STORMWATER BMP IMPLEMENTATION AND MONITORING AT THE CITY OF COVINGTON

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REFERENCE: *Proceedings of the 2009 Georgia Water Resources Conference*, held April 27–29, 2009, at the University of Georgia.

Abstract The City of Covington, Georgia was awarded a 319(h) grant in fiscal year 2003 for the installation of two stormwater Best Management Practices (BMPs) at their City Hall. The approximate 2.3-acre drainage area consisted of a City parking lot used for the storage of City vehicles and equipment. Pollutants of concern were mostly sediment, oils, and greases. The stormwater runoff from the site was not previously treated through any existing BMPs. BMPs selected included a wash pad that was connected to the sanitary sewer for the cleaning of City vehicles and a proprietary stormwater treatment unit: a Vortechs® system. The grant included design and installation of these BMPs and performance monitoring for the Vortechs® system. Monitoring at the site began in January 2008 will consist of 15 storm events. While the City is completing the monitoring phase of this project, they are implementing Phase 2 of the City's BMP upgrades at this site: a bioretention parking lot and a constructed wetlands project will both begin construction in late 2008. The Vortechs® system will serve as a pre-treatment for the constructed wetlands project, which is funded through another 319(h) grant awarded in Fiscal Year 2008.

INTRODUCTION

The City of Covington (City) has been very proactive in protecting local streams and developed a Stormwater Management Program that includes stringent requirements for the collection, storage, and treatment of stormwater runoff for all new development and redevelopment based on the Georgia Stormwater Management Manual (GSMM).

The City maintains a truck maintenance yard directly behind its City Hall. This site was selected for the City's BMP demonstration project given its potential for stormwater pollution and its previously untreated stormwater discharge.

Approximately 250 linear feet (0.05 miles) of creek is located along the northeast perimeter of the site. This tributary to Dried Indian Creek is a wet-weather conveyance that exhibits bank-full peak flows during even small, frequent rain events. Dried Indian Creek is currently included on Georgia's 303(d) list for biota impairment.

SITE DESCRIPTION

Hundreds of vehicles use the City truck maintenance yard on a daily basis. The site is mostly paved and is used for vehicle storage and maintenance. The types of vehicles serve a wide range of functions, from street sweeping, refuse removal, utilities, to transporting fill dirt. Prior to this BMP project, stormwater runoff from the site was untreated.

The wide variety of materials that the trucks transport onto the site allows opportunity for many different pollutants to quickly enter the creek Existing water quality data is not available at this site, but prior to BMP installation, visual observations immediately following rain events revealed discoloration and noticeable sheens on both the asphalt parking areas and within the creek. For the site planning phase it was assumed that, due to the activities on site, oil, grease, sediments, heavy metals, and phosphorus (from detergents used for vehicle washing) were the likely potential pollutants in the site's stormwater runoff.

PROJECT GOALS

The City was awarded a Fiscal Year 2003 319(h) grant to implement a BMP demonstration project at the above site. Given the potential pollutants onsite, a Vortechs® high flow hydrodynamic separation system, manufactured by CONTECH Construction Products (CONTECH), was selected as the main site BMP. A secondary BMP, a vehicle washing station, was implemented as part of the project. The selected suite of BMPs serves to reduce the concentration of these pollutants in stormwater leaving the site and reaching the adjacent tributary to Dried Indian Creek. The final component of this project was monitoring of the Vortechs® system to verify performance.

The City decided to pursue this project for several key reasons: 1) The City is a regulated National Pollutant Discharge Elimination System (NPDES) Phase II Regulated Municipal Separated Storm Sewer System (MS4) and felt that increased treatment for this site was a necessary component to their Pollution Prevention/Good Housekeeping Program; 2) The City had implemented a Stormwater Utility and offered a credit program allowing for the community to apply for credits on their utility bill through the implementation of BMPs. To encourage the use of innovative BMPs in the City, the City wanted to implement some demonstration sites to showcase various BMP technologies; and 3) With the increase in proprietary BMPs on the market in Georgia and with the limited relevant, local test data available, the City felt that monitoring of this project would be of benefit to them and other local municipalities faced with approval of these devices for on-site stormwater treatment.

