25.0	31.3	20.5	20.5	20.5	20.5	380	78	820	100												
2012 Average	2.0	9.1	9.7	15.5	9.0	13.6	17.9	13.5	11.8	11.7	12.1	211	39	326	60												
2012 Minimum	0.0	0.0	0.0	6.1	-1.0	0.1	1.2	4.4	4.0	4.0	4.0	33	14	84	10												
March 12, 2013	20.4	20.4	22.6	26.6	-1.3	0.9	3.7	2	1	2	1	130	17	28	<10												
April 10, 2013	6.1	6.1	13.0	14.4	3.2	4.4	5.7	4	4	4	4	150	90	65	120												
May 21, 2013	4.1	4.1	4.1	4.1	16.3	20.3	26.6	15	18	16	18	29	<10	32	<10												
June 28, 2013	10.5	10.5	10.5	20.3	16.8	18.4	21.6	21	24	20	24	620	27	97	23												
July 8, 2013	35.1	35.1	38.3	87.8	18.9	22.4	27.8	17	29	25	29	80	<10	18	10	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
August 1, 2013	36.0	36.0	36.0	69.2	14.5	18.6	23.4	18	15	26	25	<10	38	61	41												
September 26, 2013	0.0	0.0	0.0	13.4	5.3	13.8	22.8	NM	15	NM	15	NM	<10	NM	11												
October 4, 2013	26.5	26.5	26.5	28.6	13.5	17.0	22.6	17	19	19	19	160	<10	19	<10												
November 1, 2013	30.7	30.7	46.3	48.0	7.0	10.4	15.2	11	10	11	10	110	64	41	20												
2013 Maximum	36.0	36.0	46.3	87.8	18.9	22.4	27.8	21.0	29.0	26.0	29.0	620	90	97	120												
2013 Average	13.8	18.6	21.7	34.1	10.5	14.0	18.9	13.5	15.4	15.4	16.1	161	37	44	28												
2013 Minimum	0.0	0.0	0.0	4.1	-1.3	0.9	3.7	2.0	1.0	2.0	1.0	10	10	18	10												
April 4, 2014	6.6	2.8	2.8	85.4	-0.2	2.1	6.1	0.0	0.0	0.0	0.0	19	37	26	28												
April 29, 2014	0.0	0.0	0.0	6.8	5.7	7.4	8.8	8	10	8	11	46	17	34	<10												
May 15, 2014	7.8	16.9	16.9	32.9	8.9	14.5	17.4	15	19	18	19	48	27	51	12												
June 24, 2014	9.9	10.2	10.2	10.2	18.4	21.3	25.9	NF	23	20	23	NF	<10	15	<10	Not measured During-Construction				Not measured During-Construction				Not measured During-Construction			
July 7, 2014	0.0	59.3	59.3	68.4	18.9	22.3	27.0	20	23	22	22	15	29	63	45												
August 8, 2014	0.0	0.0	0.3	1.9	9.9	17.5	25.1	NF	19	17	17	NF	12	31	<10												
September 11, 2014	0.0	57.8	57.8	58.3	9.7	15.9	22.1	18	18	18	18	17	160	54	11												
September 29, 2014	0.2	0.0	0.0	1.3	8.3	16.3	24.2	NF	NF	NF	NF	NF	NF	NF	NF												
November 24, 2014	14.2	24.4	34.4	35.4	6.8	15.0	23.0	8	6	8	5	41	12	50	<10												
2014 Maximum	14.2	59.3	59.3	85.4	18.9	22.9	27.0	20.0	23.0	22.0	23.0	80	160	63	45												
2014 Average	4.3	19.9	21.2	30.4	9.2	14.7	20.0	11.0	14.8	13.9	14.4	39	41	41	17												
2014 Minimum	0.0	0.0	0.0	1.3	-0.2	2.1	6.1	0.0	0.0	0.0	0.0	15	<10	15	<10												
March 26, 2015	0.0	NM	NM	NM	-1.0	1.4	3.7	2.0	NF	NF	NF	44	NF	NF	NF	NM	NF	NF	NF	NM	NF	NF	NF	NM	NF	NF	NF
April 10, 2015	6.1	13.3	29.6	30.1	2.0	9.1	16.2	7.2	9.5	7.1	9.3	66	120	28	44	10.7	11.1	11.3	12.0	0.18	0.20	0.14	0.10	90	50	40	310
May 5, 2015	0.0	0.3	0.3	0.3	4.2	10.6	17.2	11.4	9.5	NM	11.5	15.4	51	NM	33	12.8	NM	13.6	10.2	NM	NM	NM	NM	NM	NM	NM	NM
June 8, 2015	30.0	21.2	21.2	22.0	15.8	19.3	22.7	17.2	NF	18	NF	86	NF	49	NF	8.6	NF	8.4	NF	0.26	NF	0.14	NF	840	NF	2600	NF
