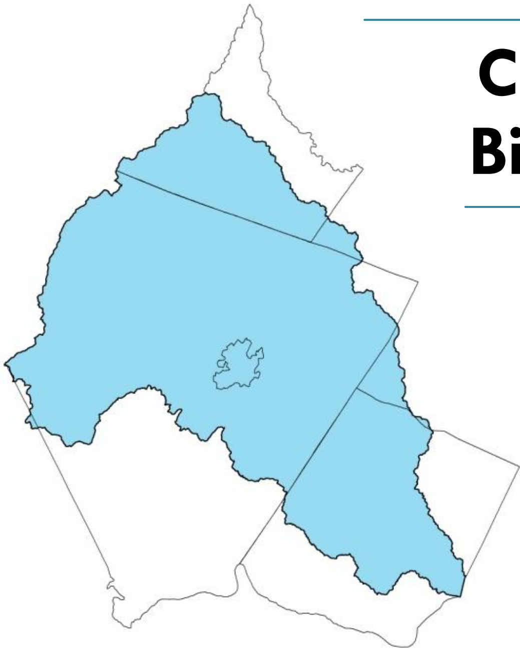

Charlottesville High School Biofilter Performance Study

Final Report | November 27, 2011

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requirements for the degree of Master of Science

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1 Abstract

A study of a bioretention filter (biofilter) located at Charlottesville High School, in Charlottesville, Virginia took place during the period from July through November of 2010. During those months, flow data and water quality samples were analyzed to quantify the biofilter's performance in treating the symptoms of altered hydrology in the drainage area, and its ability to reduce loads of Nitrate-nitrogen (N), Orthophosphate-phosphate (PO_4), and Total Suspended Solids (TSS) in the stormwater runoff. The study team measured runoff reduction and peak flow rate reduction from fifteen events, TSS and Nitrate reductions from ten events, and Orthophosphate reduction from nine events. The average runoff reduction and peak flow rate reduction were calculated to be 81% and 93.5%, respectively. Reductions in TSS, Nitrate, and Orthophosphate, as measured by the Summation of Loads (SOL) across all sampled events were 71.3% (TSS), 67.5% (Nitrate), and 75.7% (Orthophosphate). The study concludes that the biofilter is highly efficient in treating the drainage area's altered hydrologic condition, and provides substantial load reductions in the constituents of interest.

2 Introduction

In September 2009, the City of Charlottesville installed a 2,600 square foot biofilter (Figure 1) at Charlottesville High School (CHS), located at 1400 Melbourne Road, Charlottesville, Virginia in the Piedmont geographic province. The biofilter installation was included as a recommendation in the Charlottesville Stormwater Stewardship on Public Lands study undertaken by the City in 2007-2008 to identify opportunities for improving stormwater management at public facilities. The biofilter was installed in a small traffic island; the position of the island in the landscape presented an opportunity to capture previously untreated runoff from a four-acre, mostly impervious drainage area.

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FIGURE 1. TRAFFIC ISLAND, BEFORE AND AFTER THE ADDITION OF THE BIOFILTER.

The majority of the drainage area is comprised of parking lot, but also includes a portion of the adjacent neighborhood. Thus, the biofilter would captures runoff from the asphalt parking lot and a portion of the bus loop, and from residential rooftops, driveways, and yards. The setting is representative of the greater urbanized environment of the City of Charlottesville, and many other mid-Atlantic urban watersheds. As such, the conclusions of the study are highly transferable, offering insight into how urbanized environments can be adapted to mitigate water quality pollution.

The installation of the biofilter was partially funded by a grant from the National Fish and Wildlife Foundation (NFWF), in partnership with the Environmental Protection Agency (EPA). Specifically, NFWF provided funding from its Chesapeake Bay Innovative Nutrient and Sediment Reduction Program. Part of the grant agreement was to conduct a study of the effectiveness of the biofilter structure to treat the pollutants that are responsible for the impairment of the Chesapeake Bay. To that end, the study sought to quantify reductions of nitrogen (N), phosphorous (P), and sediment, and to better understand how stormwater best management practices (BMPs) can improve the hydrologic response to storm events in receiving streams. The objectives of the study are particularly relevant to the challenges that Chesapeake Bay states and localities will face as the Chesapeake Bay Total Maximum Daily Load (TMDL) process unfolds, as well as those presented by local TMDLs.

3 Background

The CHS biofilter was installed to treat non-point source pollution, the effects of which place a number of the City of Charlottesville's streams on Virginia's impaired waters list. Altered hydrology and sediment were identified as the "most probable stressors" of Charlottesville's streams, as they relate to benthic impairments, and symptoms of altered hydrology, such as channel erosion, "are the most obvious contributors" to sediment loads in these watersheds (Yagow, 2010). Nutrients are possible stressors to benthic communities in this area, but were excluded from the most probable category in the final stressor analysis conducted on Charlottesville's collection of streams in development of a TMDL for benthic impairments (Yagow, 2010).

Water Quality Constituents

Nutrients

Nitrate is the nitrogen species most often present in stormwater. Ammonia, nitrite, and organic nitrogen are also found in stormwater in smaller amounts. Ammonia and nitrite are quickly transformed to Nitrate in water and are thus only present in negligible amounts (Murphy, 2007). Organic nitrogen is nitrogen bound within plant and animal residues and was not expected to contribute significantly to the nitrogen load in the asphalt dominated drainage area. Recent stormwater analyses on the University of Virginia campus near CHS showed these compounds to be present in only trace amounts (Herman, personal communication, 2010).

Phosphorus is present in natural waters in the form of phosphates. Organic phosphate is bound by plant and animal tissue and is generally not a stormwater constituent of concern since it is not available for uptake by aquatic plants. However, inorganic phosphate is present in stormwater, often in excessive amounts, and contributes to eutrophication and hypoxia by encouraging the growth of algae. Inorganic phosphate is comprised of Orthophosphates and polyphosphates. Because polyphosphates are transformed to Orthophosphates in water (Murphy, 2007), Orthophosphate is the phosphorus species of concern in stormwater.

Excess nutrients, specifically various species of nitrogen and phosphorous, are carried in rainfall runoff ("stormwater") from sources of application, such as lawns, gardens, ball fields, illicit discharges to the conveyance system, and atmospheric deposition. Excess nutrient loads cause problems in surface waters when they enhance aquatic plant life (especially algae), which eventually die and decompose, monopolizing dissolved oxygen at the expense of other life in the water body. This process is called eutrophication and can lead to hypoxia in streams (USGS, 2009). In the CHS biofilter's drainage area, sources of nitrogen and phosphorus were expected from lawn fertilizer and possibly pet waste. Phosphorus may also result from soap used for car washing on the residential lots and accompany any sediment present in runoff. About half of nitrogen loads in surface runoff originate from atmospheric deposition (Schueler, 1987).

SEDIMENT

Sediment in runoff was not expected in large amounts, but may result from minor erosion on the school grounds. Deposits on the asphalt parking lot from on or off site were also likely to become suspended in stormwater. However, the altered hydrology of the drainage area was expected to create sedimentation problems in the receiving water body, Meadowbrook Creek. Altered hydrology refers to the domination of the drainage area's land cover by impervious surfaces that prevent infiltration of rainwater and thus significantly increase the volume of surface runoff compared to the assumed natural hydrologic condition of forested land cover. This additional volume of runoff also drains at a much faster rate than it would under predevelopment conditions, since the impervious area provides little impedance to slow the runoff. These factors produce a "flashy" hydrologic response to rain events, or spikes on the hydrograph, (Figure 2). Receiving stream channels are ill-equipped to handle the excess volume and velocity of runoff from watersheds exhibiting altered hydrology. The result is erosion of stream banks and beds.

The increased sediment loads created by in-stream erosion leads to the degradation of the geomorphologic properties of the stream that are essential for supporting aquatic life. The gravel substrate of stream beds become smothered by sediment deposition. This substrate is the breeding and feeding ground for aquatic insects. Alterations to this habitat lead to the degradation of the lower food chain, which causes disruption higher up the food chain. Additionally, turbidity blocks a portion of sun light that would otherwise reach stream beds and support photosynthesis. Ultimately, biodiversity of the aquatic habitat suffers.

Figure 2 illustrates the hypothetical hydrologic responses to a rain event from pre- and post-developed watershed conditions. The urban hydrograph has a much increased peak flow rate; it is this velocity of runoff in a short time frame that causes erosion of streams channels, as the channel is only meant to convey peak flow rates depicted by the pre-urban hydrograph.

Additionally, the area underneath the urban curve is larger than that under the pre-urban curve. The area under the curve represents the volume of runoff produced by a rain event. The urban condition produces a larger volume of runoff than the pre-urban condition, and also results in channel erosion in receiving streams. The amount of impervious surface in the drainage area is correlated with the differences between the hydrographs' shape and size, or the differences in total runoff volume produced and peak flow rate experienced (Roads and Transportation Association of Canada, 1982).

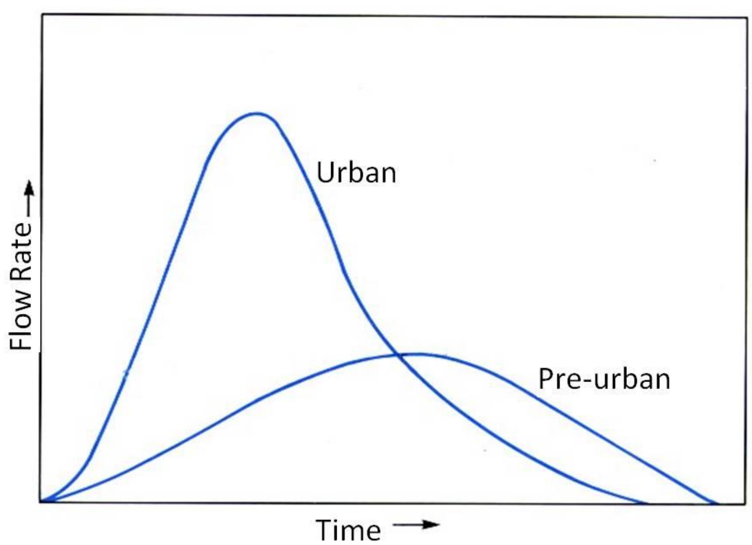


FIGURE 2. HYPOTHETICAL DISCHARGE DATA.
ADAPTED FROM ROADS AND TRANSPORTATION ASSOCIATION OF CANADA DRAINAGE MANUAL, 1982.

Biofilter Design

The biofilter was designed to receive and retain the extra volume of runoff received due to the altered hydrologic condition of the drainage area. The BMP absorbs, infiltrates, evaporates, and releases the excess volume slowly to mimic a more natural hydrologic response to rain events. It is also designed to improve the quality of stormwater by encouraging uptake of excess nutrients by plants, and consumption of pollutants by soil bacteria. Installation of the biofilter started by removing the existing soil and plant material and creating a bowl-like basin (Figure 3) that was then filled with an engineered media containing soil, sand, gravel, and organic matter. The media was planted with water tolerant species (Table 1) and a top layer of hardwood mulch is applied. The biofilter was designed with a riser to allow for1950 cubic feet of free board water storage before excess untreated runoff bypasses the biofilter and enters the stormwater conveyance infrastructure. Schematics of the biofilter are presented in Figure 4. A full plan view schematic of the drainage area can be found in Appendix F.

TABLE 1. SPECIES PLANTED IN THE BIOFILTER

Botanical Name	Common Name	# of Plants
Panicum virgatum	Shenandoah Switchgrass	125
Miscanthus 'Morning Light'	Morning Light Japanese Grass	5
Miscanthus 'Gracilimus'	Gracilimus Japanese Grass	3
Miscanthus 'Gold Bar'	Gold Bar Japanese Grass	15
Calamagrostis x 'Karl Foerster'	Karl Foerster Feather Reed Grass	30
Chasmanthium latifolium	Northern Sea Oats	36
Pharlaris arundinacea 'Feeseys var'	Ribbon Grass	divisions
Panicum virgatum 'Dallas Blues'	Dallas Blues Switchgrass	15
Ilex glabra 'Densa'	Compact Inkberry Holly	35
Ilex glabra 'Shamrock'	Shamrock Inkberry Holly	27
Ilext verticillata 'Jim Dandy'	Winterberry Holly (male)	3
Ilex verticillata 'Red Sprite'	Red Sprite Winerberry Holly	25
Cercis canadensis 'Eastern White'	White Redbud	2
Cercis canadensis 'Hearts of Gold'	Hearts of Gold Redbud	3
Fagus sylvatica atropurpurea	Copper Beech	1
Camassia leichtlinii	Caerulea Quamash	300 bulbs
Camassia quamash	Quamash	300 bulbs
Narcissus actaea	Narcissus	300 bulbs

SOURCE: CITY OF CHARLOTTESVILLE

The biofilter at CHS was designed to treat the volume of runoff received from the first ½ inch of rain that occurs in a given storm event. Rainfall events of ½ inch or less (total) account for approximately 75 percent of rain events in the region according to data collected at the McCormick Observatory by the Virginia Climatology Office, University of Virginia, Charlottesville, VA (Stenger, personal communication, 3/23/2011). Treating the first part of each rain event is considered most important because it is assumed that the "first flush" of runoff off from impervious surfaces washes off much of the pollutants deposited on them. Research suggests that approximately 40% of the pollutant load washes off in the first 20% of runoff volume produced (Tucker *et. al.*, 2007). While a larger design storm would have allowed the biofilter to more fully treat runoff from larger rain events, the site possessed significant constraints. The CHS biofilter is a stormwater retrofit, so the design was dependent on available space, as opposed to optimal space for maximum treatment. The clayey soils of the Virginia Piedmont posed another site constraint for the biofilter design. As an infiltration BMP, underdrains were added to convey filtered water that is unable to drain through the underlying soil due to the low soil permeability.

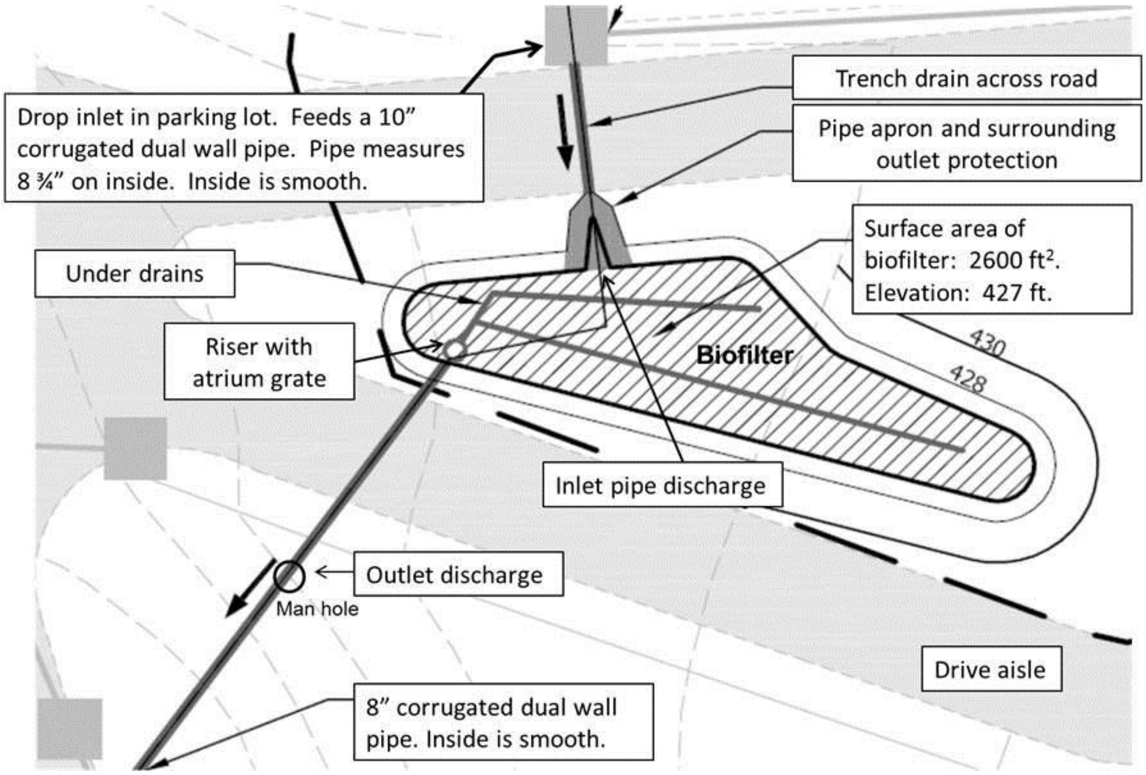
FIGURE 3. BIOFILTER CONSTRUCTION SEQUENCE.
TOP LEFT: EXCAVATION OF BOWL CONTOURS; TOP RIGHT: FILLING BOWL WITH GRAVEL LAYER AND BIOFILTER MEDIA; BOTTOM LEFT: SITE STABILIZATION; BOTTOM RIGHT: PLANTING WITH FACILTATIVE WET PLANTS

Previous work

Low Impact Design (LID) began in the 1990s in response to the discovery that conventional stormwater controls did not meet the water quality goals they were constructed to achieve (EPA, 2011). Bioretention has been a pillar of LID since its inception. However, LID has not been broadly applied in new development, despite two decades of promotion by environmental advocates, agencies, and academia. Part of the reason for slow adoption of LID is that stormwater standards have evolved very little at the federal level since the 1990s, and even less at the state and local levels. Recent initiatives to improve stormwater regulation at the federal and state levels have created the need for documentation on the performance of both conventional and LID BMPs.

To meet this demand, there has been a small, but steady stream of research on the effectiveness of stormwater BMPs during the past several years. Much of this work can be found in a central location known as the International Stormwater BMP Database. This resource started in 1996 through a partnership between the American Society of Civil Engineers and the EPA, and has expanded to include diverse support and funding from the Water Environment Research Foundation, the Federal Highway Administration, and the American Public Works Association. The database is administered by Wright Water Engineers, Inc. and Geosyntec Consultants and can be accessed at http://www.bmpdatabase.org/. The database contains over 400 BMP studies and performance analysis results covering a range of pollutants. Table 2 shows data from two technical reports released by database administrators in 2011.

Plan View



Section View

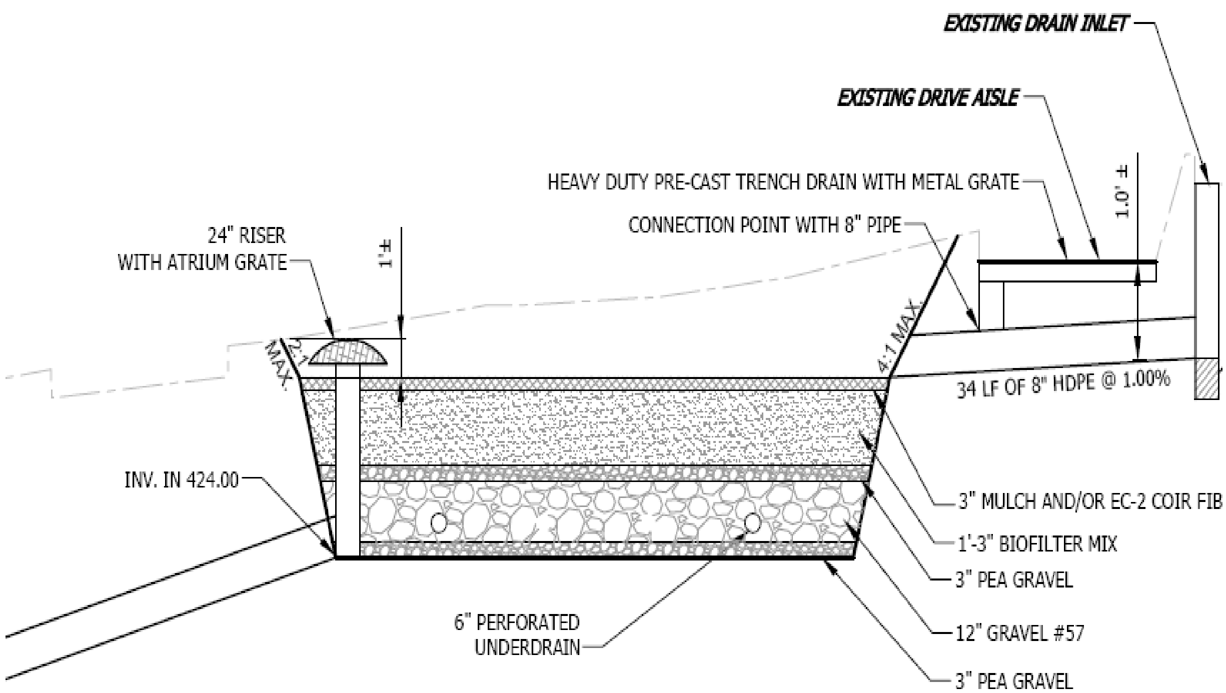


FIGURE 4. BIOFILTER DESIGN SCHEMATICS.

ADAPTED FROM BIOFILTER SITE PLAN
SOURCE: CITY OF CHARLOTTESVILLE

TABLE 2. AGGREGATED PERFORMANCE OF BIORENTION BMPS.

Constituent	# of BMPs Studied (Studies/Data Points)		Median Concentration (mg/L)		% Reduction
	Influent	Effluent	Influent	Effluent	
Total Suspended Solids	6/105	6/96	50	10	80.0%
Orthophosphate as P	7/79	7/77	0.04	0.16	-300.0%
Nitrate Nitrogen	1/14	1/11	1.38	1.09	21.0%

Source: Wright Water Engineeers, *et. al.*, 2011

4 Study Objectives

Like many localities in Virginia, the nation, and even internationally, the City of Charlottesville wrestles with local water quality issues. Improving degraded urban streams on a limited budget, and allowing for future growth are ubiquitous issues that face society. However, the City of Charlottesville and other Chesapeake Bay watershed localities will soon be asked to meet state-assigned pollution reduction goals to allow Virginia to comply with the Chesapeake Bay TMDL (Table 3). Because this TMDL will put more compliance pressure on the state and thus on localities than any previous TMDL in the state, this study focused on the pollutants of concern that are relevant to the Chesapeake Bay TMDL. Thus, the study sought to quantify the biofilter's ability to reduce nitrogen, phosphorus, and sediment (TSS) in runoff discharged from the biofilter.

TABLE 3. CHESAPEAKE BAY TMDL AND DISTRIBUTION OF LOAD REDUCTION RESPONSIBILITIES

	Load (lbs/year)[1]			Pre-TMDL Existing Load (lbs/year)			Required Reduction		
	TSS	TN	TP	TSS	TN	TP	TSS	TN	TP
Chesapeake Bay TMDLs[2]	6,453,613,196	201,621,368	12,542,374	8,090,521,521	249,262,775	16,462,955	20.2%	19.1%	23.8%
Loads assigned to Virginia	3,036,182,631	84,692,969	6,351,418	4,102,877,130	102,502,323	8,320,093	26.0%	17.4%	23.7%
Loads assigned to the City of Charlottesville by Virginia	3,157,311	45,872	8,936	3,600,936	47,905	9,777	12.3%	4.2%	8.6%

Source: U.S. Environmental Protection Agency; Virginia Department of Conservation and Recreation
[1]Sediment is measured as Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus
[2]Loads derived by Bay Model 5.3.2; updates of these loads may be forthcoming

This study also sought to quantify the ability of the biofilter to change the site's hydrologic response to precipitation to one more resembling predevelopment conditions. As noted previously, altered hydrology is the main cause of sedimentation in Charlottesville streams, and its contribution of sediment to the Chesapeake Bay. The study team measured runoff volume reduction and peak flow rate reduction from fifteen rain events to assess the biofilter's ability to treat the symptoms of the drainage area's altered hydrology. Additionally, we sought to determine the predictors of success in reducing pollutant loads and improving hydrology.

The overall objective of the study was to assess stormwater retrofitting as part of the solution to meeting new water quality requirements. The biofilter's pollution and runoff reduction capabilities provided perspective on what is possible, even given site constraints and challenges.

5 Methodology

With input from project partners, the author developed the *Charlottesville High School Biofilter Monitoring Plan* and accompanying Quality Assurance Project Plan (QAPP) (see Appendix F) to guide the study. This document established the study design and data analysis approach, as well as team member responsibilities, data quality objectives, quality control/quality assurance guidelines, and other protocols to guide the study. The monitoring plan and QAPP received Environmental Protection Agency (EPA) approval.

Data Acquisition Design

Flow rate (volume/time) was measured at the inlet and outlet of the biofilter throughout each rain event using ISCO 4230 Bubbler Flow Meters. Eight inch Palmer Bowlus insert flumes made by Plasti-Fab were connected to the inlet pipe to the biofilter and outlet pipe at the point of discharge to control the flow of water through an exact cross-section to allow the flow meters to make very precise measurements. The bubbler flow meters measured the height of water passing through the flume, and converted the height to flow rate. The flow meters logged a continuous record of flow rate entering and exiting the biofilter throughout each rain event.

Backwatering (i.e. allowing water to flow back up the inlet pipe) was observed as the depth of water increased in the biofilter. To avoid backwater in the flume, an upward bend was added to the inlet point of discharge to the biofilter, raising it to an appropriate elevation to prevent inundation of the flume (Figure 5). As a result of this rise in the point of discharge, the conveyance system was expected to retain a certain volume of runoff (~1.75 cubic feet) that would have otherwise entered the biofilter. As a percentage of the total influent volume, the retained volume was not expected to be significant enough to affect data quality, and thus was not accounted for in the data acquisition process.

Stormwater quality was measured by installing ISCO 6712 Portable Automated Samplers with a 24, 1-liter polypropylene bottle configuration at the inlet and outlet of the biofilter to extract samples from the same location that flow rate was measured (directly from influent discharge to the biofilter, and effluent discharge from the biofilter). The autosamplers were programmed to initiate collection of samples by indication from the flow meter that initial runoff was entering the biofilter. The autosamplers then initiated a time or volume paced program for collection of discrete samples. The study team adjusted autosampler pacing between events to achieve the best possible sampling coverage. Shorter summer rain events used a shorter time interval for sample collection; the time interval was lengthened for fall sampling, and volume pacing was used for some fall events. These adjustments ensured that samples were evenly distributed across the hydrograph, providing for representative samples of each event. See Appendix A for time and volume intervals used for each event.

The QAPP required that the study team program the autosamplers to collect first-flush samples, but despite numerous attempts, the team was unable to do so effectively. The study team concluded that it was more important to collect a robust dataset than to miss collection of samples from rain events while attempting to capture multiple first-flush samples. The first sample taken from each event did capture a portion of the first-flush, however.

An ISCO 674 Tipping Bucket Rain Gauge logged rain fall at the biofilter in 0.01 inch increments and stored the data on the flow meter to which it was connected. The flow meter, autosampler, and rain gauge were powered by a 12V deep cycle marine battery, which was charged by solar panels. For more detail on equipment specifications, see Appendix F. Figure 5 shows the automated equipment and field installation.

The study team tracked weather forecasts and visited the biofilter before rain events that were predicted to have a 50% or greater chance of producing rainfall. Autosamplers were loaded with ice to preserve water samples at pre-rain visits. As soon as possible after each event, the team revisited the site to collect the samples, and label, transport, and preserve the samples according to the QAPP. The team used field collection checklist to standardize activities conducted during pre- and post-event site visits. Between rain events, the study team downloaded flow and precipitation data stored on the flow meters to a field laptop using Flowlink software. For more detail on study team protocols, see Appendix F.

Row 1. Storm Boxes™ containing automated equipment, located at the inlet to the biofilter, and next to the manhole that provides access to the outlet discharge point.

Row 2. Flow meter and autosampler in a Storm Box, and the 24 bottle sampler configuration in the base of the autosampler, separated from the computer that sits on top of the base.

Row 3. The flume with flow meter and autosampler tubing installed in the manhole where biofilter effluent discharges. And the flume and associated riser attachment on the inlet pipe to the biofilter.

FIGURE 5. FIELD INSTALLATION OF AUTOMATED WATER QUALITY MONITORING INSTRUMENTATION AT CHS BIOFILTER.

Laboratory Analysis of Water Quality

NUTRIENTS

The study team analyzed samples collected by the autosamplers for Nitrate-N, Orthophosphate-PO_4, and/or TSS. The study team used CHEMetrics™ and/or HACH™ pre-loaded water chemistry kits to measure nutrient concentrations easily and inexpensively using colormetric methods. The kits consist of pre-loaded ampoules that contain an analyte-specific reagent. The reagent mixes with the water sample, turning the solution a distinct shade of color in proportion to the concentration of analyte present in the sample. The study team used a multi-analyte LED photometer to read the exact shade of color development. The specific products used are listed in Appendix F. The methods employed by these test kits are based on the EPA approved 4500-NO_3 E method found in the American Public Health Association Standard Methods, 21st edition, and the EPA 365.1 standard for measurement of orthophosphate. An exception to EPA approved methods applies to the CHEMetrics kits used to measure orthophosphate for some events. This kit is based on American Public Health Association Standard Methods, 21st ed., Method 4500-P D, stannous chloride, and is not listed as an approved method in the Code of Federal Regulations (National Archives and Records Administration, 2011).

SEDIMENT

In this study, we chose to measure Total Suspended Solids (TSS) rather than Suspended Sediment Concentration (SSC) as the measurement of sediment because SSC requires water samples to be filtered. However, the study team needed to extract small fractions (aliquots) of each sample for nutrient analysis and quality control purposes, which necessitated the use of TSS. Originally, the team wanted to use the SSC method because it is expected to better represent the actual mass of sediment in stormwater samples (See QAPP in Appendix F). Measurements of TSS are susceptible to underestimation of mass to varying degrees, depending on the particle size distribution and sediment concentration of the drainage area (Guo, 2006). The study team addressed this probable discrepancy by using the entire remainder of the water samples in the TSS determination, instead of merely an aliquot. This ensured that heavier particles that are sometimes excluded from TSS aliquot extractions, but which account for a substantial faction of the sediment mass, would be measured in the TSS determinations in this study. In addition, measurement of TSS is well cited in the literature and is used in the regulatory setting for some regulated Municipal Separate Storm Sewer Systems (WDNR, 2011).