PROJECT DESIGN

The design of the BMP demonstration site was lead by Manhard Consulting, Ltd. The Vortechs® system was selected as the BMP for this project given it's already developed conditions and no available site space to integrate a traditional above-ground BMP. The Vortechs® system is a proprietary system manufactured by CONTECH. The system is a high flow hydrodynamic separation unit that uses a combination of swirl-concentrator and flow-control technologies to maximize treatment. The Vortechs® system is advertised to remove sediment particles, oil, and debris from urban runoff. These pollutants were among the key constituents at the demonstration site.

The Vortechs® system was located along the north edge of the site. The system was installed in an offline configuration intercepting drainage from approximately 2.3 acres of the site. This device was designed to provide particle retention within the unit while simultaneously preventing re-suspension of the particles. The unit is configured in a manner such that the water velocity, upon entry, is slowed through a swirl chamber and a series of baffles. Sediment particles and pollutants denser than the water sink to the bottom of the unit while oil and hydrocarbons that are less dense than water float to the top of the chamber. A reservoir that spans the width of the unit and extends almost to the bottom prohibits the floating pollutants from leaving the unit.

The wash pad with an underground concrete sediment pit was installed at the location where the trucks were typically washed onsite. This is also along the north edge of the site, but separated from the Vortechs® unit by a series of garages. The wash pad and sediment pit redirects washwater that previously discharged into the adjacent creek, directly into the sanitary sewer system, eliminating the introduction of pollutants into the waterway.

Both the Vortechs® system and the wash pad were installed in April 2006.

PROJECT MONITORING

A Quality Assurance Project Plan (QAPP) is required to be developed and approved prior to the start of the any Environmental Protection Agency (USEPA) funded project that involves the collection of environmental data. USEPA defines a QAPP as "a 'blueprint' for obtaining the type and quality of environmental data and information needed for a specific decision or use" (USEPA, 2008). The QAPP defines the project planning process, monitoring protocol, environment, collection techniques, analysis protocol and all QA/QC methods to be implemented.

The GSMM provides the State's performance expectations for pollutant removals for many BMPs, however, information for proprietary BMPs, such as the Vortechs®, is not included. The GSMM does however provide some general guidance for hydrodynamic separation devices listed under the "Oil/Grit Separator" BMP designation (GSMM, 2001). The GSMM provides some conservative average pollutant reduction percentages for design purposes, but advises, "Field testing data and pollutant removal rates from an independent source should be obtained before using a proprietary gravity separator system." (ARC, 2001).

The performance expectation values provided by the GSMM are empirical, however the error statistics for these values are not given, which limits their usefulness for a performance evaluations such as this monitoring project. To compensate, an error of 20% was assumed based upon the accepted precision standards according to the approved QAPP and 95% confidence intervals accordingly calculated for removal expectations. Specific pollutant removal expectations for the monitoring evaluation are listed in Table 1. Fecal Coliform and Heavy Metals are also listed in the GSMM but were not included as part of this evaluation.

Table 1. Specific pollutant removal expectations of hydrodynamic separation systems such as the Vortechs® according to GSMM. Standard error was derived assuming an acceptable error of 20%.

Analyte	Removal Expectation (%)	Assumed Std. Dev. (%)	95% Conf. Int. for Removal Expectation (%)
Total Suspended Solids	40	8	24 to 56
Total Phosphorus	5	1	3 to 7
Total Nitrogen	5	1	3 to 7

The City submitted the project's QAPP for Georgia Environmental Protection Division (EPD) and USEPA review and approval in June 2006. Given the Federal priorities involving response to the severe hurricane season of 2006, there were delays in the typical review process. The City received Conditional Approval of the QAPP along with comments from USEPA in October 2007. The comments were addressed and the QAPP was re-submitted to USEPA and GA EPD in January 2008.

Water quality monitoring was covered under the grant for a period of seven months. The original goal for the monitoring component of this project was collection of ten sampling events. Given the drought conditions of 2008, ten events were not collected within this time frame. Due to the significance of the data being collected, the City decided to extend the monitoring beyond the end of the grant contract and provide for 13 rainfall events. CONTECH plans to collect an additional two events, with the help of the City staff, for a total of 15 sampled events.