July 15, 2015	0.0	0.0	0.0	0.0	10.1	15.9	21.7	NF	NF	16.5	NF	NF	NF	410	NF	NF	NF	9.2	NF	NF	NF	0.56	NF	NF	NF	480	NF
August 10, 2015	29.0	0.0	0.0	0.0	10.4	16.0	21.5	21.4	NF	20.9	NF	130	NF	390	NF	8.5	NF	9.4	NF	0.26	NF	0.47	NF	4900	NF	2700	NF
September 29, 2015	10.3	0.8	0.8	0.8	12.7	17.5	22.3	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
October 9, 2015	1.3	10.5	10.5	12.3	2.3	8.5	14.7	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF	NM	NF
October 28, 2015	29.9	0.0	0.0	15.1	7.5	11.3	15.1	11	9.5	10.4	9.8	38	30	40	44	10.8	9.3	10.3	10.3	0.14	0.07	0.11	0.07	1800	2000	2900	1000
2015 Maximum	30.0	21.2	29.6	30.1	15.8	19.3	22.7	21.4	9.5	20.9	15.4	130	120	410	44	12.8	11.1	13.6	12.0	0.26	0.20	0.56	0.10	4900	2000	2900	1000
2015 Average	11.8	6.8	10.1	10.1	7.2	12.6	17.2	11.4	9.5	14.1	10.4	61	75	135	40	10.3	10.2	10.4	10.8	0.21	0.14	0.28	0.08	1908	1025	1744	655
2015 Minimum	0.0	0.0	0.0	0.0	-1.0	1.4	3.7	2.0	9.5	7.1	9.3	38	30	10	33	8.5	9.3	8.4	10.2	0.14	0.07	0.11	0.07	90	50	40	310
March 28, 2016	22.4	0.6	0.6	42.8	0.9	4.6	9.2	NF	NF	NM	9.4	NF	NF	NM	22	NF	NF	NM	11.6	NF	NF	NM	0.10	NF	NF	NM	150
April 26, 2016	9.8	0.8	0.8	10.6	-0.4	3.2	5.3	7.5	10.9	8.4	11.7	46	12	<10	11	11.0	10.0	11.4	14.8	0.08	0.04	0.04	0.03	500	620	20	<10
May 26, 2016	9.0	0.0	0.0	9.0	15.3	21.2	27.2	16.8	NF	14.9	21.0	NF	NF	NF	140	NF	NF	NF	10.5	0.12	NF	0.14	0.13	NF	NF	320	100
June 16, 2016	0.2	15.2	15.2	15.2	12.3	19.4	25.7	18.6	NF	17.3	22.7	15	NF	<10	<10	10.3	NF	9.5	8.1	NM	NF	NM	NM	NM	NF	NM	NM
July 25, 2016	18.4	0.0	0.0	0.0	19.3	24.5	29.9	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
August 16, 2016	24.6	0.0	0.2	60.6	17.1	21.4	25.8	23.0	NF	23.2	23.8	<10	NF	<10	<10	8.1	NF	8.0	6.2	0.12	NF	0.13	0.04	9400	NF	1600	680
October 3, 2016	0.0	9.6	14.4	25.2	12.6	14.7	20.1	NF	NF	14.1	NF	NF	NF	<10	NF	NF	NF	9.4	NF	NF	NF	<0.020	NF	NF	NF	300	NF
October 20, 2016	13.6	0.2	0.4	9.0	9.9	11.6	13.5	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
November 3, 2016	22.4	8.0	8.0	10.4	5.4	10.3	13.4	NF	NF	NF	14.0	NF	NF	NF	10	NF	NF	NF	10.1	NF	NF	NF	0.20	NF	NF	NF	2100
2016 Maximum	24.6	15.2	15.2	60.6	19.3	24.5	29.9	23.0	10.9	23.2	23.8	46	12	<10	140	11.0	10.0	11.4	14.8	0.12	0.04	0.14	0.13	9400	620	1600	2100
2016 Average	13.4	3.8	4.4	19.3	9.1	13.2	17.2	16.8	10.9	17.3	23.0	31	12	<10	34	9.8	10.0	9.8	10.3	0.10	0.04	0.09	0.10	3050	620	580	600
2016 Minimum	0.0	0.0	0.0	0.0	-0.4	3.2	5.3	7.5	10.9	8.4	9.4	10	10	<10	10	8.1	10.0	8.0	6.2	0.08	0.04	0.02	0.03	300	620	20	10
Laurel Creek Watershed Study Targets								≤29°C - June and July, ≤26°C all other months				<25 mg/L				>5.0 mg/L				<0.08 mg/L				<200 CFU/100 mL			
# Target Exceedences								0	0	0	0	52	26	57	36	0	0	0	0	6	1	7	4	5	2	5	4
# Samples								60	48	74	72	59	45	76	72	6	3	6	6	6	3	7	6	6	3	6	7
% Exceedence								0%	0%	0%	0%	88%	54%	75%	50%	0%	0%	0%	0%	100%	33%	78%	57%	83%	67%	78%	57%