Water quality constituents were analyzed from ten rain events. Of these, there were three rain events that were not processed for nutrients, allowing entire samples to be filtered to determine sediment concentrations. Thus, sediment determinations for these three events were actually measures of SSC. These measurements were not considered to differ substantially from TSS measurements made from the other events because the aliquots removed for nutrient determinations were very small. For the other seven events, the study team used the Method 2540 D, “Total Suspended Solids Dried at 103°– 105° C” established by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation. See Appendix F for more information on sample analysis methods.

Data Quality Objectives

The data acquisition process was assessed using representativeness and completeness as indicators data quality. Parameters for data quality of laboratory analyses included precision and observance of minimum detection limits (MDL) defined by the water chemistry kits. These guidelines served as a point of reference for the data reconciliation process.

REPRESENTATIVENESS

Representativeness of water quality samples was assured by flow weighting concentrations and collecting samples throughout each event. This ensured that the volume of runoff represented by each sample was considered in the analysis. However, rain events were highly variable, thus representativeness of data collected from each rain event inherently varied. To minimize this variability, the QAPP required a representative sampling event to meet the guidelines established in Table 4.

TABLE 4. REPRESENTATIVE RAIN EVENT GUIDELINES

Guideline	Standard
Minimum number of samples	6 influent
Minimum storm depth	0.1 inches
Maximum volume represented by any individual sample	20% of total

COMPLETENESS

The QAPP developed for this study set the goal of data collection for five rain events, based not on statistical relevance, but rather on the logistics and costs associated with sampling and sample analysis. Thus, the datasets were considered complete after five events were sampled. However, resources allowed the study team to sample more than five events.

The number of sampled events analyzed in the study determined the confidence in (or statistical relevance of) the results. This study used an equation cited by Law *et. al.* (2008) and Burton and Pitt (2002) to determine the degree of confidence in the data collected for the study. The equation estimates the sample size needed for studies using paired samples (inlet and outlet) to reach a desired degree of confidence. The sample size is recalculated after each additional data point is obtained because new data points change the results of the equation, specifically affecting the means of the data sets. Equation results are charted in the appendices of the *Stormwater Effects Handbook* (Burton and Pitt, 2002); the series of charts represent the spectrum of possible powers, confidence levels, and number of data points. These charts were used to determine the level of confidence in the study results. The equation is calculated as follows:

$$n = 2[(Z_{1-\alpha} + Z_{1-\beta})/(\mu_1 - \mu_2)]^2\sigma^2$$

where:

α = false positive rate (1-α is the degree of confidence. The threshold of statistical significance is α = 0.05, corresponding to a 95% confidence level.)
β = false negative rate (1-β is the power.) (β = 0.2 is common, corresponding to a power of 80%)
$Z_{1-\alpha}$ = Z score (for normally distributed data) corresponding to 1-α
$Z_{1-\beta}$ = Z score corresponding to 1-β value
μ_1 = mean of data set one
μ_2 = mean of data set two
σ = standard deviation

The results section presents the statistical relevance of the data collected in the study and the additional data needs to achieve a 95% confidence level.

PRECISION AND MDLS

Accuracy and precision determined the data quality of nutrient sample measurements. For each event analyzed, the QAPP required one (one from either autosampler, not both) quality control (QC) blank, and one QC duplicate for each analyte. The QAPP set guidelines for the maximum relative percent difference between the measured sample concentration and QC duplicate. The QC duplicate for each analyte was not to exceed 20 relative percent difference. The QC blank for each analyte should have been below the MDL of the specific water chemistry kit used. Instead of excluding data based on these guidelines, the precision of sample measurements taken from each event are simply disclosed in the Results section. Quality Control blank results can be found in Appendix B.

Sediment sample measurements could not be quality controlled because the entire sample volume was filtered after aliquots for nutrient measurement were removed. This is a known drawback of measuring sediments this way, but is considered acceptable for the greater accuracy provided by filtering the whole sample.

Data Analysis

Flow data was analyzed to assess the runoff reduction and peak flow rate reduction provided by the biofilter. Water quality data was analyzed to determine the biofilter's pollutant removal efficiency based on the summation of loads percentages (SOL%).

Runoff reduction was determined by taking the difference of influent and effluent volumes for each event. Hydrographs recorded by the inlet and outlet flow meters provide discharge datasets from each event, from which total volumes were determined. The runoff reduction represents the volume of stormwater retained by the biofilter.

Peak flow reduction was determined by taking the difference in peak flow rate from the inlet hydrograph and outlet hydrograph for each rain event. This metric showed the difference in the velocity of runoff entering and exiting the biofilter.

As seen in the QAPP, the study team considered one other measurement of hydrologic treatment, but after further consideration of the parameter concluded that it did not accurately reflect biofilter activity. The parameter was the reduction in the ratio of the rising limb time to the falling limb time at the outlet as a percentage of the ratio at the inlet. The QAPP refers to this as lag time. The study team eventually realized that this parameter would only appropriately measure treatment of altered hydrology if the biofilter increased only the falling limb of the hydrograph. The study team originally established this parameter to indicate the extent to which the biofilter would extend the amount of time that runoff is released from the site (ie. extend the falling limb of the hydrograph). However, this parameter was contrived without proper consideration of the extension of the rising limb of the hydrograph that the biofilter also provides, and thus does not provide a good representation of how the biofilter treats the site hydrology. To illustrate why this parameter does not actually reflect hydrologic treatment, consider a very flashy rain event that produces a spike on the hydrograph entering the biofilter in which the ratio of the rising limb to the falling limb is nearly equal to one. The biofilter may absorb and/or infiltrate, and slowly release this runoff, creating a gentle rise and fall on the outlet hydrograph that produces a ratio that is also nearly equal to one. Since this parameter measures the reduction in the ratio of the rising limb time to the falling limb time at the outlet as a percentage of the ratio at the inlet, it would incorrectly indicate poor hydrologic treatment for an event such as the one described. For this reason, the lag time parameter was removed from the study.

The effectiveness of the biofilter to achieve water quality improvements was determined by calculating the efficiency of the biofilter to remove each of the pollutants of interest. The removal efficiency based on SOL% was chosen for data analysis because it weights sample concentrations based on the volume of flow represented by each sample, and reflects data from multiple sampled rainfall events during the study time period. Using data from multiple events is important since treatment efficiency of the biofilter was expected to be variable throughout the year as rain event duration, frequency, intensity, anthropogenic use of the drainage area, and other factors vary. The SOL% was calculated as follows:

$$SOL\% = 1 - \frac{\sum_{i=1}^{m} L_{out,i}}{\sum_{i=1}^{m} L_{in,i}}$$

where $L_{in,i}$ and $L_{out,i}$ are the mass pollutant loads at the inlet and outlet, respectively, for event i.

m is the total number of rainfall events sampled

The loads for each event were calculated as follows:

$$L_{out} = \sum_{j=1}^{n} C_{out,j} V_{out,j} \quad \text{and} \quad L_{in} = \sum_{j=1}^{n} C_{in,j} V_{in,j}$$

where, $V_{in,j}$ and $V_{out,j}$ are the inlet and outlet flow volumes, respectively, during period j

$C_{in,j}$ and $C_{out,j}$ are the representative inlet and outlet pollutant concentrations, respectively, during period j (mg/L)

n is the total number of samples taken during the event

Descriptions of measurements from individual storm events will refer to the Event Mean Concentrations (EMC) which was calculated as follows:

$$EMC_{out} = \frac{\sum_{j=1}^{n} C_{out,j} V_{out,j}}{\sum_{j=1}^{n} V_{out,j}} \quad \text{and} \quad EMC_{in} = \frac{\sum_{j=1}^{n} C_{in,j} V_{in,j}}{\sum_{j=1}^{n} V_{in,j}}$$

Finally, the study examined the correlation of pollutant reductions and hydrological indicators with rain event characteristics. This was done by plotting each rain event characteristic dataset against the percent reduction of each pollutant and hydrologic indicator for corresponding rain events. A trendline and correlation coefficient (R^2)value were established for each plot to identify the level of relationship. The closer to 1.0 the R^2 value, the higher the probability that the study parameter performance can be linearly predicted by the rain event characteristic.

6 Results

Table 5 shows the rain events that were used in the determination of results for each study parameter.

TABLE 5. EVENTS USED IN DETERMINATION OF RESULTS FOR EACH STUDY PARAMETER

Rain Event Date	Runoff Reduction	Peak Flow Reduction	Nitrate-N	Orthophosphate-PO_4	Total Suspended Solids
7/10/2010	X	X	X	X	
7/12/2010	X	X	X	X	X
7/14/2010	X	X	X	X	X
7/20/2010					X
7/29/2010	X	X			
7/31/2010	X	X			X
8/4/2010	X	X	X	X	X
8/5/2010	X	X			
8/16/2010	X	X	X		
8/18/2010	X	X	X	X	X
8/24/2010	X	X	X	X	
9/26/2010	X	X	X	X	X
9/28/2010	X	X	X	X	X
9/29/2010	X	X			X
10/27/2010	X	X			
11/16/2010	X	X	X	X	X

Biofilter Hydrologic Response: Runoff Reduction

Table 6 shows the runoff reduction achieved at the biofilter site for 15 events between July and November of 2010. The runoff reduction (volume reduction) ranged from 45 to 100 % and averaged 81%.

TABLE 6. RUNOFF REDUCTION RESULTS FOR THE CHS BIOFILTER

Event Date	Total Rain Depth (inches)	Inflow Volume (liters)	Outflow Volume (liters)	Run Off Reduction (liters)	% Reduction
7/10/2010	0.36	43,605	0	43,605	100
7/12/2010	0.29	38,454	0	38,454	100
7/14/2010	0.32	43,440	4,470	38,970	89.71
7/29/2010	0.12	6,600	0	6,600	100
7/31/2010	0.18	11,100	0	11,100	100
8/4/2010	0.31	22,583	5,056	17,527	77.61
8/5/2010	0.10	14,700	102	14,598	99.31
8/16/2010	0.25	17,410	1,201	16,209	93.10
8/18/2010	0.38	33,965	8,297	25,668	75.57
8/24/2010	0.45	21,791	6,135	15,656	71.85
9/26/2010	1.58	186,569	48,565	138,004	73.97
9/28/2010	0.73	90,807	33,066	57,741	63.59
9/29/2010	3.47	581,866	161,072	420,794	72.32
10/27/2010	0.91	88,981	42,508	46,473	52.23
11/16/2010	1.70	188,361	102,991	85,370	45.32
Average					**81.00**

Biofilter Hydrologic Response: Peak Flow Rate Reduction

As shown in Table 7, peak flow rate reduction for the 15 events during the study period ranged from 73.6% to 100% with an average reduction of 94%. Flow rate is the measure of volume per time.

TABLE 7. PEAK FLOW RATE REDUCTION IN GALLONS PER MINUTE (GPM) FOR THE CHS BIOFILTER

		Peak Flow Rate, Q (gpm)			
Event Date	**Total Rain Depth (in)**	**Inlet**	**Outlet**	**Peak Q Reduction**	**% Reduction**
7/10/2010	0.36	272	0	272	100
7/12/2010	0.29	112	0	112	100
7/14/2010	0.32	274	8	266	97.08
7/29/2010	0.12	174	0	174	100
7/31/2010	0.18	127	0	127	100
8/4/2010	0.31	312	14	298	95.58
8/5/2010	0.10	317	1	316	99.74
8/16/2010	0.25	312	7	306	97.92
8/18/2010	0.38	312	12	300	96.28
8/24/2010	0.45	312	12	301	96.31
9/26/2010	1.58	312	21	291	93.24
9/28/2010	0.73	312	49	263	84.17
9/29/2010	3.47	312	73	239	76.47
10/27/2010	0.91	312	23	289	92.50
11/16/2010	1.70	232	61	171	73.75
Average					**93.54**

Figure 6 shows the biofilters performance in reducing the indicators of altered hydrology in the drainage area for each monitored event.

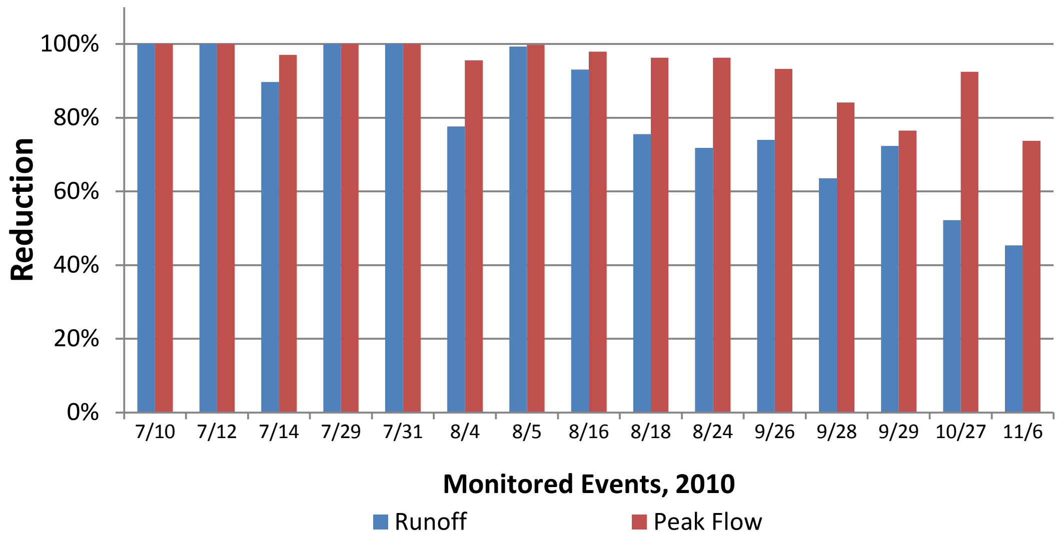


FIGURE 6. BIOFILTER PERFORMANCE ON HYDROLOGIC RESPONSE INDICATORS.

Biofilter Water Quality Improvement

Tables 8, 9, and 10 show the water quality analysis for each constituent, TSS, Nitrate-N and Orthophosphate-PO_4 respectively, and each event for which they were measured. The event efficiency is presented as both the percentage of the influent load removed, which considers the total volume of runoff produced by each event, and percentage of the influent EMC reduced, which does not considered the volume of runoff. TSS and Nitrate-N were measured in samples from ten events. Orthophosphate-PO_4 was measured from nine events.

TABLE 8. TOTAL SUSPENDED SOLIDS (TSS) PERFORMANCE RESULTS FOR THE CHS BIOFILTER.

Event Date	**Total Rain Depth** (inches)	EMC (mg/L)		Volume (liters)		TSS Load (g)		Event Efficiency (As % of influent)	
		Inflow	**Outflow**	**Inflow**	**Outflow**	**Load-in**	**Load-out**	**EMC Reduction**	**Load Removal**
7/12/2010	0.29	8.42	n/a	38,454	0	323.78	0.00	n/a	100.0%
7/14/2010	0.32	33.29	5.6	43,440	4,470	1,446.12	25.03	83.2%	98.3%
7/20/2010	0.32	95.5	n/a	8,100	0	773.5	0.00	n/a	100.0%
7/31/2010	0.12	13.01	n/a	11,100	0	144.41	0.00	n/a	100.0%
8/4/2010	0.31	29.13	5.44	22,583	5,056	657.84	27.50	81.3%	95.8%
8/18/2010	0.38	40.2	3.3	33,965	8,297	1,365.39	27.38	91.8%	98.0%
9/26/2010	1.58	11.2	10.2	186,569	48,565	2,089.6	495.4	8.9%	76.3%
9/28/2010	0.73	44.1	5.6	90,807	33,066	4,004.6	185.2	87.3%	95.4%
9/29/2010	3.47	5.2	27.4	581,866	161,072	3,025.7	4,413.4	-426.9%	-45.9%
11/16/2010	1.70	27.15	2.5	188,361	102,991	5,114.00	257.48	90.8%	95.0%
Summation of Loads = 71.3%									

TABLE 9. NITRATE PERFORMANCE RESULTS FOR THE CHS BIOFILTER.

Event Date	Total Rain Depth (inches)	EMC (mg/L)		Volume (liters)		Nitrate-N Load (g)		Event Efficiency (As % of influent)	
		Inflow	**Outflow**	**Inflow**	**Outflow**	**Load-in**	**Load-out**	**EMC Reduction**	**Load Removal**
7/10/2010	0.36	0.13	n/a	43,605	0	5.80	0.00	n/a	100.0%
7/12/2010	0.29	0.18	n/a	38,454	0	6.96	0.00	n/a	100.0%
7/14/2010	0.32	0.26	0.19	43,440	4,470	11.25	0.86	25.9%	92.4%
8/4/2010	0.31	0.15	0.77	22,583	5,056	3.43	3.90	-407.2%	-13.6%
8/16/2010	0.25	0.17	0.41	17,410	1,201	3.01	0.49	-134.7%	83.8%
8/18/2010	0.38	0.13	0.18	33,965	8,297	4.38	1.45	-35.7%	66.9%
8/24/2010	0.45	0.34	0.42	21,791	6,135	7.50	2.60	-23.0%	65.4%
9/26/2010	1.58	0.15	0.26	186,569	48,565	28.36	12.77	-73.0%	55.0%
9/28/2010	0.73	0.06	0.04	90,807	33,066	5.45	1.16	41.7%	78.8%
11/16/2010	1.70	0.16	0.11	188,361	102,991	30.14	11.33	31.3%	62.4%
Summation of Loads = 67.5%									

TABLE 10. ORTHOPHOSPHATE PERFORMANCE RESULTS FOR THE CHS BIOFILTER.

Event Date	Total Rain Depth (inches)	EMC (mg/L)		Volume (liters)		Orthophosphate-PO_4 Load (g)		Event Efficiency (As % of influent)	
		Inflow	**Outflow**	**Inflow**	**Outflow**	**Load-in**	**Load-out**	**EMC Reduction**	**Load Removal**
7/10/2010	0.36	0.37	n/a	43,605	0	15.92	0.00	n/a	100.0%
7/12/2010	0.29	0.33	n/a	38,454	0	12.61	0.00	n/a	100.0%
7/14/2010	0.32	0.14	0.07	43,440	4,470	6.04	0.31	50.4%	94.9%
8/4/2010	0.31	0.19	0.11	22,583	5,056	4.36	0.55	44.0%	87.5%
8/18/2010	0.38	0.19	0.12	33,965	8,297	6.28	1.00	34.6%	84.0%
8/24/2010	0.45	0.15	0.04	21,791	6,135	3.31	0.23	75.0%	93.0%
9/26/2010	1.58	0.23	0.20	186,569	48,565	42.54	9.81	11.4%	76.9%
9/28/2010	0.73	0.08	0.13	90,807	33,066	7.45	4.43	-63.4%	40.5%
11/16/2010	1.70	0.17	0.15	188,361	102,991	32.02	15.45	11.8%	51.8%
Summation of Loads = 75.7%									

Figure 7 shows the biofilters performance in reducing the pollutants of interest for each event that they were measured. It also shows the SOL% for each pollutant. Figure 8 illustrates the distribution of influent loads and effluent loads across each dataset.

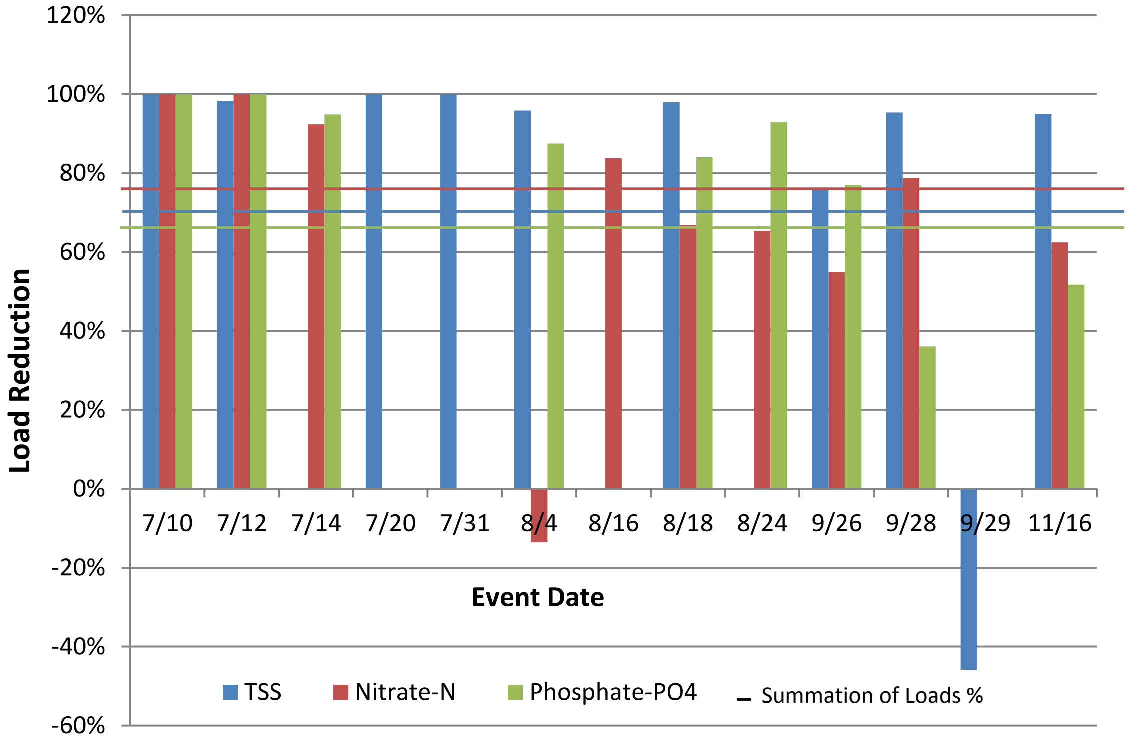


FIGURE 7. LOAD REMOVAL EFFICIENCY FOR EACH EVENT MONITORED AND SOL%.

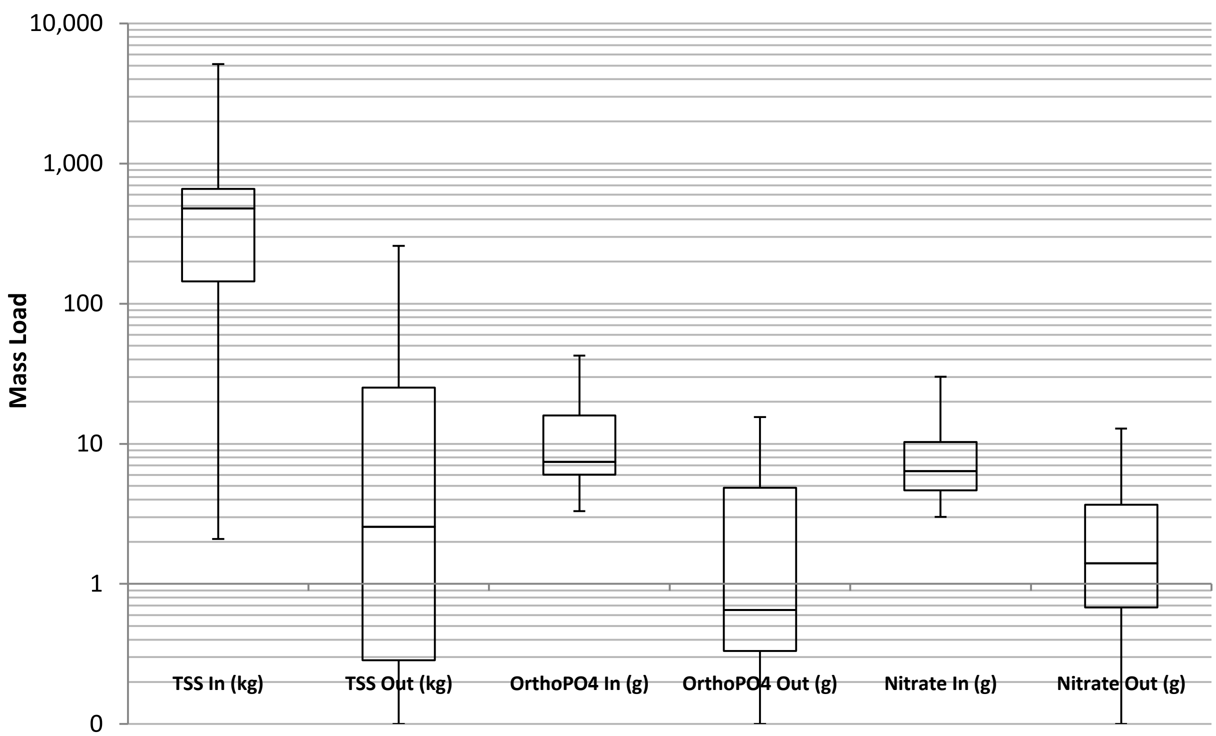


FIGURE 8. DISTRIBUTION OF INFLUENT LOADS AND EFFLUENT LOADS.

R^2 Analysis

Table 11 summarizes the results of the examination of correlation between climatic parameters, load reduction efficiency, and hydrologic indicator performance. Figures 9 - 15 show the relationship of each parameter to load reduction and hydrologic performance.

TABLE 11. R^2 SUMMARY RESULTS FOR BIOFILTER PERFORMANCE PREDICTORS.

R^2 Values	% Load Reduction			% Reduction	
Parameter	**TSS**	**Nitrate-N**	**Orthophosphate-PO_4**	**Runoff**	**Peak Q**
Total Rain Depth	0.8015	0.00008	0.3607	0.2968	0.6688
Total Rain Duration	0.4787	0.0053	0.1839	0.3263	0.6708
Antecedent Dry Days	0.0017	0.0021	0.0001	0.0086	0.0001
Ave. Rain Intensity	0.0345	0.4118	0.0153	0.001	0.0562
Max. Rain Intensity	0.1789	0.1204	0.0031	0.1552	0.0149
Runoff Reduction	0.0412	0.1884	0.6578		
Peak Flow Reduction	0.3153	0.0139	0.7672		

