CITY OF SOUTH BURLINGTON STORMWATER UTILITY FARRELL PARK GRAVEL WETLAND PERFORMANCE REPORT

Prepared for **Tom DiPietro**
Stormwater Superintendent
South Burlington Department of Public Works
104 Landfill Road
South Burlington, VT
802-658-7961

Prepared by **Vanasse Hangen Brustlin, Inc.**
7056 U.S. Route 7
North Ferrisburgh, VT
802-497-6100

December 3, 2012

Table of Contents

1.0 Introduction

This case study, prepared by Vanasse Hangen Brustlin, Inc. (VHB) for the City of South Burlington Stormwater Utility (Utility), details the results of pollutant removal efficiency testing at the Farrell Park Gravel Wetland located adjacent to Potash Brook Tributary 2 in South Burlington, Vermont (see Farrell Park Gravel Wetland Case Study Location map on Page 1 of the Appendix). The Farrell Park Gravel Wetland is an engineered stormwater wetland owned, operated, and maintained by the Utility, which captures and treats stormwater runoff from the gravel parking area and portions of paved bike path at Farrell Park. This study was conducted according to the Stormwater Best Management Practices Performance Testing Plan (BMP Testing Plan) prepared in 2009, and revised in 2011, for the Utility by VHB.

The purpose of this study was to estimate the removal efficiency of the Farrell Park Gravel Wetland for various pollutants associated with stormwater runoff. During two warm weather monitoring seasons between August 9, 2011 and July 2, 2012, stormwater runoff samples were collected from the inlets (drop basins) and Wetland outlet during storm events. The samples were then analyzed for the concentration of various pollutants. Concurrently, the water levels in the inlet and outlet structures were monitored to determine the inflow and outflow volumes during the storm events. The pollutant concentrations and flow volumes were used to calculate pollutant loads at the inlet and outlet locations, and through comparison provide pollutant removal efficiencies for the wetland.

Constructed during 2008, the Farrell Park Gravel Wetland, also known as an Advanced Wetland Stormwater Filter (AWSF), is an innovative treatment system that captures runoff from an unpaved parking lot through a series of drop inlets, which then passes through an engineered gravel wetland before discharging to Tributary 2 of Potash Brook. As described in the City of South Burlington BMP Testing Plan, this case study of the Farrell Park Gravel Wetland is the second of ten South Burlington BMPs proposed to be evaluated for pollutant removal efficiency.

The following sections of the report describe the procedure carried out during the evaluation of the Farrell Street Pond; the setup, calibration, sample collection, and model are described in Section 2.0, results and conclusions are described in Section 3.0, and recommendations are provided in Section 4.0. Supporting documents found in the Appendix include individual sampled storm results, overall combined summary of results, and photo-documentation of the setup used at the Wetland.

1.1 Site Description

The Farrell Park Gravel Wetland is located to the south of Swift Street in South Burlington, Vermont, between Farrell Park and Vermont Gas Systems, Inc. Three drop inlets, designated Tank 1 through 3, convey stormwater runoff collected from a drainage area of approximately 1.51 acres, of which 40 percent (approximately 0.6 acres) is impervious area. As shown on page 1 of the Appendix, between Tanks 1 and 2, and from Tank 2 to Tank 3, there are grassed swales which convey water (see photograph 2 on page 3 of the Appendix) through the system. The 0.6 acres of impervious drainage area includes the unpaved parking and adjacent paved bike path area. The contributing drainage area is shown on the Drainage Area map on page 2 of the Appendix.

Tank 3 discharges stormwater through a six inch outlet pipe approximately 35 feet long which flows into the gravel wetland and an overflow pipe which discharges directly to Tributary 2 of Potash Brook. The Tank 3 overflow outlet pipe diverts partial flows directly from Tank 3 to the stream, bypassing the wetland, when water level exceeds 198.3 feet (AMSL) in the tank.

The gravel wetland has a footprint of 10 feet by 30 feet, and the gravel media is approximately two-and-a-half feet deep with 35 percent voids for water storage. The gravel wetland receives flow through a three-and-a-half inch siphon pipe located in the outlet structure (see photograph 4 on page 4 of the Appendix) and then drains out the six inch outlet pipe to Tributary 2 of Potash Brook.

2.0 Methods

2.1 Setup

The Farrell Park Gravel Wetland case study was setup and conducted according to the BMP Testing Plan with slight modifications. This plan called for the installation of sampling and water level equipment (i.e., flow monitoring equipment) previously purchased by the Utility and summarized in Table 1. Specific details not referenced in the BMP Testing Plan regarding the setup, equipment used, and observations are included below.

Table 1: Water Sampling and Water Level Equipment

Water Sampling (Durham Geo)	Description	QTY	Locations
Durham Geo TR-4002	Composite Sampler	3	Tank 1, Tank 3, Outlet
TR-4002	Battery and Box	3	
Rain Gage	Rain Gage	3	
Solar Panel	Solar Trickle Charger	3	
Flow Monitoring (Solinst)	**Description**	**QTY**	
Solinst Levelogger Gold	Volumetric Pressure Sensor	2	Tank 3, Wetland Outlet Structure
Solinst Barologger	Barometric Pressure Sensor	1	Farrell Street Park

On April 3, 2011, VHB setup three TR-4000 autosamplers, two Solinst Leveloggers, and the Solinst Barologger at the Farrell Park Gravel Wetland. Autosampler setups (see Page 3 of the Appendix) were installed at Tank 1, Tank 3, and the Wetland Outlet. The Leveloggers were installed in Tank 3 and the outlet structure. A Solinst Barologger was also installed at the site to measure background barometric pressure over the course of this case study.

Photographs 1 through 12 on pages 4 through 9 of the Appendix show the gravel wetland system and adjacent area. Photograph 1 (Appendix, Page 4) shows the inlet to Tank 1 during the July 26, 2012 storm event with the autosampler visible in the background. Photograph 2 (Appendix Page 5) shows the grassed swale between Tank 1 and Tank 2 during the same storm event. The gravel wetland, gravel wetland outlet structure, and gravel wetland outlet are

shown in Photographs 3, 4, and 5, respectively on Pages 5 and 6 of the Appendix. The interior of Tank 3 showing the primary outlet and overflow outlet is shown in Photograph 6 on Page 5 of the Appendix. Photographs 7 and 8 (Page 7 of the Appendix) show the gravel parking area and bike path adjacent to the gravel wetland system. Photograph 9 (page 8 of the Appendix) shows typical samples collected during the July 12, 2012 event, from Tank 1, Tank 3, and the wetland outlet, which clearly shows a difference in turbidity as water moves through the system. Photograph 10 (page 8 of the Appendix), provided by Tom DiPietro, shows the gravel wetland during its construction in 2008. Photographs 11 and 12 (page 9 of the Appendix) shows water discharging Tank 3 from the emergency overflow entering Tributary 2 of Potash Brook, and standing water in the gravel wetland on September 9, 2012.

The autosampler rain gages, installed at Tank 1, Tank 3, and at the outlet, recorded rainfall amounts in a sliding 24 hour period and were set to collect composite water samples once specific rainfall thresholds (i.e., storms) had been met. The Leveloggers continuously measured water levels in both the Wetland Outlet structure and Tank 3 at 10 minute increments from the time of installation on June 28, 2011 to November 11, 2011 and then from April 3, 2012 until June 27, 2012. The Barologger collected atmospheric pressure data, during the same time period, to correct the Levelogger readings.

2.2 Equipment Calibration and Site Measurements

The calibration and calculation of flow volumes passing through the gravel wetland system are a key, yet challenging element of the study. In order to calibrate the system properly, a good understanding of the parameters used to calculate the flow volumes and their limitations is particularly helpful. This study also had several different potential outcomes for water that entered the system, and an understanding of where water flowed during certain time periods was also necessary. A summary of the calibration effort needed to derive required flows and the list of assumptions, is provided below.

Water levels in Tank 3 and the gravel wetland structure were measured with the leveloggers and rating tables, developed in HydroCAD®, and used to calculate the flow volumes. During

calibration it was revealed that not all of the water that passed into Tank 3 made it through to the wetland outlet during certain storm conditions. A further investigation of Tank 3 and the wetland outlet revealed that water that entered Tank 3 had two other potential destinations other than the wetland outlet:

- Up to 350 cubic feet water could be stored in the wetland (assuming dry conditions) before it began to flow out of the outlet (wetland storage was a part of every sampling event)
- When water levels exceeded 198.3 feet in Tank 3, the emergency overflow discharged directly to Tributary 2 of Potash Brook (this occurred during three of the seven sampling events described below in section 2.3)

Tank 3 was inundated during one large storm (Storm 1), and the calculated stormwater volume indicated that over 6,600 cubic feet water entered the gravel wetland with only a bit over 1,100 cubic feet indicated at the outlet. If, as calculated, almost 5,500 cubic feet of water was in the wetland, as the rating tables indicated, the system would have been overtopped, but no standing water was observed at the time of sampling. Thus, a HydroCAD-based volume for stormwater entering the system was used in place of the rating table calculated flows. For each of the other storms, the model rating tables and wetland storage capacity were used to provide flow volumes.

Careful calibration of the equipment and recording of water surface elevations was critical to the success of the study. Each autosampler was calibrated after installation to determine the number of pump cycles needed to collect a 100mL sample. Once calibrated, the samplers were set to collect 0.2L (200mL) every 10 or 15 minutes, depending on the event to be sampled. A preset amount of precipitation during a 24-hour sliding window triggered the samplers. The autosamplers were set to collect fifty 0.2 Liter samples over the course of 12.5 hours thus reaching the 10 liter sampling container capacity.

2.3 Sample Collection

At the outset of the project, the goal was to collect composite stormwater samples during four to six storm events. The protocol for triggering sample collection, described in the BMP Testing Plan, was initially used for this study but was abandoned in favor of manually triggering the samplers. Storms sampled are presented in Table 2.

Table 2: Summary of Storms and Autosampler Settings

Storm			Sampling Interval (minutes)
#	Depth (inches)	Date	
1	1.25	9/29/12	15
2	0.20	10/20/12	15
3	0.35	4/26/12	10
4	0.49	5/30/12	10
5	0.20	6/12/12	10
Z1	0.30	5/16/12	10
Z2	0.39	6/25/12	15

At the time of sample collection, relevant site information, including the autosampler readings and water surface elevation measurements, were recorded in the Sample Collection Form. The Sample Collection Form for each of the seven storms is included on pages 10 through 16 of the Appendix. After sampling was completed, the sampling equipment was cleaned, reset, and prepared for the next storm.

The design of the AWFS limited the sample collection options, particularly at the drop inlets, where inflow was vertical and the stormwater could not be sampled until it was already in the tank. Thus, inflow concentrations are likely underestimated as some proportion, mainly larger, heavier sediment, would settle out in the tank prior to being sampled. Also, calculation of removal rates for the individual tanks is challenging, since a small proportion of pollutants enters Tank 2 and 3 from their limited drainage areas and comingles with inflow from Tank 1. Also, as previously mentioned, during large storms, Tank 3 discharges directly to the stream which results in the input of both washoff pollutants and previously trapped pollutants that have been re-suspended. An estimate of the discharges associated with this condition has been provided, but the experimental design was not set up for differentiating between washoff and

re-suspended pollutants. Described in detail in Section 3.1 below, the laboratory sample for total and dissolved zinc was inadvertently left off the sampling chain-of-custody for Storms 2 and 3. Two additional storms (Storm Z1 and Z2) were sampled and analyzed for Zinc parameters only in order to complete the study. Notwithstanding these limitations, the sampling design provides information that is representative of the pollutant removal rate of the entire system.

2.4 Pollutant Concentration Analysis

Following successful water sample collection, samples were brought to Endyne Laboratories, Inc (Endyne) in Williston, Vermont for analysis of eight constituents. Each of the collection containers was then rinsed with distilled water to remove traces from the prior storm. As described in the BMP Testing Plan, a chain of custody form was filled out and submitted with each sample collection.

Constituents analyzed in the laboratory for the Farrell Park Gravel Wetland Case Study:

- Iron (Fe) Total and Dissolved
- Copper (Cu) Total and Dissolved
- Zinc (Zn) Total and Dissolved
- Total Suspended Solids (TSS)
- Chloride (CL)
- Total Nitrate (NO_3) – Nitrogen (TN)
- Total Kjeldahl Nitrogen (TKN)
- Biochemical Oxygen Demand (BOD)
- Phosphorus (TP) Total and Dissolved (TDP)
- Total Coliform

Field parameters were also measured after the completed samples were collected:

- Conductivity(µs)
- pH (SU)
- Turbidity (NTU)
- Temperature (◦C)

2.5 Data Analysis

A series of spreadsheets, as described in the BMP Testing Plan, were populated with the data generated from the various monitoring equipment and the laboratory results. These spreadsheets were used to calculate pollutant concentrations and loading. Outlet and inlet Levelogger water surface elevations were used to determine the wetland's outflow rates and volumes. The difference in water volumes (i.e., inflow volume minus outflow volume), in combination with the pollutant concentrations collected by the autosampler, were then used to determine pollutant loading and pollutant removal rates.

A separate Farrell Park Gravel Wetland BMP spreadsheet was made for each of the sampled storms. The spreadsheets' data contents, uploaded from the Leveloggers and Barologger, were restricted to the time period between when water levels began to increase in Tank 3 and the wetland outlet structure, and when water levels returned to pre-event elevations. These spreadsheets were also used to generate the charts, tables, and graphs for each storm as described below (see Results and Conclusions Section). With the exception of Storm 1, the spreadsheets were used to calculate wetland inflow and outflow volumes for each storm.

An individual Report Data Sheet, which ultimately calculates pollutant removal efficiencies, was also populated for each of the sampled storms. Inflow and outflow concentrations are derived from the Endyne lab reports, while the volumes (cubic feet) are determined from each storm's BMP spreadsheet.

3.0 Results

The Farrell Park Gravel Wetland case study found that the wetland performed comparably to similar BMPs evaluated in prior studies submitted to the International Stormwater BMP Database, and a constructed stormwater gravel wetland evaluated by the University of New Hampshire (UNH Study). All of the comparable studies sought to define the pollutant removal efficiency of the BMP being analyzed but used various experimental designs. The experimental

design for the UNH Study utilized the event mean concentration (EMC) and measured flows and other studies experimental designs were not provided. The Farrell Park Gravel Wetland study used a composite sample taken during the storm and calculated flow volumes based on changes in water surface elevations.

The Farrell Park Gravel Wetland was designed to treat small to medium storms and diverted some flow from larger storms, including Storm 1 (1.25 inches) and Storm 4 (0.49 inches), out of the emergency overflow in Tank 3. Since Storm 1 was so large in comparison to the wetland capacity it was not compared to similar BMPs, but the results from Storms 2, 3, 4, and 5 were isolated for comparison. The gravel wetland alone was effective at removing sediment with an average removal rate of 98 percent for TSS for Storms 2, 3, 4, and 5. During these four storms, approximately 28.8 pounds of sediment entered the system and approximately 27.8 pounds of sediment were removed by the full system. A summary of the pollutant removal rates for the gravel wetland alone is included in Table 3.A, and page 17 of the Appendix.

Table 3.A: Summary of Farrell Park Gravel Wetland Percent Removal (%)

Inorganics	TSS	Cl	TN	TKN	BOD	TP	TDP
Removal Rate	98	54	63	80	68	88	30

Metals	Iron (Fe)		Copper (Cu)		Zinc (Zn)	
	(Total)	(Dissolved)	(Total)	(Dissolved)	(Total)	(Dissolved)
Removal Rate	98	25	42	42	79	44

Total Coliform	Total Coliform w/E. Coli
Removal Rate	91

A summary of pollutant removal rates for the entire treatment system of the three drop inlets, two grassed swales, and the gravel wetland is included in Table 3.B and page 17 of the Appendix. The addition of the drop inlets and grassed swales to the evaluation did not result in additional treatment provided by the inlets. This decrease in percent removal occurs because of pollutant loads lost directly to the stream from the Tank 3 during overflow conditions.

Table 3.B: Summary of Full System (3 drop inlets, swales, and Farrell Park Gravel Wetland)

Percent Removal (%)							
Inorganics	**TSS**	**Cl**	**TN**	**TKN**	**BOD**	**TP**	**TDP**
Removal Rate	96	81	78	88	81	90	50
Metals		**Iron (Fe)**		**Copper (Cu)**		**Zinc (Zn)**	
		(Total)	(Dissolved)	(Total)	(Dissolved)	(Total)	(Dissolved)
Removal Rate		95	58	53	53	86	55
Total Coliform		**Total Coliform w/E. Coli**					
Removal Rate		92					

During the 19-week study period in 2011, approximately 11,100 cubic feet of water passed through the Farrell Park Gravel Wetland. During the 12-week study period in 2012, approximately 7,800 cubic feet of water passed through the Farrell Park Gravel Wetland.

3.1 Individual Storm Performance

At the Farrell Park Gravel Wetland, five storms of varying sizes were sampled between September 29, 2011 and July 12, 2012. As measured by the autosamplers, the sampled storms ranged from 0.09 inches to 1.27 inches in total rainfall.

Size and dates of each of the sampled storms:

- Storm 1 – 1.27 inches (1.25 inches at BTV) (*September 29 – 30, 2011*)
- Storm 2 – 0.15 inches (0.18 inches at BTV) (*October 20 – 21, 2011*)
- Storm 3 – 0.34 inches (0.35 inches at BTV) (*April 26, 2012*)
- Storm 4 – 0.49 inches at BTV (*May 30, 2012*)
- Storm 5 – 0.25 inches (0.20 inches at BTV) (*June 12, 2012*)
- *Z*1 – 0.20 inches at BTV (*May 16, 2012*)
- *Z*2 – 0.09 inches (0.39 inches at BTV) (*July 25, 2012*)

A continuous record of hourly water surface elevation data was collected by the Leveloggers during this project. Graphs showing cumulative and daily precipitation, as well as sampling dates for 2011 and 2012, are provided on pages 19 through 22 of the Appendix.

A summary of results for each of the five storms is presented below. The summaries include each of the following documents, referenced in the Appendix within each storm summary:

- BMP Testing Pollutant Report Data Sheet – Each of these sheets includes; storm date, start and end time, precipitation totals measured by both the autosampler and at the NOAA Weather Station at the Burlington Airport (BTV), inflow and outflow rates as calculated in the spreadsheet model, notes from the sampling, laboratory results (pollutant concentrations), calculated pollutant loading, pounds removed, and the calculated percent removal by the Farrell Street Pond.
- Graph of pond and outlet water surface elevations (feet) – Highlighting the time period during which the pond responded to the storm, each graph shows the water surface elevations in Tank 3 and the wetland's outlet structure, as measured by the Leveloggers, and includes the cumulative precipitation measured at BTV.