NOTES :

1) The LCWS targets presented for temperature and TSS are presented for comparative purposes only.
2) Rainfall amounts based on the University of Waterloo weather station
   a) During Sample: Precip recorded from 8:00 - 15:00 day of sample
   b) 24 Hour: Precip recorded from 8:00 day before sample to 8:00 day of samp
   c) 5 day: Precip recorded 8:00 5 days prior to sample to 8:00 day of sample
3) Result of 0 for TSS indicates parameter not detectable

NM Indicates Water At site but parameter not measured due to:
   a) Standing water at site
   b) Existing flow not measureable due to configuration
   c) Safety
NF Indicates no water at site
ND Parameter not detected
NA Indicates equipment malfunction

4.8 LCWS Target Exceeded
8.3 LCWS Target Met

W:\active\60308671\construction\report\2016 Monitoring\Data\Historic Monitoring Data 2006-2016.xls

Date: 3/8/2017
Time : 1:34 PM

APPENDIX D

Groundwater Monitoring Results

Table D1: Historical Groundwater Monitoring Results for Activa Conservation Drive

Date	Borehole 12	Borehole 17		Borehole 20		Borehole 101		Borehole 102	Borehole 103	Borehole 104	Borehole 105
		Borehole 17 (Upper)	Borehole 17 (Lower)	Borehole 20 (Upper)	Borehole 20 (Lower)	Borehole 101 (Upper)	Borehole 101 (Lower)				
26-Jan-07	354.78	356.31	356.03	356.23	356.2						
28-Feb-07	354.5		356.03					354.99	359.31	354.29	353.82
22-Mar-07	355.18		356.05				355.39	355.02	361.24	354.4	354.12
27-Apr-07	354.88	356.47	356.14	356.59	356.53		355.53	355.12	361.74	354.53	354.12
24-May-07	354.38	356.33	356.14	356.46	356.39		355.43	355.02	361.17	354.39	353.84
23-Jul-07	345.02	356.13	355.94	355.73	355.61		355.27	354.87	360.35	354.13	353.59
15-Aug-07	353.35	356.03	355.73	355.81	355.73		355.15	354.77	360.13	356.48	353.5
7-Sep-07	353.13	355.73	355.82	355.64	355.36		355.04	354.67	359.98	353.93	353.39
3-Oct-07	352.98	355.38	355.65	355.31	355.09		354.89	354.54	359.89	353.74	353.32
13-Nov-07	352.62	355.42	355.51	355.33	355.33		354.57	354.24	359.56	353.54	353.1
6-Dec-07	352.85	356.07	355.59	356.31	356.32		354.57	354.27	360.73	353.62	353.21
10-Jan-08	354.95	356.775	356.465	356.55	356.545		355.025	354.23	362.08	353.55	358.125
21-Feb-08		356.545	355.765		356.51		354.33	354.47	361.1	353.78	358.325
31-Mar-08	355.22	356.67	355.755	356.5	356.51		354.51	354.57	361.865	353.97	358.58
21-Apr-08	354.79	356.035	356.415	356.32	356.31		354.675	354.705	361.77	354.23	358.695
26-May-08	351.59	356.365	356.195	356.28	356.27		355.865		362		359.555
3-Jul-08	354.24	356.335	356.325	356.28	356.32		354.825	354.83	360.46	354.08	358.355
1-Aug-08	354.53	356.335	356.375	356.29	356.27		354.825	354.84	360.24	354.09	358.385
20-Aug-08	354.505	356.39	356.385	356.355	356.35		354.79	354.81	360.075	354.05	358.345