Monitoring of the Vortechs® was initiated on December 13, 2007 with full maintenance of the system and installation of all monitoring equipment. All monitoring equipment is stored on site in a shed specifically designed for storage of the automatic samplers, telemetry equipment, associated hardware and additional sample bottles. A 0.01-inch tipping bucket rain gage was also installed at the monitoring site and is linked to the automatic samplers. Photos of the monitoring shed and installed rain gage can be seen in Figure 1. Flow in the system is measured using a low profile area-velocity flow probe installed in the effluent pipe. Only effluent flow data is being collected due to the hydraulics of the Vortechs® system which makes it difficult to accurately measure flow without altering the influent conveyance system.

Figure 1. Monitoring equipment shed (left) and rain gage (right) as installed at the monitoring site.

During maintenance of the system it was determined that the conjunction manhole located between the inlet grate and the Vortechs® was acting as an upstream sump, resulting in the settling and collection of materials prior to entering the system. In an effort to promote the transport of all solids to the Vortechs® during monitoring the manhole was filled with a matrix of large gravel and cinderblocks and topped with a false floor made of ½-inch think concrete. Photos of the manhole before and after installation of the false floor can be seen in Figure 2. All alterations to the manhole are temporary and will be removed following completion of all monitoring activities.

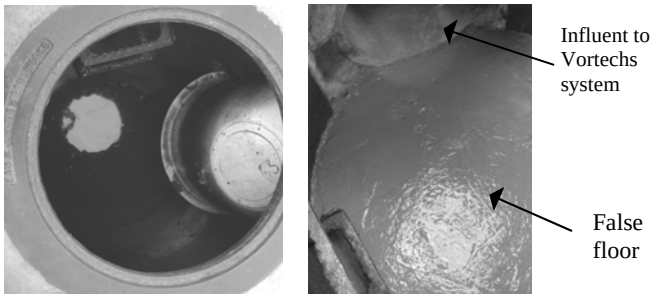

Figure 2. Original configuration of the upstream manhole (left). The down-turned elbow was removed prior to installation of false floor. Modified manhole (right) with false floor.

Influent and effluent water quality samples were collected using automatic samplers with a two part sampling program designed to collect discrete flow-paced samples (distributed among many discrete bottles) and a field grab (single bottle) over the course of a runoff event. The field grab sample is used for oil and grease, a hydrocarbon analyte that requires collection in an amber glass container without post-processing. Following a sampling event, individual influent and effluent discrete samples are combined according to the event hydrograph to create bulk influent and effluent composite samples that represent the Event Mean Concentration (EMC) influent and effluent water quality. All EMC sub-samples are collected from the bulk composite samples using a churn splitter.

Communication and programming of the automatic samplers, associated weather watching and hydraulic data collection was performed by a CONTECH project manager located in Portland, Oregon by the use of remote telemetry equipment. Following confirmation of a qualified runoff event by CONTECH, an engineer with the City visits the site to confirm sample collection, retrieve and replace sample bottles, and reset the automatic sampling equipment in preparation for the next event.

All sample processing was performed by the City using event-specific instructions provided by CONTECH. City technicians perform sample processing, which includes preparation of a composite sample and splitting the

composite storm event into sub-samples for each specific analytical method requested. Composite samples are created for each storm through the use of a churn splitter, which is the United States Geological Survey (USGS) approved methodology for preparing composite samples.

Following sample processing, all EMC sub-samples along with the oil and grease grab samples were picked up by Test America, the specified analytical laboratory for this project.

MONITORING RESULTS

The first successful sampling event occurred on January 29, 2008. To date, a total of thirteen sampling events, representing 8.75-inches of rain, have been successfully captured. A summary of events sampled to date can be seen in Table 2. Definition of a representative stormwater sampling event for this evaluation was adopted from the Technology Acceptance and Reciprocity Partnership (TARP) protocol (TARP, 2003) as the current GSMM does not list specific representative requirements.

Table 2. Summary of sampled events captured to date for the Vortechs® monitoring.