Storm 1 – 1.27 inches (1.25 inches at BTV) (September 29 – 30, 2011):

Storm 1 was the largest of the sampled storms. During this event it was calculated, based on the HydroCAD model of 1.25 inch storm event at this site, that the total inflow volume was equal to approximately 3,270 cubic feet of water, while only approximately 1,120 cubic exited the wetland's outlet structure. As observed at BTV, this large storm occurred over only a seven hour period from 6 PM to 12 AM. Nearly identical to the event observed at BTV, the gravel wetland responded from 6:30 PM to 11:50 PM, and the autosamplers collected samples at a 15 minute interval from 6:25 PM to 11:31PM, after 0.1 inches of rain fell at the site.

The disparity of volume between inflow into system and outflow from the gravel wetland outlet structure was attributed to the overflow device located in Tank 3. As shown on the graph on page 21 of the Appendix, the water level in Tank 3 rose above the invert elevation of the overflow device located at 198.3 feet. Another 300 cubic feet of water were captured by the gravel wetland during this storm, as the site was dry in the weeks leading up to Storm 1.

Storm 2 – 0.15 inches (0.18 inches at BTV) (October 20 – 21, 2011):

Storm 2, which also began collection after 0.1 inches of rain had fallen at the site, was the smallest of the monitored events (based on BTV observations). The autosamplers at the site began collecting water at 4:40 PM while water levels in Tank 3 began to rise over one and a half hours later at 5:00 PM. Water levels in Tank 3 returned to normal just over six hours later at 11:10 PM. In that time, approximately 20 cubic feet of water had entered the wetland, all of which was retained in storage by the gravel wetland. This water retention by the wetland resulted in no measurable increase in water level in the wetland's outflow structure during Storm 2 and thus no outflow. Water collected by the autosampler for this storm is attributed to residual water in the outflow pipe from the storm events leading up to Storm 2 (see the graph on page 26 of the Appendix).

The zinc sample for Storm 2 was replaced by a similar storm, Z2, which occurred on June 25, 2012. Started manually after BTV received 0.1 inches of rain at approximately 7:30PM, the Tank 1 and gravel wetland inlet autosamplers collected 15 minute interval samples until approximately 7:45 AM and 2:36 AM, respectively, on June 26, 2012. Similar to Storm 2, this storm did not produce a measurable increase in water level in the outlet structure. However, unlike Storm 2, there was no residual water in the outlet and the autosampler at this location did not collect any water following 32 attempts.

Storm 3 – 0.34 inches (0.35 inches at BTV) (April 26, 2012):

The first storm of the 2012 sampling season, autosamplers began collecting water after 0.2 inches of rain fell during the 0.35-inch Storm 3. Water levels in Tank 3 began to increase at 8:34 PM and returned to normal almost three and a half hours later, at 11:59 PM. It was found that approximately 620 cubic feet of water entered the gravel wetland during this event, while only approximately 310 cubic feet passed through the outlet structure.

The zinc sample for Storm 3 was replaced by a storm of similar size, Z1, which occurred on May 16, 2012, which measured 0.2 inches at BTV. The water level in Tank 3 began to rise at approximately 5:00 AM and returned to normal approximately one hour and 20 minutes later. It was calculated that during this time the wetland received approximately 1,000 cubic feet of water and discharged 200 cubic feet of water from the outlet structure.

Storm 4 – 0.49 inches at BTV (May 30, 2012):

Monitoring for Storm 4 was started manually after 0.50 inches of rain was observed at BTV. Sampled at a 10 minute interval, water levels in Tank 3 began to increase at 8:49 AM, and returned to normal 9:45 PM. Cumulative outflow from Tank 3 was approximately 600 cubic feet, of which approximately 540 cubic feet entered the gravel wetland. Similar to the other large storm sampled, the remaining water was determined to have exited Tank 3 directly to Potash Brook Tributary 2 through the overflow device. It was calculated that only 200 cubic feet of water passed from the gravel wetland out the outlet structure during this interval. The remaining volume, approximately 335 cubic feet was attributed to gravel wetland storage.

Storm 5 – 0.25 inches (0.20 inches at BTV) (June 12, 2012):

Similar to Storm 2, Storm 5, which measured 0.25 inches of rain at the site, produced only slight water level changes in Tank 3 over the course of approximately one hour and 20 minutes (from 5:00 PM to 6:20 PM). This relatively small storm was calculated to have produced only 9 cubic feet of inflow to the gravel wetland and caused no change in the water level in the wetland's outflow structure. Samples for this storm were collected at 10 minute intervals and began after 0.1 inches of rain was measured at the site.

Also similar to Storm 2, predicated to have zero outflow, residual water in the outflow pipe from storm events prior to Storm 5 were determined to be the source of water for the autosampler located at the outlet of the gravel wetland for this storm.

3.2 Discussion

The Farrell Park Gravel Wetland performed comparably to other gravel wetlands evaluated in similar studies and was generally more effective at treating stormwater than the detention pond evaluated on Farrell Street during the 2010 VHB Study. Treatment of TSS and total iron was nearly 100 percent, with TP and TKN at 80 percent or above. All other constituents also showed excellent removal rates comparable to the expected performance standard for this type of STP which also outperformed the Farrell Street Detention Pond (see Table 4). However, overall efficiency of the wetland was somewhat diminished because the limited storage capacity

is too small for its associated drainage area. When larger, or high intensity storms occurred the excess stormwater discharged from the system through the overflow pipe in Tank 3 during Storm 4, the removal efficiencies drop for TSS.

Table 4 below provides a comparison of this studies results which includes removal rates for the gravel wetland and the complete system including the catch basins and grass swales to data from prior studies of similar BMPs and to the 2010 Farrell Street Detention Pond study by VHB.

Table 4: Comparison of Pollutant Removal from the International Stormwater BMP Database, VSMM 2002 (Table A.5), UNH Constructed Stormwater Subsurface Gravel Wetland, and Average Farrell Park Gravel Wetland Performance

Practice (Source)	Removal (%)								
	TSS	TN	TKN	BOD	TP	TDP	Zinc	Copper	Iron
Biofilter (BMP Database)	54	-2	16	NA	-36	-389	72[1]	72[1]	NA
Stormwater Wetlands (VSMM)	76	30	NA	NA	49	NA	42[1]	42[1]	NA
Gravel Wetland (UNH)	98-100	NA	NA	NA	32-88	NA	95-98	NA	NA
Farrell Park Gravel Wetland	98	63	80	68	88	30	79	42	79
FPGW Complete System (Three drop inlets, swales, and Farrell Park Gravel Wetland)	96	78	88	81	90	50	86	53	86
Farrell Street Pond (2010 VHB Study)	96	60	76	73	92	< 1	NA	NA	NA

[1]Average of total zinc and copper
NA – Pollutants not compiled in the International Stormwater BMP Database, the VSMM, or not sampled for in this case study.

The design of the wetland system, with the drop inlets and tanks for pre-treatment, helps to prevent large particle sediment and other associated pollutants from entering the wetland under most of the storm conditions that were observed. This situation was reversed during Storm 1 where pollutant concentrations within Tank 3 were greater than those observed in Tank 1, suggesting that particles that had previously settled in Tank 3 were re-suspended as a result of the high flows. Overall system performance and the wetland performance drops considerably for Storm 1 as shown on Pages 18 and 23 of the Appendix. Since this storm greatly exceeded the design capacity of the wetland system, the results were separated and not used to analyze the overall system performance. However, the results are included in the appendices to this report.

Nutrient and metals concentration and removal results at the Farrell Park Gravel Wetland system for Storms 2 through 4 and the zinc replacement storms provided detail about the removal capacity of the wetland. For nutrients, approximately 0.18 pounds of TKN (88 percent) and 0.038 pounds of TP (90 percent) were retained by the full system. Metal results included retention of 0.92 pounds of total iron (95 percent), 0.0013 pounds of total copper (53 percent), and 0.016 pounds of zinc (86 percent) by the system. Due to the very small concentration of copper, at times just equal to the detection limit, the precision and accuracy of the result for the calculation of total load and removal rate is subject to potential overstatement, especially when comparing Tank 1, Tank 3 and the outlet. Thus, with the exception of copper, the metal and nutrient removal quantities, and in particular the removal rates, show the effectiveness of the wetland's retention of these potentially harmful pollutants.

Based on the storm events (measured at the BTV NOAA weather station) that occurred during the 2011 and 2012 monitoring seasons, it was estimated that the gravel wetland and three tank system removed a total of approximately 670 pounds of sediment, 21 pounds of total iron, and 43 pounds of chloride as well as lesser amounts of Copper (1 pound), Zinc (0.01 pounds), Nitrate (0.15 pounds), TKN (4 pounds) and Phosphorus (1 pound). A detailed table of pollutant removal estimates is provided on Page 33 of the Appendix.

4.0 Recommendations

The Farrell Park Gravel Wetland is the second BMP that VHB has evaluated for the City of South Burlington as part of the of the overall goal of testing 8 to 10 BMPs. The project was executed over the course of two seasons and pollutant loading removal rates were derived from the water quality samples collected. Similar to the Farrell Street Pond project there were several lessons learned throughout the course of this study which will help guide future planned monitoring projects. Recommendations are provided below for future BMP monitoring projects.

4.1 Method Recommendations

Using the Leveloggers at the Farrell Park Gravel Wetland presented a special challenge to monitoring, as the water levels in the various structures were subject to significant variability due to the relatively small storage volumes. We have a number of recommendations specific to better determining flow rates:

- Increase the frequency of Levelogger readings in small volume storage situations to better track water level and flows; and
- Understand the potential destinations for flow including primary routing, storage, and emergency overflow; and
- Perform additional manual measurements when on-site to confirm water elevations and provide additional reference points.

Field practices have been modified to improve battery issues that have prevented the successful capture of samples during storm events. Samplers are now manually triggered, or set to trigger, immediately prior to an event with freshly charged batteries installed. This ensures that the samplers are properly configured and have sufficient battery power to collect complete samples during the storm event.

As noted for the prior study, a month calibration period with a couple of storm events is a key element for the establishment of the proper model. Adjustments to the model inputs, in particular modifications to the rating tables based on field measured values and observations of flow, are required for accurate flow calculations.

4.2 General Recommendations

The results of this project also determined that the upper end of the rating tables used to derive flow volumes can lead to overestimates. As a solution, the City has purchased additional flow monitoring equipment that will measure flow using a Doppler sensor and pressure transducer. This setup will be used on the next monitoring project in conjunction with the Leveloggers to check the rating table derived flow volumes.

Measurements collected during the smaller storm events, especially those that produce little to no measurable\observable flow and have very small concentration values, provide limited information on BMP performance. Therefore, we recommend that the minimum storm event size for an event sample be 0.25 inches of rain in 24 hours. We also recommend that the full spectrum of events to be sampled should include the following over a minimum of five storms:

- Minimum of two (2) storms between 0.25 and 0.50 inches in 24 hours
- Minimum of two (2) storms between 0.50 and 1.0 inches in 24 hours
- One (1) storm greater than 1.0 inches in 24 hours

References

Clary, Jane. Et al. May 2008. Can Stormwater BMPs Remove Bacteria?: New Findings from the International Stormwater BMP Database. Stormwater: The Journal for Surface Water Quality Professionals.

Hoyle, Tanner & Associates, Inc. March 2007. Farrell Street/Potash Brook Stormwater Improvement Project City of South Burlington, Vermont. Construction and Permanent Easements Plan.

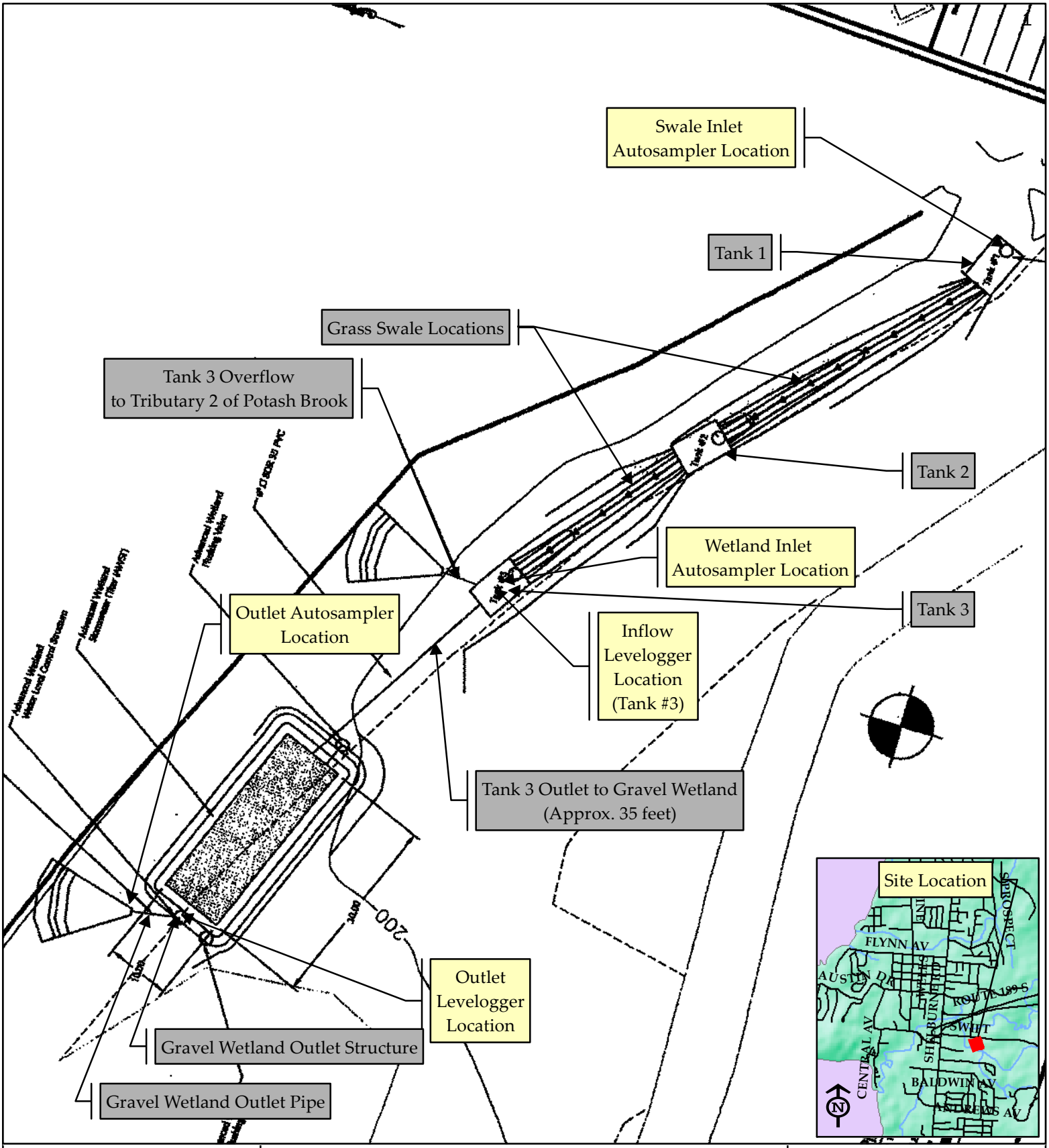
Geosyntec Consultants for the Water Environment Research Foundation (WERF), Wright Water Engineers, Inc., the American Society of Civil Engineers (ASCE/Environmental and Water Resource Institute (EWRI), the American Public Works Association (APWA), the Federal Highway Administration (FHWA), and U.S. Environmental Protection Agency (EPA). International Stormwater BMP Database. 2007. www.bmpdatabase.org

Geosyntec Consultants and Wright Water Engineers, Inc. June 2008. Overview of Performance by BMP category and Common Pollutant Type. International Stormwater Best Management Practice (BMP) Database [1999-2008]. http://www.bmpdatabase.org/Docs/Performance%20Summary%20Cut%20Sheet%20June%202008.pdf

University of New Hampshire. January 2009. Charles River Watershed Association; Low Impact Best Management Pracitce (BMP) Information Sheet http://www.crwa.org/projects/bmpfactsheets/crwa_gravelwetland.pdf

Vermont Agency of Natural Resources. August 2002. Vermont Stormwater Management Manual: Volume II – Technical Guidance. VT ANR, Waterbury, VT.

APPENDIX



Legend

- Roads
- Streams (VHD)

City of South Burlington
South Burlington, Vermont
BMP Performance Testing
Farrell Street Gravel Wetland Case Study Location

December 12, 2011

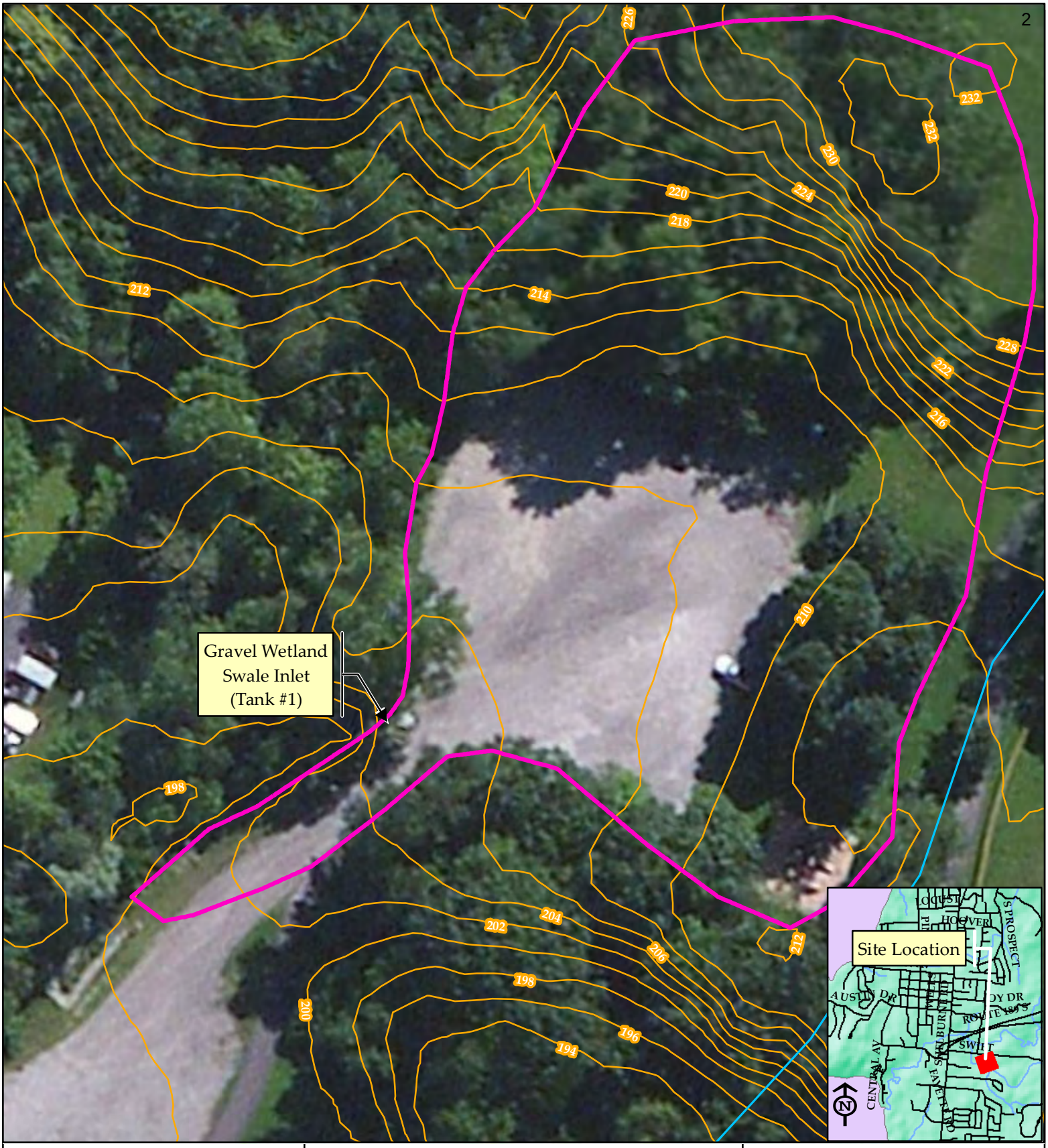
20 10 0 20 Feet

Sources: Roads by VTrans (2009); Streams by VCGI (2008); Site Plans prepared by EcoSolutions (2007).