1-Oct-08	354.5	356.315	356.205	356.24	356.23		354.755	354.78	359.81	353.99	358.3
30-Oct-08	354.4	356.225	356.375	356.2	356.18		354.655	354.7	360.01	353.89	358.2
28-Nov-08	354.75	356.415	356.405	356.39	356.38		354.635	354.66	361.625	353.935	358.355
22-Dec-08				355.71			354.675	354.74	361.51	354.03	358.495
30-Jan-09	353.74	356.325	356.385	356.15	356.27		354.975	354.99	360.62	354.24	358.515
3-Mar-09	354.7	356.405	356.425	356.335	356.3		355.115	355.06	360.69	354.36	358.66
11-Mar-09	355.14	356.675	356.395	356.59	356.58		355.095		360.82	354.31	358.685
3-Apr-09	355.19	356.625	356.445	356.62	356.63		355.255		360.75	354.46	358.775
27-May-09	354.56	356.395	356.465	356.26	356.28		355.405		361.00		358.715
12-Jun-09	354.58	356.425	356.465	356.37	356.35		355.385		360.87	354.48	358.655
27-Jul-09	354.03	356.315	356.465	356.26	356.27		355.245		360.53	354.33	358.475
25-Aug-09	353.8	356.335	356.465	356.31	356.31	359.055	355.145	355.07	361.02	354.17	358.325
6-Oct-09	354.69	356.445	356.465	356.455	356.445	359.075	354.885	354.86	360.265	353.915	358.31
4-Dec-09	354.695	356.405	356.471	356.375	356.45	359.05	354.68	354.712	360.34	353.907	358.21
17-Dec-09	354.78	356.405	356.475	356.4	356.41	359.055	354.635	353.6	360.73	353.89	358.215
15-Jan-10	354.69	356.475	356.275	356.12	356.27	360.055	354.585	354.62	360.37	353.86	358.145
11-Feb-10	354.66	356.275	356.455	356.085	356.27	359.065	354.535	354.55	360.095	353.79	358.09
15-Mar-10	355	356.485	356.545	356.29	356.5	359.065	354.455	354.48	360.81	353.83	358.275
6-Apr-10	354.936	356.375	356.423	356.5	356.49	359.065	354.567		360.716	353.922	358.283
3-Jun-10	354.66	356.201	356.41	356.208	356.207	360.18	354.569	354.57	360.452	353.88	358.18
9-Jul-10	354.72	356.445	356.41	356.47	356.5	359.055	354.555	354.46	360.45	353.87	358.135
30-Jul-10	354.195	356.265		356.3	356.3	359.035	354.525		360.73	353.86	358.155
23-Aug-10	353.78	356.155		356.21	356.22	359.035	354.455		360.06	353.76	358.045
14-Oct-10	353.912	356.525	356.415	356.56	356.558	359.06	354.365		360.372	353.647	358.033
26-Oct-10	354.2	356.415	356.42	356.43	356.42	359.065	354.375		360.6	353.66	358.065
28-Jan-11	354.707		356.42	355.958	356.267	359.081	354.248		360.122	353.59	358.009
1-Feb-11	355.143	356.582	356.88	356.528	356.573	359.081	354.219		359.907	353.52	358.009
24-Mar-11	354.94	356.66	356.345	356.48	356.45	359.075	354.415		361.37	353.9	358.535
29-Apr-11	355.006	355.672	355.744	356.552	356.506	359.088	354.75		361.833	354.163	358.752
11-May-11	354.827	355.652	355.76	356.402	356.389	359.065	354.861		361.66	354.253	358.73
23-Jun-11	354.64			356.44	356.465	359.075	355.135		360.94	354.44	358.75
28-Jul-11	353.89	355.395	355.865	356.09	356.08	359.085	355.095		360.34	354.25	358.465
11-Aug-11	353.835	355.374	355.98	356.488	356.573	359.065	355.095		360.195	354.218	358.461