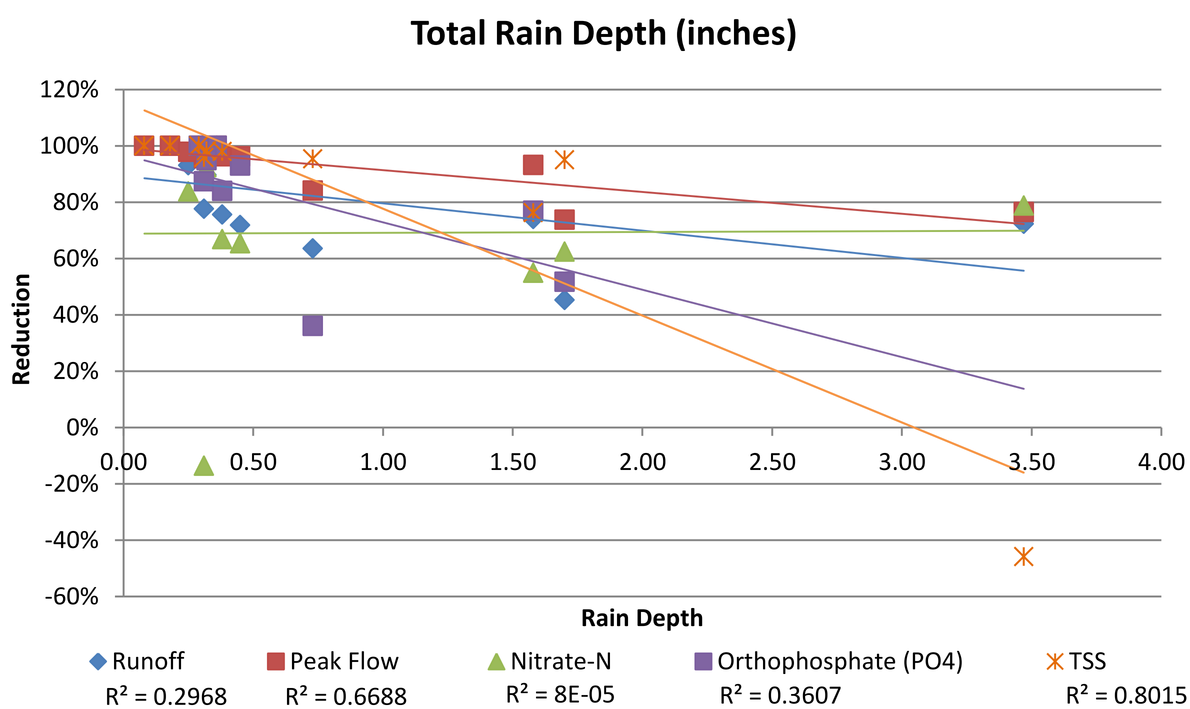


FIGURE 9. R^2 ANALYSIS PARAMETER: TOTAL RAIN DEPTH

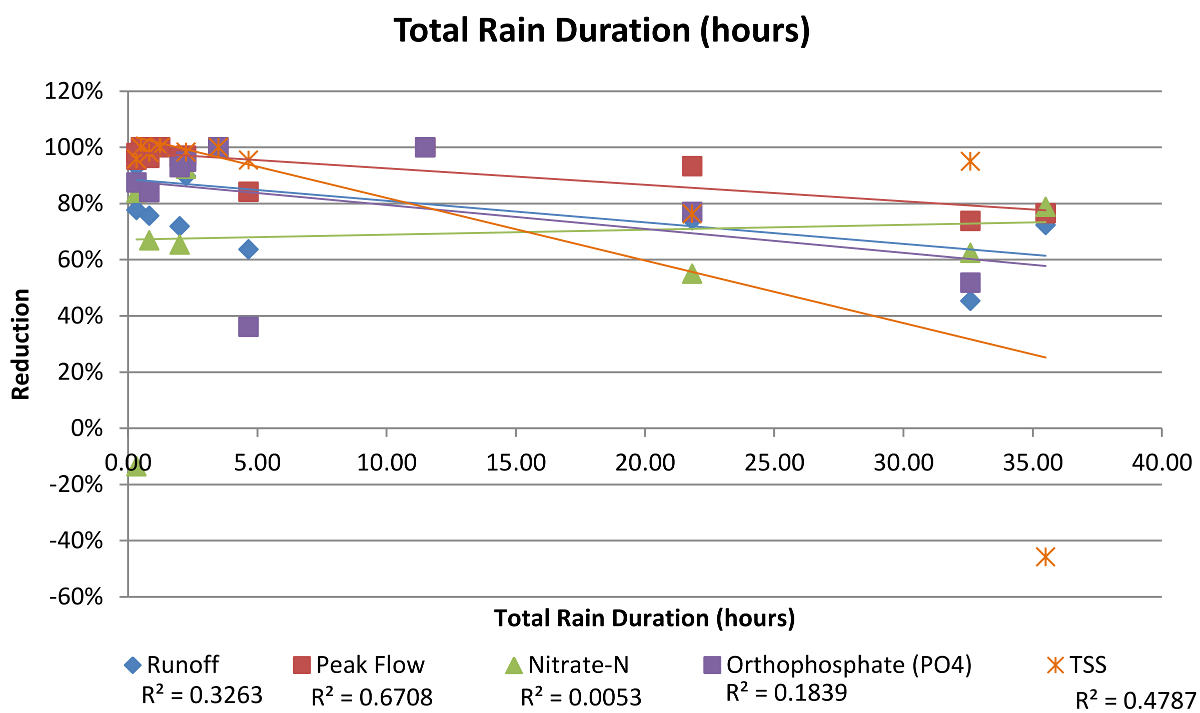


FIGURE 10. R^2 ANALYSIS PARAMETER: TOTAL RAIN DURATION

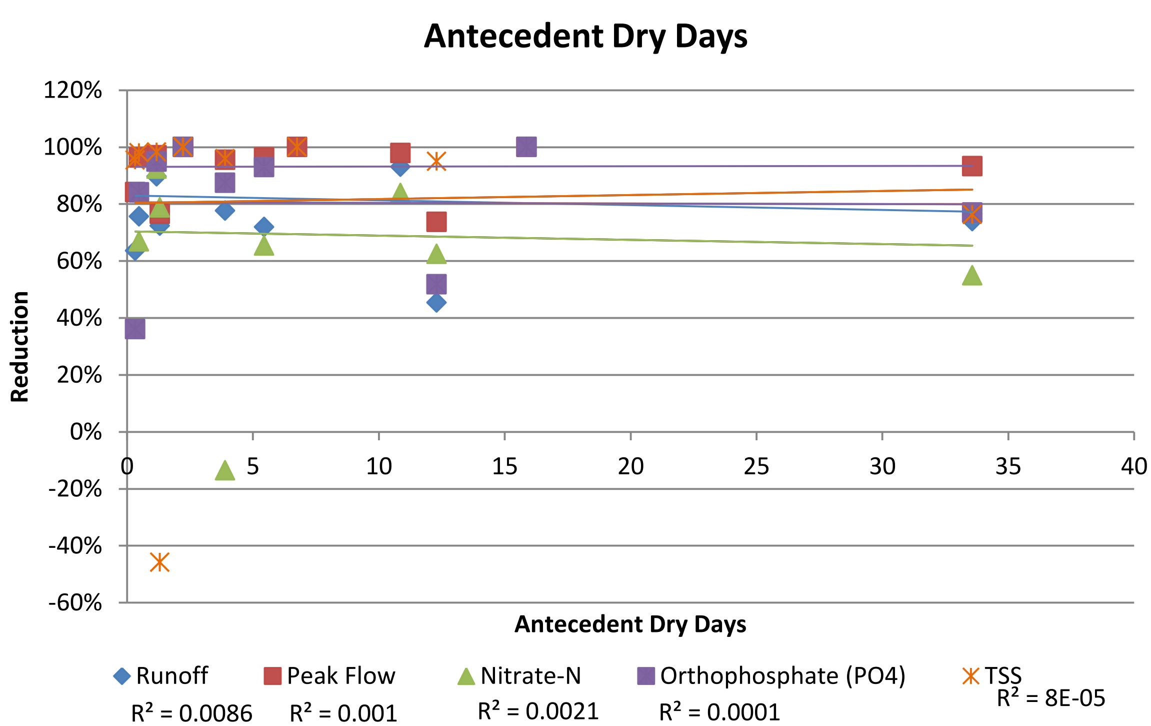


FIGURE 11. R^2 ANALYSIS PARAMETER: ANTECEDENT DRY DAYS

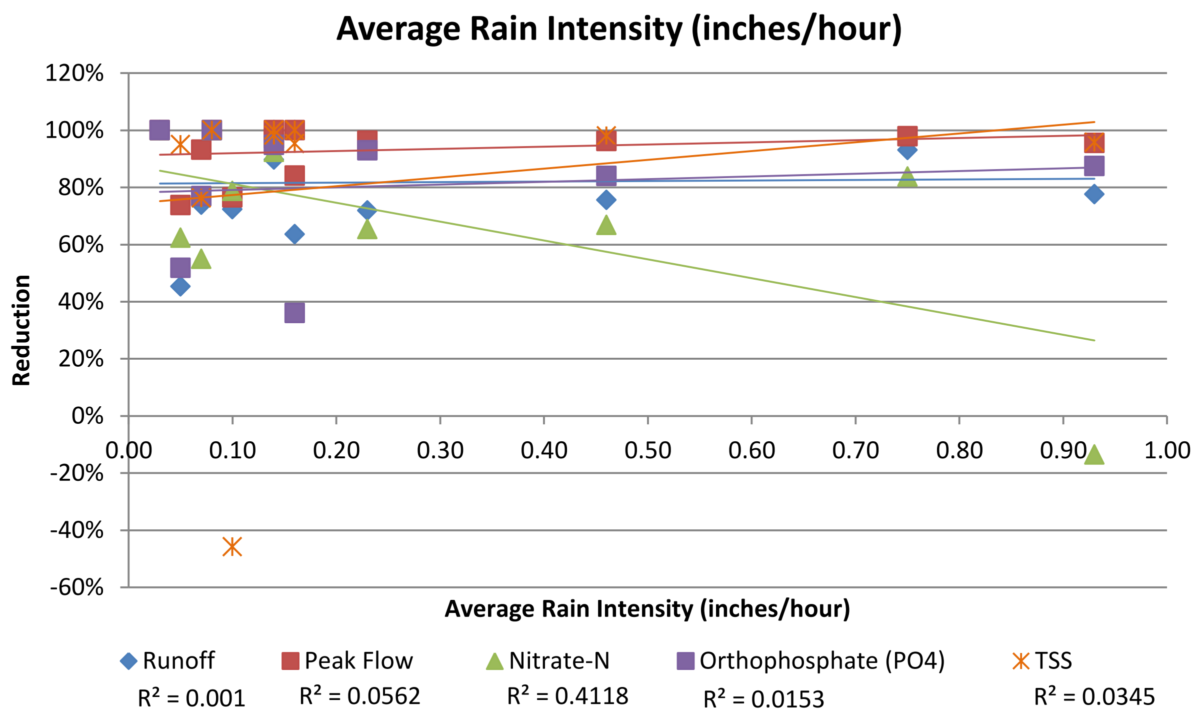


FIGURE 12. R^2 ANALYSIS PARAMETER: AVERAGE RAIN INTENSITY

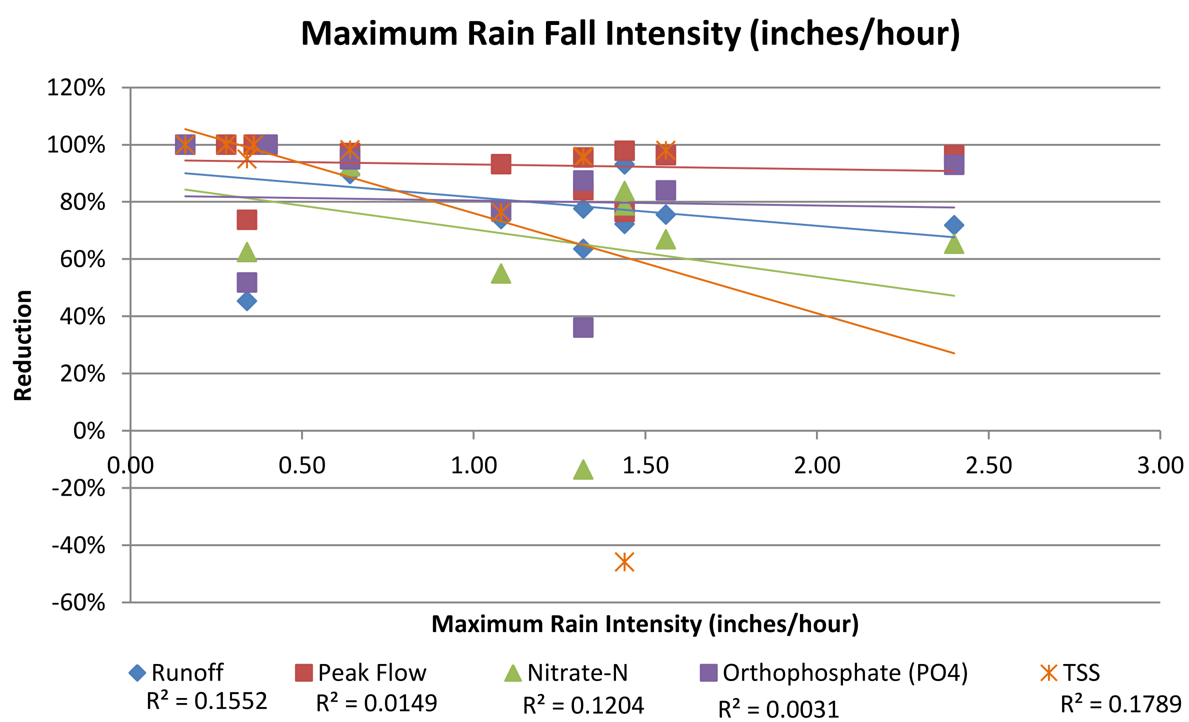


FIGURE 13. R^2 ANALYSIS PARAMETER: MAXIMUM RAIN INTENSITY

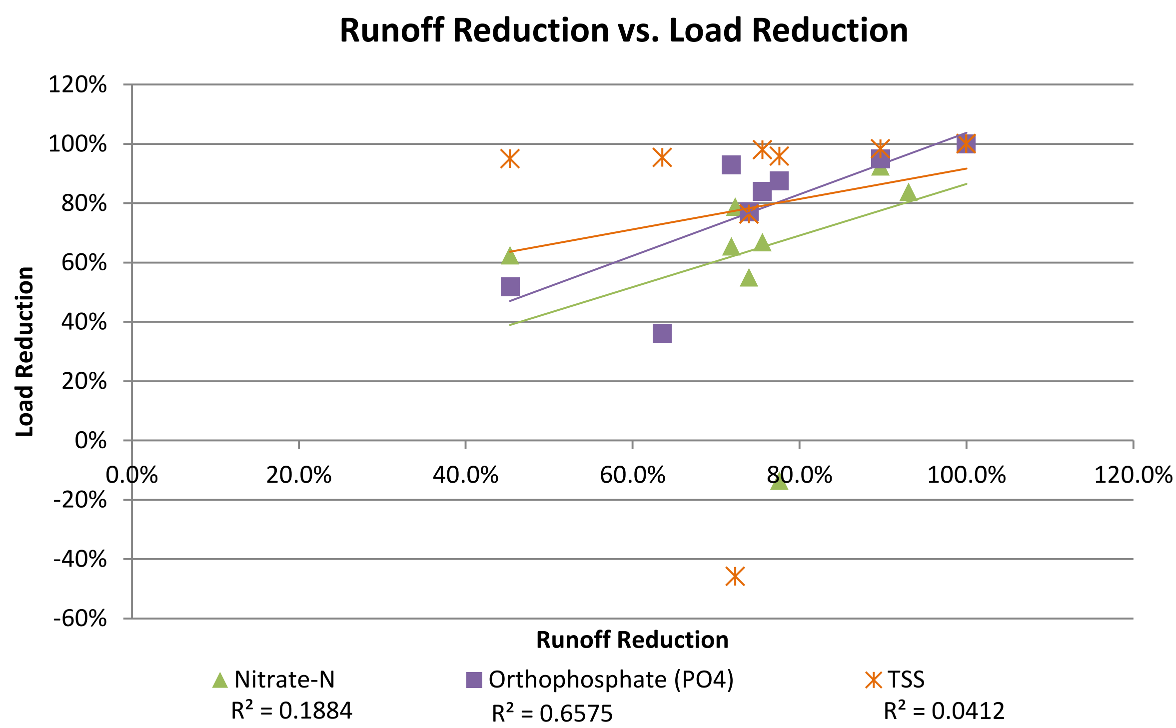


FIGURE 14. R^2 ANALYSIS PARAMETER: RUNOFF VOLUME REDUCTION

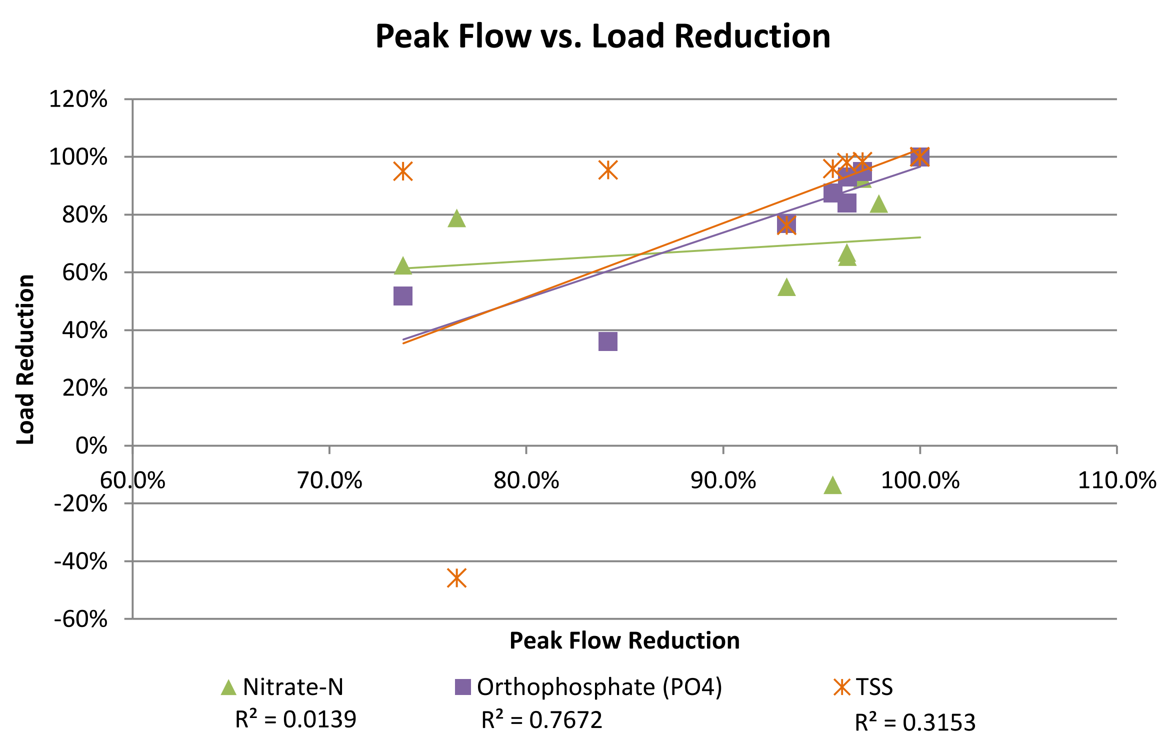


FIGURE 15. R^2 ANALYSIS PARAMETER: PEAK FLOW REDUCTION

Data Quality Objectives

Representativeness and Completeness

All but one monitored event met the guidelines established in the QAPP for representativeness. Reconciliation of this data is discussed later. Table 12 shows the level of confidence in the results presented in tables 8, 9, and 10, given the number of data points collected by this study. The degree of confidence was determined using the method described by Burton and Pitt, 2002.

Table 12. Approximate degree of confidence in results.

Power = 80% (β = 0.2)	**TSS**	**Nitrate-N**	**Phosphate-PO_4**
Difference between inlet and outlet EMCs (average over data set)	72%	43%	40%
Coefficient of Variation (σ /EMC)	0.95	0.62	0.45
Degree of Confidence	~80%	~80%	~90%
Number of events sampled	10	10	9
Number of additional events needed to reach statistical relevance (95% confidence)	~9	~10	~6

Accuracy and Precision

All QC blanks measured during lab analyses were below detection limits. Table 13 shows the precision achieved for sample analyses.

Table 13. Precision calculations.

Date	**Nitrate (mg/L)**			**Phosphate (mg/L)**		
	Original	Replicate	RPD*	Original	Replicate	RPD*
7/10/2010	No replicate samples			No replicate samples		
7/12/2010	0.197	0.195	1.0	0.368	0.351	4.7
7/14/2010	No replicate samples			No replicate samples		
8/16/2010	0.240	0.23	4.3			
	0.221	0.26	16.2			
8/18/2010	0.151	0.171	12.4	0.426	0.388	9.3
8/24/2010	0.510	0.321	45.5			
9/26-27/2010	0.161	0.163	1.2	0.741	0.82	10.1
	0.116	0.12	3.4	0.002	0.002	0.0
9/28/2010	2.8	2.780	0.7			
11/16/2010	0.130	0.145	10.9	0.060	0.091	41.1
AVERAGE			10.6			13.0

* Relative percent difference.

7 Discussion

Hydrological Indicators

The biofilter exhibits a high level of efficiency in reducing total runoff volumes and peak flow rates. These findings support the conclusion that the biofilter is largely effective in reproducing a predevelopment response to precipitation in its drainage area, as characterized by infiltration, storage, and slow release of runoff. It should be noted that the results of the Hydrologic Response analyses may be underestimated because flow at the inlet of the biofilter exceeded the flume's maximum measurable level in 10 of the 15 analyzed events. The flow data, found in Appendix A, shows that the flume's measurable volume was exceeded for 5 to 15 minutes during these events. The proportion of the volume that was not measured for these events was dictated by the total volume of runoff received by the biofilter for each event. For short summer thunderstorms, the percentage of inlet flow not measured was greater than for long, more steady fall events. Even as the runoff reductions and peak flow reductions were significant, and support the theory of very good hydrologic treatment, the performance results for these parameters are likely underestimated to some degree.

Runoff reduction did not show a strong linear correlation with any of the rain event characteristics examined in this study. Total duration was its strongest relationship, with an R^2 of 0.33, indicating that higher volumes of runoff are captured when the duration of rain is shorter. The lack of a strong linear relationship with any rainfall characteristics speaks to the complexity of hydrologic response to rainfall, even in a relatively homogenous drainage area such as the one studied here. Peak flow reduction was more strongly corrolated with both total rainfall depth ($R^2 = 0.67$) and total rain event duration ($R^2 = 0.67$), indicating the predictability of higher reductions with less total rainfall, and shorter total duration. Although these relationships show relatively strong correlations, large reductions in peak flow were achieved across the spectrum of rain event depth and duration. These large reductions should result in less channel erosion in streams, especially when coupled with steady runoff volume reductions.

Performance on hydrologic indicators concludes that properly designed and sited biofilters are a very effective option for treating the altered hydrology of urbanized watersheds to reduce its impact on receiving streams. However, the performance results of this study may or may not convey to other biofilters and other biorention/infiltration BMPs, as the performance of such practices is dependent up a number of factors. Examples of factors influencing performance include drainage area size, topography, specific design elements of the biofilter, and climate (EPA, 2011).

Water Quality Improvement

As illustrated in Tables 8, 9, and 10, EMC efficiencies always indicate less water quality treatment was provided by the biofilter than do the load removal efficiencies and total SOL% over the study period. The latter however, suggested that the biofilter provides substantial pollutant reductions. These findings indicated that volume reduction is an influential factor in reducing pollutant loads. This fact is well understood by the state of Virginia's Soil and Water Conservation Board, which is in process of tying the Virginia Stormwater Management Program permit regulations to runoff reduction achievability in site plans for new development and redevelopment (VaDCR, 2011). Even as SOL%s show promising load reductions, since influent volumes were underestimated to some degree in this study, influent loads, load reductions, and SOL%s were also underestimated.

Figure 14 compares the percentage of runoff volume reduction to the water quality load reductions for each sampled event. The study team hypothesized that a correlation existed between these parameters that is partially confirmed by the data collected in this study. The R^2 between runoff reduction and load reduction were 0.04 (TSS), 0.66 (Orthophosphate), and 0.19 (Nitrate). If a statistical analysis of the data were to suggest that the 9/29/2010 and 8/4/2010 events were outliers, removing these load removal efficiencies would improve the R^2 to 0.14 (TSS) and 0.67 (Nitrate). The strong R^2 values displayed by Nitrate and Orthophosphate data points substantially supports the linear correlation between nutrient load removal efficiency and runoff reduction. The low R^2 value displayed by the TSS dataset suggests that mechanisms other than runoff volume reduction are responsible for the relative success in sediment removal. This was not surprising, considering the difference between the dissolved nutrient constituents and particulate sediment constituents. Sediment was likely affected by settling and filtration to a greater degree than are Nitrate and Orthophosphate. Additional data points would be helpful to add confidence to the correlation between runoff reduction and nutrient load removal efficiency.

Peak flow reduction was highly correlated with Orthophosphate reduction ($R^2 = 0.77$), and to a lesser degree, TSS reductions ($R^2 = 0.32$). The lack of correlation with Nitrate ($R^2 = 0.01$) highlights the difference in behavior of Nitrate and Orthophosphate. Where Orthophosphate reductions appear to be affected by a slower introduction of runoff to the biofilter, allowing Orthophosphate removal to occur through a number of mechanisms (microbial action, plant uptake, infiltration, immobilization, precipitation, etc.) in appropriate time, Nitrate levels were less sensitive to flow rate. When the 8/4/2010 outlier result is removed, Nitrate's R^2 increases to 0.21, suggesting that slower application of runoff to the biofilter may have some affect on Nitrate-N, however it is still a weak relationship. This may be because the presumed increase in residence time allowed near as much dissolution of Nitrate from biofilter media as it does the opportunity for physical/biological removal of Nitrate from the runoff. The relationship of TSS to peak flow rate was likely affected by the increased opportunity for settling and filtration accompanying slower flow rates, although, one might expect the relationship to be stronger. However, if a statistical analysis of the data were to suggest that the 9/29/2010 event was an outlier, its removal would render the correlation much weaker, as TSS reductions were relatively high across the range of peak flow rates.

Total Suspended Solids

As presented in Table 8, TSS load reductions realized by the biofilter were generally very strong. The biofilter filters sediment through its media, and settles it in the freeboard volume between the surface of the media and the orifice of the riser when runoff ponds above the soil media. Additionally, while the biofilter achieved high TSS load reductions from surface runoff, the additional benefit of hydrologic treatment will provide reduced channel erosion downstream. The latter is perhaps a larger contributor to sediment reductions in receiving streams, albeit less quantifiable.

The only deviation from the high treatment efficiency trend was during the 9/29/2010 event when sediment was exported from the system. Although not observed in the field, flow and precipitation data support the theory that the biofilter reached its full storage capacity during this event. The additional volume of runoff would have bypassed the system through the riser, which is installed in the biofilter for this purpose. This meant the untreated or partially treated runoff exited the biofilter for a portion of the event, and would partially explain the poor performance in TSS removal. However, it does not explain the apparent export of TSS that occurred during this event. Potential causes of this export may be that fine particulates leached out of the media during the large event, and/or influent flow velocities were high enough to re-suspend particulate matter in the biofilter and carry them out through the riser during periods of bypass.

The 9/29/2010 event was by far the largest rain event monitored, and events of this size rarely occur in Virginia (Virginia Climatology Office, 2011). Additionally, a rain event of 0.73 inches occurred one day prior, which could be another factor affecting performance during this event. The biofilter was likely still processing runoff retained from that event. However, it should be noted that an analysis comparing antecedent dry days to load reductions achieved showed very little correlation.

Total Suspended Solids treatment was highly correlated ($R^2 = 0.8$) with total rain depth, and showed a moderate correlation ($R^2 = 0.48$) with total rainfall duration. The biofilter was designed with eight inches of freeboard space to allow for ponding; when capacity is reached, untreated runoff will bypass the biofilter and discharge to the stormwater conveyance system. Thus, it is no surprise that rain events delivering larger volumes, and those that last longer, resulted in diminishing biofilter capability to treat sediment. It is also possible that the biofilter media leached fine material on occasion, as it was a new system when studied.

Nitrate

Table 9 shows that Nitrate-N EMC efficiencies were often negative, a result of the fact that the Nitrate is a highly soluble compound. The biofilter is susceptible to losses of Nitrate derived from the organic matter in its media. The unusually large portion of organic matter used in the formulation of the biofilter's media produces a soil environment conducive to nitrification, especially while the system is still new (EPA, 2011). However, because of the significant volume of runoff removed by the biofilter in the events analyzed, Nitrate load reductions were almost always achieved.

The 8/4/2010 event resulted in an export of Nitrate from the biofilter. Neither flow, nor precipitation data leads to the conclusion that runoff bypassed the system, although this event had the highest average intensity of all events monitored at 0.93 inches per hour. It is possible that runoff exceeded the freeboard capacity of the biofilter and began to bypass through the riser before there was time for it to filter through the biofilter media, but the data was inconclusive. A more probable explanation is that Nitrate resulting from nitrification of organic nitrogen was flushed from the biofilter media during the 8/4/2010 event. This is also likely to explain the very poor EMC reduction performance for this event.

Recent research has shown that certain design modifications for biofilters, such as the addition of a sump zone below the underdrains, internal water storage layer above the underdrains, and an "upturned elbow" connecting the underdrain to the effluent point of discharge, increase the storage time of runoff received in the biofilter, providing time for nitrogen compounds to denitrify, or release to the atmosphere in the form of N_2 gas (Brown, *et. al.*, 2009). These design modifications increase the nitrogen treatment efficiency of biofilters. Seasonal variation in Nitrate treatment may exist in bioretention facilities, since plant growth and biological activity of bacteria are significantly reduced during the colder seasons of the year. Further sampling and analysis at the CHS biofilter would be helpful in determining the influence of temperature on Nitrate treatment.

Nitrate treatment was not strongly correlated with any rain event characteristics that were explored in this study. There was a moderate correlation ($R^2 = 0.41$) with average rain intensity, however, that show less Nitrate treatment occurs with higher average rain intensity. This may be explained by the compounds mobile nature. Higher average rain intensity would more quickly flush Nitrate from the biofilter media, leaving little time for microorganisms to process the compound, or for plants to absorb it.

Orthophosphate

Table 10 shows that Orthophosphate load reductions are often substantial and result in an overall SOL of 75%. Since these compounds are dissolved, the treatment efficiency is largely reliant on runoff volume reduction through infiltration to the underlying soil, and filtering, retention, and biological action in the biofilter media to reduce loads (Hsieh, *et. al.*, 2007). Other research has shown that phosphate compounds (other than Orthophosphate) found in stormwater are largely bound to sediment (Sansalone, 2010), and are not bioavailable. Thus, the improved efficiency in reducing sediment in runoff also reduces total phosphorus (TP), but does little to impede the Orthophosphate contribution to eutrophication. Research continues on the mechanisms that drive equilibrium between solid and aqueous phase phosphate.

The 9/28/2010 event showed a negative EMC efficiency, and relatively low load reduction compared to other events. The data do not show conclusive evidence of bypass of the system, or other potential indicators to explain this result. Additionally, measurements of Nitrate and TSS were not out of the ordinary for this event.

Reducing Orthophosphate in stormwater is important because phosphorus is the limiting nutrient for algae growth in freshwater systems, and Orthophosphate is the most bioavailable form (Murphy, 2007). Thus, reducing the ratio of P to N in natural waters inhibits algal growth, thereby preventing eutrophication and hypoxia. Studies have shown that seasonal variability of Orthophosphate and TP is generally low (Carleton, *et. al.*, 2000), although a 6% increase in load treatment efficiency of TP in the summer has been observed (Roseen, *et. al.*, 2009).

The R^2 analysis showed that Orthophosphate reduction was not highly correlated with any rainfall characteristic. It was weakly correlated with total rainfall depth ($R^2 = 0.36$), however, showing that a lower amount of Orthophosphate was removed from runoff with greater total depth. This is likely because the biofilter media becomes more fully saturated with higher amounts of rainfall, incrementally reducing its ability to infiltrate, retain, and filter runoff beyond what is discharged from its design storm of ½". The negative relationship with total depth is likely driven in part by lack of treatment during large events that send untreated runoff through the riser, bypassing treatment completely.

Effluent Concentrations

Table 14 shows the comparison of the CHS biofilter with the International Stormwater BMP Database aggregated results of water quality treatment by bioretention BMPs. The results are very similar for TSS treatment, but diverge significantly for Nitrate and Orthophosphate reductions. This variability in treatment of constituents illustrates the difficulty in comparing BMP effectiveness from one BMP to the next. These differences could be attributed to the design storm used for the various BMPs used in the International Stormwater BMP Database study, land use/land cover in the study drainage areas, rain events studied, seasonal variability, or other differences. Table 14 reports median concentrations, which, as discussed previously, do not account for volume or load reductions.

Table 14. Comparison of study results

	CHS			International Stormwater BMP Database		
	Median EMC (mg/L)		**% Change**	**Median EMC (mg/L)**		**% Change**
	Influent	Effluent		Influent	Effluent	
TSS	28.14	4.37	84.5%	50	10	80.0%
Nitrate-N	0.16	0.33	-51.5%	1.38	1.09	21.0%
Orthophosphate-PO_4[1]	0.19	0.14	35.7%	0.12	0.48	-300.0%

[1] The International Stormwater BMP Database Orthophosphate median was reported as Orthophosphate-P. It was converted to Orthophosphate-PO_4 for comparison by multiplying it by 3, as P accounts for ~1/3 of the mass of the PO_4 molecule

Finally, there is a growing school of thought that endorses effluent limits for stormwater similar to those required for wastewater treatment. Some 14 states have already passed numeric effluent limits into law (Obreza *et. al.*, 2010). As previously mentioned, Virginia is in the process of passing new stormwater regulations, but chose a percent reduction criterion for reducing pollutants, as opposed to numeric limits. This was a less stringent approach, since even a large percent reduction of a highly polluted effluent will result in pollution, whereas a numeric limit would have required an absolute standard to be met. No numeric water quality standard exists in Virginia for sediment or phosphorus, as they relate to surface waters. According to 9VAC25-260-140 Criteria for Surface Water (Code of Virginia), the Virginia standard for Nitrate is 10 mg/L to protect human health. However, aquatic life is much more sensitive to these pollutants.