	Representative Requirements				Other Event Characteristics		
Event Date	Coverage (nearest 10%) [minimum of 60]	Number of Aliquots [minimum of 6 (inf:eff)]	Event Depth (in) [minimum of 0.10]	Antecedent Dry Period (hr) [minimum 6-hours]	Total Runnoff Volume (gal)	Peak Flow (gpm)	Percent Operating Rate
1/29/2008	>90	6:7	0.19	166	12147	455	12%
2/17/2008	>90	6:7	0.16	113	8724	366	10%
2/21/2008	80	22:21	0.90	87	56950	647	17%
3/4/2008	90	22:21	1.36	166	48209	1948	51%
4/4/2008	60	10:10	0.41	130	33189	1360	36%
4/11/2008	>90	22:22	0.51	143	43655	1079	28%
5/9/2008	90	7:7	0.20	256	15950	1606	42%
5/11/2008	90	22:22	0.94	51	50463	2428	64%
5/20/2008	>90	11:11	0.28	44	22128	1574	41%
7/10/2008	90	18:19	0.29	16	20085	1635	43%
11/14/2008	>90	6:6	0.63	19	11101	525	14%
12/10/2008	>90	10:10	1.86	139	37252	413	11%
1/7/2009	>90	12:13	1.02	22	22613	1017	27%

The Regression of EMC (REMC) parametric statistical method is listed in the QAPP as the preferred method of evaluating performance of the Vortechs®. Total Phosphorus and Total Nitrogen data collected for the thirteen events sampled to date successfully produced a statistically significant regression using the REMC method and is shown in Figure 3. The solid black line represents the mean removal efficiency estimate and the 95% confidence interval is shown in dark grey. When a data set does not produce statistically significant results using the REMC method then the Aggregate Load Reduction (ALR) method, coupled with the Sign Test, is used to estimate the mean removal efficiency as per the QAPP. In cases where both methods fail to produce a result with confidence, a rough estimate of the mean removal efficiency can still be estimated based on the ALR method. This is currently the case for TSS, as seen in Figure 3 and represented by a think dotted line.

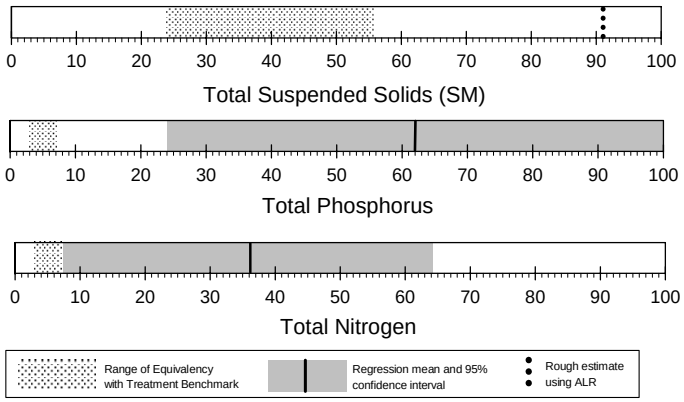

Figure 3. Preliminary removal performance observations of GSMM specified analytes for the Vortechs® evaluation at City of Covington.

LESSONS LEARNED

Many lessons were learned throughout this project. Several project delays resulted in extension of the project schedule, the most significant being the delays in QAPP approval and the extension of the monitoring period due to the drought conditions experienced in 2008. For future USEPA monitoring projects, QAPP preparation will be expedited to allow for extended review time. Additionally, sampling schedules established for monitoring projects should be extremely conservative to account for unexpected weather delays.

Other constituents of analytical methods were monitored as part of this project to help fully realize the pollutant removal capabilities of the Vortechs® unit, but were not included in this report to simplify the data for reporting purposes. One of these additional constituents/laboratory methodologies was the analysis for Total Suspended Solids (TSS) versus Suspended Solids Concentration (SSC). The analysis methodology for SSC versus TSS resulted in generally more consistent results, as the entire sample is used in the analysis as opposed to the subset used in the TSS analysis. Since the GSMM refers to TSS removal as an indicator of BMP efficiency

the constituent will be maintained in future projects, but SSC proves to be a useful monitoring constituent as well.

The summer months bring high temperatures and high humidity to Covington, Georgia and the surrounding region. These temperatures caused the ambient air within the monitoring equipment shed to become extremely hot. As a result, the top section of the automatic samplers' plastic housing became warped causing the controller heads to slump into the tops eventually inhibiting the ability of the distributor arm to function properly. After this occurrence, the samplers were disabled between July 28 and August 13, 2008 while the center sections of both samplers were replaced. To help prevent this scenario from accruing again, cross ventilation was added to the monitoring equipment shed to allow for continuous air movement over the automatic samplers.

NEXT STEPS

Following the completion of all monitoring activities the City will schedule at least one field day to allow local engineers, contractors, and other municipalities to tour the site, see the BMPs at work, and review collected monitoring data for the system.