Vanasse Hangen Brustlin, Inc.

Prepared by: SEM

F:\57406.01 SB Farrell St Gravel\GIS\Project\BMP_Sites.mxd exported by:smanley On 8/13/2012 at 10:06:49 AM



Legend

- Drainage Area
- Roads
- Stream (VHD)

City of South Burlington
South Burlington, Vermont
BMP Performance Testing
Farrell Street Gravel Wetland Case Study
Drainage Area
July 31, 2012

50 25 0 50
Feet

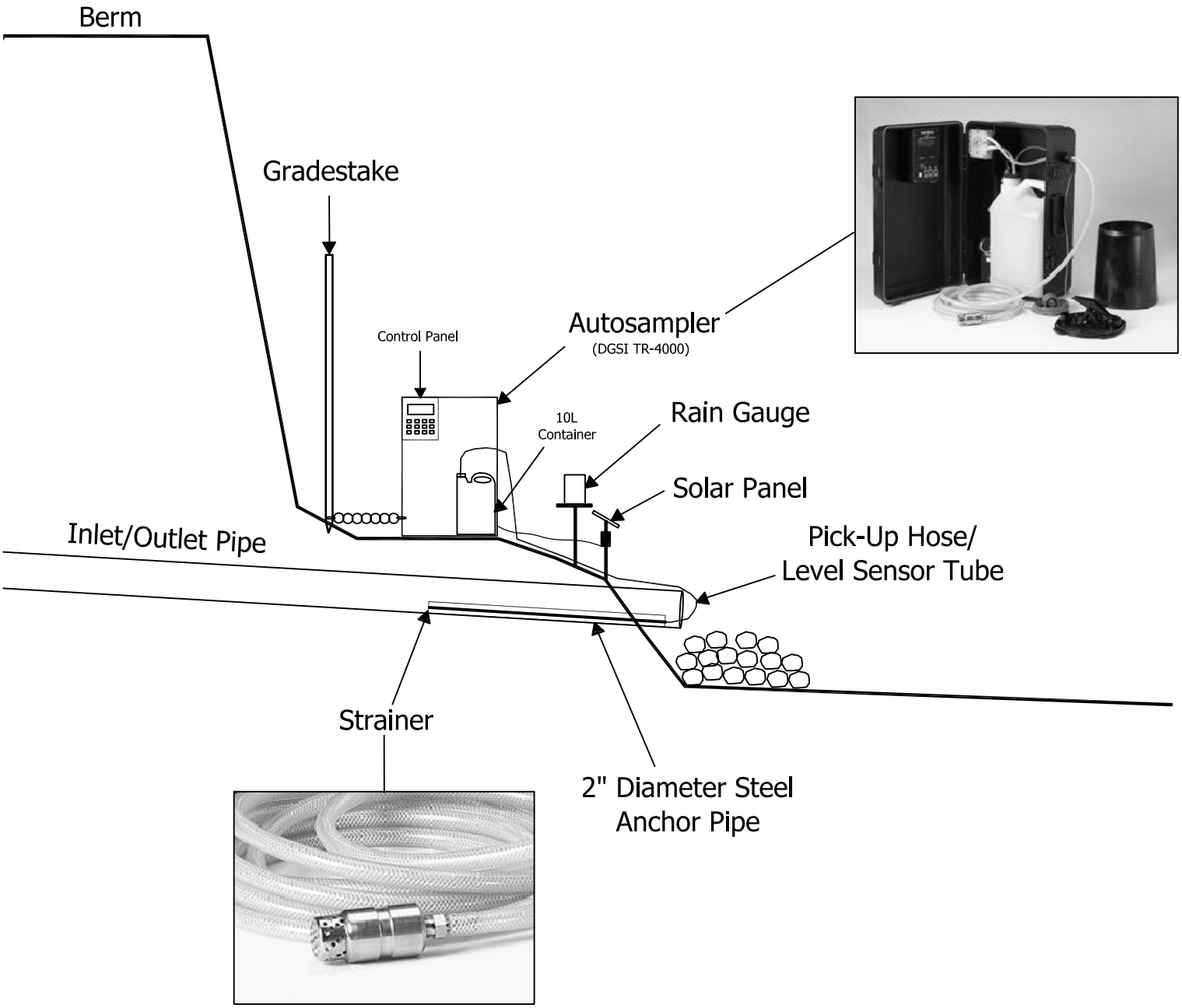
Sources: Roads by VTrans (2009); Streams by VCGI (2008); Site Plans prepared by EcoSolutions (2007).

Vanasse Hangen Brustlin, Inc.

Prepared by: SEM

F:\57406.01 SB Farrell St Gravel\GIS\Project\DrainageAreaMap.mxd exported by:smanley On 7/31/2012 at 1:43:04 PM

Drawing Not to Scale



PROJECT NO. 57294	REVISIONS		
DATE 12/11/2008	NO.	DATE	
DRAWN BY JAT			
DESIGNED BY			
CHECKED BY JLS			
FILE PATH: F:\57297.00\CAD\A-prjdwg\Autosample Schematic.dwg			

VHB PIONEER
7056 US Route 7,PO Box 120
North Ferrisburgh, VT 05473
T.802.425.7788 F.802-425.7799
www.vhb.com

City of South Burlington
Stormwater BMP
Autosampler Schematic

SHEET/DRAWING
1

City of South Burlington BMP Testing
Farrell Street Gravel Wetland Case Study Photo Document
July 31, 2012
VHB

Photo 1: View of Tank 1 inlet and autosampler. (Taken 6/26/12)

Photo 2: View from Tank 1 toward gravel wetland. (Taken 6/26/12)

City of South Burlington BMP Testing
Farrell Street Gravel Wetland Case Study Photo Document
July 31, 2012
VHB

Photo 3: View of gravel wetland, toward tank 3. (Taken 5/16/12)

Photo 4: Top view of gravel wetland outlet structure. (Taken 6/13/12)

Photo 5: Gravel wetland outlet, toward gravel wetland. (Taken 4/12/11)

Photo 6: View of inside Tank 3 – black overflow pipe on right. (Taken 4/3/12)

City of South Burlington BMP Testing
Farrell Street Gravel Wetland Case Study Photo Document
July 31, 2012
VHB

Photo 7: View of gravel wetland drainage area. (Taken 5/30/12)

Photo 8: View of gravel wetland drainage area. (Taken 4/12/11)

City of South Burlington BMP Testing
Farrell Street Gravel Wetland Case Study Photo Document
July 31, 2012
VHB

Photo 9: Autosampler collection for Storm 5 (results typical for all storms sampled)
From left to right; Tank 1 (swale inlet), Tank 2 (gravel wetland inlet), gravel wetland outlet (Taken 6/13/12)

Photo 10: View of gravel wetland during construction (Taken by Tom DiPietro, 2008)

City of South Burlington BMP Testing
Farrell Street Gravel Wetland Case Study Photo Document
July 31, 2012
VHB

Photo 11: Tank 3 outflow from emergency overflow to Tributary 2 to Potash Brook (Taken By Josh Sky, 9/8/12)

Photo 12: View of gravel wetland, toward tank 3. (Taken by Josh Sky 9/8/12)

Unless otherwise noted - all photos taken By Scott Manley of VHB.
F:\57406.01 SB Farrell St Gravel\reports\FarrellStreetGravelWetland\Photo Doc.doc

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	9/29/2011	**Sampled By**	SEM
Sample #	1	**Storm Size**[1]	1.25 inches
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	9/29/11 9:58 PM	**Sampling Time End**	9/30/11 4:21 AM
Volume Sampled (L)	10L	**Observations:** full after 29 samples	
Rain Gage Reading (inches)	1.27 inches		
Photograph Numbers	3336 - 3338		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	9/30/11 8:45 AM	**Sampling Time End**	9/30/11 8:45 AM
Volume Sampled (L)	10L	**Observations:** Dead battery, sampler did not start with the other two, collected sample all at once with a replacement battery	
Rain Gage Reading (inches)	---		
Photograph Numbers	3339		
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	9/29/11 6:25 PM	**Sampling Time End**	9/29/11 11:31 PM
Volume Sampled (L)	10L	**Observations:** full after 20 samples, total rainfall	
Rain Gage Reading (inches)	0.29 inches		
Photograph Numbers	3340		
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)	--- (feet)	**Inside Outlet Structure:**	--- (feet)
Time of Measurement:	---	**Time of Measurement:**	---
Description of Measurement Point: Rim of PVC housing into Tank #3, Rim of outlet structure			
Site Notes:			

[1]Storm size measured at BTV

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	10/20/2011	**Sampled By**	SEM
Sample #	2	**Storm Size**[1]	0.18 inches
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	10/20/11 6:28 PM	**Sampling Time End**	10/21/11 12:21 AM
Volume Sampled	10L	**Observations:** Visable scum and much cloudier than the other sampler bottles. Full after 23 samples.	
Rain Gage Reading	0.11 inches		
Photograph Numbers			
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	10/20/11 4:40 PM	**Sampling Time End**	10/20/11 11:18 PM
Volume Sampled	10L	**Observations:** Clearity of sampled water somewhere between Inlet 1 and outlet. Full after 26 samples.	
Rain Gage Reading	0.15 inches		
Photograph Numbers			
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	10/20/11 4:32 PM	**Sampling Time End**	10/20/11 10:56 PM
Volume Sampled	10L	**Observations:** visably much clearer than the two inlet sampler bottles (Clear). Full after 25 samples.	
Rain Gage Reading	0.15 inches		
Photograph Numbers	1598		
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)	--- (feet)	**Inside Outlet Structure:**	--- (feet)
Time of Measurement:	---	**Time of Measurement:**	---
Description of Measurement Point: Rim of PVC housing into Tank #3, Rim of outlet structure			
Site Notes:			
photo of wetland and outlet taken			
Depth to water surface elevations measured on 10-14-11			
Samplers re-calibrated to 100ml directly before storm			

[1]Storm size measured at BTV

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	6/25/2012	**Sampled By**	SEM
Sample #	Z2 (Storm 2 Zn Replacement)	**Storm Size**[1]	0.39
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	6/25/12 7:36 PM	**Sampling Time End**	6/26/12 7:45 AM
Volume Sampled (L)	10	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	0411		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	6/25/12 7:36 PM	**Sampling Time End**	6/26/12 2:36 AM
Volume Sampled (L)	10	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	0409, 0410, 0412		
Outlet			
Sampled	no	**Reset**	
Sampling Time Start	6/25/12 7:36 PM	**Sampling Time End**	NA
Volume Sampled (L)	0	**Observations:**	
Rain Gage Reading (inches)	NA	No outflow - sampler tried 32 samples	
Photograph Numbers			
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)		**Inside Outlet Structure:**	
Time of Measurement:		**Time of Measurement:**	
Description of Measurement Point: Rim of PVC housing into Tank #3, Rim of outlet structure			
Site Notes:			
15 min. sampling interval			
0.09 measured by autosamplers			
[1]Storm size measured at BTV			

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	4/26/2012	**Sampled By**	SEM
Sample #	3	**Storm Size**[1]	0.35
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	4/26/12 9:46 PM	**Sampling Time End**	4/27/12 12:34 AM
Volume Sampled (L)	7	**Observations:** Sampling stopped pre-maturely due to low battery. Bottle full after 16 samples	
Rain Gage Reading (inches)	0.33		
Photograph Numbers	-		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	4/27/12 8:30 AM	**Sampling Time End**	-
Volume Sampled (L)	-	**Observations:** Battery died, grab sample was collected directly before taking samples to Endyne	
Rain Gage Reading (inches)	-		
Photograph Numbers	-		
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	4/26/12 9:21 PM	**Sampling Time End**	4/26/12 10:57 PM
Volume Sampled (L)	10	**Observations:** Bottle full after only 9 samples	
Rain Gage Reading (inches)	0.34		
Photograph Numbers			
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)	-	**Inside Outlet Structure:**	
Time of Measurement:	-	**Time of Measurement:**	
Description of Measurement Point: rim of riser			
Site Notes:			

[1]Storm size measured at BTV

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	5/16/2012	**Sampled By**	SEM
Sample #	Z1 (Storm 3 Zn Replacement)	**Storm Size**[1]	0.2
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	5/16/12 6:36 PM	**Sampling Time End**	5/17/12 12:35 AM
Volume Sampled (L)	10 L	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	2632 and 2633		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	5/16/12 6:33 PM	**Sampling Time End**	5/17/12 12:33 AM
Volume Sampled (L)	10 L	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	2634		
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	5/16/12 6:33 PM	**Sampling Time End**	5/17/12 3:51 AM
Volume Sampled (L)	5 L	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	2630		
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)	-	**Inside Outlet Structure:**	
Time of Measurement:	-	**Time of Measurement:**	
Description of Measurement Point: rim of riser			
Site Notes:			
Autosamplers manually started following 0.2'' storm measured at BTV. Sampled at 10min intervals. Photo of 3 bottles show all three samples (2635) outlet, wetland inlet, and swale inlet.			
[1]Storm size measured at BTV			

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	5/30/2012	**Sampled By**	SEM
Sample #	4	**Storm Size**[1]	0.49
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	5/30/12 7:00 AM	**Sampling Time End**	5/30/12 4:00 PM
Volume Sampled (L)	10L	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	0031		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	5/30/12 7:00 AM	**Sampling Time End**	5/30/12 4:00 PM
Volume Sampled	10L	**Observations:**	
Volume Sampled (L)	NA		
Rain Gage Reading (inches)	0029		
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	5/30/12 7:00 AM	**Sampling Time End**	5/30/12 4:00 PM
Volume Sampled (L)	10L	**Observations:**	
Rain Gage Reading (inches)	NA		
Photograph Numbers	0026		
Depth to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)		**Inside Outlet Structu**	
Time of Measurement:		**Time of Measurement:**	
Description of Measurement Point:			
Site Notes:			
Manually tripped all three samples following 0.5 inch event measured at BTV. 10 minute sampling interval (0.2L volume per sample)			
[1]Storm size measured at BTV			

City of South Burlington Stormwater Utility
Sample Collection Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	6/12/2012	**Sampled By**	SEM
Sample #	5	**Storm Size**[1]	0.2
Inlet 1: Swale Inlet			
Sampled	yes	**Reset**	
Sampling Time Start	6/12/12 4:53 PM	**Sampling Time End**	6/13/12 12:01 AM
Volume Sampled (L)	10L	**Observations:** full after 25 samples. photos from cell phone	
Rain Gage Reading (inches)	0.19		
Photograph Numbers	2012-06-13 07.54.16, 2012-06-13 07.53.39		
Inlet 2: Wetland Inlet (Tank #3)			
Sampled	yes	**Reset**	
Sampling Time Start	6/12/12 6:45 PM	**Sampling Time End**	6/13/12 12:35 AM
Volume Sampled (L)	10 L	**Observations:** full after 41 samples	
Rain Gage Reading (inches)	0.19		
Photograph Numbers			
Outlet			
Sampled	yes	**Reset**	
Sampling Time Start	6/12/12 4:39 PM	**Sampling Time End**	6/13/12 12:10 AM
Volume Sampled (L)	10 L	**Observations:** full after 32 samples	
Rain Gage Reading (inches)	0.32		
Photograph Numbers	2012-06-13 08.26.49		
Depth (inches) to Water Surface, Below Measurement Point:			
Inside Tank #3 (Inlet)	39.25	**Inside Outlet Structure:**	18.31
Time of Measurement:	6/13/2012 8:24	**Time of Measurement:**	6/13/12 8:28AM
Description of Measurement Point: Rim of PVC housing into Tank #3, Rim of outlet structure			
Site Notes:			
samplers checked on at 8:30pm on 6/12/12 - wetland inlet needed to be re-started (had come un-plugged), swale inlet and outlet were okay.			
[1]Storm size measured at BTV			