In 2010, the EPA proposed nutrient standards for the state of Florida from 0.824 – 1.8 mg/L (total nitrogen), and 0.043 – 0.74 mg/L (total phosphorus). While these numbers are difficult to compare to Nitrate and Orthophosphate concentrations, we can see that International Stormwater BMP Database Nitrate concentrations alone fall into the EPA proposed range for total nitrogen, and Nitrate is only a fraction of total nitrogen. The same is true for Orthophosphate. If considering nutrient concentrations in isolation from volume reductions, the EPA proposed standards would seem difficult to meet using biofiltration, at least with the design specifications studied here. In Virginia, the Department of Environmental Quality issues point-source permits that define average TSS limits from 10 – 30 mg/L. Both the CHS study and the International Stormwater BMP Database study show that biofiltration could effectively meet similar standards.

Data Quality Objectives

Completeness & Representativeness

Available resources allowed the study team to monitor twice as many events as it originally estimated would be possible, thus more than fulfilling the completeness data quality objective. To achieve a scientific validity however, further sampling to achieve statistical relevance is required. Table 12 shows the number of data points still needed.

All but one monitored event met the guidelines established in the QAPP for representativeness. Data from this event was not excluded from the study, however. While neither the minimum rainfall depth, nor minimum number of samples established by the guidelines were met, the event created runoff, and samples were obtained across the majority of the hydrographs, which is what the guidelines are meant to ensure. Representativeness of sampling from each event was also of high quality; over 75% of the inlet and outlet hydrograph volumes were sampled, averaging 93% of event volume. In load calculations, no sample represented more than 20% of the volume produced by the event.

Precision and MDLs

For many events, sample concentrations approached, and in some cases were less than the minimum detection limit, which calls into question the accuracy of the measurements. However, since this affected the majority of laboratory analyses, it was not possible to exclude data based on this parameter. Two assumptions lead the study team to conclude that the nutrient measurements were still of acceptable quality:

1. *The lab kits used to measure nutrient concentrations in this study make conservative estimates of the MDL (Culver, personal communication, January 13, 2011).*
2. *Measurements below the minimum detection limit mean only that there is a lower degree of certainty that the measurements are correct, not that the measurement is incorrect (Thomas, personal communication, August 25, 2011).*

It was the professional judgment of the study team leaders that sacrificing the robustness of the dataset for what was assumed to be small deviations in accuracy was not necessary.

Precision measurements, when taken, met the data quality objectives in all cases except for two. Precision averages were 10.6 (Nitrate-N), and 13 (Orthophosphate-PO_4) relative percent difference. No replicate samples were measured for the 7/10/2010 or 7/14/2010 events. The two cases that did not meet the

QAPP guideline of 20 relative percent difference did not preclude the dataset averages from meeting the guideline and thus were not thought to compromise data quality.

8 Conclusion

To date, the study of the biofilter shows that it is a useful BMP for treating the altered hydrology of the urban drainage area. It also shows promise in treating stormwater for nutrients and sediment, with the greatest performance in Orthophosphate reductions. The data show that Nitrate concentrations increased on several occasions in the effluent. However, because the volume reductions were usually significant, an overall decrease in Nitrate load was observed from most events for each constituent of interest.

The results of the study show that the biofilter is a useful tool for reducing nutrients and sediment, pollutants that impair both Charlottesville's local streams, and the Chesapeake Bay. These results are particularly promising because they support the effectiveness of retrofitting older urban infrastructure to treat stormwater before it is discharged to local streams as a strategy to improve local water quality, as well as to benefit downstream water bodies. The results suggest that bioretention is an effective strategy for meeting stricter standards on stormwater quality and quantity for past and future development.

Finally, previous research in the field has shown that biofilter performance changes over time as plant growth promotes more nutrient uptake and the biofilter media changes. Additionally, it is possible for stormwater BMP performance to vary by season. Permanent water quality improvements rely on the long-term successful functioning of the BMPs implemented to achieve them. Climatic variation and physical and biological evolution in the structure present the opportunity to obtain additional data in order to characterize water quality treatment efficiency over the life of the biofilter. It would be beneficial to focus future work on quantifying trends in performance over time.

Additionally, while this study focuses only on Nitrate and Orthophosphate, future research on the effectiveness of the biofilter to treat Total Nitrogen and Total Phosphorus would also be helpful. Localities could more easily translate BMP performance on total nutrient reductions, which are now being used in the regulatory setting. Access to total nutrient reduction performance data for a range of stormwater BMPs could be used as the basis for decision making related to meeting target load reductions assigned to localities by VaDCR. Another practical avenue of future study would involve the examination of the relationship between BMP installation cost and treatment efficiency. Ultimately, this is the information that localities need to efficiently retrofit urban watersheds.

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Appendix A – Raw Data

Precipitation Data

EVENT DATE: 7/10/2010

Site Name	CHS Inlet		Total Depth of Event	0.36	inches
Isco Quantity	Rainfall		Total Duration of Event	690	minutes
Label	Rainfall		Average Intensity	0.03	inch/hr
Units	**in**		Max Intensity	0.4	inch/hr
Resolution	0.01		Antecedent Dry Days	15.87	days

Date & Time	**Depth**				
7/9/2010 20:00	0				
7/9/2010 20:15	0.01		Start of storm		
7/9/2010 20:30	0				
7/9/2010 20:45	0.01				
7/9/2010 21:00	0				
7/9/2010 21:15	0				
7/9/2010 21:30	0				
7/9/2010 21:45	0				
7/9/2010 22:00	0				
7/9/2010 22:15	0				
7/9/2010 22:30	0.01				
7/9/2010 22:45	0				
7/9/2010 23:00	0				
7/9/2010 23:15	0				
7/9/2010 23:30	0				
7/9/2010 23:45	0.01				
7/10/2010 0:00	0				
7/10/2010 0:15	0				
7/10/2010 0:30	0				
7/10/2010 0:45	0				
7/10/2010 1:00	0				
7/10/2010 1:15	0				
7/10/2010 1:30	0				
7/10/2010 1:45	0				
7/10/2010 2:00	0				
7/10/2010 2:15	0				
7/10/2010 2:30	0				
7/10/2010 2:45	0				
7/10/2010 3:00	0				
7/10/2010 3:15	0				

Date & Time	Depth				
7/10/2010 3:30	0				
7/10/2010 3:45	0.01				
7/10/2010 4:00	0				
7/10/2010 4:15	0				
7/10/2010 4:30	0.01				
7/10/2010 4:45	0				
7/10/2010 5:00	0.01				
7/10/2010 5:15	0				
7/10/2010 5:30	0				
7/10/2010 5:45	0				
7/10/2010 6:00	0				
7/10/2010 6:15	0				
7/10/2010 6:30	0.05				
7/10/2010 6:45	0.1				
7/10/2010 7:00	0.07				
7/10/2010 7:15	0.02				
7/10/2010 7:30	0.04				
7/10/2010 7:45	0.01		end of storm		
7/10/2010 8:00	0				

Event Date: 7/12/2010

Site Name	CHS Inlet		Total Depth of Event	0.29	inches
Isco Quantity	Rainfall		Total Duration of Event	210	minutes
Label	Rainfall		Average Intensity	0.08	inch/hr
Units	in		Max Intensity	0.16	inch/hr
Resolution	0.01		Antecedent Dry Days	2.23	days

Date & Time	Depth				
7/12/2010 13:00	0				
7/12/2010 13:15	0.02		start of storm		
7/12/2010 13:30	0.02				
7/12/2010 13:45	0.03				
7/12/2010 14:00	0.04				
7/12/2010 14:15	0.01				
7/12/2010 14:30	0.02				
7/12/2010 14:45	0.01				
7/12/2010 15:00	0.01				
7/12/2010 15:15	0				
7/12/2010 15:30	0.01				
7/12/2010 15:45	0.04				

Date & Time	**Depth**				
7/12/2010 16:00	0.04				
7/12/2010 16:15	0.01				
7/12/2010 16:30	0.01				
7/12/2010 16:45	0.02		end of storm		
7/12/2010 17:00	0				

EVENT DATE: 7/14/2010

Site Name	CHS Inlet		Total Depth of Event	0.32	inches
Isco Quantity	Rainfall		Total Duration of Event	135	minutes
Label	Rainfall		Average Intensity	0.14	inch/hr
Units	in		Max Intensity	0.64	inch/hr
Resolution	0.01		Antecedent Dry Days	1.17	days

Date & Time	**Depth**				
7/13/2010 20:00	0				
7/13/2010 20:15	0				
7/13/2010 20:30	0				
7/13/2010 20:45	0				
7/13/2010 21:00	0.01		start of storm		
7/13/2010 21:15	0				
7/13/2010 21:30	0				
7/13/2010 21:45	0.01				
7/13/2010 22:00	0.01				
7/13/2010 22:15	0.04				
7/13/2010 22:30	0.07				
7/13/2010 22:45	0.16				
7/13/2010 23:00	0.02		end of storm		
7/13/2010 23:15	0				

EVENT DATE: 7/20/2010

Site Name	CHS Inlet		Total Depth of Event	0.08	inches
Isco Quantity	Rainfall		Total Duration of Event	30	minutes
Label	Rainfall		Average Intensity	0.16	inch/hr
Units	in		Max Intensity	0.28	inch/hr
Resolution	0.01		Antecedent Dry Days	6.76	days
Date & Time	**Depth**				
7/20/2010 17:30	0				
7/20/2010 17:45	0.07		start of storm		
7/20/2010 18:00	0.01		end of storm		
7/20/2010 18:15	0				

EVENT DATE: 7/29/2010

Site Name	CHS Inlet		Total Depth of Event	0.12	inches
Isco Quantity	Rainfall		Total Duration of Event	30	minutes
Label	Rainfall		Average Intensity	0.24	inch/hour
Units	in		Max Intensity	0.48	inch/hour
Resolution	0.1		Antecedent Dry Days	15.69	days

Date & Time	Depth				
7/29/2010 15:50	0				
7/29/2010 15:55	0.02				
7/29/2010 16:00	0.04				
7/29/2010 16:05	0.04				
7/29/2010 16:10	0.01				
7/29/2010 16:15	0				
7/29/2010 16:20	0.01				
7/29/2010 16:25	0				

EVENT DATE: 7/31/2010

Site Name	CHS Inlet		Total Depth of Event	0.18	inches
Isco Quantity	Rainfall		Total Duration of Event	75	minutes
Label	Rainfall		Average Intensity	0.144	inch/hr
Units	in		Max Intensity	0.36	inch/hr
Resolution	0.01		Antecedent Dry Days	2.22	days

Date & Time	Depth				
7/31/2010 21:40	0				
7/31/2010 21:45	0.01		start of event		
7/31/2010 21:50	0				
7/31/2010 21:55	0				
7/31/2010 22:00	0				
7/31/2010 22:05	0.01				
7/31/2010 22:10	0				
7/31/2010 22:15	0.02				
7/31/2010 22:20	0.03				
7/31/2010 22:25	0.01				
7/31/2010 22:30	0.02				
7/31/2010 22:35	0.01				
7/31/2010 22:40	0.03				
7/31/2010 22:45	0.02				
7/31/2010 22:50	0.01				
7/31/2010 22:55	0.01		end of event		
7/31/2010 23:00	0				

EVENT DATE: 8/4/2010

Site Name	CHS Inlet		Total Depth of Event	0.31	inches
Isco Quantity	Rainfall		Total Duration of Event	20	minutes
Label	Rainfall		Average Intensity	0.93	inch/hr
Units	in		Max Intensity	1.32	inch/hr
Resolution	0.01		Antecedent Dry Days	3.88	days
Date & Time	**Depth**				
8/4/2010 20:15	0.11		start of first storm		
8/4/2010 20:20	0.1				
8/4/2010 20:25	0.08				
8/4/2010 20:30	0.02				
8/4/2010 20:35	0		end of first storm		

EVENT DATE: 8/5/2010

Site Name	CHS Inlet		Total Depth of Event	0.1	inches
Isco Quantity	Rainfall		Total Duration of Event	20	minutes
Label	Rainfall		Average Intensity	0.3	inch/hour
Units	in		Max Intensity	1.2	inch/hour
Resolution	0.01		Antecedent Dry Days	0.87	days

Date & Time	**Depth**				
8/5/10 5:20 PM	0				
8/5/10 5:25 PM	0.01		start of storm		
8/5/10 5:30 PM	0.07				
8/5/10 5:35 PM	0.1				
8/5/10 5:40 PM	0.01		end of storm		
8/5/10 5:45 PM	0				

Event Date: 8/16/2010

Site Name	CHS Inlet		Total Depth of Event	0.25	inches
Isco Quantity	Rainfall		Total Duration of Event	20	minutes
Label	Rainfall		Average Intensity	0.75	inch/hr
Units	in		Max Intensity	1.44	inch/hr
Resolution	0.01		Antecedent Dry Days	10.86	days
Date & Time	**Depth**				
8/16/2010 15:30	0.03		start of storm		
8/16/2010 15:35	0.08				
8/16/2010 15:40	0.12				
8/16/2010 15:45	0.02		end of storm		

Event Date: 8/18/2010

Site Name	CHS Inlet		Total Depth of Event	0.38	inches
Isco Quantity	Rainfall		Total Duration of Event	50	minutes
Label	Rainfall		Average Intensity	0.46	inch/hr
Units	in		Max Intensity	1.56	inch/hr
Resolution	0.01		Antecedent Dry Days	0.47	days
Date & Time	**Depth**				
8/18/2010 15:10	0				
8/18/2010 15:15	0.04		start of storm		
8/18/2010 15:20	0.13				
8/18/2010 15:25	0.08				
8/18/2010 15:30	0.03				
8/18/2010 15:35	0.03				
8/18/2010 15:40	0				
8/18/2010 15:45	0.01				
8/18/2010 15:50	0.02				
8/18/2010 15:55	0.03				
8/18/2010 16:00	0.01		end of storm		
8/18/2010 16:05	0				

EVENT DATE: 8/24/2010

Site Name	CHS Inlet		Total Depth of Event	0.45	inches
Isco Quantity	Rainfall		Total Duration of Event	120	minutes
Label	Rainfall		Average Intensity	0.23	inch/hr
Units	in		Max Intensity	2.4	inch/hr
Resolution	0.01		Antecedent Dry Days	5.45	days
Date & Time	**Depth**				
8/24/2010 2:45	0				
8/24/2010 2:55	0.03		start of storm		
8/24/2010 3:00	0.2				
8/24/2010 3:05	0.12				
8/24/2010 3:10	0.02				
8/24/2010 3:15	0.01				
8/24/2010 3:20	0				
8/24/2010 3:25	0				
8/24/2010 3:30	0				
8/24/2010 3:35	0				
8/24/2010 3:40	0				
8/24/2010 3:45	0				
8/24/2010 3:50	0				
8/24/2010 3:55	0				
8/24/2010 4:00	0				
8/24/2010 4:05	0				
8/24/2010 4:10	0				
8/24/2010 4:15	0.01				
8/24/2010 4:20	0				
8/24/2010 4:25	0.01				
8/24/2010 4:30	0.01				
8/24/2010 4:35	0.01				
8/24/2010 4:40	0.01				
8/24/2010 4:45	0.01				
8/24/2010 4:50	0.01		end of storm		
8/24/2010 4:55	0				

EVENT DATE: 9/26/2010

Site Name	CHS Inlet		Total Depth of Event	1.58	inches
Isco Quantity	Rainfall		Total Duration of Event	1205	minutes
Label	Rainfall		Average Intensity	0.07	inch/hr
Units	**in**		Max Intensity	1.08	inch/hr
Resolution	0.01		Antecedent Dry Days	33.57	days

Date & Time	**Depth**				
9/26/2010 18:30	0				
9/26/2010 18:35	0.05		start of storm		
9/26/2010 18:40	0.03				
9/26/2010 18:45	0.02				
9/26/2010 18:50	0				
9/26/2010 18:55	0				
9/26/2010 19:00	0				
9/26/2010 19:05	0.01				
9/26/2010 19:10	0				
9/26/2010 19:15	0				
9/26/2010 19:20	0.01				
9/26/2010 19:25	0				
9/26/2010 19:30	0				
9/26/2010 19:35	0.01				
9/26/2010 19:40	0				
9/26/2010 19:45	0.03				
9/26/2010 19:50	0.01				
9/26/2010 19:55	0.01				
9/26/2010 20:00	0.02				
9/26/2010 20:05	0.03				
9/26/2010 20:10	0.04				
9/26/2010 20:15	0.02				
9/26/2010 20:20	0.01				
9/26/2010 20:25	0.02				
9/26/2010 20:30	0.01				
9/26/2010 20:35	0.01				
9/26/2010 20:40	0.01				
9/26/2010 20:45	0				
9/26/2010 20:50	0.01				
9/26/2010 20:55	0.01				
9/26/2010 21:00	0.01				
9/26/2010 21:05	0.01				
9/26/2010 21:10	0.01				
9/26/2010 21:15	0.01				

Date & Time	**Depth**				
9/26/2010 21:20	0.09				
9/26/2010 21:25	0.03				
9/26/2010 21:30	0.01				
9/26/2010 21:35	0				
9/26/2010 21:40	0.01				
9/26/2010 21:45	0				
9/26/2010 21:50	0.01				
9/26/2010 21:55	0				
9/26/2010 22:00	0				
9/26/2010 22:05	0				
9/26/2010 22:10	0.01				
9/26/2010 22:15	0				
9/26/2010 22:20	0				
9/26/2010 22:25	0				
9/26/2010 22:30	0				
9/26/2010 22:35	0.01				
9/26/2010 22:40	0				
9/26/2010 22:45	0				
9/26/2010 22:50	0				
9/26/2010 22:55	0				
9/26/2010 23:00	0				
9/26/2010 23:05	0				
9/26/2010 23:10	0				
9/26/2010 23:15	0				
9/26/2010 23:20	0				
9/26/2010 23:25	0				
9/26/2010 23:30	0				
9/26/2010 23:35	0				
9/26/2010 23:40	0				
9/26/2010 23:45	0				
9/26/2010 23:50	0				
9/26/2010 23:55	0.01				
9/27/2010 0:00	0				
9/27/2010 0:05	0				
9/27/2010 0:10	0				
9/27/2010 0:15	0				
9/27/2010 0:20	0				
9/27/2010 0:25	0.01				
9/27/2010 0:30	0				
9/27/2010 0:35	0				
9/27/2010 0:40	0				

Date & Time	Depth				
9/27/2010 0:45	0				
9/27/2010 0:50	0				
9/27/2010 0:55	0				
9/27/2010 1:00	0.01				
9/27/2010 1:05	0				
9/27/2010 1:10	0				
9/27/2010 1:15	0				
9/27/2010 1:20	0				
9/27/2010 1:25	0				
9/27/2010 1:30	0				
9/27/2010 1:35	0				
9/27/2010 1:40	0				
9/27/2010 1:45	0				
9/27/2010 1:50	0				
9/27/2010 1:55	0				
9/27/2010 2:00	0				
9/27/2010 2:05	0				
9/27/2010 2:10	0				
9/27/2010 2:15	0				
9/27/2010 2:20	0				
9/27/2010 2:25	0				
9/27/2010 2:30	0.01				
9/27/2010 2:35	0				
9/27/2010 2:40	0				
9/27/2010 2:45	0				
9/27/2010 2:50	0				
9/27/2010 2:55	0				
9/27/2010 3:00	0				
9/27/2010 3:05	0				
9/27/2010 3:10	0				
9/27/2010 3:15	0				
9/27/2010 3:20	0				
9/27/2010 3:25	0.01				
9/27/2010 3:30	0				
9/27/2010 3:35	0				
9/27/2010 3:40	0				
9/27/2010 3:45	0				
9/27/2010 3:50	0				
9/27/2010 3:55	0				
9/27/2010 4:00	0.01				
9/27/2010 4:05	0				

Date & Time	Depth				
9/27/2010 4:10	0.01				
9/27/2010 4:15	0				
9/27/2010 4:20	0.01				
9/27/2010 4:25	0.03				
9/27/2010 4:30	0.04				
9/27/2010 4:35	0.02				
9/27/2010 4:40	0.03				
9/27/2010 4:45	0.03				
9/27/2010 4:50	0.03				
9/27/2010 4:55	0.04				
9/27/2010 5:00	0.02				
9/27/2010 5:05	0.02				
9/27/2010 5:10	0.01				
9/27/2010 5:15	0.01				
9/27/2010 5:20	0.03				
9/27/2010 5:25	0.04				
9/27/2010 5:30	0.04				
9/27/2010 5:35	0.02				
9/27/2010 5:40	0.03				
9/27/2010 5:45	0.01				
9/27/2010 5:50	0				
9/27/2010 5:55	0.01				
9/27/2010 6:00	0				
9/27/2010 6:05	0				
9/27/2010 6:10	0				
9/27/2010 6:15	0				
9/27/2010 6:20	0.01				
9/27/2010 6:25	0				
9/27/2010 6:30	0				
9/27/2010 6:35	0				
9/27/2010 6:40	0				
9/27/2010 6:45	0				
9/27/2010 6:50	0				
9/27/2010 6:55	0				
9/27/2010 7:00	0.01				
9/27/2010 7:05	0				
9/27/2010 7:10	0.01				
9/27/2010 7:15	0				
9/27/2010 7:20	0.01				
9/27/2010 7:25	0				
9/27/2010 7:30	0.01				

Date & Time	**Depth**				
9/27/2010 7:35	0				
9/27/2010 7:40	0.01				
9/27/2010 7:45	0				
9/27/2010 7:50	0.01				
9/27/2010 7:55	0				
9/27/2010 8:00	0				
9/27/2010 8:05	0.01				
9/27/2010 8:10	0				
9/27/2010 8:15	0				
9/27/2010 8:20	0				
9/27/2010 8:25	0.01				
9/27/2010 8:30	0				
9/27/2010 8:35	0				
9/27/2010 8:40	0				
9/27/2010 8:45	0				
9/27/2010 8:50	0.01				
9/27/2010 8:55	0				
9/27/2010 9:00	0.01				
9/27/2010 9:05	0.01				
9/27/2010 9:10	0.01				
9/27/2010 9:15	0				
9/27/2010 9:20	0.01				
9/27/2010 9:25	0				
9/27/2010 9:30	0.01				
9/27/2010 9:35	0				
9/27/2010 9:40	0				
9/27/2010 9:45	0				
9/27/2010 9:50	0				
9/27/2010 9:55	0.01				
9/27/2010 10:00	0				
9/27/2010 10:05	0.01				
9/27/2010 10:10	0				
9/27/2010 10:15	0				
9/27/2010 10:20	0.01				
9/27/2010 10:25	0				
9/27/2010 10:30	0				
9/27/2010 10:35	0				
9/27/2010 10:40	0				
9/27/2010 10:45	0.01				
9/27/2010 10:50	0				
9/27/2010 10:55	0				

Date & Time	Depth				
9/27/2010 11:00	0				
9/27/2010 11:05	0.01				
9/27/2010 11:10	0				
9/27/2010 11:15	0				
9/27/2010 11:20	0.01				
9/27/2010 11:25	0				
9/27/2010 11:30	0				
9/27/2010 11:35	0				
9/27/2010 11:40	0				
9/27/2010 11:45	0				
9/27/2010 11:50	0				
9/27/2010 11:55	0				
9/27/2010 12:00	0				
9/27/2010 12:05	0				
9/27/2010 12:10	0				
9/27/2010 12:15	0				
9/27/2010 12:20	0				
9/27/2010 12:25	0				
9/27/2010 12:30	0				
9/27/2010 12:35	0				
9/27/2010 12:40	0				
9/27/2010 12:45	0				
9/27/2010 12:50	0				
9/27/2010 12:55	0				
9/27/2010 13:00	0				
9/27/2010 13:05	0				
9/27/2010 13:10	0				
9/27/2010 13:15	0				
9/27/2010 13:20	0				
9/27/2010 13:25	0.01				
9/27/2010 13:30	0.01				
9/27/2010 13:35	0.01				
9/27/2010 13:40	0				
9/27/2010 13:45	0.01				
9/27/2010 13:50	0.07				
9/27/2010 13:55	0.02				
9/27/2010 14:00	0.04				
9/27/2010 14:05	0.01				
9/27/2010 14:10	0				
9/27/2010 14:15	0				
9/27/2010 14:20	0				

Date & Time	Depth				
9/27/2010 14:25	0				
9/27/2010 14:30	0				
9/27/2010 14:35	0.01				
9/27/2010 14:40	0				
9/27/2010 14:45	0				
9/27/2010 14:50	0				
9/27/2010 14:55	0				
9/27/2010 15:00	0				
9/27/2010 15:05	0				
9/27/2010 15:10	0				
9/27/2010 15:15	0				
9/27/2010 15:20	0				
9/27/2010 15:25	0				
9/27/2010 15:30	0.01				
9/27/2010 15:35	0				
9/27/2010 15:40	0				
9/27/2010 15:45	0				
9/27/2010 15:50	0				
9/27/2010 15:55	0				
9/27/2010 16:00	0				
9/27/2010 16:05	0.01				
9/27/2010 16:10	0.02				
9/27/2010 16:15	0.01				
9/27/2010 16:20	0.01		end of storm		
9/27/2010 16:25	0				

Event Date: 9/28/2010

Site Name	CHS Inlet		Total Depth of Event	0.73	inches
Isco Quantity	Rainfall		Total Duration of Event	1205	minutes
Label	Rainfall		Average Intensity	0.16	inch/hr
Units	in		Max Intensity	1.32	inch/hr
Resolution	0.01		Antecedent Dry Days	0.33	days

Date & Time	Depth				
9/28/2010 0:20	0				
9/28/2010 0:25	0.01		start of storm		
9/28/2010 0:30	0				
9/28/2010 0:35	0				
9/28/2010 0:40	0				
9/28/2010 0:45	0				

Date & Time	Depth				
9/28/2010 0:50	0				
9/28/2010 0:55	0.01				
9/28/2010 1:00	0				
9/28/2010 1:05	0				
9/28/2010 1:10	0				
9/28/2010 1:15	0				
9/28/2010 1:20	0				
9/28/2010 1:25	0.01				
9/28/2010 1:30	0				
9/28/2010 1:35	0				
9/28/2010 1:40	0				
9/28/2010 1:45	0				
9/28/2010 1:50	0				
9/28/2010 1:55	0				
9/28/2010 2:00	0.01				
9/28/2010 2:05	0				
9/28/2010 2:10	0				
9/28/2010 2:15	0.01				
9/28/2010 2:20	0.01				
9/28/2010 2:25	0.01				
9/28/2010 2:30	0.01				
9/28/2010 2:35	0.02				
9/28/2010 2:40	0.03				
9/28/2010 2:45	0.08				
9/28/2010 2:50	0.02				
9/28/2010 2:55	0				
9/28/2010 3:00	0				
9/28/2010 3:05	0.02				
9/28/2010 3:10	0.05				
9/28/2010 3:15	0.11				
9/28/2010 3:20	0.04				
9/28/2010 3:25	0.02				
9/28/2010 3:30	0.02				
9/28/2010 3:35	0.09				
9/28/2010 3:40	0.02				
9/28/2010 3:45	0.03				
9/28/2010 3:50	0.04				
9/28/2010 3:55	0.03				
9/28/2010 4:00	0.02				
9/28/2010 4:05	0				
9/28/2010 4:10	0				

Date & Time	Depth				
9/28/2010 4:15	0				
9/28/2010 4:20	0				
9/28/2010 4:25	0				
9/28/2010 4:30	0				
9/28/2010 4:35	0				
9/28/2010 4:40	0				
9/28/2010 4:45	0				
9/28/2010 4:50	0				
9/28/2010 4:55	0				
9/28/2010 5:00	0.01		end of storm		
9/28/2010 5:05	0				

Event Date: 9/29/2010

Site Name	CHS Inlet		Total Depth of Event	3.47	inches
Isco Quantity	Rainfall		Total Duration of Event	2130	minutes
Label	Rainfall		Average Intensity	0.10	inch/hr
Units	in		Max Intensity	1.44	inch/hr
Resolution	0.01		Antecedent Dry Days	1.30	days

Date & Time	Depth				
9/29/2010 12:10	0				
9/29/2010 12:15	0.01		start of storm		
9/29/2010 12:20	0				
9/29/2010 12:25	0				
9/29/2010 12:30	0				
9/29/2010 12:35	0				
9/29/2010 12:40	0				
9/29/2010 12:45	0				
9/29/2010 12:50	0				
9/29/2010 12:55	0.01				
9/29/2010 13:00	0				
9/29/2010 13:05	0				
9/29/2010 13:10	0				
9/29/2010 13:15	0.01				
9/29/2010 13:20	0				
9/29/2010 13:25	0				
9/29/2010 13:30	0				
9/29/2010 13:35	0				
9/29/2010 13:40	0				
9/29/2010 13:45	0.01				

Date & Time	Depth				
9/29/2010 13:50	0				
9/29/2010 13:55	0				
9/29/2010 14:00	0.01				
9/29/2010 14:05	0				
9/29/2010 14:10	0				
9/29/2010 14:15	0				
9/29/2010 14:20	0.01				
9/29/2010 14:25	0				
9/29/2010 14:30	0				
9/29/2010 14:35	0.01				
9/29/2010 14:40	0				
9/29/2010 14:45	0				
9/29/2010 14:50	0.01				
9/29/2010 14:55	0.01				
9/29/2010 15:00	0				
9/29/2010 15:05	0				
9/29/2010 15:10	0				
9/29/2010 15:15	0				
9/29/2010 15:20	0.01				
9/29/2010 15:25	0				
9/29/2010 15:30	0				
9/29/2010 15:35	0.01				
9/29/2010 15:40	0				
9/29/2010 15:45	0.01				
9/29/2010 15:50	0				
9/29/2010 15:55	0.01				
9/29/2010 16:00	0				
9/29/2010 16:05	0.01				
9/29/2010 16:10	0				
9/29/2010 16:15	0.01				
9/29/2010 16:20	0				
9/29/2010 16:25	0				
9/29/2010 16:30	0.01				
9/29/2010 16:35	0				
9/29/2010 16:40	0				
9/29/2010 16:45	0.01				
9/29/2010 16:50	0				
9/29/2010 16:55	0				
9/29/2010 17:00	0.01				
9/29/2010 17:05	0.01				
9/29/2010 17:10	0				