20-Sep-11	353.441	355.487	355.965	356.488	356.413	359.065	354.901		359.953	354.008	358.259
3-Oct-11	353.488	355.44	355.887	356.503	356.468	359.073	354.841		360.038	353.982	358.259
23-Nov-11	353.539	356.159	356.285	356.579	356.526	359.085	354.77			353.999	358.35
4-Jan-12	354.925	356.15	356.27	356.47	356.48	359.055	354.815			354.295	358.745
31-Jan-12	354.896	356.42	356.385	356.473	356.464	359.08	355.111			354.399	358.732
14-Feb-12	354.763		356.473	356.406	356.407	359.078	355.146			354.406	358.697
5-Mar-12	354.857			356.447	356.44	359.078	355.125			354.38	358.73
25-Apr-12	354.63	356.535	356.8	356.325	356.325	359.055	355.115			354.265	358.47
1-Jun-12	354.14	356.398	356.728	356.179	356.29	359.075	354.975			354.11	358.335
16-Jul-12	353.755	356.345	356.695	355.925	355.945	359.054	354.81			353.945	358.16
10-Aug-12	353.4	356.525	356.739	355.575	355.615	359.045	354.675			353.8	357.95
25-Sep-12	353.39	355.91	355.79	356.315	356.31	358.845	354.315			353.78	358.605
23-Oct-12		356.035	355.875	356.605	356.605	359.07	354.455			353.61	358.125
13-Nov-12	354.73	356.075	355.935	356.45	356.45	359.085	354.445			353.77	358.175
21-Dec-12	354.925	355.825	355.905	356.53	356.56	359.065	354.475			353.8	358.205
10-Jan-13	354.77	355.535	355.89	356.305	356.305	359.075	354.385			353.725	358.115
22-Feb-13	354.95	356.64		356.41	356.39	359.075	354.55			353.909	358.248
12-Mar-13	354.96	355.915	355.895	356.585	356.63	359.075	354.575			353.935	358.095
17-Apr-13	354.905	355.8	355.895	356.455	356.45	359.075	354.855			354.285	358.83
21-May-13	354.81	355.672	355.915	356.355	356.35	359.075	355.165			354.455	358.75
28-Jun-13	354.83	355.845	355.995	356.57	356.57	359.065	355.275			354.47	358.72
8-Jul-13	354.842	356.821	356.985	356.509	356.547	359.078	355.31			354.512	358.861
7-Aug-13	354.567	356.95	356.97	356.481	356.458	359.077	355.398			354.521	358.736
7-Oct-13	355.04	356.94	356.89	356.635	356.69	359.065	355.2			354.37	358.675
23-Oct-13	354.845	357.02	356.91	356.485	356.485	359.075	355.2			354.43	358.73
19-Nov-13	354.86	356.99	356.91	356.465	356.465	359.08	355.295			354.57	358.845
4-Dec-13	354.814	356.965	356.901	356.437	356.417	359.079	355.342			354.588	358.791
30-Jan-14	354.72	357.02	356.92	356.395	356.405	359.075	355.29			354.52	358.735
28-Feb-14	354.727		356.92	356.393	356.378	359.076	355.184			354.369	358.585
30-Apr-14	355.025	356.855	356.89	356.603	356.69	359.08	355.5			354.76	359.075
15-May-14	356.41			356.655	356.6	359.085	355.575			354.82	359.125
27-Jun-14	354.68	356.98	356.985	356.46	356.455	359.075	355.525			354.68	358.835
10-Jul-14	354.84			356.48	356.49	359.08	355.495		357.185	354.628	358.8975
21-Aug-14	354.63	356.79	356.94	356.43	356.44	359.085	355.515		360.725	354.58	358.745