City of South Burlington
Stormwater Utility

BMP ID	Farrell Street Gravel Wetland
Number of Storms	4*

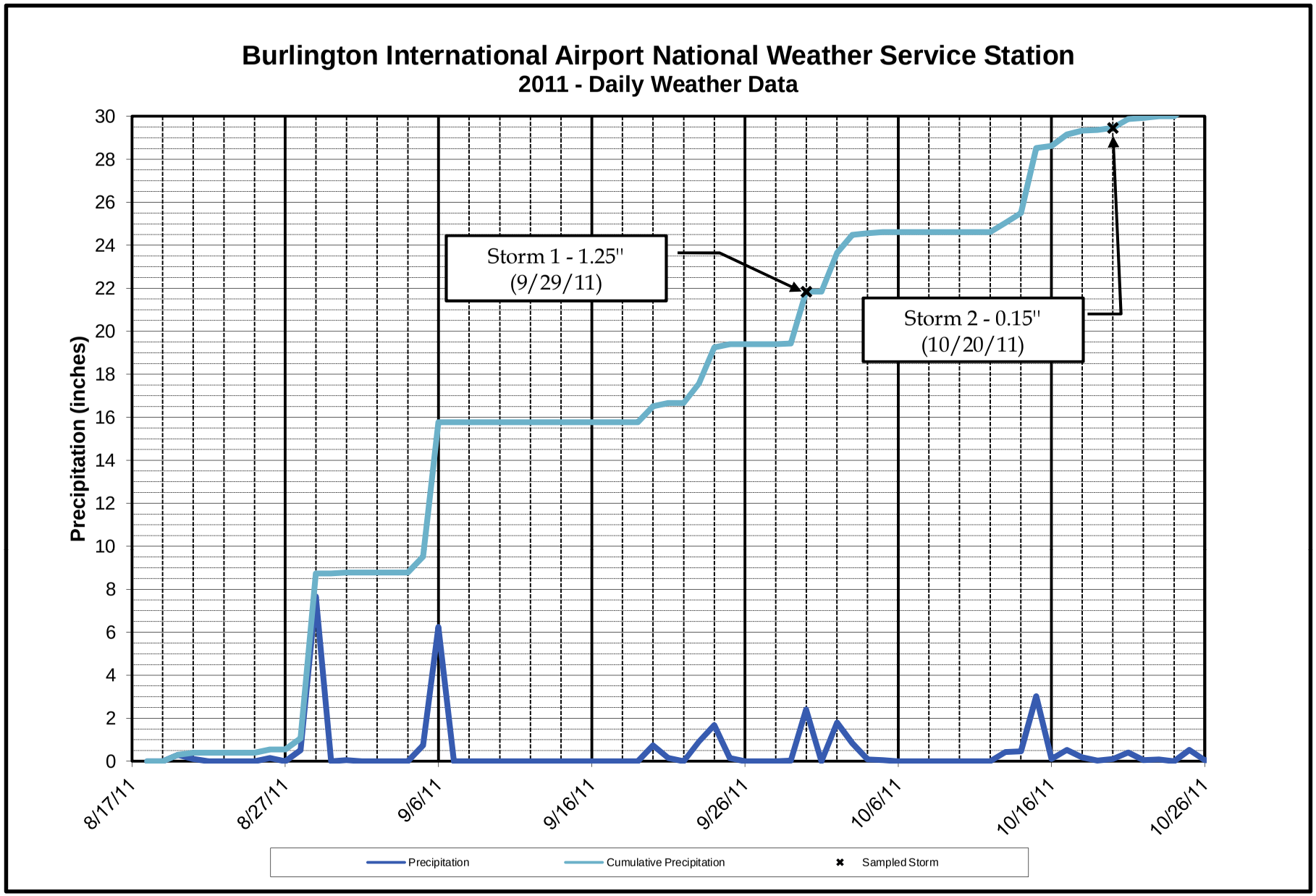
Category	Pollutant	Tank 1 Average Concentration (mg/l) (system inflow)	Tank 1 Total Load (lbs) (system inflow)	Tank 3 Average Concentration (mg/l) (wetland inflow)	Tank 3 Total Load (lbs) (wetland inflow)	Average Wetland Outlet Concentration (mg/l)	Total Wetland Outlet Load (lbs)	Tank 3 Total Overflow Load (lbs) (to stream)	Percent Removal	
									Wetland Percent Removal	Complete System Removal
Metals	Iron (Fe) Total	16.40	0.97	5.35	0.37	0.28	0.01	0.04	98%	95%
	Iron (Fe) Dissolved	1.45	0.02	0.43	0.01	0.14	0.007	0.001	25%	58%
	Copper (Cu) Total	0.02	0.002	0.02	0.001	0.02	0.0006	0.0001	42%	53%
	Copper (Cu) Dissolved	0.02	0.002	0.02	0.001	0.02	0.0006	0.0001	42%	53%
	Zinc (Zn) Total	0.17	0.02	0.05	0.003	0.02	0.0006	0.003	79%	86%
	Zinc (Zn) Dissolved	0.13	0.01	0.11	0.00	0.07	0.003	0.003	44%	55%
Inorganic Analyses	Total Suspended Solids (TSS)	420	28.8	117	7.88	3.25	0.15	0.87	98%	96%
	Chloride (Cl) Total	65.3	4.51	31.7	1.52	22.1	0.70	0.17	54%	81%
	Nitrate (NO_3)- Total Nitrogen (TN)	0.13	0.02	0.14	0.01	0.28	0.004	0.0001	63%	78%
	Total Kjeldahl Nitrogen (TKN)	3.98	0.22	1.91	0.09	0.64	0.02	0.01	80%	88%
	Biochemical Oxygen Demand (BOD)	22.6	0.68	5.83	0.31	2.50	0.10	0.03	68%	81%
	Total Phosphorus (TP)	0.53	0.04	0.31	0.02	0.07	0.002	0.00	88%	90%
	Total Dissolved Phosphorus (TDP)	0.03	0.00	0.06	0.002	0.05	0.002	0.0001	30%	50%
pH and Total Coliform	pH (expressed in SU)	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total Coliform w/ E. Coli (expressed in	NA	NA	NA	NA	NA	NA	NA	NA	NA

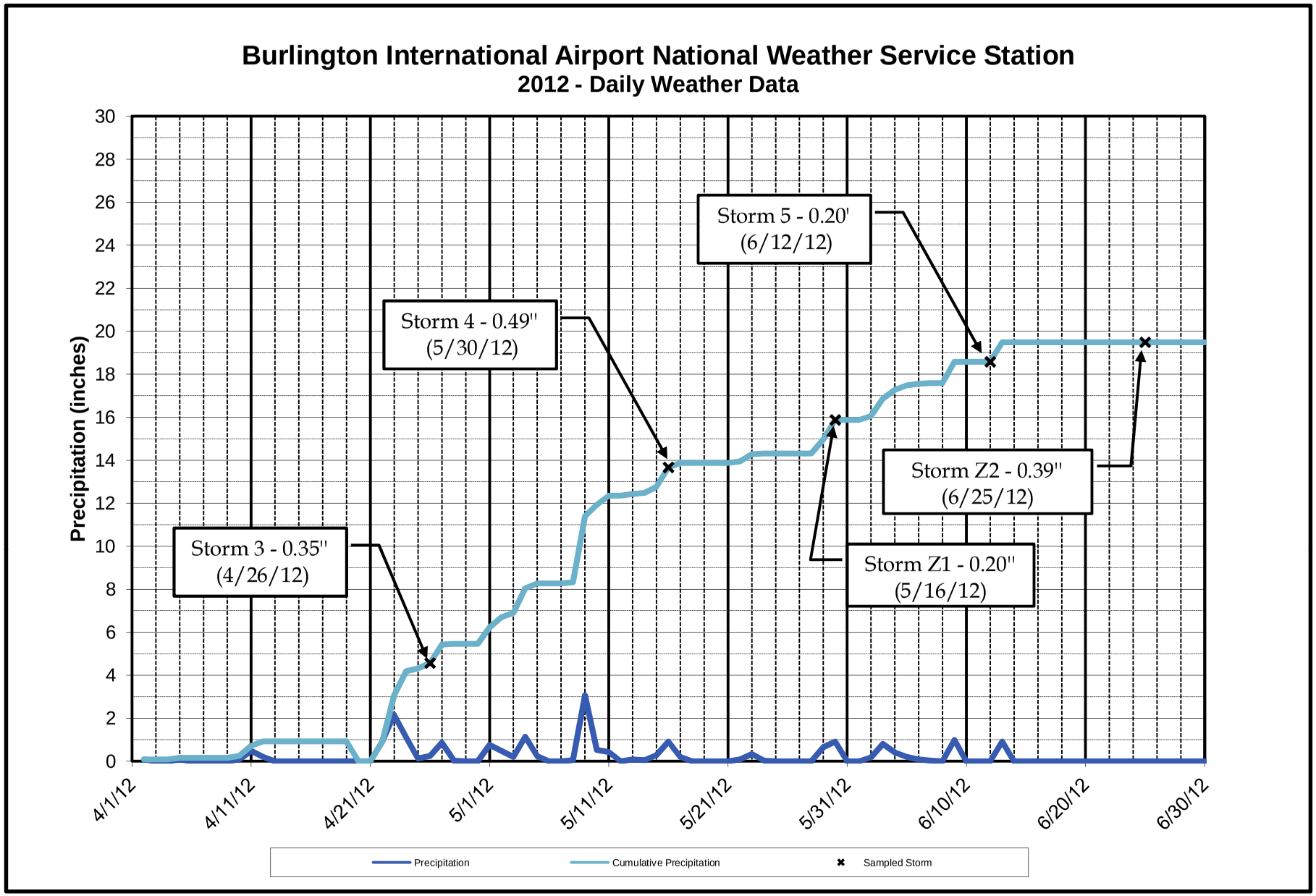
*Does not include concentrations from Storm 1

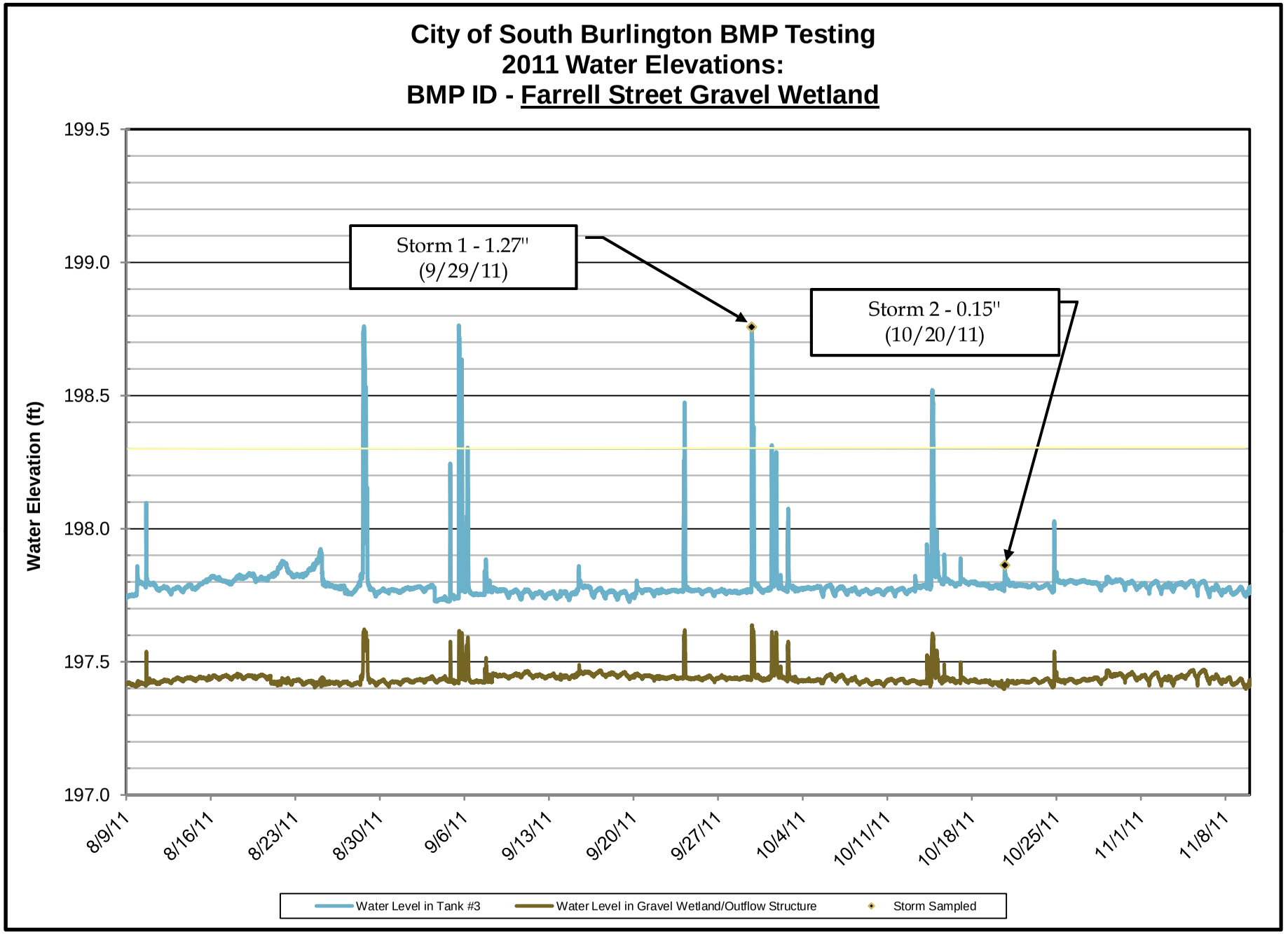
City of South Burlington
Stormwater Utility

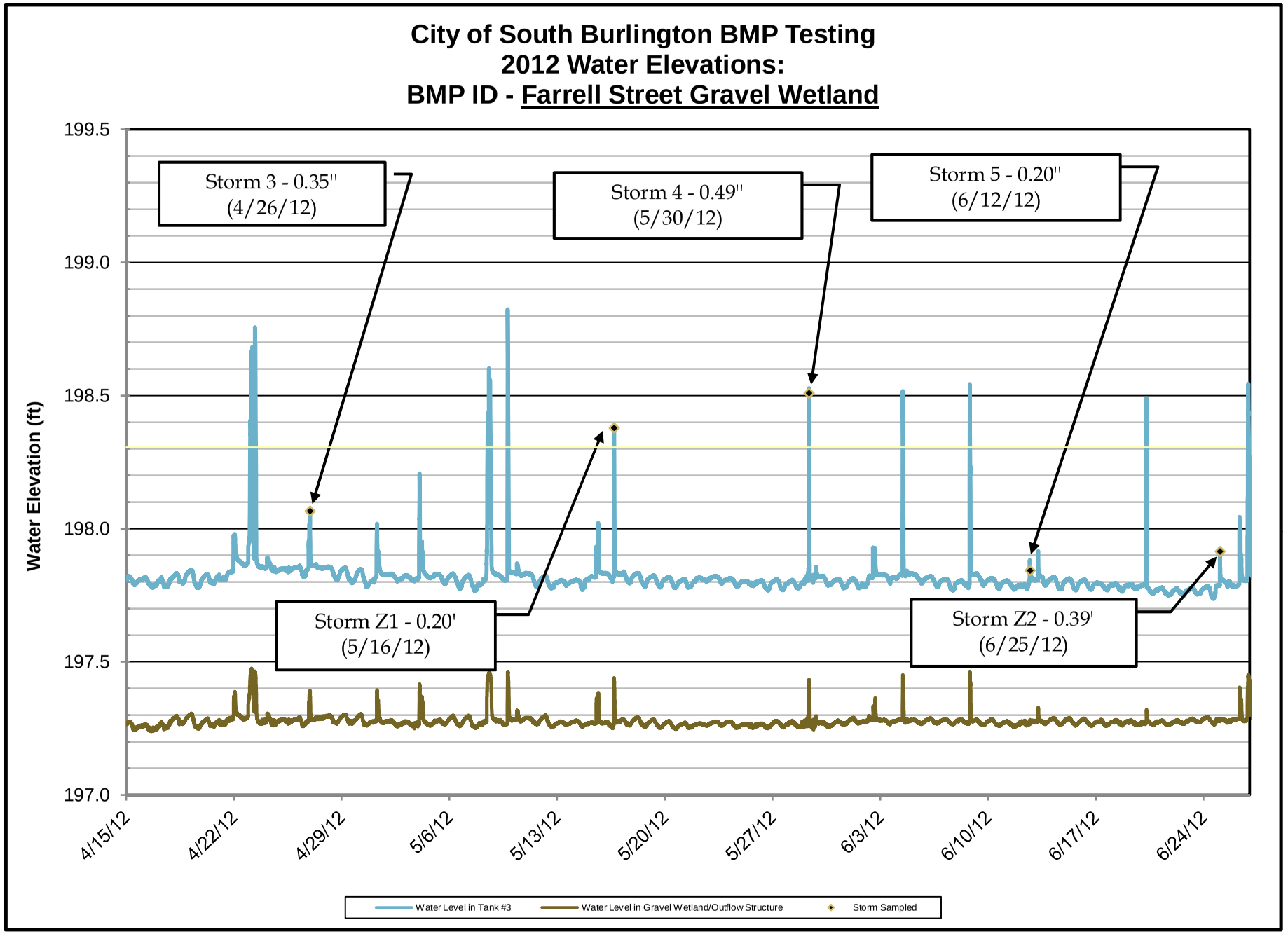
BMP ID	Farrell Street Gravel Wetland
Number of Storms	5

Category	Pollutant	Tank 1 Average Concentration (mg/l) (system inflow)	Tank 1 Total Load (lbs) (system inflow)	Tank 3 Average Concentration (mg/l) (wetland inflow)	Tank 3 Total Load (lbs) (wetland inflow)	Average Wetland Outlet Concentration (mg/l)	Total Wetland Outlet Load (lbs)	Tank 3 Total Overflow Load (lbs) (to stream)	Percent Removal	
									Wetland Percent Removal	Complete System Removal
Metals	Iron (Fe) Total	15.12	3.00	9.06	2.74	0.54	2.19	0.81	20%	0%
	Iron (Fe) Dissolved	1.26	0.12	0.69	0.19	0.11	0.19	0.06	3%	-100%
	Copper (Cu) Total	0.02	0.01	0.01	0.00	0.02	0.00	0.00	74%	64%
	Copper (Cu) Dissolved	0.02	0.01	0.01	0.00	0.02	0.00	0.00	74%	64%
	Zinc (Zn) Total	0.15	0.04	0.09	0.02	0.02	0.01	0.01	33%	56%
	Zinc (Zn) Dissolved	0.11	0.01	0.06	0.01	0.06	0.00	0.00	81%	71%
Inorganic Analyses	Total Suspended Solids (TSS)	406.00	100.08	399.88	83.21	9.00	4.01	25.41	95%	71%
	Chloride (Cl) Total	52.78	5.10	51.83	1.96	18.34	0.75	0.31	62%	79%
	Nitrate (NO_3)- Total Nitrogen (TN)	0.11	0.03	0.11	0.02	0.24	0.01	0.00	73%	69%
	Total Kjeldahl Nitrogen (TKN)	3.54	0.59	3.48	0.55	0.64	0.40	0.16	27%	5%
	Biochemical Oxygen Demand (BOD)	21.46	4.15	21.11	2.96	2.96	2.17	0.89	27%	26%
	Total Phosphorus (TP)	0.53	0.15	0.53	0.14	0.08	0.11	0.04	23%	4%
	Total Dissolved Phosphorus (TDP)	0.04	0.02	0.04	0.02	0.05	0.01	0.01	30%	-21%
pH and Total Coliform	pH (expressed in SU)	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	NA	NA	NA	NA	NA	NA	NA	NA	NA


Burlington International Airport National Weather Service Station
2011 - Daily Weather Data
Precipitation (inches)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
8/17/11
8/27/11
9/6/11
9/16/11
9/26/11
10/6/11
10/16/11
10/26/11
Storm 1 - 1.25"
(9/29/11)
Storm 2 - 0.15"
(10/20/11)
Precipitation
Cumulative Precipitation
Sampled Storm


Burlington International Airport National Weather Service Station
2012 - Daily Weather Data
Precipitation (inches)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
4/1/12
4/11/12
4/21/12
5/1/12
5/11/12
5/21/12
5/31/12
6/10/12
6/20/12
6/30/12
Storm 5 - 0.20'
(6/12/12)
Storm 4 - 0.49"
(5/30/12)
Storm Z2 - 0.39"
(6/25/12)
Storm 3 - 0.35"
(4/26/12)
Storm Z1 - 0.20"
(5/16/12)
Precipitation
Cumulative Precipitation
Sampled Storm


City of South Burlington BMP Testing
2011 Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
Storm 1 - 1.27"
(9/29/11)
Storm 2 - 0.15"
(10/20/11)
8/9/11
8/16/11
8/23/11
8/30/11
9/6/11
9/13/11
9/20/11
9/27/11
10/4/11
10/11/11
10/18/11
10/25/11
11/1/11
11/8/11
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled


City of South Burlington BMP Testing
2012 Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
Storm 3 - 0.35"
(4/26/12)
Storm 4 - 0.49"
(5/30/12)
Storm 5 - 0.20"
(6/12/12)
Storm Z1 - 0.20'
(5/16/12)
Storm Z2 - 0.39'
(6/25/12)
4/15/12
4/22/12
4/29/12
5/6/12
5/13/12
5/20/12
5/27/12
6/3/12
6/10/12
6/17/12
6/24/12
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled

City of South Burlington
Stormwater Utility

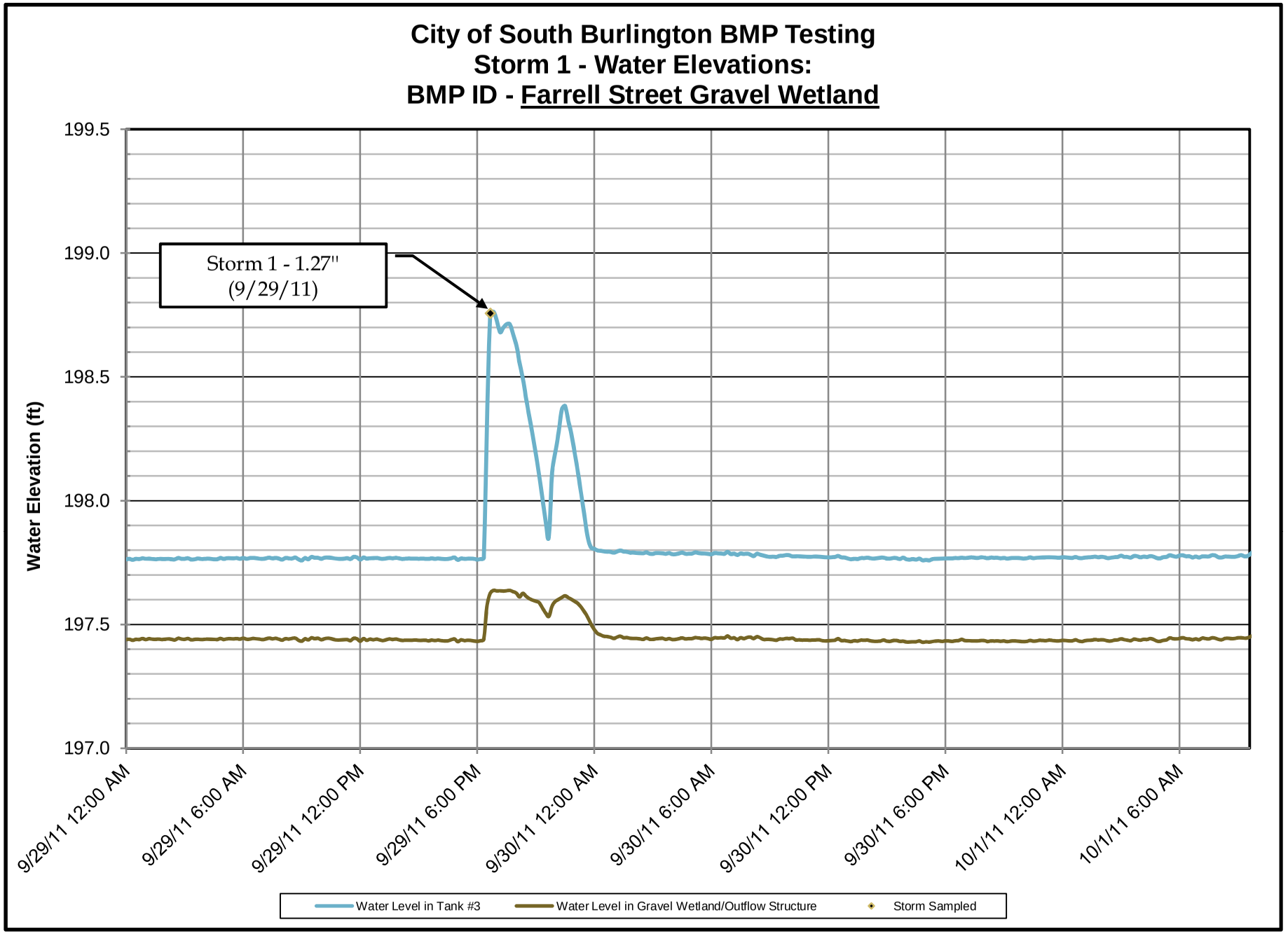
BMP Testing Pollutant Report Data Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	9/29/2011	**Sampled By**	SEM (VHB)
Start Time	6:25 PM	**End Time**	11:31 PM
Precipitation Total (measured at Pond by Autosamplers)	1.27 inches	**Sample #**	1
Precipitation Total (measured at BTV)	1.25 inches		
Total Inflow (cf)	3,267	**Wetalnd Outlet Flow (cf)**	1,938
Tank 3 Inflow (cf)	3,267	**Inlet 3 Primary Outflow (cf)** (inflow to wetland)	2,238
Wetland Storage (cf)	300	**Inlet 3 Overflow (cf)** (to stream)	729

Notes:
15 minute autosampler interval

Photos: #3336 through 2340

Category	Pollutant	Method	Tank 1 Concentraton (mg/l) (system inflow)	Tank 1 Load (lbs)	Tank 3 Concentraton (mg/l) (wetland inflow)	Tank 3 Primary Load (lbs) (wetland inflow)	Tank 3 Overflow Load (lbs) (to stream)	Wetland Outlet Concentration (mg/l)	Wetland Outlet Load (lbs)	Load Removed (lbs) (by wetland)	Percent Removal		
											Wetland Removal Rate	Tank 1 to Tank 3 Removal Rate	Total System Removal Rate
Metals	Iron (Fe) Total	EPA 200.7	10	2.04	17	2.37	0.77	1.6	0.19	2.18	92%	-54%	53%
	Iron (Fe) Dissolved	EPA 200.7	0.51	0.10	1.3	0.18	0.06	< 0.020	0.002	0.18	99%	-131%	41%
	Copper (Cu) Total	EPA 200.7	< 0.020	0.004	0.02	0.003	0.001	< 0.020	0.002	0.0004	13%	9.2%	18%
	Copper (Cu) Dissolved	EPA 200.7	< 0.020	0.004	< 0.020	0.003	0.001	< 0.020	0.002	0.0004	13%	9.2%	18%
	Zinc (Zn) Total	EPA 200.7	0.076	0.02	0.094	0.01	0.00	0.024	0.003	0.01	78%	-12.3%	54%
	Zinc (Zn) Dissolved	EPA 200.7	0.0065	0.00	0.005	0.0007	0.0002	< 0.020	0.002	-0.002	-246%	30%	-100%
Inorganic Analyses	Total Suspended Solids (TSS)	SM18 2540D	350	71.28	540	75.33	24.54	32	3.87	71	95%	-40%	60%
	Chloride (Cl) Total	EPA 300.0	2.9	0.59	3.1	0.43	0.14	3.20	0.39	0.05	10.6%	3%	11%
	Nitrate (NO_3)- Total Nitrogen (TN)	EPA 300.0	0.064	0.01	0.077	0.01	0.00	0.073	0.01	0.00	17.9%	-9%	5%
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2	1.8	0.37	3.3	0.46	0.15	0.65	0.08	0.38	83%	-66%	38%
	Biochemical Oxygen Demand (BOD)	SM18 5210B	17	3.46	19	2.65	0.86	4.80	0.58	2.07	78%	-2%	58%
	Total Phosphorus (TP)	EPA 365.1	0.55	0.11	0.85	0.12	0.04	0.12	0.01	0.10	88%	-40%	53%
	Total Dissolved Phosphorus (TDP)	EPA 365.1	0.059	0.01	0.12	0.02	0.01	0.042	0.01	0.01	70%	-85%	12%
Total Coliform	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	SM18 9223B	2400	489	1,990	278	90	> 2400	289.93	-12.32	-4%	25%	22%
Field Parameters	pH (expressed in SU)	-	6.8	---	6.67	---	---	7.04	---	---	---	---	---
	Conductivity (µs)	-	141	---	159.2	---	---	135.6	---	---	---	---	---
	Turbidity (NTU)	-	160	---	277	---	---	92	---	---	---	---	---
	Temperature (°C)	-	15.1	---	17.1	---	---	15.0	---	---	---	---	---


City of South Burlington BMP Testing
Storm 1 - Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
Storm 1 - 1.27"
(9/29/11)
9/29/11 12:00 AM
9/29/11 6:00 AM
9/29/11 12:00 PM
9/29/11 6:00 PM
9/30/11 12:00 AM
9/30/11 6:00 AM
9/30/11 12:00 PM
9/30/11 6:00 PM
10/1/11 12:00 AM
10/1/11 6:00 AM
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled

City of South Burlington
Stormwater Utility

BMP Testing Pollutant Report Data Sheet

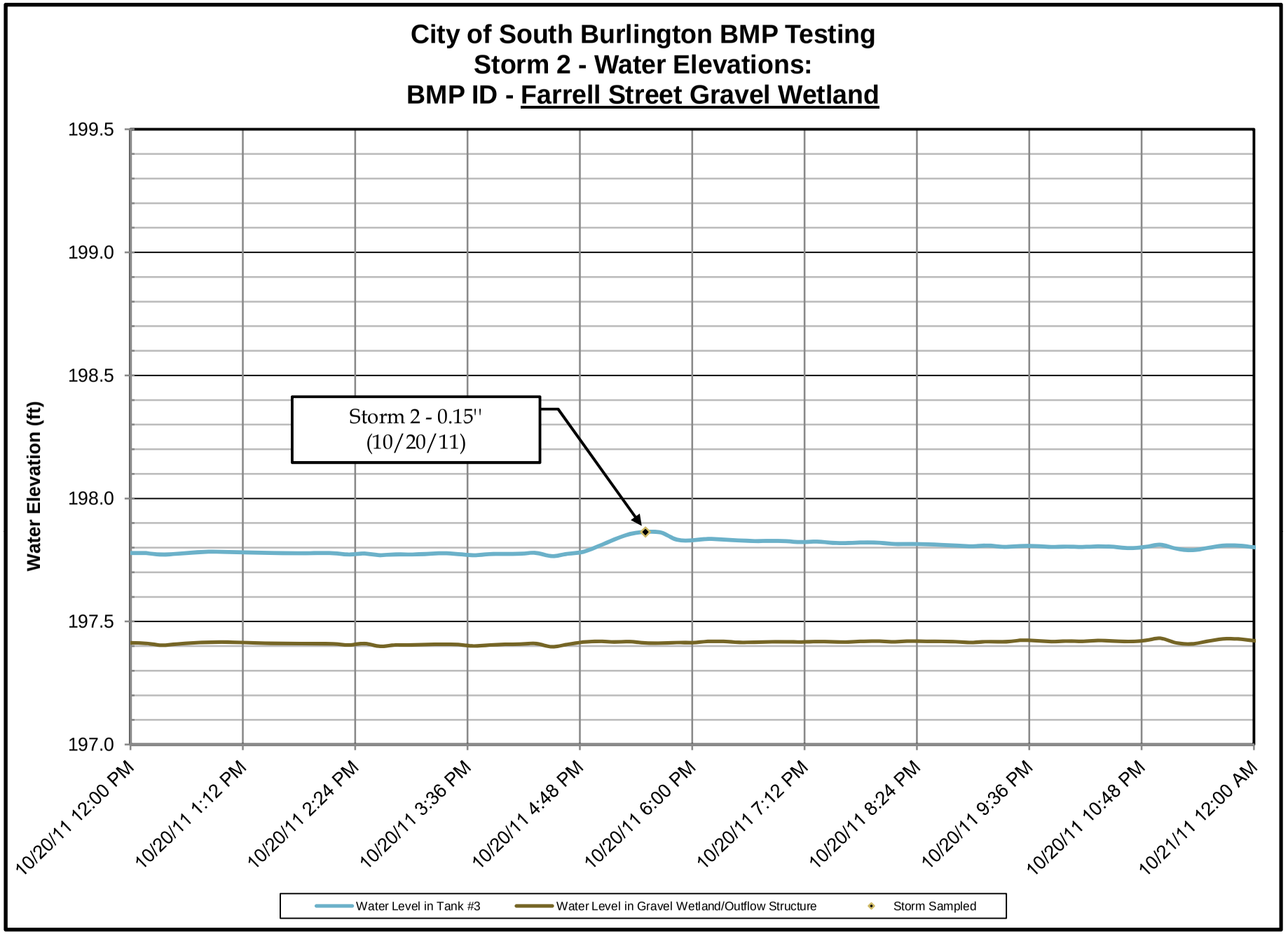
BMP ID	Farrell Street Gravel Wetland		
Storm Date	10/20/2011	**Sampled By**	SEM (VHB)
Start Time	10/20/11 4:40 PM	**End Time**	10/20/11 11:18 PM
Precipitation Total (measured at Pond by Autosamplers)	0.15 inches	**Sample #**	2
Precipitation Total (measured at BTV)	0.20 inches		
Total Inflow (cf)	18	**Wetalnd Outlet Flow (cf)**	6
Drop Inlet 3 Inflow (cf)	18	**Inlet 3 Primary Outflow (cf)** (inflow to wetland)	18
Wetland Storage (cf)	18	**Inlet 3 Overflow (cf)** (to stream)	0

Notes:
15 minute autosampler interval
Both samplers full after 25/26 samples. Collection triggered at ~16:32. Sample bottles were visably much clearer at wetland outlet - inlet samples had visable scum and cloudy.

Photos: 1598 & 1599

Category	Pollutant	Method	Tank 1 Concentraton (mg/l) (system inflow)	Tank 1 Load (lbs)	Tank 3 Concentraton (mg/l) (wetland inflow)	Tank 3 Primary Load (lbs) (wetland inflow)	Tank 3 Overflow Load (lbs) (to stream)	Wetland Outlet Concentration (mg/l)	Wetland Outlet Load (lbs)	Load Removed (lbs) (by wetland)	Percent Removal		
											Wetland Removal Rate	Tank 1 to Tank 3 Removal Rate	Total System Removal Rate
Metals	Iron (Fe) Total	EPA 200.7	15	0.02	5.5	0.01	0	0.19	0.00	0.01	99%	63%	100%
	Iron (Fe) Dissolved	EPA 200.7	4.8	0.01	0.99	0.00	0	0.033	0.000	0.00	99%	79.4%	100%
	Copper (Cu) Total	EPA 200.7	0.020	0.000	< 0.020	0.000	0	< 0.020	0.000	0.00	66.7%	0.0%	67%
	Copper (Cu) Dissolved	EPA 200.7	< 0.020	0.000	< 0.020	0.000	0	< 0.020	0.000	0.00	66.7%	0.0%	67%
	Zinc (Zn) Total[1]	EPA 200.7	0.071	0.00	0.022	0.00	0	0	0.000	0.00	0%	100%	100%
	Zinc (Zn) Dissolved[1]	EPA 200.7	0.14	0.00	0.120	0.000	0	0	0.000	0.00	0%	100%	100%
Inorganic Analyses	Total Suspended Solids (TSS)	SM18 2540D	190	0.21	130	0.15	0	2	0.00	0	99%	32%	100%
	Chloride (Cl) Total	EPA 300.0	< 5	0.01	2.8	0.00	0	< 2.5	0.00	0.00	70.2%	44%	83%
	Nitrate (NO_3)- Total Nitrogen (TN)	EPA 300.0	0.04	0.00	0.078	0.00	0	0.13	0.00	0.00	44.4%	-95%	-8%
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2	4.6	0.01	2.9	0.00	0	0.27	0.00	0.00	97%	37%	98%
	Biochemical Oxygen Demand (BOD)	SM18 5210B	35	0.04	5.6	0.01	0	< 2.0	0.00	0.01	88%	84%	98%
	Total Phosphorus (TP)	EPA 365.1	0.34	0.00	0.41	0.00	0	0.078	0.00	0.00	94%	-21%	92%
	Total Dissolved Phosphorus (TDP)	EPA 365.1	0.02	0.00	0.13	0.00	0	0.058	0.00	0.00	85%	-550%	3%
Total Coliform	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	SM18 9223B	> 24,000	27	> 24,000	27	0	11,000	4.11	23	85%	0%	85%
Field Parameters	pH (expressed in SU)	-	6.91	---	7.25	---	---	7.40	---	---	---	---	---
	Conductivity (µs)	-	291	---	174	---	---	153.0	---	---	---	---	---
	Turbidity (NTU)	-	163	---	62	---	---	1.80	---	---	---	---	---
	Temperature (°C)	-	10.9	---	10.8	---	---	11.0	---	---	---	---	---

[1]Zinc concentrations from similar storm Z2 (6/25/12)


City of South Burlington BMP Testing
Storm 2 - Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
Storm 2 - 0.15''
(10/20/11)
10/20/11 12:00 PM
10/20/11 1:12 PM
10/20/11 2:24 PM
10/20/11 3:36 PM
10/20/11 4:48 PM
10/20/11 6:00 PM
10/20/11 7:12 PM
10/20/11 8:24 PM
10/20/11 9:36 PM
10/20/11 10:48 PM
10/21/11 12:00 AM
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled

City of South Burlington
Stormwater Utility

BMP Testing Pollutant Report Data Sheet

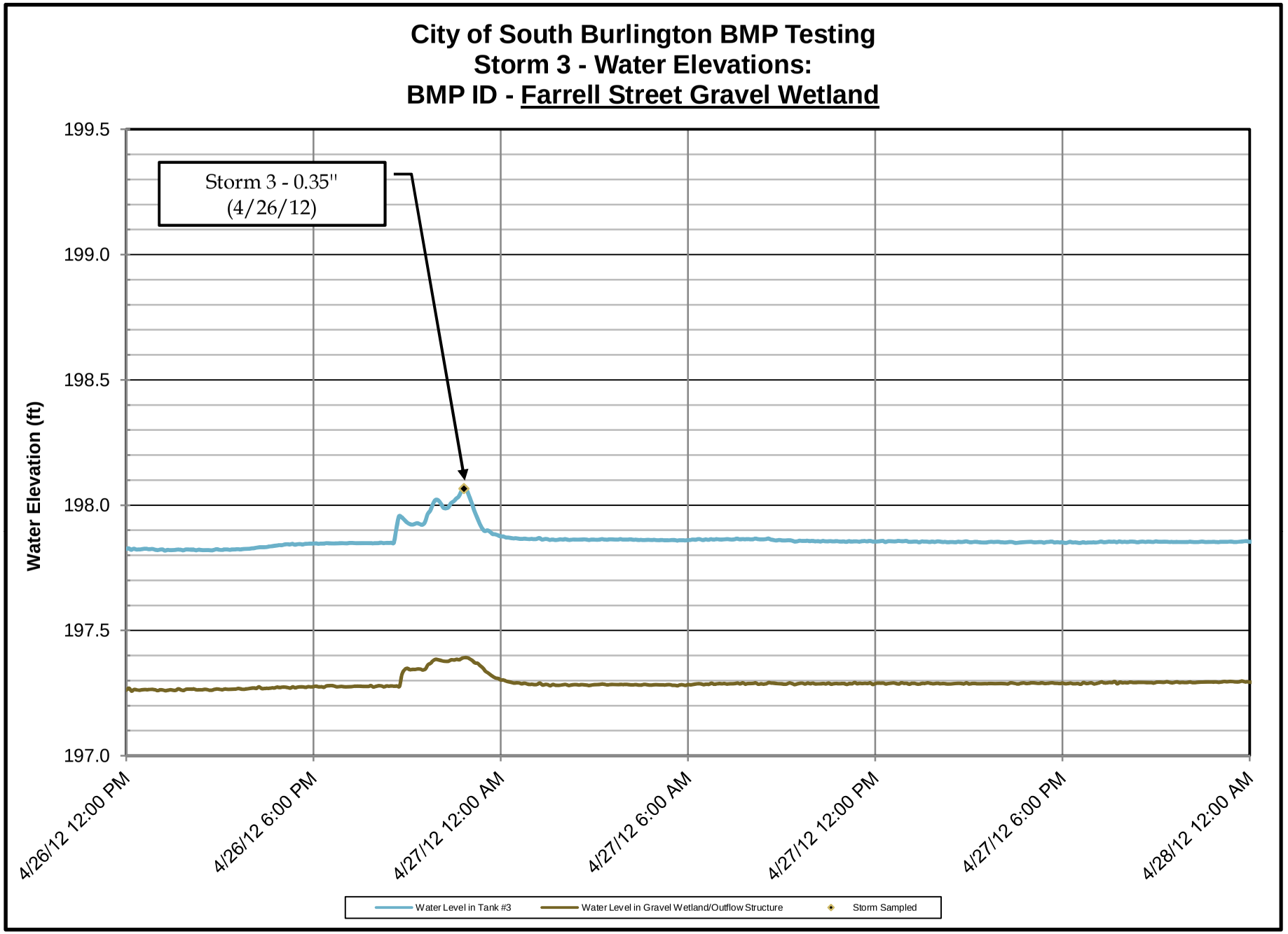
BMP ID	Farrell Street Gravel Wetland		
Storm Date	4/26/2012	**Sampled By**	SEM (VHB)
Start Time	4/26/12 9:46 PM	**End Time**	4/27/12 12:00 AM
Precipitation Total (measured at Pond by Autosamplers)	0.33	**Sample #**	3
Precipitation Total (measured at BTV)	0.35		
Total Inflow (cf)	621	**Wetalnd Outlet Flow (cf)**	312
Drop Inlet 3 Inflow (cf)	621	**Inlet 3 Primary Outflow (cf)** (inflow to wetland)	336
Wetland Storage (cf)	135	**Inlet 3 Overflow (cf)** (to stream)	0

Notes:
10 minute sampling interval. Wetland inlet batter died, grab sample collected before taking to Endyne. Autosampler set to start collecting after 0.20 inches of rain.