Date & Time	Depth				
9/29/2010 17:15	0.01				
9/29/2010 17:20	0.01				
9/29/2010 17:25	0.01				
9/29/2010 17:30	0				
9/29/2010 17:35	0.01				
9/29/2010 17:40	0				
9/29/2010 17:45	0.01				
9/29/2010 17:50	0				
9/29/2010 17:55	0				
9/29/2010 18:00	0				
9/29/2010 18:05	0				
9/29/2010 18:10	0				
9/29/2010 18:15	0				
9/29/2010 18:20	0				
9/29/2010 18:25	0.01				
9/29/2010 18:30	0				
9/29/2010 18:35	0				
9/29/2010 18:40	0				
9/29/2010 18:45	0				
9/29/2010 18:50	0				
9/29/2010 18:55	0				
9/29/2010 19:00	0.01				
9/29/2010 19:05	0				
9/29/2010 19:10	0				
9/29/2010 19:15	0				
9/29/2010 19:20	0				
9/29/2010 19:25	0				
9/29/2010 19:30	0				
9/29/2010 19:35	0				
9/29/2010 19:40	0				
9/29/2010 19:45	0.01				
9/29/2010 19:50	0				
9/29/2010 19:55	0				
9/29/2010 20:00	0.01				
9/29/2010 20:05	0.01				
9/29/2010 20:10	0.01				
9/29/2010 20:15	0.01				
9/29/2010 20:20	0				
9/29/2010 20:25	0				
9/29/2010 20:30	0				
9/29/2010 20:35	0				

Date & Time	Depth				
9/29/2010 20:40	0				
9/29/2010 20:45	0				
9/29/2010 20:50	0				
9/29/2010 20:55	0				
9/29/2010 21:00	0				
9/29/2010 21:05	0				
9/29/2010 21:10	0				
9/29/2010 21:15	0				
9/29/2010 21:20	0				
9/29/2010 21:25	0				
9/29/2010 21:30	0.01				
9/29/2010 21:35	0				
9/29/2010 21:40	0				
9/29/2010 21:45	0				
9/29/2010 21:50	0.01				
9/29/2010 21:55	0				
9/29/2010 22:00	0.01				
9/29/2010 22:05	0				
9/29/2010 22:10	0.01				
9/29/2010 22:15	0				
9/29/2010 22:20	0				
9/29/2010 22:25	0.01				
9/29/2010 22:30	0				
9/29/2010 22:35	0				
9/29/2010 22:40	0				
9/29/2010 22:45	0.01				
9/29/2010 22:50	0				
9/29/2010 22:55	0				
9/29/2010 23:00	0				
9/29/2010 23:05	0				
9/29/2010 23:10	0.01				
9/29/2010 23:15	0				
9/29/2010 23:20	0				
9/29/2010 23:25	0				
9/29/2010 23:30	0.01				
9/29/2010 23:35	0				
9/29/2010 23:40	0				
9/29/2010 23:45	0				
9/29/2010 23:50	0				
9/29/2010 23:55	0.01				
9/30/2010 0:00	0				

Date & Time	Depth				
9/30/2010 0:05	0				
9/30/2010 0:10	0.01				
9/30/2010 0:15	0				
9/30/2010 0:20	0				
9/30/2010 0:25	0.01				
9/30/2010 0:30	0				
9/30/2010 0:35	0.01				
9/30/2010 0:40	0.01				
9/30/2010 0:45	0.01				
9/30/2010 0:50	0				
9/30/2010 0:55	0.01				
9/30/2010 1:00	0				
9/30/2010 1:05	0.01				
9/30/2010 1:10	0				
9/30/2010 1:15	0				
9/30/2010 1:20	0				
9/30/2010 1:25	0.01				
9/30/2010 1:30	0.01				
9/30/2010 1:35	0				
9/30/2010 1:40	0.01				
9/30/2010 1:45	0.02				
9/30/2010 1:50	0.01				
9/30/2010 1:55	0.01				
9/30/2010 2:00	0.01				
9/30/2010 2:05	0.01				
9/30/2010 2:10	0.01				
9/30/2010 2:15	0				
9/30/2010 2:20	0				
9/30/2010 2:25	0.02				
9/30/2010 2:30	0.01				
9/30/2010 2:35	0.02				
9/30/2010 2:40	0.03				
9/30/2010 2:45	0.02				
9/30/2010 2:50	0.02				
9/30/2010 2:55	0				
9/30/2010 3:00	0.02				
9/30/2010 3:05	0.01				
9/30/2010 3:10	0.01				
9/30/2010 3:15	0.02				
9/30/2010 3:20	0.01				
9/30/2010 3:25	0.01				

Date & Time	Depth				
9/30/2010 3:30	0.01				
9/30/2010 3:35	0.04				
9/30/2010 3:40	0.05				
9/30/2010 3:45	0.01				
9/30/2010 3:50	0.02				
9/30/2010 3:55	0.02				
9/30/2010 4:00	0.02				
9/30/2010 4:05	0.02				
9/30/2010 4:10	0.02				
9/30/2010 4:15	0.01				
9/30/2010 4:20	0.02				
9/30/2010 4:25	0.01				
9/30/2010 4:30	0.02				
9/30/2010 4:35	0.01				
9/30/2010 4:40	0.01				
9/30/2010 4:45	0.01				
9/30/2010 4:50	0.01				
9/30/2010 4:55	0.01				
9/30/2010 5:00	0.01				
9/30/2010 5:05	0.01				
9/30/2010 5:10	0.02				
9/30/2010 5:15	0.01				
9/30/2010 5:20	0.02				
9/30/2010 5:25	0.01				
9/30/2010 5:30	0.01				
9/30/2010 5:35	0.02				
9/30/2010 5:40	0.01				
9/30/2010 5:45	0.03				
9/30/2010 5:50	0.02				
9/30/2010 5:55	0.01				
9/30/2010 6:00	0.01				
9/30/2010 6:05	0.01				
9/30/2010 6:10	0.01				
9/30/2010 6:15	0.01				
9/30/2010 6:20	0.02				
9/30/2010 6:25	0.02				
9/30/2010 6:30	0.02				
9/30/2010 6:35	0.02				
9/30/2010 6:40	0.02				
9/30/2010 6:45	0.03				
9/30/2010 6:50	0.1				

Date & Time	Depth				
9/30/2010 6:55	0.06				
9/30/2010 7:00	0.12				
9/30/2010 7:05	0.06				
9/30/2010 7:10	0.04				
9/30/2010 7:15	0.05				
9/30/2010 7:20	0.05				
9/30/2010 7:25	0.04				
9/30/2010 7:30	0.02				
9/30/2010 7:35	0.01				
9/30/2010 7:40	0.06				
9/30/2010 7:45	0.05				
9/30/2010 7:50	0.05				
9/30/2010 7:55	0.04				
9/30/2010 8:00	0.03				
9/30/2010 8:05	0.04				
9/30/2010 8:10	0.03				
9/30/2010 8:15	0.06				
9/30/2010 8:20	0.04				
9/30/2010 8:25	0.01				
9/30/2010 8:30	0.01				
9/30/2010 8:35	0.01				
9/30/2010 8:40	0.02				
9/30/2010 8:45	0.02				
9/30/2010 8:50	0.01				
9/30/2010 8:55	0				
9/30/2010 9:00	0.01				
9/30/2010 9:05	0.01				
9/30/2010 9:10	0				
9/30/2010 9:15	0.02				
9/30/2010 9:20	0				
9/30/2010 9:25	0.01				
9/30/2010 9:30	0				
9/30/2010 9:35	0				
9/30/2010 9:40	0.01				
9/30/2010 9:45	0.01				
9/30/2010 9:50	0				
9/30/2010 9:55	0.01				
9/30/2010 10:00	0.01				
9/30/2010 10:05	0.01				
9/30/2010 10:10	0.01				
9/30/2010 10:15	0.06				

Date & Time	Depth				
9/30/2010 10:20	0.02				
9/30/2010 10:25	0.01				
9/30/2010 10:30	0				
9/30/2010 10:35	0.01				
9/30/2010 10:40	0				
9/30/2010 10:45	0				
9/30/2010 10:50	0				
9/30/2010 10:55	0				
9/30/2010 11:00	0				
9/30/2010 11:05	0				
9/30/2010 11:10	0				
9/30/2010 11:15	0				
9/30/2010 11:20	0				
9/30/2010 11:25	0				
9/30/2010 11:30	0				
9/30/2010 11:35	0				
9/30/2010 11:40	0				
9/30/2010 11:45	0				
9/30/2010 11:50	0				
9/30/2010 11:55	0				
9/30/2010 12:00	0				
9/30/2010 12:05	0				
9/30/2010 12:10	0				
9/30/2010 12:15	0				
9/30/2010 12:20	0				
9/30/2010 12:25	0				
9/30/2010 12:30	0				
9/30/2010 12:35	0				
9/30/2010 12:40	0				
9/30/2010 12:45	0				
9/30/2010 12:50	0.01				
9/30/2010 12:55	0				
9/30/2010 13:00	0				
9/30/2010 13:05	0				
9/30/2010 13:10	0				
9/30/2010 13:15	0				
9/30/2010 13:20	0				
9/30/2010 13:25	0				
9/30/2010 13:30	0.01				
9/30/2010 13:35	0.05				
9/30/2010 13:40	0.03				

Date & Time	Depth				
9/30/2010 13:45	0.03				
9/30/2010 13:50	0.04				
9/30/2010 13:55	0.06				
9/30/2010 14:00	0.05				
9/30/2010 14:05	0.02				
9/30/2010 14:10	0				
9/30/2010 14:15	0				
9/30/2010 14:20	0				
9/30/2010 14:25	0				
9/30/2010 14:30	0				
9/30/2010 14:35	0				
9/30/2010 14:40	0				
9/30/2010 14:45	0				
9/30/2010 14:50	0				
9/30/2010 14:55	0				
9/30/2010 15:00	0				
9/30/2010 15:05	0				
9/30/2010 15:10	0				
9/30/2010 15:15	0				
9/30/2010 15:20	0				
9/30/2010 15:25	0				
9/30/2010 15:30	0				
9/30/2010 15:35	0				
9/30/2010 15:40	0				
9/30/2010 15:45	0				
9/30/2010 15:50	0				
9/30/2010 15:55	0				
9/30/2010 16:00	0				
9/30/2010 16:05	0				
9/30/2010 16:10	0				
9/30/2010 16:15	0.01				
9/30/2010 16:20	0				
9/30/2010 16:25	0				
9/30/2010 16:30	0				
9/30/2010 16:35	0				
9/30/2010 16:40	0				
9/30/2010 16:45	0				
9/30/2010 16:50	0				
9/30/2010 16:55	0				
9/30/2010 17:00	0				
9/30/2010 17:05	0				

Date & Time	Depth				
9/30/2010 17:10	0				
9/30/2010 17:15	0				
9/30/2010 17:20	0				
9/30/2010 17:25	0				
9/30/2010 17:30	0				
9/30/2010 17:35	0.01				
9/30/2010 17:40	0				
9/30/2010 17:45	0				
9/30/2010 17:50	0				
9/30/2010 17:55	0				
9/30/2010 18:00	0				
9/30/2010 18:05	0.01				
9/30/2010 18:10	0				
9/30/2010 18:15	0				
9/30/2010 18:20	0				
9/30/2010 18:25	0				
9/30/2010 18:30	0				
9/30/2010 18:35	0				
9/30/2010 18:40	0				
9/30/2010 18:45	0				
9/30/2010 18:50	0				
9/30/2010 18:55	0				
9/30/2010 19:00	0				
9/30/2010 19:05	0.02				
9/30/2010 19:10	0				
9/30/2010 19:15	0				
9/30/2010 19:20	0				
9/30/2010 19:25	0				
9/30/2010 19:30	0.01				
9/30/2010 19:35	0.02				
9/30/2010 19:40	0.01				
9/30/2010 19:45	0.02				
9/30/2010 19:50	0.02				
9/30/2010 19:55	0				
9/30/2010 20:00	0.01				
9/30/2010 20:05	0				
9/30/2010 20:10	0				
9/30/2010 20:15	0.01				
9/30/2010 20:20	0				
9/30/2010 20:25	0				
9/30/2010 20:30	0				

Date & Time	Depth				
9/30/2010 20:35	0				
9/30/2010 20:40	0				
9/30/2010 20:45	0				
9/30/2010 20:50	0.01				
9/30/2010 20:55	0.01				
9/30/2010 21:00	0.01				
9/30/2010 21:05	0.02				
9/30/2010 21:10	0.02				
9/30/2010 21:15	0.01				
9/30/2010 21:20	0.01				
9/30/2010 21:25	0.01				
9/30/2010 21:30	0.01				
9/30/2010 21:35	0.01				
9/30/2010 21:40	0.01				
9/30/2010 21:45	0.01				
9/30/2010 21:50	0.01				
9/30/2010 21:55	0				
9/30/2010 22:00	0.02				
9/30/2010 22:05	0.02				
9/30/2010 22:10	0.02				
9/30/2010 22:15	0.02				
9/30/2010 22:20	0.01				
9/30/2010 22:25	0.02				
9/30/2010 22:30	0.02				
9/30/2010 22:35	0.01				
9/30/2010 22:40	0.01				
9/30/2010 22:45	0				
9/30/2010 22:50	0.01				
9/30/2010 22:55	0.01				
9/30/2010 23:00	0				
9/30/2010 23:05	0				
9/30/2010 23:10	0.01				
9/30/2010 23:15	0				
9/30/2010 23:20	0				
9/30/2010 23:25	0				
9/30/2010 23:30	0				
9/30/2010 23:35	0				
9/30/2010 23:40	0.01		end of storm		
9/30/2010 23:45	0				

EVENT DATE: 10/27/2010

Site Name	CHS Inlet		Total Depth of Event	0.91	inches
Isco Quantity	Rainfall		Total Duration of Event	565.2	minutes
Label	Rainfall		Average Intensity	0.01	inch/hour
Units	in		Max Intensity	1.2	inch/hour
Resolution	0.01		Antecedent Dry Days	6.62	days

Date & Time	**Depth**				
10/27/2010 3:30	0				
10/27/2010 3:35	0.01				
10/27/2010 3:40	0				
10/27/2010 3:45	0				
10/27/2010 3:50	0				
10/27/2010 3:55	0				
10/27/2010 4:00	0.01				
10/27/2010 4:05	0.01				
10/27/2010 4:10	0.02				
10/27/2010 4:15	0.01				
10/27/2010 4:20	0				
10/27/2010 4:25	0.01				
10/27/2010 4:30	0.05				
10/27/2010 4:35	0.01				
10/27/2010 4:40	0.01				
10/27/2010 4:45	0				
10/27/2010 4:50	0.01				
10/27/2010 4:55	0.03				
10/27/2010 5:00	0				
10/27/2010 5:05	0.01				
10/27/2010 5:10	0.01				
10/27/2010 5:15	0				
10/27/2010 5:20	0				
10/27/2010 5:25	0.01				
10/27/2010 5:30	0				
10/27/2010 5:35	0				
10/27/2010 5:40	0				
10/27/2010 5:45	0				
10/27/2010 5:50	0.01				
10/27/2010 5:55	0.07				
10/27/2010 6:00	0.1				
10/27/2010 6:05	0.05				
10/27/2010 6:10	0.04				
10/27/2010 6:15	0.03				

Date & Time	Depth				
10/27/2010 6:20	0.02				
10/27/2010 6:25	0.01				
10/27/2010 6:30	0				
10/27/2010 6:35	0.01				
10/27/2010 6:40	0				
10/27/2010 6:45	0.01				
10/27/2010 6:50	0.01				
10/27/2010 6:55	0.01				
10/27/2010 7:00	0.01				
10/27/2010 7:05	0				
10/27/2010 7:10	0				
10/27/2010 7:15	0				
10/27/2010 7:20	0.01				
10/27/2010 7:25	0				
10/27/2010 7:30	0				
10/27/2010 7:35	0				
10/27/2010 7:40	0				
10/27/2010 7:45	0				
10/27/2010 7:50	0				
10/27/2010 7:55	0				
10/27/2010 8:00	0				
10/27/2010 8:05	0				
10/27/2010 8:10	0				
10/27/2010 8:15	0				
10/27/2010 8:20	0				
10/27/2010 8:25	0				
10/27/2010 8:30	0				
10/27/2010 8:35	0				
10/27/2010 8:40	0				
10/27/2010 8:45	0				
10/27/2010 8:50	0				
10/27/2010 8:55	0				
10/27/2010 9:00	0				
10/27/2010 9:05	0				
10/27/2010 9:10	0				
10/27/2010 9:15	0				
10/27/2010 9:20	0				
10/27/2010 9:25	0				
10/27/2010 9:30	0				
10/27/2010 9:35	0				
10/27/2010 9:40	0				

Date & Time	Depth				
10/27/2010 9:45	0				
10/27/2010 9:50	0				
10/27/2010 9:55	0				
10/27/2010 10:00	0				
10/27/2010 10:05	0				
10/27/2010 10:10	0				
10/27/2010 10:15	0				
10/27/2010 10:20	0				
10/27/2010 10:25	0				
10/27/2010 10:30	0.01				
10/27/2010 10:35	0				
10/27/2010 10:40	0.01				
10/27/2010 10:45	0				
10/27/2010 10:50	0				
10/27/2010 10:55	0				
10/27/2010 11:00	0				
10/27/2010 11:05	0				
10/27/2010 11:10	0				
10/27/2010 11:15	0				
10/27/2010 11:20	0.01				
10/27/2010 11:25	0				
10/27/2010 11:30	0.01				
10/27/2010 11:35	0.02				
10/27/2010 11:40	0.02				
10/27/2010 11:45	0.03				
10/27/2010 11:50	0.02				
10/27/2010 11:55	0.02				
10/27/2010 12:00	0.02				
10/27/2010 12:05	0.02				
10/27/2010 12:10	0.02				
10/27/2010 12:15	0.01				
10/27/2010 12:20	0.02				
10/27/2010 12:25	0.01				
10/27/2010 12:30	0.01				
10/27/2010 12:35	0.01				
10/27/2010 12:40	0.01				
10/27/2010 12:45	0.01				
10/27/2010 12:50	0.01				
10/27/2010 12:55	0.01				

EVENT DATE: 11/16/2010

Unavailable. This rain data was affected by high winds. Therefore, rainfall statistics were estimated from neighboring gages.

Flow Data

Flow rate was measure in gallons per minute (gmp)

Event Date: 7/10/2010

Inflow

Date and Time	Flow Rate (gpm)
7/10/2010 6:30	0.861
7/10/2010 6:45	158.303
7/10/2010 7:00	272.275
7/10/2010 7:15	138.381
7/10/2010 7:30	118.749
7/10/2010 7:45	62.982
7/10/2010 8:00	16.405

Outflow

No outflow occurred for this event.

Event date: 7/12/2010

Inflow

Date & Time	Flow Rate (gpm)
7/12/2010 12:45	0.073
7/12/2010 13:00	0.693
7/12/2010 13:15	1.194
7/12/2010 13:30	1.314
7/12/2010 13:45	1.296
7/12/2010 14:00	63.043
7/12/2010 14:15	70.838
7/12/2010 14:30	40.985
7/12/2010 14:45	35.08
7/12/2010 15:00	21.123
7/12/2010 15:15	17.323
7/12/2010 15:30	5.484
7/12/2010 15:45	9.609
7/12/2010 16:00	100.904
7/12/2010 16:15	112.334
7/12/2010 16:30	51.412
7/12/2010 16:45	36.61
7/12/2010 17:00	45.473
7/12/2010 17:15	27.177
7/12/2010 17:30	18.134
7/12/2010 17:45	13.353
7/12/2010 18:00	3.468

Date & Time	Flow Rate (gpm)
7/12/2010 18:15	0.129
7/12/2010 18:30	0.067
7/12/2010 18:45	0.052
7/12/2010 19:00	0.073
7/12/2010 19:15	0

Outflow

No outflow occurred for this event.

Event date: 7/14/2010

Inflow

Date & Time	Flow Rate (gpm)
7/14/2010 19:15	0.001
7/14/2010 19:30	0.016
7/14/2010 19:45	0
7/14/2010 20:00	0.016
7/14/2010 20:15	0.015
7/14/2010 20:30	0
7/14/2010 20:45	0
7/14/2010 21:00	0.431
7/14/2010 21:15	0.227
7/14/2010 21:30	0.109
7/14/2010 21:45	0.462
7/14/2010 22:00	1.258
7/14/2010 22:15	1.179
7/14/2010 22:30	148.705
7/14/2010 22:45	273.695
7/14/2010 23:00	231.546
7/14/2010 23:15	54.6
7/14/2010 23:30	22.226
7/14/2010 23:45	16.9
7/15/2010 0:00	11.495
7/15/2010 0:15	2.053
7/15/2010 0:30	0.101

Outflow

Date & Time	Outflow
7/14/2010 23:30	0.00
7/14/2010 23:45	1.30
7/15/2010 0:00	5.81
7/15/2010 0:15	7.46

Date & Time	Outflow
7/15/2010 0:30	7.87
7/15/2010 0:45	7.30
7/15/2010 1:00	6.83
7/15/2010 1:15	6.28
7/15/2010 1:30	5.83
7/15/2010 1:45	5.31
7/15/2010 2:00	4.77
7/15/2010 2:15	4.38
7/15/2010 2:30	3.89
7/15/2010 2:45	3.52
7/15/2010 3:00	3.03
7/15/2010 3:15	2.46
7/15/2010 3:30	1.74
7/15/2010 3:45	0.95
7/15/2010 4:00	0.00

Event date: 7/20/2010

Inflow

Date & Time	Flowrate (gpm)
7/20/2010 18:00	126.8
7/20/2010 18:15	15.85

Outflow

No outflow occurred for this event.

Event date: 7/29/2010

Inflow

Date & Time	Flowrate (gpm)
7/29/10 4:00 PM	0
7/29/10 4:05 PM	110.952256
7/29/10 4:10 PM	174.353545
7/29/10 4:15 PM	47.5509667
7/29/10 4:20 PM	15.8503222
7/29/10 4:25 PM	0

Outflow

No outflow occurred for this event.

Event date: 7/31/2010

Inflow

Date & Time	Flowrate (gpm)
7/31/10 10:25 PM	0

7/31/10 10:30 PM	63.40
7/31/10 10:35 PM	63.40
7/31/10 10:40 PM	79.25
7/31/10 10:45 PM	126.80
7/31/10 10:50 PM	110.95
7/31/10 10:55 PM	79.25
7/31/10 11:00 PM	47.55
7/31/10 11:05 PM	15.85
7/31/10 11:10 PM	0

Outflow

No outflow occurred for this event.

Event date: 8/4/2010

Inflow

Date & Time	Flow Rate (gpm)
8/4/2010 20:15	1.90
8/4/2010 20:20	304.58
8/4/2010 20:25	311.62
8/4/2010 20:30	306.66
8/4/2010 20:35	169.99
8/4/2010 20:40	64.53
8/4/2010 20:45	22.69
8/4/2010 20:50	8.77
8/4/2010 20:55	2.43

Outflow

Date & Time	Flow Rate (gpm)
8/4/2010 21:45	1.702
8/4/2010 21:50	7.558
8/4/2010 21:55	11.034
8/4/2010 22:00	13.041
8/4/2010 22:05	13.841
8/4/2010 22:10	13.785
8/4/2010 22:15	13.533
8/4/2010 22:20	12.993
8/4/2010 22:25	12.555
8/4/2010 22:30	11.944
8/4/2010 22:35	11.341
8/4/2010 22:40	11.057
8/4/2010 22:45	10.786
8/4/2010 22:50	10.377
8/4/2010 22:55	9.519
8/4/2010 23:00	9.348

Date & Time	Flow Rate (gpm)
8/4/2010 23:05	8.784
8/4/2010 23:10	8.107
8/4/2010 23:15	7.638
8/4/2010 23:20	7.379
8/4/2010 23:25	6.902
8/4/2010 23:30	6.341
8/4/2010 23:35	6.205
8/4/2010 23:40	5.492
8/4/2010 23:45	5.19
8/4/2010 23:50	4.899
8/4/2010 23:55	4.447
8/5/2010 0:00	4.023
8/5/2010 0:05	3.496
8/5/2010 0:10	3.268
8/5/2010 0:15	2.697
8/5/2010 0:20	2.42
8/5/2010 0:25	2.008
8/5/2010 0:30	1.627
8/5/2010 0:35	1.153
8/5/2010 0:40	0.582
8/5/2010 0:45	0.07
8/5/2010 0:50	0.001

EVENT DATE: 8/5/2010

INFLOW

Date & Time	Flow Rate (gpm)
8/5/10 5:30 PM	0
8/5/10 5:35 PM	221.90
8/5/10 5:40 PM	317.01
8/5/10 5:45 PM	174.35
8/5/10 5:50 PM	47.55
8/5/10 5:55 PM	15.85
8/5/10 6:00 PM	0

OUTFLOW

Date & Time	Flowrate (gpm)
8/5/10 8:40 PM	0
8/5/10 8:45 PM	0.001
8/5/10 8:50 PM	0.076
8/5/10 8:55 PM	0.326
8/5/10 9:00 PM	0.554

Date & Time	Flowrate (gpm)
8/5/10 9:05 PM	0.711
8/5/10 9:10 PM	0.84
8/5/10 9:15 PM	0.815
8/5/10 9:20 PM	0.728
8/5/10 9:25 PM	0.592
8/5/10 9:30 PM	0.421
8/5/10 9:35 PM	0.246
8/5/10 9:40 PM	0.054
8/5/10 9:45 PM	0.005
8/5/10 9:50 PM	0

Event date: 8/16/2010

Inflow

Date & Time	Flow Rate (gpm)
8/16/2010 15:35	62.55
8/16/2010 15:40	311.62
8/16/2010 15:45	298.68
8/16/2010 15:50	151.76
8/16/2010 15:55	65.93
8/16/2010 16:00	21.53
8/16/2010 16:05	6.78
8/16/2010 16:10	1.01

Outflow

Date & Time	Flow Rate (gpm)
8/16/2010 16:50	0.58
8/16/2010 16:55	3.69
8/16/2010 17:00	5.51
8/16/2010 17:05	6.52
8/16/2010 17:10	6.13
8/16/2010 17:15	5.73
8/16/2010 17:20	5.08
8/16/2010 17:25	4.67
8/16/2010 17:30	4.05
8/16/2010 17:35	3.77
8/16/2010 17:40	3.36
8/16/2010 17:45	3.09
8/16/2010 17:50	2.80
8/16/2010 17:55	2.49
8/16/2010 18:00	2.07
8/16/2010 18:05	1.76

Date & Time	Flow Rate (gpm)
8/16/2010 18:10	1.15
8/16/2010 18:15	0.73
8/16/2010 18:20	0.25
8/16/2010 18:25	0.01

Event date: 8/18/2010

Inflow

Date & Time	Flow Rate (gpm)
8/18/2010 3:45	0
8/18/2010 3:50	6.417
8/18/2010 3:55	12.371
8/18/2010 4:00	9.413
8/18/2010 4:05	7.112
8/18/2010 4:10	4.621
8/18/2010 4:15	2.144
8/18/2010 4:20	0.283

Outflow

Date & Time	Flow Rate (gpm)
8/18/2010 17:15	2.47
8/18/2010 17:20	6.245
8/18/2010 17:25	8.622
8/18/2010 17:30	9.897
8/18/2010 17:35	10.617
8/18/2010 17:40	11.281
8/18/2010 17:45	11.623
8/18/2010 17:50	11.544
8/18/2010 17:55	11.333
8/18/2010 18:00	11.127
8/18/2010 18:05	11.035
8/18/2010 18:10	10.857
8/18/2010 18:15	10.543
8/18/2010 18:20	10.65
8/18/2010 18:25	10.161
8/18/2010 18:30	10.092
8/18/2010 18:35	9.873
8/18/2010 18:40	9.775
8/18/2010 18:45	9.497
8/18/2010 18:50	9.486
8/18/2010 18:55	9.053
8/18/2010 19:00	8.97

Date & Time	Flow Rate (gpm)
8/18/2010 19:05	8.747
8/18/2010 19:10	8.621
8/18/2010 19:15	8.298
8/18/2010 19:20	8.238
8/18/2010 19:25	8.104
8/18/2010 19:30	7.94
8/18/2010 19:35	7.714
8/18/2010 19:40	7.738
8/18/2010 19:45	7.477
8/18/2010 19:50	7.294
8/18/2010 19:55	7.127
8/18/2010 20:00	7.085
8/18/2010 20:05	6.995
8/18/2010 20:10	6.926
8/18/2010 20:15	6.74
8/18/2010 20:20	6.459
8/18/2010 20:25	6.456
8/18/2010 20:30	6.294
8/18/2010 20:35	5.985
8/18/2010 20:40	5.625
8/18/2010 20:45	5.543
8/18/2010 20:50	5.498
8/18/2010 20:55	5.371
8/18/2010 21:00	5.193
8/18/2010 21:05	5.237
8/18/2010 21:10	4.718
8/18/2010 21:15	4.605
8/18/2010 21:20	4.37
8/18/2010 21:25	4.312
8/18/2010 21:30	4.171
8/18/2010 21:35	3.797
8/18/2010 21:40	3.438
8/18/2010 21:45	3.203
8/18/2010 21:50	3.041
8/18/2010 21:55	2.719
8/18/2010 22:00	2.394
8/18/2010 22:05	2.217
8/18/2010 22:10	2.041
8/18/2010 22:15	1.719
8/18/2010 22:20	1.397
8/18/2010 22:25	1.123

Date & Time	Flow Rate (gpm)
8/18/2010 22:30	0.897
8/18/2010 22:35	0.577
8/18/2010 22:40	0.19
8/18/2010 22:45	0.005
8/18/2010 22:50	0

Event date: 8/24/2010

Inflow

Date & Time	Flow Rate (gpm)
8/24/2010 3:00	133.694
8/24/2010 3:05	311.624
8/24/2010 3:10	311.624
8/24/2010 3:15	217.151
8/24/2010 3:20	89.945
8/24/2010 3:25	32.961
8/24/2010 3:30	11.809
8/24/2010 3:35	2.27
8/24/2010 3:40	0
8/24/2010 3:45	0
8/24/2010 3:50	0
8/24/2010 3:55	0
8/24/2010 4:00	0
8/24/2010 4:05	0
8/24/2010 4:10	0
8/24/2010 4:15	0
8/24/2010 4:20	0
8/24/2010 4:25	0
8/24/2010 4:30	0
8/24/2010 4:35	0
8/24/2010 4:40	0
8/24/2010 4:45	0
8/24/2010 4:50	10.58
8/24/2010 4:55	16.663
8/24/2010 5:00	9.34
8/24/2010 5:05	3.595
8/24/2010 5:10	0.04