17-Sep-14	354.88	356.78	356.91	356.455	356.51	359.08	355.455		360.85	354.625	358.815
24-Oct-14	354.82	356.78	356.91	356.49	356.545	359.08	355.415		360.92	354.59	358.82
24-Nov-14	355.11	356.78	356.91	356.665	356.69	359.22	355.405		360.51	354.565	358.8075
30-Jan-15	354.565	356.62	frozen	356.71	356.706	359.47	355.686		covered in ice	354.724	358.699
4-Mar-15	354.68	frozen	frozen	356.645	356.64	359.467	355.535		covered in ice	355.57	358.6637
10-Apr-15	355.22	356.65	356.89	356.92	356.965	359.652	355.455		could not open	354.59	358.795
5-May-15	354.88	356.61	356.85	356.72	356.7	359.462	355.505		could not open	354.59	358.795
11-Jun-15	354.11	356.61	356.82	356.74	356.73	359.467	355.405		could not open	354.545	358.625
15-Jul-15	355.11	356.6	356.82	356.9	356.915	359.467	355.375		could not open	354.52	358.605
13-Aug-15	355.5	grown over	grown over	356.69	356.685	359.462	355.315		could not open	354.44	358.48
5-Oct-15	353.78	356.62	356.805	356.47	356.9	359.472	355.135		could not open	354.32	358.285
24-Nov-15	tape stuck at 0.99	grown over	grown over	356.355	356.705	359.452	354.965		could not open	354.16	358.3
11-Jan-16	tape stuck at 0.100	covered in ice	covered in ice	356.395	frozen	359.547	354.925		covered in ice	locked	locked
11-Feb-16	tape stuck at 0.100	missing	missing	356.390	356.760	359.472	354.895		could not open	354.31	lock rusted shut
25-Feb-16	tape stuck at 0.99	missing	missing	356.485	356.825	359.472	355.015		360.99	354.34	full of ice
28-Mar-16	tape stuck at 0.99		356.645	356.060	356.590	360.090	355.145		Full of water	354.62	
27-May-16	354.72	Clogged/dry at 0.48	Clogged/Dry at 1.49	356.395	356.400	359.080	354.180		360.99	353.20	358.69
16-Jun-16	tape stuck at 0.99	Completely blocked	Blocked at 0.07m	356.415	356.430	359.280	355.170		360.79	354.11	358.59
25-Jul-16	353.57	Completely blocked	Completely blocked	356.305	356.310	359.080	355.000		360.47	353.87	358.33
16-Aug-16	353.70	Completely blocked	Completely blocked		356.650		354.830		360.69	353.70	358.31
3-Oct-16	353.80	Completely blocked	Completely blocked	356.315			354.720		360.48	353.65	358.17
2-Nov-16	353.92	Completely blocked	Completely blocked	356.255			354.600		358.22	352.57	357.11
Max	**356.41**	**357.02**	**356.99**	**356.92**	**356.97**	**360.18**	**355.87**	**355.12**	**362.08**	**356.48**	**359.56**
Average	**354.38**	**356.33**	**356.36**	**356.36**	**356.40**	**359.18**	**354.96**	**354.68**	**360.59**	**354.17**	**358.00**
Min	**345.02**	**355.37**	**355.51**	**355.31**	**355.09**	**358.85**	**354.18**	**353.60**	**357.19**	**352.57**	**353.10**
2016 Max	354.72		356.65	356.49	356.83	360.09	355.17		360.99	354.62	358.69
2016 Average	353.94		356.65	356.33	356.57	359.41	354.84		360.38	353.82	358.20
2016 Min	353.57		356.65	356.06	356.31	359.08	354.18		358.22	352.57	357.11