Photos: none

Category	Pollutant	Method	Tank 1 Concentraton (mg/l) (system inflow)	Tank 1 Load (lbs)	Tank 3 Concentraton (mg/l) (wetland inflow)	Tank 3 Primary Load (lbs) (wetland inflow)	Tank 3 Overflow Load (lbs) (to stream)	Wetland Outlet Concentration (mg/l)	Wetland Outlet Load (lbs)	Load Removed (lbs) (by wetland)	Percent Removal		
											Wetland Removal Rate	Tank 1 to Tank 3 Removal Rate	Total System Removal Rate
Metals	Iron (Fe) Total	EPA 200.7	7.6	0.29	3.0	0.06	0	0.25	0.005	0.0580	92%	79%	98%
	Iron (Fe) Dissolved	EPA 200.7	0.21	0.01	0.16	0.003	0	0.360	0.007	-0.0037	-109%	58.8%	13.9%
	Copper (Cu) Total	EPA 200.7	< 0.020	0.001	< 0.020	0.000	0	< 0.020	0.000	0.0000	7%	45.9%	49.8%
	Copper (Cu) Dissolved	EPA 200.7	< 0.020	0.001	< 0.020	0.000	0	< 0.020	0.000	0.0000	7%	45.9%	49.8%
	Zinc (Zn) Total[1]	EPA 200.7	0.35	0.02	0.069	0.00	0	< 0.020	0.0004	0.0006	62%	83.1%	86.2%
	Zinc (Zn) Dissolved[1]	EPA 200.7	0.13	0.01	0.060	0.001	0	< 0.090	0.002	-0.0009	-97%	60.5%	49.1%
Inorganic Analyses	Total Suspended Solids (TSS)	SM18 2540D	230	8.90	50	1.05	0	5	0.10	1	91%	88%	99%
	Chloride (Cl) Total	EPA 300.0	51	1.97	12.0	0.25	0	27	0.53	-0.27	-108.9%	87%	73%
	Nitrate (NO_3)- Total Nitrogen (TN)	EPA 300.0	0.43	0.02	0.45	0.01	0	0.070	0.00	0.01	85.6%	43%	92%
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2	2.7	0.10	0.82	0.02	0	0.57	0.01	0.01	35%	84%	89%
	Biochemical Oxygen Demand (BOD)	SM18 5210B	7.3	0.28	4.1	0.09	0	3.80	0.07	0.01	14%	70%	74%
	Total Phosphorus (TP)	EPA 365.1	0.35	0.01	0.17	0.00	0	0.06	0.00	0.00	67%	74%	91%
	Total Dissolved Phosphorus (TDP)	EPA 365.1	0.04	0.00	0.06	0.00	0	0.05	0.00	0.00	23%	19%	37%
Total Coliform	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	SM18 9223B	30000	1161	21,000	440	0	> 201	3.91	435.93	99%	62%	100%
Field Parameters	pH (expressed in SU)	SM18 4500-H B	7.58	---	7.57	---	---	7.23	---	---	---	---	---
	Conductivity (µs)	-	174	---	93	---	---	153	---	---	---	---	---
	Turbidity (NTU)	-	309	---	111	---	---	6.7	---	---	---	---	---
	Temperature (°C)	-	6.2	---	6.90	---	---	6.5	---	---	---	---	---

[1]Zinc concentrations from similar storm Z1 (5/16/12)


City of South Burlington BMP Testing
Storm 3 - Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Storm 3 - 0.35"
(4/26/12)
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
4/26/12 12:00 PM
4/26/12 6:00 PM
4/27/12 12:00 AM
4/27/12 6:00 AM
4/27/12 12:00 PM
4/27/12 6:00 PM
4/28/12 12:00 AM
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled

City of South Burlington
Stormwater Utility

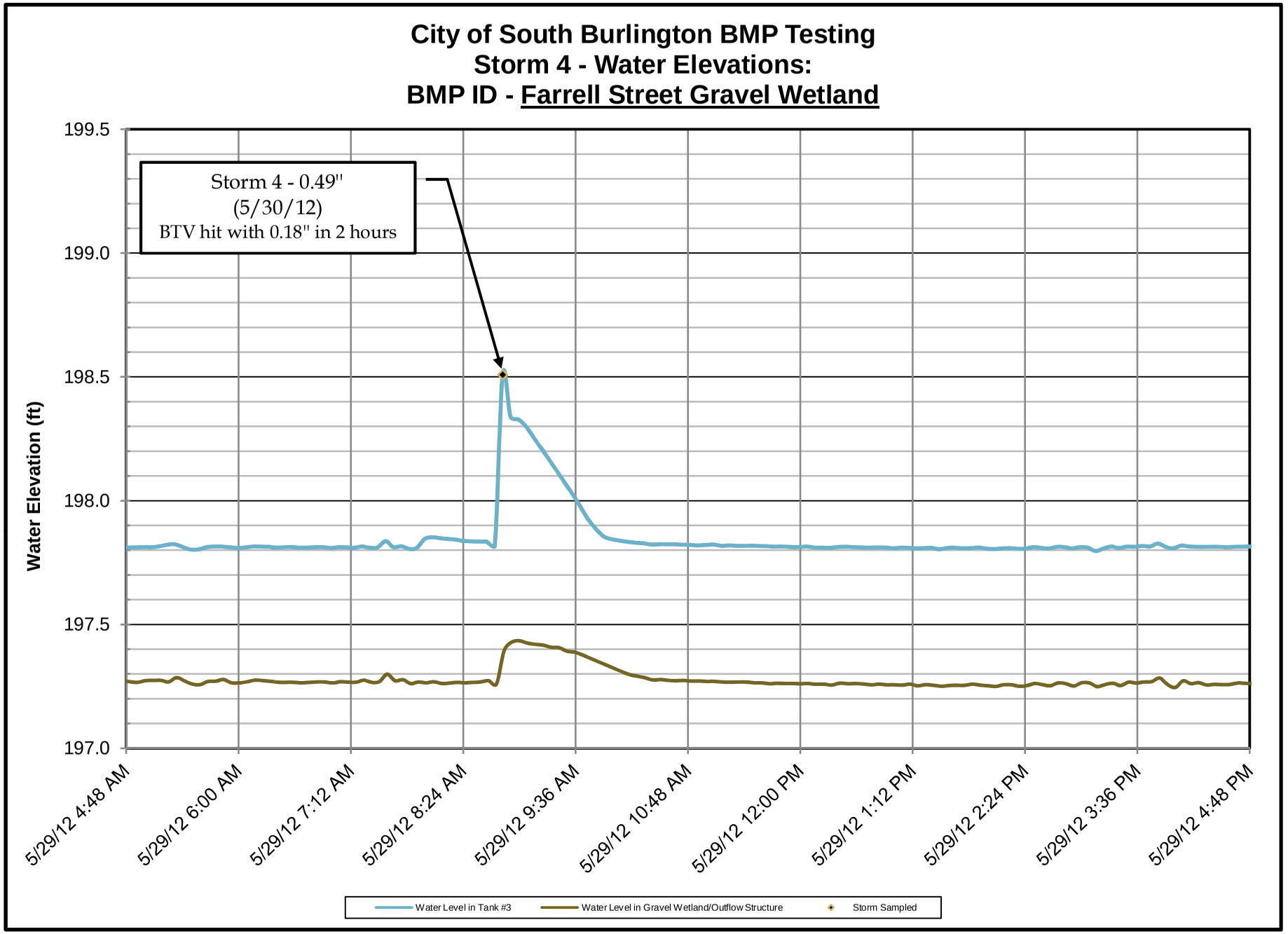
BMP Testing Pollutant Report Data Sheet

BMP ID	Farrell Street Gravel Wetland		
Storm Date	5/30/2012	**Sampled By**	SEM (VHB)
Start Time	5/30/12 7:00 AM	**End Time**	5/30/12 4:00 PM
Precipitation Total (measured at Pond by Autosamplers)	NA (manually tripped based on BTV data)	**Sample #**	4
Precipitation Total (measured at BTV)	0.49		
Total Inflow (cf)	606	**Wetalnd Outlet Flow (cf)**	201
Drop Inlet 3 Inflow (cf)	606	**Inlet 3 Primary Outflow (cf)** (inflow to wetland)	536
Wetland Storage (cf)	335	**Inlet 3 Overflow (cf)** (to stream)	70

Notes:
10 minute sampling inverval (0.2L per sample). Sample manually tripped at 7AM with new batteries. Outlet full after 36 samples

Photos:

											Percent Removal		
Category	**Pollutant**	**Method**	**Tank 1 Concentraton (mg/l)** (system inflow)	**Tank 1 Load (lbs)**	**Tank 3 Concentrat on (mg/l)** (wetland inflow)	**Tank 3 Primary Load (lbs)** (wetland inflow)	**Tank 3 Overflow Load (lbs)** (to stream)	**Wetland Outlet Concentration (mg/l)**	**Wetland Outlet Load (lbs)**	**Load Removed (lbs)** (by wetland)	**Wetland Removal Rate**	**Tank 1 to Tank 3 Removal Rate**	**Total System Removal Rate**
Metals	Iron (Fe) Total	EPA 200.7	17	0.64	9.0	0.30	0.04	0.29	0.00	0.04	99%	47%	93%
	Iron (Fe) Dissolved	EPA 200.7	0.14	0.01	0.16	0.005	0.00	0.03	0.000	0.00	93%	-14.3%	80%
	Copper (Cu) Total	EPA 200.7	< 0.020	0.00	< 0.020	0.001	0.000	< 0.020	0.000	0.00	62.5%	0.0%	55%
	Copper (Cu) Dissolved	EPA 200.7	< 0.020	0.00	< 0.020	0.001	0.000	< 0.020	0.000	0.00	62.5%	0.0%	55%
	Zinc (Zn) Total	EPA 200.7	0.11	0.00	0.062	0.00	0.00	< 0.020	0.000	0.00	88%	43.6%	87%
	Zinc (Zn) Dissolved	EPA 200.7	0.11	0.00	0.120	0.004	0.001	0.081	0.001	0.00	75%	-9.1%	63%
Inorganic Analyses	Total Suspended Solids (TSS)	SM18 2540D	510	19.27	200	6.68	0.87	4	0.05	1	99%	61%	95%
	Chloride (Cl) Total	EPA 300.0	65	2.46	38	1.27	0.17	14	0.18	-0.01	86.2%	42%	86%
	Nitrate (NO_3)- Total Nitrogen (TN)	EPA 300.0	< 0.020	0.00	< 0.020	0.00	0.00	0.190	0.00	0.00	-256.2%	0%	-227%
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2	2.9	0.11	2.0	0.07	0.01	0.53	0.01	0.00	90%	31%	86%
	Biochemical Oxygen Demand (BOD)	SM18 5210B	9	0.34	6.6	0.22	0.03	< 2.0	0.03	0.00	89%	27%	84%
	Total Phosphorus (TP)	EPA 365.1	0.73	0.03	0.46	0.02	0.00	0.092	0.00	0.00	93%	37%	89%
	Total Dissolved Phosphorus (TDP)	EPA 365.1	0.053	0.00	0.029	0.00	0.00	0.054	0.00	0.00	30%	45%	60%
Total Coliform	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	SM18 9223B	200,000	7555	92,000	3074	401	> 24,000	300.70	100.73	90%	54%	91%
Field Parameters	pH (expressed in SU)	-	7.59	---	7.67	---	---	7.81	---	---	---	---	---
	Conductivity (µs)	-	380	---	304	---	---	307	---	---	---	---	---
	Turbidity (NTU)	-	650	---	300	---	---	5.2	---	---	---	---	---
	Temperature (°C)	-	24	---	26.0	---	---	29.5	---	---	---	---	---


City of South Burlington BMP Testing
Storm 4 - Water Elevations:
BMP ID - Farrell Street Gravel Wetland
Storm 4 - 0.49"
(5/30/12)
BTV hit with 0.18" in 2 hours
Water Elevation (ft)
199.5
199.0
198.5
198.0
197.5
197.0
5/29/12 4:48 AM
5/29/12 6:00 AM
5/29/12 7:12 AM
5/29/12 8:24 AM
5/29/12 9:36 AM
5/29/12 10:48 AM
5/29/12 12:00 PM
5/29/12 1:12 PM
5/29/12 2:24 PM
5/29/12 3:36 PM
5/29/12 4:48 PM
Water Level in Tank #3
Water Level in Gravel Wetland/Outflow Structure
Storm Sampled

City of South Burlington
Stormwater Utility

BMP Testing Pollutant Report Data Sheet

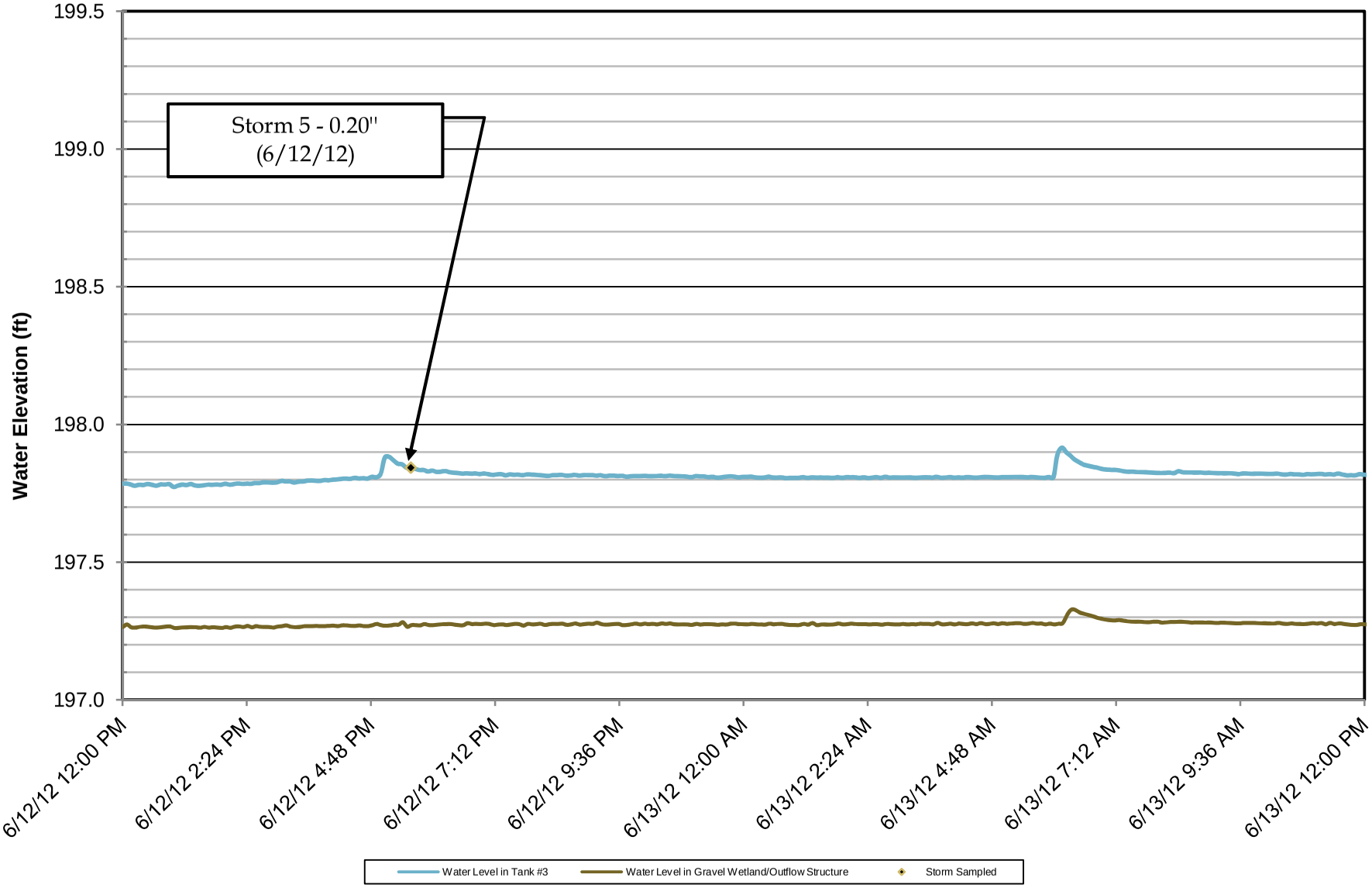
BMP ID	Farrell Street Gravel Wetland		
Storm Date	6/12/2012	**Sampled By**	SEM (VHB)
Start Time	6/12/12 4:53 PM	**End Time**	6/13/12 12:20 AM
Precipitation Total (measured at Pond by Autosamplers)	0.25	**Sample #**	5
Precipitation Total (measured at BTV)	0.20		
Total Inflow (cf)	9	**Wetalnd Outlet Flow (cf)**	0
Drop Inlet 3 Inflow (cf)	9	**Inlet 3 Primary Outflow (cf)** (inflow to wetland)	0
Wetland Storage (cf)	9	**Inlet 3 Overflow (cf)** (to stream)	0