Outflow

Date & Time	Flow Rate (gpm)
8/24/2010 4:50	1.906
8/24/2010 4:55	6.524

Date & Time	Flow Rate (gpm)
8/24/2010 5:00	8.938
8/24/2010 5:05	10.275
8/24/2010 5:10	10.998
8/24/2010 5:15	11.457
8/24/2010 5:20	11.296
8/24/2010 5:25	10.959
8/24/2010 5:30	10.993
8/24/2010 5:35	10.65
8/24/2010 5:40	10.619
8/24/2010 5:45	10.168
8/24/2010 5:50	9.984
8/24/2010 5:55	9.715
8/24/2010 6:00	9.433
8/24/2010 6:05	9.227
8/24/2010 6:10	9.092
8/24/2010 6:15	8.799
8/24/2010 6:20	8.653
8/24/2010 6:25	8.449
8/24/2010 6:30	8.363
8/24/2010 6:35	8.031
8/24/2010 6:40	7.552
8/24/2010 6:45	7.377
8/24/2010 6:50	7.081
8/24/2010 6:55	7.128
8/24/2010 7:00	6.759
8/24/2010 7:05	6.714
8/24/2010 7:10	6.483
8/24/2010 7:15	6.127
8/24/2010 7:20	5.802
8/24/2010 7:25	5.717
8/24/2010 7:30	5.599
8/24/2010 7:35	5.321
8/24/2010 7:40	4.931
8/24/2010 7:45	4.529
8/24/2010 7:50	4.179
8/24/2010 7:55	3.96
8/24/2010 8:00	3.707
8/24/2010 8:05	3.404
8/24/2010 8:10	3.149
8/24/2010 8:15	2.81
8/24/2010 8:20	2.587

Date & Time	Flow Rate (gpm)
8/24/2010 8:25	2.254
8/24/2010 8:30	2.001
8/24/2010 8:35	1.566
8/24/2010 8:40	1.251
8/24/2010 8:45	0.925
8/24/2010 8:50	0.53
8/24/2010 8:55	0.132
8/24/2010 9:00	0.002

Event date: 9/26/2010

Inflow

Date & Time	Flow Rate (gpm)
9/26/2010 18:30	0
9/26/2010 18:35	0
9/26/2010 18:40	51.163
9/26/2010 18:45	188.114
9/26/2010 18:50	95.264
9/26/2010 18:55	40.217
9/26/2010 19:00	14.452
9/26/2010 19:05	5.244
9/26/2010 19:10	0.761
9/26/2010 19:15	0
9/26/2010 19:20	0
9/26/2010 19:25	0
9/26/2010 19:30	0
9/26/2010 19:35	0
9/26/2010 19:40	0
9/26/2010 19:45	0
9/26/2010 19:50	7.795
9/26/2010 19:55	41.571
9/26/2010 20:00	49.353
9/26/2010 20:05	70.462
9/26/2010 20:10	164.094
9/26/2010 20:15	234.371
9/26/2010 20:20	160.606
9/26/2010 20:25	98.756
9/26/2010 20:30	86.389
9/26/2010 20:35	77.629
9/26/2010 20:40	58.638
9/26/2010 20:45	41.677
9/26/2010 20:50	34.011

Date & Time	Flow Rate (gpm)
9/26/2010 20:55	35.424
9/26/2010 21:00	34.462
9/26/2010 21:05	35.733
9/26/2010 21:10	36.332
9/26/2010 21:15	33.268
9/26/2010 21:20	154.802
9/26/2010 21:25	311.623
9/26/2010 21:30	253.099
9/26/2010 21:35	130.052
9/26/2010 21:40	74.003
9/26/2010 21:45	43.435
9/26/2010 21:50	28.607
9/26/2010 21:55	20.295
9/26/2010 22:00	15.66
9/26/2010 22:05	12.941
9/26/2010 22:10	10.601
9/26/2010 22:15	8.886
9/26/2010 22:20	7.706
9/26/2010 22:25	6.639
9/26/2010 22:30	6.135
9/26/2010 22:35	5.731
9/26/2010 22:40	5.473
9/26/2010 22:45	5.091
9/26/2010 22:50	4.705
9/26/2010 22:55	4.519
9/26/2010 23:00	4.189
9/26/2010 23:05	4.175
9/26/2010 23:10	3.959
9/26/2010 23:15	3.858
9/26/2010 23:20	3.784
9/26/2010 23:25	3.732
9/26/2010 23:30	3.392
9/26/2010 23:35	3.2
9/26/2010 23:40	3.033
9/26/2010 23:45	2.805
9/26/2010 23:50	2.544
9/26/2010 23:55	2.405
9/27/2010 0:00	2.192
9/27/2010 0:05	1.986
9/27/2010 0:10	1.786
9/27/2010 0:15	1.516

Date & Time	Flow Rate (gpm)
9/27/2010 0:20	1.231
9/27/2010 0:25	1.154
9/27/2010 0:30	1.067
9/27/2010 0:35	0.953
9/27/2010 0:40	0.877
9/27/2010 0:45	0.799
9/27/2010 0:50	0.805
9/27/2010 0:55	0.821
9/27/2010 1:00	0.684
9/27/2010 1:05	0.643
9/27/2010 1:10	0.721
9/27/2010 1:15	0.811
9/27/2010 1:20	0.842
9/27/2010 1:25	0.871
9/27/2010 1:30	0.901
9/27/2010 1:35	0.909
9/27/2010 1:40	0.913
9/27/2010 1:45	0.85
9/27/2010 1:50	0.878
9/27/2010 1:55	0.846
9/27/2010 2:00	1.11
9/27/2010 2:05	0.931
9/27/2010 2:10	0.925
9/27/2010 2:15	0.727
9/27/2010 2:20	0.723
9/27/2010 2:25	0.666
9/27/2010 2:30	0.585
9/27/2010 2:35	0.462
9/27/2010 2:40	0.448
9/27/2010 2:45	0.352
9/27/2010 2:50	0.344
9/27/2010 2:55	0.309
9/27/2010 3:00	0.427
9/27/2010 3:05	0.444
9/27/2010 3:10	0.522
9/27/2010 3:15	0.586
9/27/2010 3:20	0.571
9/27/2010 3:25	0.557
9/27/2010 3:30	0.624
9/27/2010 3:35	0.642
9/27/2010 3:40	0.61

Date & Time	Flow Rate (gpm)
9/27/2010 3:45	0.651
9/27/2010 3:50	0.621
9/27/2010 3:55	0.721
9/27/2010 4:00	0.918
9/27/2010 4:05	1.035
9/27/2010 4:10	1.443
9/27/2010 4:15	1.803
9/27/2010 4:20	3.719
9/27/2010 4:25	15.646
9/27/2010 4:30	92.557
9/27/2010 4:35	173.461
9/27/2010 4:40	188.01
9/27/2010 4:45	217.426
9/27/2010 4:50	224.006
9/27/2010 4:55	249.404
9/27/2010 5:00	235.613
9/27/2010 5:05	202.883
9/27/2010 5:10	185.836
9/27/2010 5:15	142.131
9/27/2010 5:20	124.181
9/27/2010 5:25	162.185
9/27/2010 5:30	281.085
9/27/2010 5:35	300.089
9/27/2010 5:40	225.588
9/27/2010 5:45	224.223
9/27/2010 5:50	159.464
9/27/2010 5:55	95.901
9/27/2010 6:00	67.663
9/27/2010 6:05	46.503
9/27/2010 6:10	33.644
9/27/2010 6:15	25.399
9/27/2010 6:20	20.341
9/27/2010 6:25	17.016
9/27/2010 6:30	14.349
9/27/2010 6:35	12.716
9/27/2010 6:40	11.18
9/27/2010 6:45	9.835
9/27/2010 6:50	8.891
9/27/2010 6:55	8.535
9/27/2010 7:00	9.086
9/27/2010 7:05	10.439

Date & Time	Flow Rate (gpm)
9/27/2010 7:10	12.319
9/27/2010 7:15	13.341
9/27/2010 7:20	14.292
9/27/2010 7:25	15.432
9/27/2010 7:30	17.076
9/27/2010 7:35	18.548
9/27/2010 7:40	19.31
9/27/2010 7:45	19.554
9/27/2010 7:50	20.638
9/27/2010 7:55	20.728
9/27/2010 8:00	19.062
9/27/2010 8:05	17.375
9/27/2010 8:10	18.852
9/27/2010 8:15	20.761
9/27/2010 8:20	20.129
9/27/2010 8:25	18.934
9/27/2010 8:30	17.424
9/27/2010 8:35	14.81
9/27/2010 8:40	12.544
9/27/2010 8:45	10.723
9/27/2010 8:50	10.886
9/27/2010 8:55	12.261
9/27/2010 9:00	13.922
9/27/2010 9:05	17.416
9/27/2010 9:10	23.985
9/27/2010 9:15	32.678
9/27/2010 9:20	35.241
9/27/2010 9:25	33.773
9/27/2010 9:30	30.936
9/27/2010 9:35	28.69
9/27/2010 9:40	25.949
9/27/2010 9:45	22.731
9/27/2010 9:50	19.892
9/27/2010 9:55	18.656
9/27/2010 10:00	18.84
9/27/2010 10:05	19.308
9/27/2010 10:10	19.502
9/27/2010 10:15	20.536
9/27/2010 10:20	19.584
9/27/2010 10:25	19.237
9/27/2010 10:30	17.705

Date & Time	Flow Rate (gpm)
9/27/2010 10:35	15.766
9/27/2010 10:40	14.361
9/27/2010 10:45	13.583
9/27/2010 10:50	12.769
9/27/2010 10:55	12.534
9/27/2010 11:00	12.532
9/27/2010 11:05	12.185
9/27/2010 11:10	11.692
9/27/2010 11:15	11.41
9/27/2010 11:20	11.896
9/27/2010 11:25	12.205
9/27/2010 11:30	12.418
9/27/2010 11:35	11.785
9/27/2010 11:40	10.847
9/27/2010 11:45	9.775
9/27/2010 11:50	8.853
9/27/2010 11:55	7.917
9/27/2010 12:00	7.014
9/27/2010 12:05	6.651
9/27/2010 12:10	6.335
9/27/2010 12:15	5.898
9/27/2010 12:20	5.688
9/27/2010 12:25	5.679
9/27/2010 12:30	5.684
9/27/2010 12:35	5.412
9/27/2010 12:40	5.097
9/27/2010 12:45	5.022
9/27/2010 12:50	4.718
9/27/2010 12:55	4.651
9/27/2010 13:00	4.437
9/27/2010 13:05	4.302
9/27/2010 13:10	4.183
9/27/2010 13:15	3.987
9/27/2010 13:20	3.858
9/27/2010 13:25	4.193
9/27/2010 13:30	5.513
9/27/2010 13:35	10.557
9/27/2010 13:40	22.355
9/27/2010 13:45	31.713
9/27/2010 13:50	102.354
9/27/2010 13:55	262.906

Date & Time	Flow Rate (gpm)
9/27/2010 14:00	228.978
9/27/2010 14:05	260.477
9/27/2010 14:10	157.07
9/27/2010 14:15	91.412
9/27/2010 14:20	54.821
9/27/2010 14:25	34.261
9/27/2010 14:30	23.768
9/27/2010 14:35	18.626
9/27/2010 14:40	18.187
9/27/2010 14:45	22.936
9/27/2010 14:50	26.932
9/27/2010 14:55	25.074
9/27/2010 15:00	20.396
9/27/2010 15:05	15.972
9/27/2010 15:10	13.321
9/27/2010 15:15	11.264
9/27/2010 15:20	9.696
9/27/2010 15:25	9.052
9/27/2010 15:30	9.999
9/27/2010 15:35	13.679
9/27/2010 15:40	18.234
9/27/2010 15:45	16.403
9/27/2010 15:50	14.51
9/27/2010 15:55	12.407
9/27/2010 16:00	10.606
9/27/2010 16:05	9.375
9/27/2010 16:10	9.536
9/27/2010 16:15	17.911
9/27/2010 16:20	40.313
9/27/2010 16:25	60.189
9/27/2010 16:30	52.908
9/27/2010 16:35	39.295
9/27/2010 16:40	28.02
9/27/2010 16:45	21.073
9/27/2010 16:50	16.836
9/27/2010 16:55	14.363
9/27/2010 17:00	13.53
9/27/2010 17:05	12.808
9/27/2010 17:10	11.714
9/27/2010 17:15	10.57
9/27/2010 17:20	9.484

Date & Time	Flow Rate (gpm)
9/27/2010 17:25	8.639
9/27/2010 17:30	7.63
9/27/2010 17:35	7.001
9/27/2010 17:40	6.582
9/27/2010 17:45	6.233
9/27/2010 17:50	5.865
9/27/2010 17:55	5.63
9/27/2010 18:00	5.541
9/27/2010 18:05	5.494
9/27/2010 18:10	5.252
9/27/2010 18:15	5.114
9/27/2010 18:20	5.111
9/27/2010 18:25	4.964
9/27/2010 18:30	4.856
9/27/2010 18:35	3.963
9/27/2010 18:40	2.646
9/27/2010 18:45	2.556
9/27/2010 18:50	2.486
9/27/2010 18:55	2.379
9/27/2010 19:00	2.266
9/27/2010 19:05	2.083
9/27/2010 19:10	2.007
9/27/2010 19:15	1.879
9/27/2010 19:20	1.712
9/27/2010 19:25	1.578
9/27/2010 19:30	1.654
9/27/2010 19:35	1.542
9/27/2010 19:40	1.408
9/27/2010 19:45	1.191
9/27/2010 19:50	1.111
9/27/2010 19:55	0.981
9/27/2010 20:00	0.875
9/27/2010 20:05	0.774
9/27/2010 20:10	0.655
9/27/2010 20:15	0.615
9/27/2010 20:20	0.539
9/27/2010 20:25	0.468
9/27/2010 20:30	0.26
9/27/2010 20:35	0.214
9/27/2010 20:40	0.206
9/27/2010 20:45	0.228

Date & Time	Flow Rate (gpm)
9/27/2010 20:50	0.19
9/27/2010 20:55	0.205
9/27/2010 21:00	0.184
9/27/2010 21:05	0.2
9/27/2010 21:10	0.179
9/27/2010 21:15	0.129
9/27/2010 21:20	0.161
9/27/2010 21:25	0.165
9/27/2010 21:30	0.352
9/27/2010 21:35	0.259
9/27/2010 21:40	0.28
9/27/2010 21:45	0.118
9/27/2010 21:50	0.146
9/27/2010 21:55	0.139
9/27/2010 22:00	0.14
9/27/2010 22:05	0.135
9/27/2010 22:10	0.088
9/27/2010 22:15	0.104
9/27/2010 22:20	0.105
9/27/2010 22:25	0.081
9/27/2010 22:30	0.087
9/27/2010 22:35	0.117
9/27/2010 22:40	0.09
9/27/2010 22:45	0.136
9/27/2010 22:50	0.112
9/27/2010 22:55	0.137
9/27/2010 23:00	0.036

Outflow

Date and Time	Flow Rate (gpm)
9/26/2010 21:40	0
9/26/2010 21:45	0
9/26/2010 21:50	1.271
9/26/2010 21:55	4.493
9/26/2010 22:00	9.691
9/26/2010 22:05	14.54
9/26/2010 22:10	17.549
9/26/2010 22:15	20.107
9/26/2010 22:20	20.683
9/26/2010 22:25	20.871
9/26/2010 22:30	20.353

Date and Time	Flow Rate (gpm)
9/26/2010 22:35	19.4
9/26/2010 22:40	18.362
9/26/2010 22:45	17.835
9/26/2010 22:50	16.755
9/26/2010 22:55	16.445
9/26/2010 23:00	15.293
9/26/2010 23:05	14.659
9/26/2010 23:10	13.564
9/26/2010 23:15	12.78
9/26/2010 23:20	11.938
9/26/2010 23:25	11.026
9/26/2010 23:30	10.622
9/26/2010 23:35	9.638
9/26/2010 23:40	8.929
9/26/2010 23:45	7.536
9/26/2010 23:50	7.185
9/26/2010 23:55	6.252
9/27/2010 0:00	5.698
9/27/2010 0:05	5.062
9/27/2010 0:10	4.45
9/27/2010 0:15	4.002
9/27/2010 0:20	3.55
9/27/2010 0:25	3.13
9/27/2010 0:30	2.786
9/27/2010 0:35	2.331
9/27/2010 0:40	2.027
9/27/2010 0:45	1.636
9/27/2010 0:50	1.129
9/27/2010 0:55	0.641
9/27/2010 1:00	0.134
9/27/2010 1:05	0.003
9/27/2010 1:10	0
9/27/2010 1:15	0
9/27/2010 1:20	0
9/27/2010 1:25	0
9/27/2010 1:30	0
9/27/2010 1:35	0
9/27/2010 1:40	0
9/27/2010 1:45	0
9/27/2010 1:50	0
9/27/2010 1:55	0

Date and Time	Flow Rate (gpm)
9/27/2010 2:00	0
9/27/2010 2:05	0
9/27/2010 2:10	0
9/27/2010 2:15	0
9/27/2010 2:20	0
9/27/2010 2:25	0
9/27/2010 2:30	0
9/27/2010 2:35	0
9/27/2010 2:40	0
9/27/2010 2:45	0
9/27/2010 2:50	0
9/27/2010 2:55	0
9/27/2010 3:00	0
9/27/2010 3:05	0
9/27/2010 3:10	0
9/27/2010 3:15	0
9/27/2010 3:20	0
9/27/2010 3:25	0
9/27/2010 3:30	0
9/27/2010 3:35	0
9/27/2010 3:40	0
9/27/2010 3:45	0
9/27/2010 3:50	0
9/27/2010 3:55	0
9/27/2010 4:00	0
9/27/2010 4:05	0
9/27/2010 4:10	0
9/27/2010 4:15	0
9/27/2010 4:20	0
9/27/2010 4:25	0
9/27/2010 4:30	0
9/27/2010 4:35	0
9/27/2010 4:40	0
9/27/2010 4:45	0
9/27/2010 4:50	0
9/27/2010 4:55	0
9/27/2010 5:00	0
9/27/2010 5:05	0
9/27/2010 5:10	0
9/27/2010 5:15	0
9/27/2010 5:20	0

Date and Time	Flow Rate (gpm)
9/27/2010 5:25	0
9/27/2010 5:30	0
9/27/2010 5:35	0
9/27/2010 5:40	0.244
9/27/2010 5:45	1.728
9/27/2010 5:50	3.747
9/27/2010 5:55	7.008
9/27/2010 6:00	10.998
9/27/2010 6:05	14.936
9/27/2010 6:10	17.98
9/27/2010 6:15	19.764
9/27/2010 6:20	20.577
9/27/2010 6:25	21.088
9/27/2010 6:30	21.06
9/27/2010 6:35	20.843
9/27/2010 6:40	20.692
9/27/2010 6:45	20.522
9/27/2010 6:50	20.038
9/27/2010 6:55	19.939
9/27/2010 7:00	19.803
9/27/2010 7:05	19.334
9/27/2010 7:10	19.32
9/27/2010 7:15	18.919
9/27/2010 7:20	18.285
9/27/2010 7:25	18.493
9/27/2010 7:30	17.818
9/27/2010 7:35	17.721
9/27/2010 7:40	17.714
9/27/2010 7:45	17.408
9/27/2010 7:50	17.37
9/27/2010 7:55	17.039
9/27/2010 8:00	17.106
9/27/2010 8:05	16.807
9/27/2010 8:10	16.574
9/27/2010 8:15	16.51
9/27/2010 8:20	16.439
9/27/2010 8:25	16.387
9/27/2010 8:30	15.995
9/27/2010 8:35	15.859
9/27/2010 8:40	15.666
9/27/2010 8:45	15.373

Date and Time	Flow Rate (gpm)
9/27/2010 8:50	15.157
9/27/2010 8:55	15.299
9/27/2010 9:00	14.83
9/27/2010 9:05	14.774
9/27/2010 9:10	14.74
9/27/2010 9:15	14.78
9/27/2010 9:20	14.469
9/27/2010 9:25	14.546
9/27/2010 9:30	14.247
9/27/2010 9:35	14.281
9/27/2010 9:40	14.274
9/27/2010 9:45	14.236
9/27/2010 9:50	14.143
9/27/2010 9:55	13.941
9/27/2010 10:00	13.976
9/27/2010 10:05	13.932
9/27/2010 10:10	13.744
9/27/2010 10:15	13.559
9/27/2010 10:20	13.354
9/27/2010 10:25	13.357
9/27/2010 10:30	13.258
9/27/2010 10:35	13.117
9/27/2010 10:40	13.132
9/27/2010 10:45	13.026
9/27/2010 10:50	12.872
9/27/2010 10:55	13.027
9/27/2010 11:00	12.935
9/27/2010 11:05	13.005
9/27/2010 11:10	12.75
9/27/2010 11:15	12.592
9/27/2010 11:20	12.637
9/27/2010 11:25	12.43
9/27/2010 11:30	12.279
9/27/2010 11:35	11.748
9/27/2010 11:40	11.86
9/27/2010 11:45	11.943
9/27/2010 11:50	11.895
9/27/2010 11:55	11.952
9/27/2010 12:00	11.395
9/27/2010 12:05	11.597
9/27/2010 12:10	11.548

Date and Time	Flow Rate (gpm)
9/27/2010 12:15	11.575
9/27/2010 12:20	11.576
9/27/2010 12:25	10.819
9/27/2010 12:30	10.58
9/27/2010 12:35	10.931
9/27/2010 12:40	10.366
9/27/2010 12:45	10.607
9/27/2010 12:50	10.44
9/27/2010 12:55	10.214
9/27/2010 13:00	10.051
9/27/2010 13:05	9.812
9/27/2010 13:10	9.577
9/27/2010 13:15	9.486
9/27/2010 13:20	9.145
9/27/2010 13:25	8.912
9/27/2010 13:30	8.733
9/27/2010 13:35	8.485
9/27/2010 13:40	8.314
9/27/2010 13:45	8.272
9/27/2010 13:50	8.139
9/27/2010 13:55	7.606
9/27/2010 14:00	7.697
9/27/2010 14:05	7.891
9/27/2010 14:10	8.801
9/27/2010 14:15	9.308
9/27/2010 14:20	9.994
9/27/2010 14:25	11.143
9/27/2010 14:30	11.574
9/27/2010 14:35	11.683
9/27/2010 14:40	12.589
9/27/2010 14:45	12.199
9/27/2010 14:50	12.569
9/27/2010 14:55	12.554
9/27/2010 15:00	12.672
9/27/2010 15:05	13.008
9/27/2010 15:10	12.611
9/27/2010 15:15	12.51
9/27/2010 15:20	12.756
9/27/2010 15:25	12.47
9/27/2010 15:30	12.201
9/27/2010 15:35	12.003

Date and Time	Flow Rate (gpm)
9/27/2010 15:40	12.322
9/27/2010 15:45	11.884
9/27/2010 15:50	11.992
9/27/2010 15:55	11.988
9/27/2010 16:00	11.635
9/27/2010 16:05	12.003
9/27/2010 16:10	11.747
9/27/2010 16:15	11.627
9/27/2010 16:20	11.821
9/27/2010 16:25	11.618
9/27/2010 16:30	11.753
9/27/2010 16:35	11.919
9/27/2010 16:40	11.779
9/27/2010 16:45	11.488
9/27/2010 16:50	11.716
9/27/2010 16:55	11.439
9/27/2010 17:00	11.352
9/27/2010 17:05	11.57
9/27/2010 17:10	11.467
9/27/2010 17:15	11.294
9/27/2010 17:20	11.469
9/27/2010 17:25	11.147
9/27/2010 17:30	10.943
9/27/2010 17:35	10.957
9/27/2010 17:40	10.535
9/27/2010 17:45	10.495
9/27/2010 17:50	10.557
9/27/2010 17:55	10.349
9/27/2010 18:00	10.411
9/27/2010 18:05	9.945
9/27/2010 18:10	9.594
9/27/2010 18:15	9.88
9/27/2010 18:20	9.198
9/27/2010 18:25	9.715
9/27/2010 18:30	9.252
9/27/2010 18:35	9.282
9/27/2010 18:40	8.873
9/27/2010 18:45	8.738
9/27/2010 18:50	8.539
9/27/2010 18:55	8.207
9/27/2010 19:00	7.862

Date and Time	Flow Rate (gpm)
9/27/2010 19:05	7.667
9/27/2010 19:10	7.337
9/27/2010 19:15	7.419
9/27/2010 19:20	7.127
9/27/2010 19:25	7.01
9/27/2010 19:30	6.625
9/27/2010 19:35	6.706
9/27/2010 19:40	6.308
9/27/2010 19:45	6.073
9/27/2010 19:50	5.875
9/27/2010 19:55	5.85
9/27/2010 20:00	5.54
9/27/2010 20:05	5.162
9/27/2010 20:10	4.936
9/27/2010 20:15	4.919
9/27/2010 20:20	4.666
9/27/2010 20:25	4.294
9/27/2010 20:30	3.91
9/27/2010 20:35	3.729
9/27/2010 20:40	3.559
9/27/2010 20:45	3.445
9/27/2010 20:50	3.201
9/27/2010 20:55	2.809
9/27/2010 21:00	2.577
9/27/2010 21:05	2.416
9/27/2010 21:10	2.23
9/27/2010 21:15	1.892
9/27/2010 21:20	1.732
9/27/2010 21:25	1.452
9/27/2010 21:30	1.163
9/27/2010 21:35	0.808
9/27/2010 21:40	0.714
9/27/2010 21:45	0.369
9/27/2010 21:50	0.056
9/27/2010 21:55	0.005
9/27/2010 22:00	0

EVENT DATE: 9/28/2010

INFLOW

Date & Time	Flow Rate (gpm)

Date & Time	Flow Rate (gpm)
9/28/2010 0:00	0.11
9/28/2010 0:05	0.104
9/28/2010 0:10	0.091
9/28/2010 0:15	0.088
9/28/2010 0:20	0.102
9/28/2010 0:25	0.087
9/28/2010 0:30	0.063
9/28/2010 0:35	0.03
9/28/2010 0:40	0.048
9/28/2010 0:45	0.016
9/28/2010 0:50	0.042
9/28/2010 0:55	0.038
9/28/2010 1:00	0.057
9/28/2010 1:05	0.073
9/28/2010 1:10	0.045
9/28/2010 1:15	0.032
9/28/2010 1:20	0.06
9/28/2010 1:25	0.211
9/28/2010 1:30	1.594
9/28/2010 1:35	2.083
9/28/2010 1:40	2.377
9/28/2010 1:45	3.092
9/28/2010 1:50	3.254
9/28/2010 1:55	3.356
9/28/2010 2:00	3.193
9/28/2010 2:05	3.19
9/28/2010 2:10	3.45
9/28/2010 2:15	4.576
9/28/2010 2:20	9.148
9/28/2010 2:25	20.361
9/28/2010 2:30	38.222
9/28/2010 2:35	80.575
9/28/2010 2:40	146.326
9/28/2010 2:45	273.847
9/28/2010 2:50	311.623
9/28/2010 2:55	222.022
9/28/2010 3:00	101.439
9/28/2010 3:05	62.238
9/28/2010 3:10	80.844
9/28/2010 3:15	296.61
9/28/2010 3:20	311.623

Date & Time	Flow Rate (gpm)
9/28/2010 3:25	290.67
9/28/2010 3:30	243.246
9/28/2010 3:35	281.132
9/28/2010 3:40	311.623
9/28/2010 3:45	271.957
9/28/2010 3:50	237.923
9/28/2010 3:55	302.717
9/28/2010 4:00	281.584
9/28/2010 4:05	181.909
9/28/2010 4:10	111.412
9/28/2010 4:15	62.383
9/28/2010 4:20	37.641
9/28/2010 4:25	25.838
9/28/2010 4:30	18.827
9/28/2010 4:35	14.67
9/28/2010 4:40	12.158
9/28/2010 4:45	10.235
9/28/2010 4:50	9.018
9/28/2010 4:55	7.725
9/28/2010 5:00	7.047
9/28/2010 5:05	6.864
9/28/2010 5:10	6.851
9/28/2010 5:15	6.739
9/28/2010 5:20	6.265
9/28/2010 5:25	5.877
9/28/2010 5:30	5.399
9/28/2010 5:35	4.919
9/28/2010 5:40	4.415
9/28/2010 5:45	4.13
9/28/2010 5:50	3.777
9/28/2010 5:55	3.453
9/28/2010 6:00	3.171
9/28/2010 6:05	2.912
9/28/2010 6:10	2.697
9/28/2010 6:15	2.607
9/28/2010 6:20	2.469
9/28/2010 6:25	2.311
9/28/2010 6:30	1.964
9/28/2010 6:35	1.774
9/28/2010 6:40	1.699
9/28/2010 6:45	1.556

Date & Time	Flow Rate (gpm)
9/28/2010 6:50	1.425
9/28/2010 6:55	1.323
9/28/2010 7:00	1.194
9/28/2010 7:05	0.974
9/28/2010 7:10	0.826
9/28/2010 7:15	0.771
9/28/2010 7:20	0.671
9/28/2010 7:25	0.534
9/28/2010 7:30	0.419
9/28/2010 7:35	0.276
9/28/2010 7:40	0.228
9/28/2010 7:45	0.128
9/28/2010 7:50	0.089
9/28/2010 7:55	0.076
9/28/2010 8:00	0.079
9/28/2010 8:05	0.028
9/28/2010 8:10	0.056
9/28/2010 8:15	0.039
9/28/2010 8:20	0.051
9/28/2010 8:25	0.033
9/28/2010 8:30	0.015
9/28/2010 8:35	0.027
9/28/2010 8:40	0.034
9/28/2010 8:45	0.11
9/28/2010 8:50	0.095
9/28/2010 8:55	0.078
9/28/2010 9:00	0.089
9/28/2010 9:05	0.09
9/28/2010 9:10	0.032
9/28/2010 9:15	0.017
9/28/2010 9:20	0