Figure D2: Activa Conservation Drive 2016 Groundwater Monitoring Results

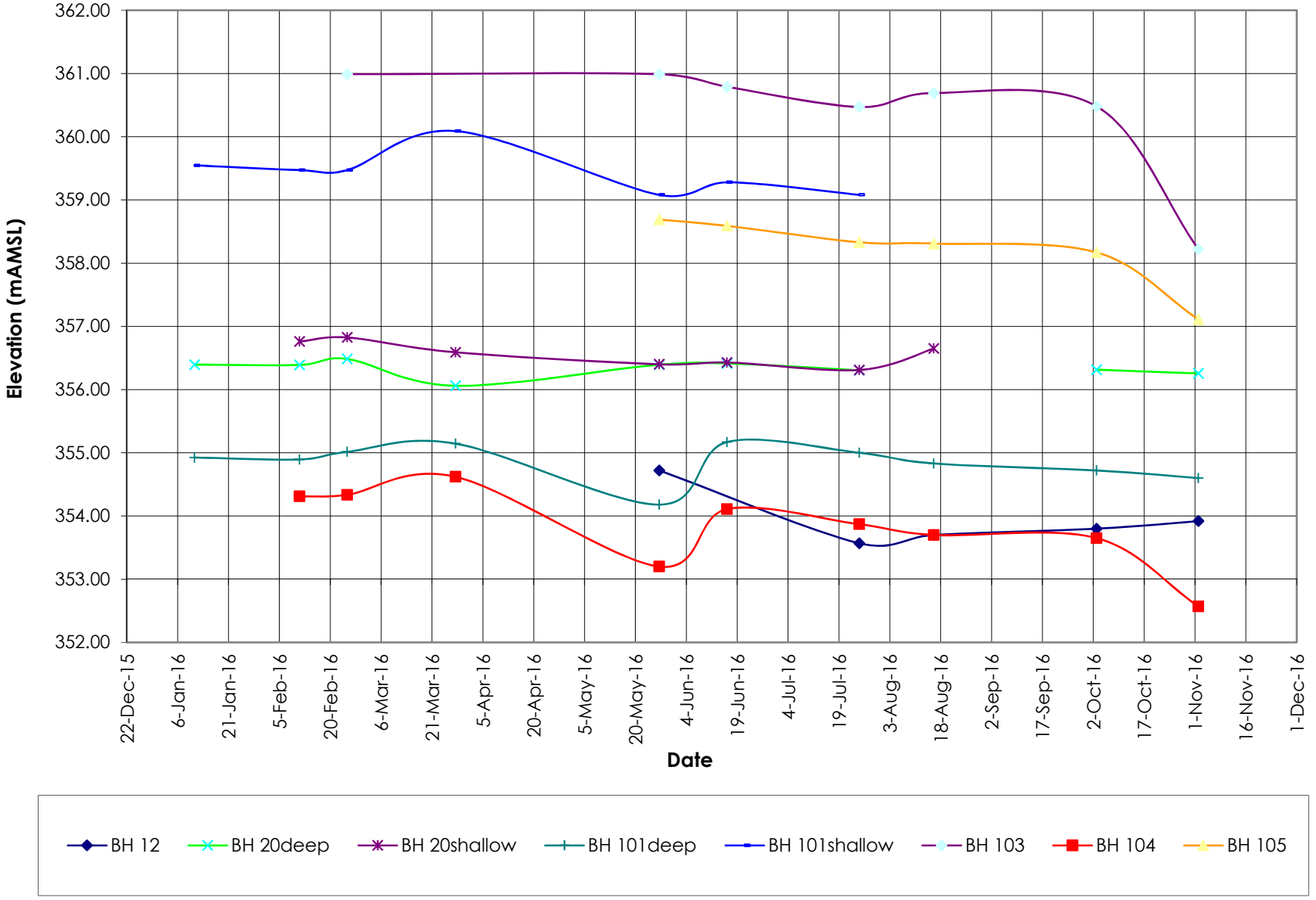


Figure D3: Historical Groundwater Monitoring Results (2007 - 2016)
Activa Conservation Drive Subdivision