The City continues to provide innovative BMPs at their City Hall site through the implementation of additional BMPs within the complex. These BMPs include a bioretention parking lot and a constructed wetlands project.

Bioretention Parking Lot: The City began construction of a new parking lot for the City Hall complex in November 2008. This 1-acre parking lot was needed to provide overflow parking for the City Hall and City engineering buildings. Integrated into the design by Manhard Consulting, Ltd., were bioretention stormwater treatment cells that provide water quality treatment and a dry detention pond to provide channel protection, overbank, and extreme flood protection.

Constructed Wetlands: The City began construction for another BMP project, a 1.2-acre urban stormwater treatment wetland in an empty lot next to Dried Indian Creek. Stormwater runoff from the City Complex and the surrounding streets naturally drains to this location. This property is located within the floodplain and is frequently inundated during large storms.

The proposed constructed wetland will serve as the final treatment feature to the above group of BMPs currently under design for the City Complex – an oil/grit separator, a wash pad/water-sediment basin tied to the sanitary sewer system, and a bio-retention BMP for a proposed parking lot.

The expected pollutants in stormwater runoff are typical of urbanized watershed and composed of primarily oil, grease, suspended solids, fecal coliform, phosphorus and heavy metals. The oil/grit separator is being designed to remove TSS and oil/grease but the rest of the stormwater pollutants will go the wetland for additional pollutant reduction. The bioretention treatment in the parking area has been designed to the GSMM standards and will provide Water Quality and Channel Protection benefits; flows discharged from this treatment will be directed to the proposed constructed wetlands area for polishing. The constructed wetland will also provide stormwater treatment for the remainder of the drainage area that is not served by the other BMPs, approximately 28 acres that includes about a quarter of the City's downtown area.

The constructed wetland project, also designed by Manhard Consulting, is another 319(h) grant funded project. A layout of the projects and their physical relationships are shown on Figure 4.

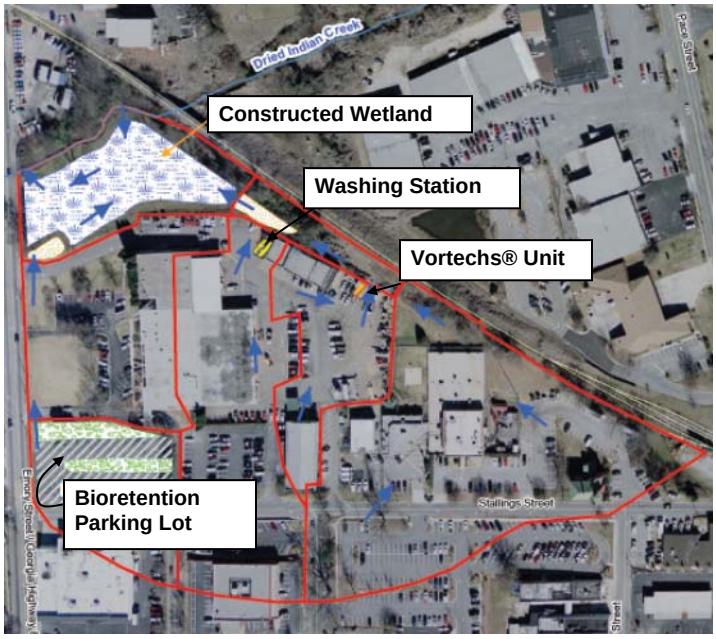

Figure 4. Covington City Hall Site Layout and BMP Locations

CONCLUSIONS

This City has implemented several BMP projects at their City Hall, retrofitting a site that previously had no stormwater treatment BMPs. In addition, the City is treating approximately 28 acres of offsite drainage. This site discharges directly into Dried Indian Creek, which is 303(d) listed for biota impairment. These projects have been made possible through a combination of federal USEPA grants and local stormwater utility funds.

The ongoing monitoring project provides a glimpse into the water quality improvement that these BMPs are

providing for the impaired stream segment; additionally it provides a local test case verifying the pollutant removal that the Vortechs® proprietary hydrodynamic separator provides.

The City hopes that at the end of this project that definitive monitoring results can be summarized to provide local test results that will be used by municipalities around the Metro-Atlanta area that are considering approval of the Vortechs® system.

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