Outflow

Date & Time	Flow Rate (gpm)
9/28/2010 3:10	0
9/28/2010 3:15	0
9/28/2010 3:20	0
9/28/2010 3:25	0
9/28/2010 3:30	0.006
9/28/2010 3:35	1.793
9/28/2010 3:40	23.302

Date & Time	Flow Rate (gpm)
9/28/2010 3:45	49.443
9/28/2010 3:50	46.747
9/28/2010 3:55	14.252
9/28/2010 4:00	11.339
9/28/2010 4:05	13.396
9/28/2010 4:10	11.742
9/28/2010 4:15	9.364
9/28/2010 4:20	6.358
9/28/2010 4:25	29.889
9/28/2010 4:30	45.066
9/28/2010 4:35	44.272
9/28/2010 4:40	40.824
9/28/2010 4:45	36.082
9/28/2010 4:50	31.523
9/28/2010 4:55	28.339
9/28/2010 5:00	25.825
9/28/2010 5:05	24.208
9/28/2010 5:10	23.579
9/28/2010 5:15	22.474
9/28/2010 5:20	22.362
9/28/2010 5:25	21.502
9/28/2010 5:30	21.332
9/28/2010 5:35	20.98
9/28/2010 5:40	20.106
9/28/2010 5:45	19.789
9/28/2010 5:50	19.307
9/28/2010 5:55	18.392
9/28/2010 6:00	18.192
9/28/2010 6:05	17.762
9/28/2010 6:10	17.602
9/28/2010 6:15	17.577
9/28/2010 6:20	17.505
9/28/2010 6:25	16.918
9/28/2010 6:30	17.001
9/28/2010 6:35	16.626
9/28/2010 6:40	16.751
9/28/2010 6:45	16.655
9/28/2010 6:50	16.448
9/28/2010 6:55	16.001
9/28/2010 7:00	15.975
9/28/2010 7:05	15.92

Date & Time	Flow Rate (gpm)
9/28/2010 7:10	15.824
9/28/2010 7:15	15.57
9/28/2010 7:20	15.67
9/28/2010 7:25	15.218
9/28/2010 7:30	15.373
9/28/2010 7:35	15.017
9/28/2010 7:40	14.877
9/28/2010 7:45	14.685
9/28/2010 7:50	14.824
9/28/2010 7:55	14.469
9/28/2010 8:00	14.27
9/28/2010 8:05	14.264
9/28/2010 8:10	14.063
9/28/2010 8:15	13.96
9/28/2010 8:20	13.827
9/28/2010 8:25	13.711
9/28/2010 8:30	13.409
9/28/2010 8:35	13.466
9/28/2010 8:40	13.114
9/28/2010 8:45	12.887
9/28/2010 8:50	12.804
9/28/2010 8:55	12.895
9/28/2010 9:00	12.774
9/28/2010 9:05	12.715
9/28/2010 9:10	12.635
9/28/2010 9:15	12.421
9/28/2010 9:20	12.534
9/28/2010 9:25	12.138
9/28/2010 9:30	12.294
9/28/2010 9:35	12.109
9/28/2010 9:40	12.098
9/28/2010 9:45	11.883
9/28/2010 9:50	11.692
9/28/2010 9:55	11.629
9/28/2010 10:00	11.729
9/28/2010 10:05	11.398
9/28/2010 10:10	11.451
9/28/2010 10:15	11.032
9/28/2010 10:20	11.14
9/28/2010 10:25	10.799
9/28/2010 10:30	10.851

Date & Time	Flow Rate (gpm)
9/28/2010 10:35	10.632
9/28/2010 10:40	10.622
9/28/2010 10:45	10.421
9/28/2010 10:50	10.069
9/28/2010 10:55	9.92
9/28/2010 11:00	9.842
9/28/2010 11:05	9.775
9/28/2010 11:10	9.247
9/28/2010 11:15	9.261
9/28/2010 11:20	9.135
9/28/2010 11:25	9.097
9/28/2010 11:30	8.769
9/28/2010 11:35	8.25
9/28/2010 11:40	8.126
9/28/2010 11:45	8.051
9/28/2010 11:50	7.919
9/28/2010 11:55	7.609
9/28/2010 12:00	7.238
9/28/2010 12:05	6.99
9/28/2010 12:10	7.007
9/28/2010 12:15	6.728
9/28/2010 12:20	6.363
9/28/2010 12:25	6.335
9/28/2010 12:30	6.136
9/28/2010 12:35	5.838
9/28/2010 12:40	5.493
9/28/2010 12:45	4.963
9/28/2010 12:50	4.663
9/28/2010 12:55	4.651
9/28/2010 13:00	4.289
9/28/2010 13:05	3.994
9/28/2010 13:10	3.736
9/28/2010 13:15	3.534
9/28/2010 13:20	3.316
9/28/2010 13:25	3.051
9/28/2010 13:30	2.704
9/28/2010 13:35	2.593
9/28/2010 13:40	2.283
9/28/2010 13:45	1.95
9/28/2010 13:50	1.777
9/28/2010 13:55	1.542

Date & Time	Flow Rate (gpm)
9/28/2010 14:00	1.301
9/28/2010 14:05	1.02
9/28/2010 14:10	0.546
9/28/2010 14:15	0.153
9/28/2010 14:20	0.024
9/28/2010 14:25	0.001
9/28/2010 14:30	0

Event date: 9/30/2010

Inflow

Date & Time	Flow Rate (gpm)
9/29/2010 14:50	0
9/29/2010 14:55	1.019
9/29/2010 15:00	12.412
9/29/2010 15:05	12.467
9/29/2010 15:10	10.117
9/29/2010 15:15	7.767
9/29/2010 15:20	6.422
9/29/2010 15:25	6.227
9/29/2010 15:30	6.603
9/29/2010 15:35	6.502
9/29/2010 15:40	7.249
9/29/2010 15:45	8.75
9/29/2010 15:50	10.118
9/29/2010 15:55	12.248
9/29/2010 16:00	14.705
9/29/2010 16:05	17.165
9/29/2010 16:10	18.71
9/29/2010 16:15	21.304
9/29/2010 16:20	22.019
9/29/2010 16:25	20.518
9/29/2010 16:30	17.715
9/29/2010 16:35	16.22
9/29/2010 16:40	15.364
9/29/2010 16:45	15.582
9/29/2010 16:50	15.966
9/29/2010 16:55	16.914
9/29/2010 17:00	18.576
9/29/2010 17:05	22.721
9/29/2010 17:10	28.386
9/29/2010 17:15	33.109

Date & Time	Flow Rate (gpm)
9/29/2010 17:20	34.171
9/29/2010 17:25	42.912
9/29/2010 17:30	52.625
9/29/2010 17:35	46.917
9/29/2010 17:40	41.947
9/29/2010 17:45	37.571
9/29/2010 17:50	31.618
9/29/2010 17:55	24.702
9/29/2010 18:00	18.677
9/29/2010 18:05	14.234
9/29/2010 18:10	11.522
9/29/2010 18:15	9.56
9/29/2010 18:20	8.394
9/29/2010 18:25	7.841
9/29/2010 18:30	7.436
9/29/2010 18:35	7.478
9/29/2010 18:40	7.705
9/29/2010 18:45	7.658
9/29/2010 18:50	7.287
9/29/2010 18:55	6.781
9/29/2010 19:00	6.275
9/29/2010 19:05	5.559
9/29/2010 19:10	5.057
9/29/2010 19:15	4.303
9/29/2010 19:20	3.833
9/29/2010 19:25	3.862
9/29/2010 19:30	3.836
9/29/2010 19:35	3.841
9/29/2010 19:40	3.772
9/29/2010 19:45	3.891
9/29/2010 19:50	4.061
9/29/2010 19:55	6.29
9/29/2010 20:00	12.867
9/29/2010 20:05	14.161
9/29/2010 20:10	18.34
9/29/2010 20:15	31.321
9/29/2010 20:20	39.527
9/29/2010 20:25	35.641
9/29/2010 20:30	28.758
9/29/2010 20:35	23.725
9/29/2010 20:40	19.752

Date & Time	Flow Rate (gpm)
9/29/2010 20:45	16.836
9/29/2010 20:50	14.726
9/29/2010 20:55	13.052
9/29/2010 21:00	11.874
9/29/2010 21:05	10.932
9/29/2010 21:10	10.121
9/29/2010 21:15	9.511
9/29/2010 21:20	9.233
9/29/2010 21:25	9.228
9/29/2010 21:30	9.413
9/29/2010 21:35	9.699
9/29/2010 21:40	10.111
9/29/2010 21:45	11.29
9/29/2010 21:50	13.415
9/29/2010 21:55	16.842
9/29/2010 22:00	20.962
9/29/2010 22:05	25.668
9/29/2010 22:10	29.542
9/29/2010 22:15	31.223
9/29/2010 22:20	32.643
9/29/2010 22:25	34.499
9/29/2010 22:30	33.43
9/29/2010 22:35	31.131
9/29/2010 22:40	28.301
9/29/2010 22:45	25.653
9/29/2010 22:50	23.125
9/29/2010 22:55	20.828
9/29/2010 23:00	18.953
9/29/2010 23:05	18.113
9/29/2010 23:10	18.16
9/29/2010 23:15	18.899
9/29/2010 23:20	19.092
9/29/2010 23:25	18.841
9/29/2010 23:30	19.383
9/29/2010 23:35	21.192
9/29/2010 23:40	22.691
9/29/2010 23:45	23.307
9/29/2010 23:50	23.267
9/29/2010 23:55	22.104
9/30/2010 0:00	21.765
9/30/2010 0:05	22.44

Date & Time	Flow Rate (gpm)
9/30/2010 0:10	23.357
9/30/2010 0:15	23.061
9/30/2010 0:20	22.353
9/30/2010 0:25	22.095
9/30/2010 0:30	24.653
9/30/2010 0:35	29.593
9/30/2010 0:40	38.411
9/30/2010 0:45	48.871
9/30/2010 0:50	53.8
9/30/2010 0:55	53.416
9/30/2010 1:00	53.686
9/30/2010 1:05	51.589
9/30/2010 1:10	47.111
9/30/2010 1:15	43.034
9/30/2010 1:20	38.048
9/30/2010 1:25	34.284
9/30/2010 1:30	34.422
9/30/2010 1:35	38.171
9/30/2010 1:40	45.195
9/30/2010 1:45	58.578
9/30/2010 1:50	82.819
9/30/2010 1:55	94.597
9/30/2010 2:00	103.594
9/30/2010 2:05	134.784
9/30/2010 2:10	128.368
9/30/2010 2:15	95.584
9/30/2010 2:20	67.661
9/30/2010 2:25	56.679
9/30/2010 2:30	73.466
9/30/2010 2:35	94.868
9/30/2010 2:40	156.068
9/30/2010 2:45	236.532
9/30/2010 2:50	229.516
9/30/2010 2:55	184.208
9/30/2010 3:00	137.499
9/30/2010 3:05	115.73
9/30/2010 3:10	123.984
9/30/2010 3:15	132.853
9/30/2010 3:20	148.41
9/30/2010 3:25	136.01
9/30/2010 3:30	120.479

Date & Time	Flow Rate (gpm)
9/30/2010 3:35	149.955
9/30/2010 3:40	295.927
9/30/2010 3:45	304.233
9/30/2010 3:50	210.879
9/30/2010 3:55	174.896
9/30/2010 4:00	199.885
9/30/2010 4:05	217.008
9/30/2010 4:10	200.578
9/30/2010 4:15	186.506
9/30/2010 4:20	159.466
9/30/2010 4:25	158.037
9/30/2010 4:30	174.884
9/30/2010 4:35	169.707
9/30/2010 4:40	154.41
9/30/2010 4:45	145.698
9/30/2010 4:50	128.761
9/30/2010 4:55	105.555
9/30/2010 5:00	94.709
9/30/2010 5:05	100.799
9/30/2010 5:10	121.475
9/30/2010 5:15	133.822
9/30/2010 5:20	139.391
9/30/2010 5:25	149.456
9/30/2010 5:30	147.819
9/30/2010 5:35	152.266
9/30/2010 5:40	146.508
9/30/2010 5:45	169.96
9/30/2010 5:50	254.27
9/30/2010 5:55	207.412
9/30/2010 6:00	166.769
9/30/2010 6:05	127.339
9/30/2010 6:10	107.146
9/30/2010 6:15	106.18
9/30/2010 6:20	119.504
9/30/2010 6:25	147.652
9/30/2010 6:30	182.304
9/30/2010 6:35	213.282
9/30/2010 6:40	218.381
9/30/2010 6:45	239.261
9/30/2010 6:50	289.003
9/30/2010 6:55	311.623

Date & Time	Flow Rate (gpm)
9/30/2010 7:00	311.623
9/30/2010 7:05	311.623
9/30/2010 7:10	311.623
9/30/2010 7:15	311.623
9/30/2010 7:20	311.623
9/30/2010 7:25	311.623
9/30/2010 7:30	310.737
9/30/2010 7:35	240.636
9/30/2010 7:40	196.706
9/30/2010 7:45	308.409
9/30/2010 7:50	311.623
9/30/2010 7:55	311.623
9/30/2010 8:00	311.623
9/30/2010 8:05	311.623
9/30/2010 8:10	311.019
9/30/2010 8:15	309.295
9/30/2010 8:20	311.623
9/30/2010 8:25	311.623
9/30/2010 8:30	232.678
9/30/2010 8:35	151.582
9/30/2010 8:40	146.49
9/30/2010 8:45	173.449
9/30/2010 8:50	171.233
9/30/2010 8:55	148.608
9/30/2010 9:00	116.705
9/30/2010 9:05	94.925
9/30/2010 9:10	87.012
9/30/2010 9:15	92.791
9/30/2010 9:20	101.143
9/30/2010 9:25	100.593
9/30/2010 9:30	81.195
9/30/2010 9:35	63.61
9/30/2010 9:40	57.134
9/30/2010 9:45	63.579
9/30/2010 9:50	68.786
9/30/2010 9:55	72.515
9/30/2010 10:00	84.368
9/30/2010 10:05	85.795
9/30/2010 10:10	91.978
9/30/2010 10:15	152.909
9/30/2010 10:20	307.15

Date & Time	Flow Rate (gpm)
9/30/2010 10:25	271.206
9/30/2010 10:30	174.331
9/30/2010 10:35	130.329
9/30/2010 10:40	92.772
9/30/2010 10:45	64.862
9/30/2010 10:50	45.663
9/30/2010 10:55	34.285
9/30/2010 11:00	27.845
9/30/2010 11:05	23.939
9/30/2010 11:10	20.942
9/30/2010 11:15	19.094
9/30/2010 11:20	17.869
9/30/2010 11:25	16.706
9/30/2010 11:30	15.809
9/30/2010 11:35	14.923
9/30/2010 11:40	14.211
9/30/2010 11:45	14.413
9/30/2010 11:50	14.28
9/30/2010 11:55	13.533
9/30/2010 12:00	13.39
9/30/2010 12:05	13.231
9/30/2010 12:10	13.263
9/30/2010 12:15	13.361
9/30/2010 12:20	13.175
9/30/2010 12:25	12.695
9/30/2010 12:30	12.49
9/30/2010 12:35	12.127
9/30/2010 12:40	12.598
9/30/2010 12:45	14.971
9/30/2010 12:50	16.71
9/30/2010 12:55	17.922
9/30/2010 13:00	18.104
9/30/2010 13:05	17.164
9/30/2010 13:10	15.971
9/30/2010 13:15	14.87
9/30/2010 13:20	13.583
9/30/2010 13:25	11.797
9/30/2010 13:30	12.684
9/30/2010 13:35	65.309
9/30/2010 13:40	288.209
9/30/2010 13:45	236.073

Date & Time	Flow Rate (gpm)
9/30/2010 13:50	266.961
9/30/2010 13:55	311.623
9/30/2010 14:00	311.623
9/30/2010 14:05	311.623
9/30/2010 14:10	250.357
9/30/2010 14:15	127.603
9/30/2010 14:20	75.574
9/30/2010 14:25	51.91
9/30/2010 14:30	38.172
9/30/2010 14:35	30.119
9/30/2010 14:40	24.804
9/30/2010 14:45	20.837
9/30/2010 14:50	18.153
9/30/2010 14:55	16.392
9/30/2010 15:00	15.163
9/30/2010 15:05	14.303
9/30/2010 15:10	13.098
9/30/2010 15:15	12.708
9/30/2010 15:20	12.117
9/30/2010 15:25	11.678
9/30/2010 15:30	10.952
9/30/2010 15:35	10.571
9/30/2010 15:40	10.428
9/30/2010 15:45	9.918
9/30/2010 15:50	9.506
9/30/2010 15:55	10.249
9/30/2010 16:00	10.782
9/30/2010 16:05	10.64
9/30/2010 16:10	10.706
9/30/2010 16:15	11.499
9/30/2010 16:20	12.778
9/30/2010 16:25	13.592
9/30/2010 16:30	14.709
9/30/2010 16:35	16.246
9/30/2010 16:40	16.908
9/30/2010 16:45	16.601
9/30/2010 16:50	15.701
9/30/2010 16:55	14.196
9/30/2010 17:00	13.019
9/30/2010 17:05	12.023
9/30/2010 17:10	11.32

Date & Time	**Flow Rate (gpm)**
9/30/2010 17:15	10.634
9/30/2010 17:20	10.24
9/30/2010 17:25	9.98
9/30/2010 17:30	10.319
9/30/2010 17:35	11.553
9/30/2010 17:40	13.47
9/30/2010 17:45	16.469
9/30/2010 17:50	20.656
9/30/2010 17:55	24.734
9/30/2010 18:00	27.163
9/30/2010 18:05	27.317
9/30/2010 18:10	27.457
9/30/2010 18:15	28.169
9/30/2010 18:20	26.682
9/30/2010 18:25	23.636
9/30/2010 18:30	20.645
9/30/2010 18:35	18.532
9/30/2010 18:40	16.543
9/30/2010 18:45	14.935
9/30/2010 18:50	13.992
9/30/2010 18:55	13.344
9/30/2010 19:00	13.079
9/30/2010 19:05	12.681
9/30/2010 19:10	11.9
9/30/2010 19:15	13.546
9/30/2010 19:20	12.84
9/30/2010 19:25	12.718
9/30/2010 19:30	13.012
9/30/2010 19:35	15.116
9/30/2010 19:40	30.622
9/30/2010 19:45	82.712
9/30/2010 19:50	134.165
9/30/2010 19:55	147.822
9/30/2010 20:00	126.542
9/30/2010 20:05	101.318
9/30/2010 20:10	74.598
9/30/2010 20:15	58.799
9/30/2010 20:20	50.589
9/30/2010 20:25	44.644
9/30/2010 20:30	38.885
9/30/2010 20:35	33.68

Date & Time	**Flow Rate (gpm)**
9/30/2010 20:40	28.793
9/30/2010 20:45	24.77
9/30/2010 20:50	22.862
9/30/2010 20:55	22.959
9/30/2010 21:00	31.856
9/30/2010 21:05	82.565
9/30/2010 21:10	153.326
9/30/2010 21:15	154.531
9/30/2010 21:20	145.227
9/30/2010 21:25	137.94
9/30/2010 21:30	137.816
9/30/2010 21:35	132.585
9/30/2010 21:40	128.316
9/30/2010 21:45	120.34
9/30/2010 21:50	105.705
9/30/2010 21:55	90.826
9/30/2010 22:00	83.558
9/30/2010 22:05	114.689
9/30/2010 22:10	194.14
9/30/2010 22:15	221.967
9/30/2010 22:20	202.266
9/30/2010 22:25	190.773
9/30/2010 22:30	182.071
9/30/2010 22:35	178.531
9/30/2010 22:40	163.275
9/30/2010 22:45	132.871
9/30/2010 22:50	115.321
9/30/2010 22:55	100.463
9/30/2010 23:00	81.592
9/30/2010 23:05	64.858
9/30/2010 23:10	58.367
9/30/2010 23:15	56.142
9/30/2010 23:20	50.417
9/30/2010 23:25	41.112
9/30/2010 23:30	33.722
9/30/2010 23:35	29.356
9/30/2010 23:40	30.952
9/30/2010 23:45	34.887
9/30/2010 23:50	34.299
9/30/2010 23:55	30.481
10/1/2010 0:00	26.559

Date & Time	Flow Rate (gpm)
10/1/2010 0:05	23.293
10/1/2010 0:10	20.789
10/1/2010 0:15	18.627
10/1/2010 0:20	17.221
10/1/2010 0:25	16.073
10/1/2010 0:30	15.139
10/1/2010 0:35	14.361
10/1/2010 0:40	13.775
10/1/2010 0:45	13.165
10/1/2010 0:50	12.558
10/1/2010 0:55	12.127
10/1/2010 1:00	11.963
10/1/2010 1:05	11.618
10/1/2010 1:10	11.397
10/1/2010 1:15	10.979
10/1/2010 1:20	10.958
10/1/2010 1:25	10.685
10/1/2010 1:30	10.41
10/1/2010 1:35	10.091
10/1/2010 1:40	10.086
10/1/2010 1:45	9.92
10/1/2010 1:50	9.764
10/1/2010 1:55	9.568
10/1/2010 2:00	9.472
10/1/2010 2:05	9.516
10/1/2010 2:10	9.28
10/1/2010 2:15	9.058
10/1/2010 2:20	8.973
10/1/2010 2:25	8.723
10/1/2010 2:30	8.702
10/1/2010 2:35	8.59
10/1/2010 2:40	8.443
10/1/2010 2:45	8.196
10/1/2010 2:50	8.032
10/1/2010 2:55	7.813
10/1/2010 3:00	8.028
10/1/2010 3:05	7.981
10/1/2010 3:10	7.801
10/1/2010 3:15	7.627
10/1/2010 3:20	7.557
10/1/2010 3:25	7.415

Date & Time	Flow Rate (gpm)
10/1/2010 3:30	7.349
10/1/2010 3:35	7.289
10/1/2010 3:40	7.198
10/1/2010 3:45	7.172
10/1/2010 3:50	7.167
10/1/2010 3:55	6.952
10/1/2010 4:00	6.929
10/1/2010 4:05	6.846
10/1/2010 4:10	6.796
10/1/2010 4:15	6.517
10/1/2010 4:20	6.253
10/1/2010 4:25	5.774
10/1/2010 4:30	5.244
10/1/2010 4:35	4.578
10/1/2010 4:40	3.986
10/1/2010 4:45	2.866
10/1/2010 4:50	1.858
10/1/2010 4:55	0.546
10/1/2010 5:00	0.005
10/1/2010 5:05	0

OUTFLOW

Date & Time	Flow Rate (gpm)
9/29/2010 23:55	0
9/30/2010 0:00	0.001
9/30/2010 0:05	0
9/30/2010 0:10	0
9/30/2010 0:15	0
9/30/2010 0:20	0
9/30/2010 0:25	0
9/30/2010 0:30	0.001
9/30/2010 0:35	0.004
9/30/2010 0:40	0.035
9/30/2010 0:45	0.304
9/30/2010 0:50	0.502
9/30/2010 0:55	0.651
9/30/2010 1:00	0.812
9/30/2010 1:05	0.925
9/30/2010 1:10	0.752
9/30/2010 1:15	0.988
9/30/2010 1:20	1.073

Date & Time	Flow Rate (gpm)
9/30/2010 1:25	1.294
9/30/2010 1:30	1.46
9/30/2010 1:35	1.648
9/30/2010 1:40	1.74
9/30/2010 1:45	1.884
9/30/2010 1:50	2.188
9/30/2010 1:55	2.128
9/30/2010 2:00	2.21
9/30/2010 2:05	2.592
9/30/2010 2:10	2.862
9/30/2010 2:15	3.306
9/30/2010 2:20	3.488
9/30/2010 2:25	4.04
9/30/2010 2:30	4.52
9/30/2010 2:35	4.713
9/30/2010 2:40	5.15
9/30/2010 2:45	5.736
9/30/2010 2:50	6.247
9/30/2010 2:55	6.816
9/30/2010 3:00	7.351
9/30/2010 3:05	8.134
9/30/2010 3:10	8.907
9/30/2010 3:15	10.167
9/30/2010 3:20	10.364
9/30/2010 3:25	11.062
9/30/2010 3:30	11.578
9/30/2010 3:35	11.704
9/30/2010 3:40	11.827
9/30/2010 3:45	12.77
9/30/2010 3:50	14.726
9/30/2010 3:55	16.375
9/30/2010 4:00	17.492
9/30/2010 4:05	20.501
9/30/2010 4:10	27.674
9/30/2010 4:15	36.276
9/30/2010 4:20	40.767
9/30/2010 4:25	43.996
9/30/2010 4:30	46.036
9/30/2010 4:35	49.013
9/30/2010 4:40	47.443
9/30/2010 4:45	47.84

Date & Time	Flow Rate (gpm)
9/30/2010 4:50	48
9/30/2010 4:55	47.367
9/30/2010 5:00	47.024
9/30/2010 5:05	47.208
9/30/2010 5:10	46.492
9/30/2010 5:15	46.386
9/30/2010 5:20	45.519
9/30/2010 5:25	46.267
9/30/2010 5:30	47.236
9/30/2010 5:35	47.435
9/30/2010 5:40	47.79
9/30/2010 5:45	46.942
9/30/2010 5:50	46.429
9/30/2010 5:55	40.566
9/30/2010 6:00	35.608
9/30/2010 6:05	36.821
9/30/2010 6:10	41.225
9/30/2010 6:15	46.284
9/30/2010 6:20	47.394
9/30/2010 6:25	47.359
9/30/2010 6:30	48.558
9/30/2010 6:35	47.937
9/30/2010 6:40	45.571
9/30/2010 6:45	38.622
9/30/2010 6:50	22.695
9/30/2010 6:55	14.934
9/30/2010 7:00	33.383
9/30/2010 7:05	65.855
9/30/2010 7:10	73.427
9/30/2010 7:15	71.522
9/30/2010 7:20	73.459
9/30/2010 7:25	71.619
9/30/2010 7:30	66.567
9/30/2010 7:35	53.269
9/30/2010 7:40	38.336
9/30/2010 7:45	35.114
9/30/2010 7:50	41.75
9/30/2010 7:55	48.549
9/30/2010 8:00	52.3
9/30/2010 8:05	51.844
9/30/2010 8:10	47.986

Date & Time	Flow Rate (gpm)
9/30/2010 8:15	46.741
9/30/2010 8:20	51.101
9/30/2010 8:25	50.004
9/30/2010 8:30	45.793
9/30/2010 8:35	35.073
9/30/2010 8:40	26.786
9/30/2010 8:45	21.454
9/30/2010 8:50	19.291
9/30/2010 8:55	16.836
9/30/2010 9:00	12.969
9/30/2010 9:05	9.145
9/30/2010 9:10	6.936
9/30/2010 9:15	12.58
9/30/2010 9:20	44.421
9/30/2010 9:25	46.763
9/30/2010 9:30	48
9/30/2010 9:35	47.13
9/30/2010 9:40	46.591
9/30/2010 9:45	44.241
9/30/2010 9:50	41.21
9/30/2010 9:55	39.999
9/30/2010 10:00	37.676
9/30/2010 10:05	36.843
9/30/2010 10:10	35.6
9/30/2010 10:15	36.173
9/30/2010 10:20	41.645
9/30/2010 10:25	47.413
9/30/2010 10:30	47.763
9/30/2010 10:35	47.663
9/30/2010 10:40	47.248
9/30/2010 10:45	47.39
9/30/2010 10:50	46.574
9/30/2010 10:55	46.185
9/30/2010 11:00	44.968
9/30/2010 11:05	42.285
9/30/2010 11:10	39.058
9/30/2010 11:15	35.927
9/30/2010 11:20	32.941
9/30/2010 11:25	30.015
9/30/2010 11:30	27.513
9/30/2010 11:35	26.324

Date & Time	Flow Rate (gpm)
9/30/2010 11:40	24.871
9/30/2010 11:45	24.085
9/30/2010 11:50	24.022
9/30/2010 11:55	23.688
9/30/2010 12:00	22.904
9/30/2010 12:05	22.637
9/30/2010 12:10	22.502
9/30/2010 12:15	22.118
9/30/2010 12:20	22.033
9/30/2010 12:25	21.926
9/30/2010 12:30	21.336
9/30/2010 12:35	20.481
9/30/2010 12:40	20.059
9/30/2010 12:45	20.072
9/30/2010 12:50	19.499
9/30/2010 12:55	19.622
9/30/2010 13:00	19.438
9/30/2010 13:05	19.336
9/30/2010 13:10	19.235
9/30/2010 13:15	19.022
9/30/2010 13:20	18.702
9/30/2010 13:25	19.137
9/30/2010 13:30	18.464
9/30/2010 13:35	18.655
9/30/2010 13:40	18.139
9/30/2010 13:45	18.519
9/30/2010 13:50	19.518
9/30/2010 13:55	21.579
9/30/2010 14:00	26.865
9/30/2010 14:05	42.851
9/30/2010 14:10	49.758
9/30/2010 14:15	47.8
9/30/2010 14:20	46.133
9/30/2010 14:25	47.344
9/30/2010 14:30	46.581
9/30/2010 14:35	46.457
9/30/2010 14:40	44.684
9/30/2010 14:45	42.123
9/30/2010 14:50	38.689
9/30/2010 14:55	36.3
9/30/2010 15:00	33.484

Date & Time	Flow Rate (gpm)
9/30/2010 15:05	31.186
9/30/2010 15:10	29.559
9/30/2010 15:15	28.602
9/30/2010 15:20	27.754
9/30/2010 15:25	27.289
9/30/2010 15:30	27.115
9/30/2010 15:35	26.897
9/30/2010 15:40	26.091
9/30/2010 15:45	26.002
9/30/2010 15:50	25.431
9/30/2010 15:55	25.352
9/30/2010 16:00	24.679
9/30/2010 16:05	24.102
9/30/2010 16:10	23.495
9/30/2010 16:15	23.528
9/30/2010 16:20	23.235
9/30/2010 16:25	22.943
9/30/2010 16:30	22.783
9/30/2010 16:35	23.181
9/30/2010 16:40	22.625
9/30/2010 16:45	22.288
9/30/2010 16:50	22.233
9/30/2010 16:55	22.171
9/30/2010 17:00	21.684
9/30/2010 17:05	21.92
9/30/2010 17:10	21.944
9/30/2010 17:15	21.505
9/30/2010 17:20	21.441
9/30/2010 17:25	21.005
9/30/2010 17:30	21.085
9/30/2010 17:35	20.93
9/30/2010 17:40	20.401
9/30/2010 17:45	20.248
9/30/2010 17:50	20.243
9/30/2010 17:55	19.755
9/30/2010 18:00	19.554
9/30/2010 18:05	19.405
9/30/2010 18:10	19.051
9/30/2010 18:15	19.201
9/30/2010 18:20	18.836
9/30/2010 18:25	18.717