Notes:
10 minute samling interval. Auto sampler set to trip at 0.10 inches

Photos:

											Percent Removal		
Category	**Pollutant**	**Method**	**Tank 1 Concentraton (mg/l)** (system inflow)	**Tank 1 Load (lbs)**	**Tank 3 Concentraton (mg/l)** (wetland inflow)	**Tank 3 Primary Load (lbs)** (wetland inflow)	**Tank 3 Overflow Load (lbs)** (to stream)	**Wetland Outlet Concentration (mg/l)**	**Wetland Outlet Load (lbs)**	**Load Removed (lbs)** (by wetland)	**Wetland Removal Rate**	**Tank 1 to Tank 3 Removal Rate**	**Total System Removal Rate**
Metals	Iron (Fe) Total	EPA 200.7	26	0.01	3.90	0	0	0.37	0	0.00	0%	100%	100%
	Iron (Fe) Dissolved	EPA 200.7	0.64	0.0004	0.41	0	0	0.12	0	0.00	0%	100%	100%
	Copper (Cu) Total	EPA 200.7	< 0.020	0.00001	< 0.020	0	0	< 0.020	0	0.00	0.0%	100%	100%
	Copper (Cu) Dissolved	EPA 200.7	< 0.020	0.00001	< 0.020	0	0	< 0.020	0	0.00	0.0%	100%	100%
	Zinc (Zn) Total	EPA 200.7	0.14	0.0001	0.057	0	0	< 0.020	0	0.00	0%	100%	100%
	Zinc (Zn) Dissolved	EPA 200.7	0.15	0.0001	0.120	0	0	0.11	0	0.00	0%	100%	100%
Inorganic Analyses	Total Suspended Solids (TSS)	SM18 2540D	750	0.42	87	0	0	< 2	0	0	0%	100%	100%
	Chloride (Cl) Total	EPA 300.0	140	0.08	74	0	0	45	0	0.00	0.0%	100%	100%
	Nitrate (NO_3)- Total Nitrogen (TN)	EPA 300.0	< 0.020	0.00	< 0.020	0	0	0.730	0	0.00	0.0%	100%	100%
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2	5.7	0.00	1.9	0	0	1.20	0	0.00	0%	100%	100%
	Biochemical Oxygen Demand (BOD)	SM18 5210B	39	0.02	7	0	0	2.20	0	0.00	0%	100%	100%
	Total Phosphorus (TP)	EPA 365.1	0.7	0.00	0.20	0	0	0.07	0	0.00	0%	100%	100%
	Total Dissolved Phosphorus (TDP)	EPA 365.1	< 0.005	0.00	0.01	0	0	0.041	0	0.00	0%	100%	100%
Total Coliform	Total Coliform w/ E. Coli (expressed in MPN/100 ml)	SM18 9223B	> 2420	1	> 2420	0	0	2000	0	0.00	0%	100%	100%
Field Parameters	pH (expressed in SU)	-	7.24	---	7.46	---	---	7.79	---	---	---	---	---
	Conductivity (µs)	-	0.605	---	339	---	---	314	---	---	---	---	---
	Turbidity (NTU)	-	650	---	90	---	---	3.6	---	---	---	---	---
	Temperature (°C)	-	18.3	---	18.3	---	---	18.6	---	---	---	---	---

City of South Burlington BMP Testing
Storm 5 - Water Elevations:
BMP ID - Farrell Street Gravel Wetland



City of South Burlington
Stormwater Utility

Pounds Removed	9/10/11 to 10/26/11					4/10/12 to 6/30/12			TOTAL REMOVED
	5 storms similar to Storm 1		3 storms similar to Storm 2		Sub-Total Removed (lbs)	11 average storms		Sub-Total Removed (lbs)	
	Removed by Gravel Wetland	Removed by Tanks	Removed by Gravel Wetland	Removed by Tanks		Removed by Gravel Wetland	Removed by Tanks		
Iron (Fe) Total	2.2	0.00	0.01	0.01	**11**	0.36	0.60	**11**	21
Iron (Fe) Dissolved	0.18	0.00	0.001	0.004	**0.9**	0.002	0.009	**0.13**	1
Copper (Cu) Total	0.0004	0.00	0.00	0.000	**0.002**	0.0005	0.0005	**0.01**	0
Copper (Cu) Dissolved	0.0004	0.00	0.00	0.0000	**0.002**	0.0005	0.0005	**0.01**	0
Zinc (Zn) Total	0.01	0.00	0.00	0.0001	**0.1**	0.002	0.022	**0.27**	0
Zinc (Zn) Dissolved	0.0	0.00	0.00	0.0002	**0.0004**	0.002	0.007	**0.10**	0
Total Suspended Solids (TSS)	71.5	0.00	0	0.07	**358**	8	21	**315**	673
Chloride (Cl) Total	0.0	0.16	0.00	0.00	**1.03**	0.8	3.0	**42**	43
Nitrate (NO_3)- Total Nitrogen (TN)	0.0	0.00	0.00	0.00	**0.01**	0.01	0.01	**0.15**	0
Total Kjeldahl Nitrogen (TKN)	0.4	0.00	0.00	0.00	**1.92**	0.07	0.14	**2.25**	4
Biochemical Oxygen Demand (BOD)	2.1	0.81	0.01	0.03	**14.5**	0.21	0.37	**6.42**	21
Total Phosphorus (TP)	0.1	0.00	0.00	0.00	**0.52**	0.02	0.02	**0.44**	1
Total Dissolved Phosphorus (TDP)	0.0	0.00	0.00	0.00	**0.06**	0.001	0.001	**0.02**	0
Total Coliform w/ E. Coli (expressed in MPN/100 ml)	0	211.14	23	0.00	**1101**	3232	5204	**92794**	93896

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: Not Indicated
WORK ORDER: **1109-14492**
DATE RECEIVED: September 30, 2011
DATE REPORTED: October 19, 2011
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and “N” the Plattsburgh, NY lab under certification ELAP 11892. “Sub” indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. “A” indicates the referenced laboratory is NELAC accredited for the parameter reported. “N” indicates the laboratory is not accredited. “U” indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an “A” meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 10/19/2011

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Not Indicated

WORK ORDER: **1109-14492**
DATE RECEIVED 09/30/2011

001 Site: Wetland Inlet — Date Sampled: 9/30/11 Time: 8:45

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	1990	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
e. coli	1700	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
BOD-5day	19	mg/L	SM18 5210B	9/30/11	15:24	W JSS	A	
Chloride	3.1	mg/L	EPA 300.0	9/30/11		W CM	A	
Nitrate as N	0.077	mg/L	EPA 300.0	9/30/11	15:19	W CM	A	
TKN	3.3	mg/L	EPA 351.2	10/6/11		N PDH	A	
Phosphorus, Total Dissolved	0.12	mg/L	EPA 365.1	10/13/11		W AM	A	
Phosphorus, Total	0.85	mg/L	EPA 365.1	10/13/11		W AM	A	
Solids, Total Suspended	540	mg/L	SM18 2540D	10/4/11		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	10/18/11		W ETK	A	
Copper, Total	0.02	mg/L	EPA 200.7	10/5/11		W ETK	A	
Iron, Dissolved	1.3	mg/L	EPA 200.7	10/18/11		W ETK	A	
Iron, Total	17	mg/L	EPA 200.7	10/5/11		W ETK	A	
Zinc, Dissolved	0.005	mg/L	EPA 200.7	10/18/11		W ETK	A	
Zinc, Total	0.094	mg/L	EPA 200.7	10/5/11		W ETK	A	

002 Site: Swale Inlet — Date Sampled: 9/29/11 Time: 21:58

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	2400	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
e. coli	2400	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
BOD-5day	17	mg/L	SM18 5210B	9/30/11	15:30	W JSS	A	
Chloride	2.9	mg/L	EPA 300.0	9/30/11		W CM	A	
Nitrate as N	0.064	mg/L	EPA 300.0	9/30/11	15:37	W CM	A	
TKN	1.8	mg/L	EPA 351.2	10/6/11		N PDH	A	
Phosphorus, Total Dissolved	0.058	mg/L	EPA 365.1	10/14/11		W AM	A	
Phosphorus, Total	0.55	mg/L	EPA 365.1	10/14/11		W AM	A	
Solids, Total Suspended	350	mg/L	SM18 2540D	10/4/11		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	10/18/11		W ETK	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	10/5/11		W ETK	A	
Iron, Dissolved	0.51	mg/L	EPA 200.7	10/18/11		W ETK	A	
Iron, Total	10	mg/L	EPA 200.7	10/5/11		W ETK	A	
Zinc, Dissolved	0.0065	mg/L	EPA 200.7	10/18/11		W ETK	A	
Zinc, Total	0.076	mg/L	EPA 200.7	10/5/11		W ETK	A	

003 Site: Outlet — Date Sampled: 9/29/11 Time: 18:25

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	> 2400	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
e. coli	1000	MPN/100ml	SM18 9223B	9/30/11	11:00	W RJL	N	
BOD-5day	4.8	mg/L	SM18 5210B	9/30/11	15:33	W JSS	A	
Chloride	3.2	mg/L	EPA 300.0	9/30/11		W CM	A	

Laboratory Report

DATE REPORTED: 10/19/2011

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Not Indicated

WORK ORDER: **1109-14492**
DATE RECEIVED 09/30/2011

003 Site: Outlet Date Sampled: 9/29/11 Time: 18:25

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Nitrate as N	0.073	mg/L	EPA 300.0	9/30/11 15:54	W CM	A	
TKN	0.65	mg/L	EPA 351.2	10/6/11	N PDH	A	
Phosphorus, Total Dissolved	0.042	mg/L	EPA 365.1	10/14/11	W AM	A	
Phosphorus, Total	0.12	mg/L	EPA 365.1	10/14/11	W AM	A	
Solids, Total Suspended	32	mg/L	SM18 2540D	10/4/11	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	10/18/11	W ETK	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	10/5/11	W ETK	A	
Iron, Dissolved	0.075	mg/L	EPA 200.7	10/18/11	W ETK	A	
Iron, Total	1.6	mg/L	EPA 200.7	10/5/11	W ETK	A	
Zinc, Dissolved	< 0.020	mg/L	EPA 200.7	10/18/11	W ETK	A	
Zinc, Total	0.024	mg/L	EPA 200.7	10/5/11	W ETK	A	

Report Summary of Qualifiers and Notes

EPA standards dictate that sample filtration be performed within 15 miuntes of sample collection. Sample Filtration was performed as soon as possible upon arrival at the Laboratory.

HTE: The holding time for the analysis of coliform and ecoli in non-potable water is 6 hours. Regulatory samples are deemed invalid after the hold time has expired, however, Endyne will report qualified non-compliance samples that exceed the hold time since the user may obtain useful information depending on the end use of the data.

smanley@vhb.com

ENDYNE, INC.

160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

54613

Special Reporting Instructions/PO#: 57406.01

Project Name:	Client/Contact Name: VHB	Sampler Name: Scott Manley
	Phone #: 802-425-7788	Phone #: 802-425-7788
State of Origin: VT ✓ NY __ NH __ Other __	Mailing Address:	Billing Address: VHB
Endyne WO # 1109-14492		

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
Wetland Inlet			X	9/30/11 8:45	5		Ice	2, 5, 6, 7, 8, 9, 12, 17, 31	17= 7/Ecoli total	
Swale Inlet			X	9/29/11 21:58	↓		↓	↓	↓	
Outlet			X	9/29/11 18:23	↓		↓	↓	↓	

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
Scott Manley	9/30/11 9:50			Eileen Toomey	9/30/11 9:50

1	pH	(6)	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
(2)	Chloride	(7)	Total P	(12)	TSS	(17)	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	(8)	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	(9)	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
(5)	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
(31)	Metals (Total) (Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, (Cu) (Fe) Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, (Zn)										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 6.8
Comment: On ice

(White - Laboratory / Yellow - Client)

Page ____ of ____

37

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: SBBMP
WORK ORDER: **1110-15776**
DATE RECEIVED: October 21, 2011
DATE REPORTED: November 21, 2011
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 11/21/2011

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP

WORK ORDER: **1110-15776**
DATE RECEIVED 10/21/2011

001 Site: Outlet — Date Sampled: 10/20/11 Time: 16:32

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Total Coliform	11,000	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
e. coli	13	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
BOD-5day	< 2.0	mg/L	SM18 5210B	10/21/11 14:57	W JSS	A	
Chloride	< 2.5	mg/L	EPA 300.0	10/21/11	W CM	A	
Nitrate as N	0.13	mg/L	EPA 300.0	10/21/11 13:14	W CM	A	
TKN	0.27	mg/L	EPA 351.2	10/31/11	N PDH	A	
Phosphorus, Total Dissolved	0.058	mg/L	EPA 365.1	11/1/11	W AM	A	
Phosphorus, Total	0.078	mg/L	EPA 365.1	11/1/11	W AM	A	
Solids, Total Suspended	2	mg/L	SM18 2540D	10/26/11	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Dissolved	0.033	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Total	0.19	mg/L	EPA 200.7	11/14/11	W ETK	A	

002 Site: Wetland Inlet — Date Sampled: 10/20/11 Time: 16:40

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Total Coliform	> 24,000	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
e. coli	17,000	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
BOD-5day	5.6	mg/L	SM18 5210B	10/21/11 15:00	W JSS	A	
Chloride	2.8	mg/L	EPA 300.0	10/21/11	W CM	A	
Nitrate as N	0.078	mg/L	EPA 300.0	10/21/11 13:31	W CM	A	
TKN	2.9	mg/L	EPA 351.2	10/31/11	N PDH	A	
Phosphorus, Total Dissolved	0.13	mg/L	EPA 365.1	11/1/11	W AM	A	
Phosphorus, Total	0.41	mg/L	EPA 365.1	11/1/11	W AM	A	
Solids, Total Suspended	130	mg/L	SM18 2540D	10/26/11	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Dissolved	0.99	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Total	5.5	mg/L	EPA 200.7	11/14/11	W ETK	A	

003 Site: Swale Inlet — Date Sampled: 10/20/11 Time: 18:28

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Total Coliform	> 24,000	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
e. coli	178	MPN/100ml	SM18 9223B	10/21/11 16:10	W KMB	N	
BOD-5day	35	mg/L	SM18 5210B	10/21/11 15:04	W JSS	A	
Chloride	< 5.0	mg/L	EPA 300.0	10/21/11	W CM	A	
Nitrate as N	0.040	mg/L	EPA 300.0	10/21/11 13:49	W CM	A	
TKN	4.6	mg/L	EPA 351.2	10/31/11	N PDH	A	
Phosphorus, Total Dissolved	0.020	mg/L	EPA 365.1	11/1/11	W AM	A	
Phosphorus, Total	0.34	mg/L	EPA 365.1	11/1/11	W AM	A	

Laboratory Report

DATE REPORTED: 11/21/2011

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP

WORK ORDER: **1110-15776**
DATE RECEIVED 10/21/2011

003 Site: Swale Inlet Date Sampled: 10/20/11 Time: 18:28

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Solids, Total Suspended	190	mg/L	SM18 2540D	10/26/11	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Copper, Total	0.020	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Dissolved	4.8	mg/L	EPA 200.7	11/14/11	W ETK	A	
Iron, Total	15	mg/L	EPA 200.7	11/14/11	W ETK	A	

Report Summary of Qualifiers and Notes

EPA standards dictate that sample filtration be performed within 15 miuntes of sample collection. Sample Filtration was performed as soon as possible upon arrival at the Laboratory.

Smanley@VHB.com

ENDYNE, INC.

160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

55461

Special Reporting Instructions/PO#: 57406.01

Project Name: SB BMP	Client/Contact Name: VHB	Sampler Name: Scott Martin
State of Origin: VT ✓ NY __ NH __ Other __	Phone #: 802-425-7788	Phone #: 802-425-7788
Endyne WO # 1110-15776	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
Outlet			X	10/20/11 16:32	5		Ice	2,5,6,7,8,9, 12,17,31	17=EColi total	
Wetland Inlet			X	10/20/11 16:40	↓		↓	↓		
Swale Inlet			X	10/20/11 18:38	↓		↓	↓		

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
Scott Martin	10-21-11 8:51			Eileen Pomroy	10/21 @ 8:55

1	pH	(6)	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
(2)	Chloride	(7)	Total P	(12)	TSS	(17)	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	(8)	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	(9)	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
(5)	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
(31)	Metals ((Total) (Diss)) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, (Cu) Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 5.0
Comment:

(White - Laboratory / Yellow - Client)

Page ____ of ____

41

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: Storm Water
WORK ORDER: **1204-05729**
DATE RECEIVED: April 27, 2012
DATE REPORTED: May 16, 2012
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 05/16/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Storm Water

WORK ORDER: **1204-05729**
DATE RECEIVED 04/27/2012

001 Site: Outlet — Date Sampled: 4/26/12 Time: 21:21

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	> 201	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN1
e. coli	18	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN1
BOD-5day	3.8	mg/L	SM18 5210B	4/27/12	14:30	W JSS	A	
Chloride	27	mg/L	EPA 300.0	4/27/12		W CM	A	
Nitrate as N	0.070	mg/L	EPA 300.0	4/27/12	16:52	W CM	A	
TKN	0.57	mg/L	EPA 351.2	5/10/12		N JGM	A	
pH	7.23	SU at 22C	SM18 4500-H B	4/30/12	15:43	W JSS	U	
Phosphorus, Total Dissolved	0.05	mg/L	EPA 365.1	5/3/12		N JGM	A	
Phosphorus, Total	0.06	mg/L	EPA 365.1	5/3/12		N JGM	A	
Solids, Total Suspended	5	mg/L	SM18 2540D	5/1/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	5/7/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	5/7/12		W LJF	A	
Iron, Dissolved	0.036	mg/L	EPA 200.7	5/7/12		W LJF	A	
Iron, Total	0.25	mg/L	EPA 200.7	5/7/12		W LJF	A	

002 Site: Wetland Inlet — Date Sampled: 4/27/12 Time: 8:30

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	21,000	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN2
e. coli	160	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN2
BOD-5day	4.1	mg/L	SM18 5210B	4/27/12	14:32	W JSS	A	
Chloride	12	mg/L	EPA 300.0	4/27/12		W CM	A	
Nitrate as N	0.45	mg/L	EPA 300.0	4/27/12	17:49	W CM	A	
TKN	0.82	mg/L	EPA 351.2	5/10/12		N JGM	A	
pH	7.57	SU at 22C	SM18 4500-H B	4/30/12	15:45	W JSS	U	
Phosphorus, Total Dissolved	0.06	mg/L	EPA 365.1	5/3/12		N JGM	A	
Phosphorus, Total	0.17	mg/L	EPA 365.1	5/3/12		N JGM	A	
Solids, Total Suspended	50	mg/L	SM18 2540D	5/1/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	5/7/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	5/7/12		W LJF	A	
Iron, Dissolved	0.16	mg/L	EPA 200.7	5/7/12		W LJF	A	
Iron, Total	3.0	mg/L	EPA 200.7	5/7/12		W LJF	A	

003 Site: Swale Inlet — Date Sampled: 4/26/12 Time: 21:46

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	30,000	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN1
e. coli	300	MPN/100ml	SM18 9223B	4/27/12	13:40	W KMB	N	AN1
BOD-5day	7.3	mg/L	SM18 5210B	4/27/12	14:34	W JSS	A	
Chloride	51	mg/L	EPA 300.0	4/27/12		W CM	A	
Nitrate as N	0.43	mg/L	EPA 300.0	4/27/12	20:26	W CM	A	
TKN	2.7	mg/L	EPA 351.2	5/10/12		N JGM	A	

Laboratory Report

DATE REPORTED: 05/16/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Storm Water

WORK ORDER: **1204-05729**
DATE RECEIVED 04/27/2012

003 Site: Swale Inlet Date Sampled: 4/26/12 Time: 21:46

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
pH	7.58	SU at 21.9C	SM18 4500-H B	4/30/12 15:43	W JSS	U	
Phosphorus, Total Dissolved	0.04	mg/L	EPA 365.1	5/3/12	N JGM	A	
Phosphorus, Total	0.35	mg/L	EPA 365.1	5/3/12	N JGM	A	
Solids, Total Suspended	230	mg/L	SM18 2540D	5/1/12	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	5/7/12	W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	5/7/12	W LJF	A	
Iron, Dissolved	0.21	mg/L	EPA 200.7	5/7/12	W LJF	A	
Iron, Total	7.6	mg/L	EPA 200.7	5/7/12	W LJF	A	

Report Summary of Qualifiers and Notes

AN1: Sample was received and analyzed past Method specified holding times for Total coliform bacteria and E. coli. Sample was incubated over the method-specified 24 hours. Therefore, total coliform results may be biased high.

AN2: Sample was incubated over the method-specified 24 hours. Therefore, total coliform results may be biased high.

Smanley@VHB.com

≡ ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

Special Reporting Instructions/PO#: 57406.01

№ 60454

Project Name: Stormwater State of Origin: VT ✓ NY __ NH __ Other __	Client/Contact Name: VHB Phone #: 802 425 7788	Sampler Name: Scott Manley Phone #: 802 425 7788
Endyne WO # 1204-05729	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
outlet			✓	4-26-12 21:21		[illegible]	Ice	1,2,5,6,7,8,9,12,17,31	17=E.Coli total	
Wetland Inlet			✓	4-27-12 8:30				↓		
Swale Inlet			✓	4-26-12 21:46				✓		

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
[signature]	4-27-12 9:33			Eleen Poomey	4/27@9:40

(1)	pH	(6)	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
(2)	Chloride	(7)	Total P	(12)	TSS	(17)	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	(8)	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	(9)	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
(5)	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
(31)	Metals ((Total), (Diss.)) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, (Cu), (Fe), Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 1.3
Comment:

(White - Laboratory / Yellow - Client)

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: SBBMP FSGW
WORK ORDER: **1205-07490**
DATE RECEIVED: May 30, 2012
DATE REPORTED: June 28, 2012
SAMPLER: Scott

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 06/28/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP FSGW

WORK ORDER: **1205-07490**
DATE RECEIVED 05/30/2012

001 Site: Swale Inlet — Date Sampled: 5/30/12 Time: 7:00

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	200,000	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
e. coli	400	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
BOD-5day	9.0	mg/L	SM18 5210B	5/31/12	15:03	W JSS	A	
Chloride	65	mg/L	EPA 300.0	5/31/12		W CM	A	
Nitrate as N	< 0.020	mg/L	EPA 300.0	5/31/12	12:12	W CM	A	
TKN	2.9	mg/L	EPA 351.2	6/4/12		N JGM	A	
Phosphorus, Total Dissolved	0.053	mg/L	EPA 365.1	6/4/12		W AM	A	AN1
Phosphorus, Total	0.73	mg/L	EPA 365.1	6/4/12		W AM	A	
Solids, Total Suspended	510	mg/L	SM18 2540D	6/1/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/19/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/14/12		W RJL	A	
Iron, Dissolved	0.14	mg/L	EPA 200.7	6/19/12		W LJF	A	
Iron, Total	17	mg/L	EPA 200.7	6/25/12		W LJF	A	
Zinc, Dissolved	0.11	mg/L	EPA 200.7	6/19/12		W LJF	A	
Zinc, Total	0.11	mg/L	EPA 200.7	6/14/12		W RJL	A	

002 Site: Wetland Inlet — Date Sampled: 5/30/12 Time: 7:00

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	92,000	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
e. coli	190	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
BOD-5day	6.6	mg/L	SM18 5210B	5/31/12	15:06	W JSS	A	
Chloride	38	mg/L	EPA 300.0	5/31/12		W CM	A	
Nitrate as N	< 0.020	mg/L	EPA 300.0	5/31/12	11:34	W CM	A	
TKN	2.0	mg/L	EPA 351.2	6/4/12		N JGM	A	
Phosphorus, Total Dissolved	0.029	mg/L	EPA 365.1	6/4/12		W AM	A	AN1
Phosphorus, Total	0.46	mg/L	EPA 365.1	6/4/12		W AM	A	
Solids, Total Suspended	200	mg/L	SM18 2540D	6/1/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/19/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/14/12		W RJL	A	
Iron, Dissolved	0.16	mg/L	EPA 200.7	6/19/12		W LJF	A	
Iron, Total	9.0	mg/L	EPA 200.7	6/14/12		W RJL	A	
Zinc, Dissolved	0.12	mg/L	EPA 200.7	6/19/12		W LJF	A	
Zinc, Total	0.062	mg/L	EPA 200.7	6/14/12		W RJL	A	

003 Site: Outlet — Date Sampled: 5/30/12 Time: 7:00

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	> 24,000	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
e. coli	9	MPN/100ml	SM18 9223B	5/30/12	17:55	W KMB	N	HTE
BOD-5day	< 2.0	mg/L	SM18 5210B	5/31/12	15:14	W JSS	A	
Chloride	14	mg/L	EPA 300.0	5/31/12		W CM	A	

Laboratory Report

DATE REPORTED: 06/28/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP FSGW

WORK ORDER: **1205-07490**
DATE RECEIVED 05/30/2012

003 Site: Outlet Date Sampled: 5/30/12 Time: 7:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Nitrate as N	0.19	mg/L	EPA 300.0	5/31/12 11:53	W CM	A	
TKN	0.53	mg/L	EPA 351.2	6/4/12	N JGM	A	
Phosphorus, Total Dissolved	0.054	mg/L	EPA 365.1	6/4/12	W AM	A	
Phosphorus, Total	0.092	mg/L	EPA 365.1	6/4/12	W AM	A	
Solids, Total Suspended	4	mg/L	SM18 2540D	6/1/12	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/19/12	W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/14/12	W RJL	A	
Iron, Dissolved	0.030	mg/L	EPA 200.7	6/19/12	W LJF	A	
Iron, Total	0.29	mg/L	EPA 200.7	6/14/12	W RJL	A	
Zinc, Dissolved	0.081	mg/L	EPA 200.7	6/19/12	W LJF	A	
Zinc, Total	< 0.020	mg/L	EPA 200.7	6/14/12	W RJL	A	

Report Summary of Qualifiers and Notes

HTE: The holding time for the analysis by enumeration of coliform and ecoli in non-potable water is 6 hours. Regulatory samples are deemed invalid after the hold time has expired, however, Endyne will report qualified non-compliance samples that exceed the hold time since the user may obtain useful information depending on the end use of the data.

AN1: The digestion blank for this sample set was elevated at 0.008 mg/L. Subsequent blank later in the run was acceptable indicating some temporary contination of the system.

ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

~~Scott~~ Smanley@VHB.com

54614

Special Reporting Instructions/PO#: 57406.01

Project Name: SBB4P BGW	Client/Contact Name: VHB	Sampler Name: Scott Manley
State of Origin: VT ✓ NY __ NH __ Other __	Phone #: 8024257788	Phone #: 8024257788
Endyne WO # 1205-07490	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
Swale Inlet			X	5-30-12 7AM	5		Ice	2,5,6,7,8,9,12,14,31	31 Ecoltel	
Wetland Inlet			↓	↓	↓		↓	↓		
Outlet			↓	↓	↓		↓	↓		
				each site						
				1/2 gal						
				16oz		✓			metals not field filtered	
				8oz glass	✓					
				8oz plastic						
				100mL						

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
[signature]	5-30-12 17:08			Ellen Dooney	5/30 @ 5:10

1	pH	6	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
2	Chloride	7	Total P	12	TSS	17	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	8	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	9	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
5	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
31	Metals (Total, Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 4.7
Comment:

(White - Laboratory / Yellow - Client)

Page ____ of ____

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.	
PO Box 120	090395
N. Ferrisburgh, VT 05473	
Atten: Scott Manley	

PROJECT: SBBMP FSGW
WORK ORDER: **1206-08263**
DATE RECEIVED: June 13, 2012
DATE REPORTED: June 28, 2012
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 06/28/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP FSGW

WORK ORDER: **1206-08263**
DATE RECEIVED 06/13/2012

001 Site: Swale Inlet — Date Sampled: 6/12/12 Time: 16:53

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	> 2420	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
e. coli	220	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
BOD-5day	39	mg/L	SM18 5210B	6/13/12	13:01	W JSS	A	
Chloride	140	mg/L	EPA 300.0	6/13/12		W KMB	A	
Nitrate as N	< 0.020	mg/L	EPA 300.0	6/13/12	10:50	W KMB	A	
TKN	5.7	mg/L	EPA 351.2	6/19/12		N JGM	A	
Phosphorus, Total Dissolved	< 0.005	mg/L	EPA 365.1	6/19/12		W AM	A	
Phosphorus, Total	0.70	mg/L	EPA 365.1	6/19/12		W AM	A	
Solids, Total Suspended	750	mg/L	SM18 2540D	6/14/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/26/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/26/12		W LJF	A	
Iron, Dissolved	0.64	mg/L	EPA 200.7	6/26/12		W LJF	A	
Iron, Total	26	mg/L	EPA 200.7	6/26/12		W LJF	A	
Zinc, Dissolved	0.15	mg/L	EPA 200.7	6/26/12		W LJF	A	
Zinc, Total	0.14	mg/L	EPA 200.7	6/26/12		W LJF	A	

002 Site: Wetland Inlet — Date Sampled: 6/12/12 Time: 18:45

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	> 2420	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
e. coli	79	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
BOD-5day	7	mg/L	SM18 5210B	6/13/12	13:09	W JSS	A	
Chloride	74	mg/L	EPA 300.0	6/13/12		W KMB	A	
Nitrate as N	< 0.020	mg/L	EPA 300.0	6/13/12	11:29	W KMB	A	
TKN	1.9	mg/L	EPA 351.2	6/19/12		N JGM	A	
Phosphorus, Total Dissolved	0.010	mg/L	EPA 365.1	6/19/12		W AM	A	
Phosphorus, Total	0.20	mg/L	EPA 365.1	6/19/12		W AM	A	
Solids, Total Suspended	87	mg/L	SM18 2540D	6/14/12		W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/26/12		W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/26/12		W LJF	A	
Iron, Dissolved	0.41	mg/L	EPA 200.7	6/26/12		W LJF	A	
Iron, Total	3.9	mg/L	EPA 200.7	6/26/12		W LJF	A	
Zinc, Dissolved	0.12	mg/L	EPA 200.7	6/26/12		W LJF	A	
Zinc, Total	0.057	mg/L	EPA 200.7	6/26/12		W LJF	A	

003 Site: Outlet — Date Sampled: 6/12/12 Time: 16:39

Parameter	Result	Units	Method	Analysis Date/Time		Lab/Tech	NELAC	Qual.
Total Coliform	2,000	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
e. coli	< 1	MPN/100ml	SM18 9223B	6/13/12	11:56	W AM	N	
BOD-5day	2.2	mg/L	SM18 5210B	6/13/12	13:15	W JSS	A	
Chloride	45	mg/L	EPA 300.0	6/13/12		W KMB	A	

Laboratory Report

DATE REPORTED: 06/28/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: SBBMP FSGW

WORK ORDER: **1206-08263**
DATE RECEIVED 06/13/2012

003 Site: Outlet — Date Sampled: 6/12/12 Time: 16:39

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Nitrate as N	0.73	mg/L	EPA 300.0	6/13/12 11:48	W KMB	A	
TKN	1.2	mg/L	EPA 351.2	6/19/12	N JGM	A	
Phosphorus, Total Dissolved	0.041	mg/L	EPA 365.1	6/19/12	W AM	A	
Phosphorus, Total	0.068	mg/L	EPA 365.1	6/19/12	W AM	A	
Solids, Total Suspended	< 2	mg/L	SM18 2540D	6/14/12	W AM	A	
Copper, Dissolved	< 0.020	mg/L	EPA 200.7	6/26/12	W LJF	A	
Copper, Total	< 0.020	mg/L	EPA 200.7	6/26/12	W LJF	A	
Iron, Dissolved	0.12	mg/L	EPA 200.7	6/26/12	W LJF	A	
Iron, Total	0.37	mg/L	EPA 200.7	6/26/12	W LJF	A	
Zinc, Dissolved	0.11	mg/L	EPA 200.7	6/26/12	W LJF	A	
Zinc, Total	< 0.020	mg/L	EPA 200.7	6/26/12	W LJF	A	

ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

Special Reporting Instructions/PO#: 57406.01

№ 59760

Project Name:	Client/Contact Name: VHB	Sampler Name: Scott Manley
	Phone #: 802-425-7788	Phone #: 802-425-7788
State of Origin: VT ✓ NY __ NH __ Other __	Mailing Address:	Billing Address:
Endyne WO # 1206-0526 3		

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
Wetland Inlet			X	6-12-12 16:45	5		Ice		17 tot-1 Ecoli	
Swale Inlet			↓	6-12-12 16:53	↓					
Outlet			↓	6-12-12 16:39	↓					

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
Scott Manley	6-13-12 6:59			Laura Hartman	6/13/12 9:00

1	pH	6	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
2	Chloride	7	Total P	12	TSS	17	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	8	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	9	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
5	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
31	Metals (Total) (Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 5.1
Comment: Ecoli expired
GM

(White - Laboratory / Yellow - Client)

Page ____ of ____

53

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: Storm Water
WORK ORDER: **1205-06853**
DATE RECEIVED: May 17, 2012
DATE REPORTED: June 12, 2012
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 06/12/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Storm Water

WORK ORDER: **1205-06853**
DATE RECEIVED 05/17/2012

001 Site: Outlet — Date Sampled: 5/16/12 Time: 18:33

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Zinc, Dissolved	< 0.090	mg/L	EPA 200.7	6/5/12	W LJF	A	RL
Zinc, Total	< 0.020	mg/L	EPA 200.7	6/5/12	W LJF	A	

002 Site: Wetland Inlet — Date Sampled: 5/16/12 Time: 18:33

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Zinc, Dissolved	0.060	mg/L	EPA 200.7	6/5/12	W LJF	A	
Zinc, Total	0.069	mg/L	EPA 200.7	6/5/12	W LJF	A	

003 Site: Swale — Date Sampled: 5/16/12 Time: 18:36

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Zinc, Dissolved	0.13	mg/L	EPA 200.7	6/5/12	W LJF	A	
Zinc, Total	0.35	mg/L	EPA 200.7	6/5/12	W LJF	A	

Report Summary of Qualifiers and Notes

Samples received in this project required filtration for Dissolved Metals. The EPA hold time for filtration is 15 minutes and should be performed at the time of collection. Analysis was performed as soon as possible upon arrival at the laboratory.

RL: Reporting limit increased due to apparent sample contamination during the sample filtration process.

ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

SmanleyeVHB.com

55464

Special Reporting Instructions/PO#: 57406.01

Project Name: Storm Water	Client/Contact Name: VHB	Sampler Name: Scott Manley
State of Origin: VT ✓ NY __ NH __ Other __	Phone #: 8024257788	Phone #:
Endyne WO # 1205-06853	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
outlet	ww		✓	5-16-12 18:33	1	80z	Ice	31		
Wetland Inlet	↓		↓	↓ 18:33	↓	↓	↓	↓		
Swale Inlet	↓		↓	↓ 18:36	↓	↓	↓	↓		

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
Scott Manley	5/17 8:15			Eileen Rooney	5/17 @8:15

1	pH	6	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
2	Chloride	7	Total P	12	TSS	17	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	8	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	9	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
5	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
31	Metals (Total, Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 0.9
Comment:

(White - Laboratory / Yellow - Client)

Page ____ of ____

ENDYNE Inc.
Environmental Laboratories

Vanasse Hangen Brustlin, Inc.
PO Box 120 090395
N. Ferrisburgh, VT 05473

PROJECT: Storm Water
WORK ORDER: **1206-09024**
DATE RECEIVED: June 26, 2012
DATE REPORTED: July 17, 2012
SAMPLER: Scott Manley

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corresponding NELAC and Qual fields.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report

DATE REPORTED: 07/17/2012

CLIENT: Vanasse Hangen Brustlin, Inc.
PROJECT: Storm Water

WORK ORDER: **1206-09024**
DATE RECEIVED 06/26/2012

001 Site: Swale Inlet — Date Sampled: 6/25/12 Time: 19:36

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Zinc, Dissolved	0.14	mg/L	EPA 200.7	7/13/12	W LJF	A	
Zinc, Total	0.071	mg/L	EPA 200.7	7/9/12	W LJF	A	

002 Site: Wetland Inlet — Date Sampled: 6/25/12 Time: 19:36

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
Zinc, Dissolved	0.12	mg/L	EPA 200.7	7/13/12	W LJF	A	
Zinc, Total	0.022	mg/L	EPA 200.7	7/9/12	W LJF	A	

ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

smankeyeVHB.com

Special Reporting Instructions/PO#: 57406.01

№ 61177

Project Name:	Client/Contact Name: VHB	Sampler Name: Scott Manley
State of Origin: VT ✓ NY __ NH __ Other __	Phone #: 8024257788	Phone #:
Endyne WO # 2206-09024	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	FieldResults/Remarks	Due Date
Swale Inlet			X	6-25-12 14:30	1	8oz	Ice	31		
Wetland Inlet			X	6-25-12 14:36	1	8oz	Ice	31		

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
[signature]	6-26-12 5:38			[signature]	6/26/12 8:40

1	pH	6	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only
2	Chloride	7	Total P	12	TSS	17	Coliform (Specify)	22	8015 GRO	27	8081 Pest
3	Ammonia N	8	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB
4	Nitrite N	9	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals
5	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8
31	Metals (Total, Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn										
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other				
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other				
38	Other										

LAB USE ONLY
Delivery: Client
Temp: 2.7
Comment:

(White - Laboratory / Yellow - Client)