Date & Time	Flow Rate (gpm)
9/30/2010 18:30	18.5
9/30/2010 18:35	18.504
9/30/2010 18:40	18.325
9/30/2010 18:45	18.083
9/30/2010 18:50	18.101
9/30/2010 18:55	18.005
9/30/2010 19:00	17.542
9/30/2010 19:05	17.334
9/30/2010 19:10	17.474
9/30/2010 19:15	17.153
9/30/2010 19:20	16.789
9/30/2010 19:25	16.862
9/30/2010 19:30	16.62
9/30/2010 19:35	16.387
9/30/2010 19:40	16.148
9/30/2010 19:45	15.763
9/30/2010 19:50	15.906
9/30/2010 19:55	15.655
9/30/2010 20:00	15.423
9/30/2010 20:05	15.96
9/30/2010 20:10	16.307
9/30/2010 20:15	16.675
9/30/2010 20:20	16.805
9/30/2010 20:25	16.754
9/30/2010 20:30	16.883
9/30/2010 20:35	16.847
9/30/2010 20:40	16.827
9/30/2010 20:45	16.663
9/30/2010 20:50	16.433
9/30/2010 20:55	16.496
9/30/2010 21:00	16.569
9/30/2010 21:05	16.43
9/30/2010 21:10	16.232
9/30/2010 21:15	16.131
9/30/2010 21:20	16.528
9/30/2010 21:25	16.892
9/30/2010 21:30	17.332
9/30/2010 21:35	17.682
9/30/2010 21:40	17.948
9/30/2010 21:45	18.269
9/30/2010 21:50	18.997

Date & Time	Flow Rate (gpm)
9/30/2010 21:55	19.076
9/30/2010 22:00	19.314
9/30/2010 22:05	19.719
9/30/2010 22:10	20.221
9/30/2010 22:15	20.539
9/30/2010 22:20	20.864
9/30/2010 22:25	21.634
9/30/2010 22:30	21.965
9/30/2010 22:35	22.957
9/30/2010 22:40	23.81
9/30/2010 22:45	24.208
9/30/2010 22:50	24.938
9/30/2010 22:55	25.374
9/30/2010 23:00	25.568
9/30/2010 23:05	25.676
9/30/2010 23:10	25.752
9/30/2010 23:15	25.882
9/30/2010 23:20	26.259
9/30/2010 23:25	26.221
9/30/2010 23:30	26.636
9/30/2010 23:35	26.01
9/30/2010 23:40	26.109
9/30/2010 23:45	26.141
9/30/2010 23:50	26.399
9/30/2010 23:55	25.63
10/1/2010 0:00	25.446
10/1/2010 0:05	24.974
10/1/2010 0:10	24.865
10/1/2010 0:15	25.039
10/1/2010 0:20	24.536
10/1/2010 0:25	24.377
10/1/2010 0:30	24.138
10/1/2010 0:35	24.199
10/1/2010 0:40	23.742
10/1/2010 0:45	23.339
10/1/2010 0:50	23.475
10/1/2010 0:55	23.026
10/1/2010 1:00	22.911
10/1/2010 1:05	22.793
10/1/2010 1:10	22.538
10/1/2010 1:15	21.66

Date & Time	Flow Rate (gpm)
10/1/2010 1:20	21.807
10/1/2010 1:25	21.051
10/1/2010 1:30	21.213
10/1/2010 1:35	21.069
10/1/2010 1:40	20.51
10/1/2010 1:45	20.574
10/1/2010 1:50	20.114
10/1/2010 1:55	19.638
10/1/2010 2:00	19.117
10/1/2010 2:05	18.86
10/1/2010 2:10	18.812
10/1/2010 2:15	18.401
10/1/2010 2:20	18.081
10/1/2010 2:25	17.627
10/1/2010 2:30	17.261
10/1/2010 2:35	17.12
10/1/2010 2:40	16.9
10/1/2010 2:45	16.584
10/1/2010 2:50	16.078
10/1/2010 2:55	15.649
10/1/2010 3:00	15.378
10/1/2010 3:05	15.099
10/1/2010 3:10	15.049
10/1/2010 3:15	14.556
10/1/2010 3:20	14.56
10/1/2010 3:25	14.336
10/1/2010 3:30	14.198
10/1/2010 3:35	13.655
10/1/2010 3:40	12.775
10/1/2010 3:45	12.908
10/1/2010 3:50	12.522
10/1/2010 3:55	12.656
10/1/2010 4:00	11.95
10/1/2010 4:05	11.883
10/1/2010 4:10	11.291
10/1/2010 4:15	11.233
10/1/2010 4:20	10.635
10/1/2010 4:25	10.258
10/1/2010 4:30	9.914
10/1/2010 4:35	9.292
10/1/2010 4:40	8.685

Date & Time	Flow Rate (gpm)
10/1/2010 4:45	7.999
10/1/2010 4:50	7.425
10/1/2010 4:55	7.084
10/1/2010 5:00	6.512
10/1/2010 5:05	5.871
10/1/2010 5:10	5.359
10/1/2010 5:15	5.066
10/1/2010 5:20	4.546
10/1/2010 5:25	4.363
10/1/2010 5:30	4.035
10/1/2010 5:35	3.644
10/1/2010 5:40	3.155
10/1/2010 5:45	2.774
10/1/2010 5:50	2.445
10/1/2010 5:55	2.234
10/1/2010 6:00	1.983
10/1/2010 6:05	1.623
10/1/2010 6:10	1.464
10/1/2010 6:15	1.121
10/1/2010 6:20	0.709
10/1/2010 6:25	0.13
10/1/2010 6:30	0.008
10/1/2010 6:35	0

Event date: 10/27/2010

Inflow

Date & Time	Flow Rate (gpm)
10/27/2010 4:15	0
10/27/2010 4:20	27.08
10/27/2010 4:25	18.651
10/27/2010 4:30	15.264
10/27/2010 4:35	199.509
10/27/2010 4:40	146.772
10/27/2010 4:45	80.266
10/27/2010 4:50	33.07
10/27/2010 4:55	47.304
10/27/2010 5:00	98.059
10/27/2010 5:05	64.262
10/27/2010 5:10	33.3
10/27/2010 5:15	29.333
10/27/2010 5:20	27.345

Date & Time	Flow Rate (gpm)
10/27/2010 5:25	20.75
10/27/2010 5:30	11.997
10/27/2010 5:35	5.582
10/27/2010 5:40	1.206
10/27/2010 5:45	0
10/27/2010 5:50	0
10/27/2010 5:55	25.197
10/27/2010 6:00	271.045
10/27/2010 6:05	311.624
10/27/2010 6:10	311.624
10/27/2010 6:15	299.235
10/27/2010 6:20	223.642
10/27/2010 6:25	129.759
10/27/2010 6:30	79.575
10/27/2010 6:35	55.564
10/27/2010 6:40	44.868
10/27/2010 6:45	33.159
10/27/2010 6:50	41.825
10/27/2010 6:55	50.788
10/27/2010 7:00	53.237
10/27/2010 7:05	42.653
10/27/2010 7:10	28.815
10/27/2010 7:15	17.786
10/27/2010 7:20	10.257
10/27/2010 7:25	7.06
10/27/2010 7:30	4.908
10/27/2010 7:35	2.245
10/27/2010 7:40	0.187
10/27/2010 7:45	0
10/27/2010 7:50	0
10/27/2010 7:55	0
10/27/2010 8:00	0
10/27/2010 8:05	0
10/27/2010 8:10	0
10/27/2010 8:15	0
10/27/2010 8:20	0
10/27/2010 8:25	0
10/27/2010 8:30	0
10/27/2010 8:35	0
10/27/2010 8:40	0
10/27/2010 8:45	0

Date & Time	Flow Rate (gpm)
10/27/2010 8:50	0
10/27/2010 8:55	0
10/27/2010 9:00	0
10/27/2010 9:05	0
10/27/2010 9:10	0
10/27/2010 9:15	0
10/27/2010 9:20	0
10/27/2010 9:25	0
10/27/2010 9:30	0
10/27/2010 9:35	0
10/27/2010 9:40	0
10/27/2010 9:45	0
10/27/2010 9:50	0
10/27/2010 9:55	0
10/27/2010 10:00	0
10/27/2010 10:05	0
10/27/2010 10:10	0
10/27/2010 10:15	0
10/27/2010 10:20	0
10/27/2010 10:25	0
10/27/2010 10:30	0
10/27/2010 10:35	0
10/27/2010 10:40	0
10/27/2010 10:45	0
10/27/2010 10:50	2.008
10/27/2010 10:55	3.703
10/27/2010 11:00	4.943
10/27/2010 11:05	3.613
10/27/2010 11:10	1.447
10/27/2010 11:15	0
10/27/2010 11:20	0
10/27/2010 11:25	0
10/27/2010 11:30	1.015
10/27/2010 11:35	193.023
10/27/2010 11:40	311.624
10/27/2010 11:45	311.624
10/27/2010 11:50	279.533
10/27/2010 11:55	151.675
10/27/2010 12:00	157.682
10/27/2010 12:05	146.064
10/27/2010 12:10	94.863

Date & Time	Flow Rate (gpm)
10/27/2010 12:15	50.474
10/27/2010 12:20	28.471
10/27/2010 12:25	18.463
10/27/2010 12:30	12.493
10/27/2010 12:35	8.775
10/27/2010 12:40	6.247
10/27/2010 12:45	4.37
10/27/2010 12:50	2.733
10/27/2010 12:55	1.332
10/27/2010 13:00	0.269
10/27/2010 13:05	0

Outflow

Date and Time	Flow Rate (gpm)
10/27/2010 6:45	0
10/27/2010 6:50	1.613
10/27/2010 6:55	6.933
10/27/2010 7:00	12.843
10/27/2010 7:05	17.124
10/27/2010 7:10	19.125
10/27/2010 7:15	21.091
10/27/2010 7:20	22.108
10/27/2010 7:25	22.698
10/27/2010 7:30	23.025
10/27/2010 7:35	23.309
10/27/2010 7:40	23.106
10/27/2010 7:45	22.564
10/27/2010 7:50	22.75
10/27/2010 7:55	22.201
10/27/2010 8:00	22.265
10/27/2010 8:05	22.166
10/27/2010 8:10	21.636
10/27/2010 8:15	21.314
10/27/2010 8:20	21.082
10/27/2010 8:25	20.857
10/27/2010 8:30	20.315
10/27/2010 8:35	20.152
10/27/2010 8:40	19.846
10/27/2010 8:45	19.831
10/27/2010 8:50	19.401
10/27/2010 8:55	19.284

Date and Time	Flow Rate (gpm)
10/27/2010 9:00	18.73
10/27/2010 9:05	18.746
10/27/2010 9:10	18.23
10/27/2010 9:15	18.199
10/27/2010 9:20	18.201
10/27/2010 9:25	17.471
10/27/2010 9:30	17.697
10/27/2010 9:35	17.332
10/27/2010 9:40	16.91
10/27/2010 9:45	16.582
10/27/2010 9:50	16.638
10/27/2010 9:55	16.496
10/27/2010 10:00	16.122
10/27/2010 10:05	15.64
10/27/2010 10:10	15.892
10/27/2010 10:15	15.545
10/27/2010 10:20	15.204
10/27/2010 10:25	15.022
10/27/2010 10:30	14.638
10/27/2010 10:35	14.162
10/27/2010 10:40	13.989
10/27/2010 10:45	13.629
10/27/2010 10:50	13.36
10/27/2010 10:55	13.464
10/27/2010 11:00	13.211
10/27/2010 11:05	13.139
10/27/2010 11:10	12.92
10/27/2010 11:15	12.473
10/27/2010 11:20	12.646
10/27/2010 11:25	12.15
10/27/2010 11:30	11.838
10/27/2010 11:35	11.867
10/27/2010 11:40	11.87
10/27/2010 11:45	12.724
10/27/2010 11:50	12.753
10/27/2010 11:55	14.323
10/27/2010 12:00	16.08
10/27/2010 12:05	17.865
10/27/2010 12:10	19.434
10/27/2010 12:15	20.706
10/27/2010 12:20	21.7

Date and Time	Flow Rate (gpm)
10/27/2010 12:25	22.538
10/27/2010 12:30	22.686
10/27/2010 12:35	23.379
10/27/2010 12:40	23.074
10/27/2010 12:45	23.373
10/27/2010 12:50	22.913
10/27/2010 12:55	22.329
10/27/2010 13:00	22.376
10/27/2010 13:05	22.012
10/27/2010 13:10	21.741
10/27/2010 13:15	21.49
10/27/2010 13:20	21.289
10/27/2010 13:25	21.456
10/27/2010 13:30	21.356
10/27/2010 13:35	20.766
10/27/2010 13:40	20.698
10/27/2010 13:45	20.73
10/27/2010 13:50	20.337
10/27/2010 13:55	19.933
10/27/2010 14:00	19.637
10/27/2010 14:05	19.425
10/27/2010 14:10	19.515
10/27/2010 14:15	18.874
10/27/2010 14:20	18.782
10/27/2010 14:25	18.892
10/27/2010 14:30	18.554
10/27/2010 14:35	18.34
10/27/2010 14:40	17.742
10/27/2010 14:45	17.65
10/27/2010 14:50	17.277
10/27/2010 14:55	17.062
10/27/2010 15:00	17.122
10/27/2010 15:05	16.71
10/27/2010 15:10	16.718
10/27/2010 15:15	16.41
10/27/2010 15:20	16.149
10/27/2010 15:25	16.145
10/27/2010 15:30	15.697
10/27/2010 15:35	15.578
10/27/2010 15:40	15.116
10/27/2010 15:45	14.771

Date and Time	Flow Rate (gpm)
10/27/2010 15:50	14.445
10/27/2010 15:55	14.384
10/27/2010 16:00	13.992
10/27/2010 16:05	13.488
10/27/2010 16:10	13.375
10/27/2010 16:15	12.785
10/27/2010 16:20	12.611
10/27/2010 16:25	12.661
10/27/2010 16:30	12.134
10/27/2010 16:35	11.912
10/27/2010 16:40	11.602
10/27/2010 16:45	11.908
10/27/2010 16:50	11.658
10/27/2010 16:55	11.123
10/27/2010 17:00	10.676
10/27/2010 17:05	9.987
10/27/2010 17:10	9.413
10/27/2010 17:15	9.193
10/27/2010 17:20	8.482
10/27/2010 17:25	7.828
10/27/2010 17:30	7.088
10/27/2010 17:35	6.729
10/27/2010 17:40	6.223
10/27/2010 17:45	5.802
10/27/2010 17:50	5.514
10/27/2010 17:55	4.899
10/27/2010 18:00	4.667
10/27/2010 18:05	4.34
10/27/2010 18:10	3.769
10/27/2010 18:15	3.492
10/27/2010 18:20	3.151
10/27/2010 18:25	2.96
10/27/2010 18:30	2.609
10/27/2010 18:35	2.419
10/27/2010 18:40	2.213
10/27/2010 18:45	1.87
10/27/2010 18:50	1.532
10/27/2010 18:55	1.096
10/27/2010 19:00	0.663
10/27/2010 19:05	0.284
10/27/2010 19:10	0.024

Date and Time	Flow Rate (gpm)
10/27/2010 19:15	0

Event date: 11/16/2010

Inflow

Date & Time	Flow Rate (gpm)
11/16/2010 6:00	0.468
11/16/2010 6:15	2.725
11/16/2010 6:30	6.562
11/16/2010 6:45	19.438
11/16/2010 7:00	9.671
11/16/2010 7:15	7.106
11/16/2010 7:30	3.485
11/16/2010 7:45	23.745
11/16/2010 8:00	93.956
11/16/2010 8:15	35.641
11/16/2010 8:30	46.822
11/16/2010 8:45	88.269
11/16/2010 9:00	91.505
11/16/2010 9:15	98.049
11/16/2010 9:30	39.044
11/16/2010 9:45	45.069
11/16/2010 10:00	39.769
11/16/2010 10:15	51.809
11/16/2010 10:30	38.611
11/16/2010 10:45	12.781
11/16/2010 11:00	6.492
11/16/2010 11:15	4.907
11/16/2010 11:30	17.112
11/16/2010 11:45	28.085
11/16/2010 12:00	95.476
11/16/2010 12:15	231.581
11/16/2010 12:30	117.277
11/16/2010 12:45	85.48
11/16/2010 13:00	175.843
11/16/2010 13:15	126.394
11/16/2010 13:30	74.907
11/16/2010 13:45	49.466
11/16/2010 14:00	53.049
11/16/2010 14:15	39.024
11/16/2010 14:30	21.034
11/16/2010 14:45	29.036

Date & Time	Flow Rate (gpm)
11/16/2010 15:00	34.053
11/16/2010 15:15	38.769
11/16/2010 15:30	46.952
11/16/2010 15:45	26.847
11/16/2010 16:00	64.111
11/16/2010 16:15	33.609
11/16/2010 16:30	14.113
11/16/2010 16:45	6.229
11/16/2010 17:00	2.334
11/16/2010 17:15	0.523
11/16/2010 17:30	0.014
11/16/2010 17:45	4.375
11/16/2010 18:00	4.282
11/16/2010 18:15	10.656
11/16/2010 18:30	65.678
11/16/2010 18:45	40.143
11/16/2010 19:00	30.296
11/16/2010 19:15	51.389
11/16/2010 19:30	92.199
11/16/2010 19:45	54.367
11/16/2010 20:00	114.811
11/16/2010 20:15	61.57
11/16/2010 20:30	23.158
11/16/2010 20:45	10.478
11/16/2010 21:00	7.22
11/16/2010 21:15	3.835
11/16/2010 21:30	1.581
11/16/2010 21:45	0.145
11/16/2010 22:00	0
11/16/2010 22:15	0
11/16/2010 22:30	0
11/16/2010 22:45	0
11/16/2010 23:00	0
11/16/2010 23:15	0
11/16/2010 23:30	3.387
11/16/2010 23:45	105.479
11/17/2010 0:00	179.522
11/17/2010 0:15	55.798
11/17/2010 0:30	76.269
11/17/2010 0:45	65.077
11/17/2010 1:00	51.281

Date & Time	Flow Rate (gpm)
11/17/2010 1:15	19.704
11/17/2010 1:30	5.095
11/17/2010 1:45	2.112
11/17/2010 2:00	0.161
11/17/2010 2:15	0

OUTFLOW

Date & Time	Flow Rate (gpm)
11/16/2010 10:15	0
11/16/2010 10:20	0.279
11/16/2010 10:25	1.796
11/16/2010 10:30	3.394
11/16/2010 10:35	5.29
11/16/2010 10:40	6.49
11/16/2010 10:45	7.534
11/16/2010 10:50	8.297
11/16/2010 10:55	9.035
11/16/2010 11:00	9.439
11/16/2010 11:05	9.892
11/16/2010 11:10	9.86
11/16/2010 11:15	9.941
11/16/2010 11:20	10.134
11/16/2010 11:25	10.233
11/16/2010 11:30	10.358
11/16/2010 11:35	10.326
11/16/2010 11:40	10.405
11/16/2010 11:45	10.402
11/16/2010 11:50	10.727
11/16/2010 11:55	10.452
11/16/2010 12:00	10.638
11/16/2010 12:05	10.85
11/16/2010 12:10	11.135
11/16/2010 12:15	11.409
11/16/2010 12:20	12.567
11/16/2010 12:25	14.076
11/16/2010 12:30	15.314
11/16/2010 12:35	16.232
11/16/2010 12:40	17.295
11/16/2010 12:45	17.761
11/16/2010 12:50	19.487
11/16/2010 12:55	27.804

Date & Time	Flow Rate (gpm)
11/16/2010 13:00	37.025
11/16/2010 13:05	44.876
11/16/2010 13:10	52.493
11/16/2010 13:15	59.239
11/16/2010 13:20	60.77
11/16/2010 13:25	52.035
11/16/2010 13:30	51.271
11/16/2010 13:35	49.365
11/16/2010 13:40	47.086
11/16/2010 13:45	45.977
11/16/2010 13:50	44.458
11/16/2010 13:55	43.498
11/16/2010 14:00	42.368
11/16/2010 14:05	40.979
11/16/2010 14:10	39.575
11/16/2010 14:15	38.071
11/16/2010 14:20	35.921
11/16/2010 14:25	34.068
11/16/2010 14:30	32.152
11/16/2010 14:35	29.643
11/16/2010 14:40	27.979
11/16/2010 14:45	26.828
11/16/2010 14:50	26.242
11/16/2010 14:55	26.08
11/16/2010 15:00	25.475
11/16/2010 15:05	24.753
11/16/2010 15:10	24.483
11/16/2010 15:15	24.73
11/16/2010 15:20	25.159
11/16/2010 15:25	25.593
11/16/2010 15:30	25.637
11/16/2010 15:35	25.755
11/16/2010 15:40	24.549
11/16/2010 15:45	24.309
11/16/2010 15:50	24.45
11/16/2010 15:55	25.926
11/16/2010 16:00	27.309
11/16/2010 16:05	27.62
11/16/2010 16:10	26.999
11/16/2010 16:15	26.827
11/16/2010 16:20	25.754

Date & Time	Flow Rate (gpm)
11/16/2010 16:25	24.908
11/16/2010 16:30	23.42
11/16/2010 16:35	22.388
11/16/2010 16:40	21.26
11/16/2010 16:45	20.894
11/16/2010 16:50	20.5
11/16/2010 16:55	20.188
11/16/2010 17:00	19.616
11/16/2010 17:05	19.402
11/16/2010 17:10	19.316
11/16/2010 17:15	19.084
11/16/2010 17:20	18.833
11/16/2010 17:25	18.293
11/16/2010 17:30	18.396
11/16/2010 17:35	18.199
11/16/2010 17:40	17.894
11/16/2010 17:45	17.139
11/16/2010 17:50	17.335
11/16/2010 17:55	17.274
11/16/2010 18:00	16.608
11/16/2010 18:05	16.151
11/16/2010 18:10	16.538
11/16/2010 18:15	15.976
11/16/2010 18:20	16.282
11/16/2010 18:25	16.31
11/16/2010 18:30	16.684
11/16/2010 18:35	16.934
11/16/2010 18:40	17.307
11/16/2010 18:45	17.127
11/16/2010 18:50	17.227
11/16/2010 18:55	17.137
11/16/2010 19:00	17.441
11/16/2010 19:05	17.325
11/16/2010 19:10	17.668
11/16/2010 19:15	17.745
11/16/2010 19:20	18.106
11/16/2010 19:25	18.385
11/16/2010 19:30	18.463
11/16/2010 19:35	19.101
11/16/2010 19:40	19.854
11/16/2010 19:45	20.12

Date & Time	Flow Rate (gpm)
11/16/2010 19:50	20.308
11/16/2010 19:55	20.843
11/16/2010 20:00	23.717
11/16/2010 20:05	27.722
11/16/2010 20:10	30.04
11/16/2010 20:15	30.631
11/16/2010 20:20	30.425
11/16/2010 20:25	29.72
11/16/2010 20:30	28.63
11/16/2010 20:35	27.156
11/16/2010 20:40	25.761
11/16/2010 20:45	24.537
11/16/2010 20:50	23.374
11/16/2010 20:55	22.895
11/16/2010 21:00	22.256
11/16/2010 21:05	21.616
11/16/2010 21:10	21.423
11/16/2010 21:15	21.561
11/16/2010 21:20	21.096
11/16/2010 21:25	20.649
11/16/2010 21:30	20.56
11/16/2010 21:35	20.02
11/16/2010 21:40	19.989
11/16/2010 21:45	19.939
11/16/2010 21:50	19.587
11/16/2010 21:55	19.118
11/16/2010 22:00	19.032
11/16/2010 22:05	18.659
11/16/2010 22:10	18.166
11/16/2010 22:15	17.626
11/16/2010 22:20	17.793
11/16/2010 22:25	17.568
11/16/2010 22:30	17.423
11/16/2010 22:35	17.046
11/16/2010 22:40	17.313
11/16/2010 22:45	16.981
11/16/2010 22:50	16.895
11/16/2010 22:55	16.85
11/16/2010 23:00	16.907
11/16/2010 23:05	16.714
11/16/2010 23:10	16.52

Date & Time	Flow Rate (gpm)
11/16/2010 23:15	16.214
11/16/2010 23:20	16.24
11/16/2010 23:25	16.232
11/16/2010 23:30	15.961
11/16/2010 23:35	16.065
11/16/2010 23:40	15.831
11/16/2010 23:45	15.945
11/16/2010 23:50	16.402
11/16/2010 23:55	17.157
11/17/2010 0:00	18.274
11/17/2010 0:05	19.418
11/17/2010 0:10	19.777
11/17/2010 0:15	20.445
11/17/2010 0:20	20.949
11/17/2010 0:25	21.658
11/17/2010 0:30	22.329
11/17/2010 0:35	22.672
11/17/2010 0:40	23.535
11/17/2010 0:45	23.66
11/17/2010 0:50	24.337
11/17/2010 0:55	25.036
11/17/2010 1:00	25.271
11/17/2010 1:05	25.786
11/17/2010 1:10	25.375
11/17/2010 1:15	24.675
11/17/2010 1:20	24.621
11/17/2010 1:25	24.104
11/17/2010 1:30	23.671
11/17/2010 1:35	23.628
11/17/2010 1:40	23.257
11/17/2010 1:45	23.086
11/17/2010 1:50	22.676
11/17/2010 1:55	22.104
11/17/2010 2:00	22.388
11/17/2010 2:05	22.173
11/17/2010 2:10	21.736
11/17/2010 2:15	21.24
11/17/2010 2:20	21.012
11/17/2010 2:25	21.029
11/17/2010 2:30	20.625
11/17/2010 2:35	20.145

Date & Time	Flow Rate (gpm)
11/17/2010 2:40	20.252
11/17/2010 2:45	19.758
11/17/2010 2:50	20.013
11/17/2010 2:55	19.432
11/17/2010 3:00	19.405
11/17/2010 3:05	19.476
11/17/2010 3:10	19.373
11/17/2010 3:15	19.111
11/17/2010 3:20	18.978
11/17/2010 3:25	18.687
11/17/2010 3:30	18.766
11/17/2010 3:35	18.532
11/17/2010 3:40	18.342
11/17/2010 3:45	18.128
11/17/2010 3:50	18.167
11/17/2010 3:55	18.06
11/17/2010 4:00	17.935
11/17/2010 4:05	17.562
11/17/2010 4:10	17.298
11/17/2010 4:15	17.485
11/17/2010 4:20	16.937
11/17/2010 4:25	16.962
11/17/2010 4:30	16.643
11/17/2010 4:35	16.646
11/17/2010 4:40	16.449
11/17/2010 4:45	16.374
11/17/2010 4:50	16.119
11/17/2010 4:55	16.116
11/17/2010 5:00	15.827
11/17/2010 5:05	15.84
11/17/2010 5:10	15.452
11/17/2010 5:15	15.445
11/17/2010 5:20	15.252
11/17/2010 5:25	15.365
11/17/2010 5:30	15.121
11/17/2010 5:35	15.031
11/17/2010 5:40	14.786
11/17/2010 5:45	14.662
11/17/2010 5:50	14.482
11/17/2010 5:55	14.783
11/17/2010 6:00	14.169

Date & Time	Flow Rate (gpm)
11/17/2010 6:05	13.734
11/17/2010 6:10	13.867
11/17/2010 6:15	13.953
11/17/2010 6:20	13.726
11/17/2010 6:25	13.168
11/17/2010 6:30	12.96
11/17/2010 6:35	13.26
11/17/2010 6:40	12.748
11/17/2010 6:45	12.923
11/17/2010 6:50	12.938
11/17/2010 6:55	12.694
11/17/2010 7:00	12.124
11/17/2010 7:05	12.576
11/17/2010 7:10	12.053
11/17/2010 7:15	11.953
11/17/2010 7:20	11.991
11/17/2010 7:25	11.815
11/17/2010 7:30	12.073
11/17/2010 7:35	11.333
11/17/2010 7:40	11.067
11/17/2010 7:45	10.859
11/17/2010 7:50	10.838
11/17/2010 7:55	10.546
11/17/2010 8:00	10.354
11/17/2010 8:05	10.41
11/17/2010 8:10	10.11
11/17/2010 8:15	9.659
11/17/2010 8:20	9.315
11/17/2010 8:25	9.012
11/17/2010 8:30	9.022
11/17/2010 8:35	8.398
11/17/2010 8:40	8.185
11/17/2010 8:45	7.727
11/17/2010 8:50	7.166
11/17/2010 8:55	6.999
11/17/2010 9:00	6.667
11/17/2010 9:05	6.166
11/17/2010 9:10	5.903
11/17/2010 9:15	5.427
11/17/2010 9:20	5.082
11/17/2010 9:25	5.062

Date & Time	**Flow Rate (gpm)**
11/17/2010 9:30	4.728
11/17/2010 9:35	4.403
11/17/2010 9:40	4.096
11/17/2010 9:45	3.77
11/17/2010 9:50	3.442
11/17/2010 9:55	3.156
11/17/2010 10:00	2.949
11/17/2010 10:05	2.634
11/17/2010 10:10	2.44
11/17/2010 10:15	2.132
11/17/2010 10:20	1.83
11/17/2010 10:25	1.494
11/17/2010 10:30	1.118
11/17/2010 10:35	0.802
11/17/2010 10:40	0.409
11/17/2010 10:45	0.132
11/17/2010 10:50	0.013
11/17/2010 10:55	0

Appendix B – Laboratory Records

EVENT DATE: 7/10/2010

Field site:		CHS Biofilter	Date of Analysis:	7/10/2010		
Who performed analysis?		Kate Abshire, Kristen Cannatelli, Michael Downey				
Detection range for NO_3		0.2 - ?	Detection range for PO_4		0.3 - ?	
NO_3 Blank completed?		No	PO_4 Blank completed?		No	
NO_3 Replicate completed?		No	PO_4 Replicate completed?		No	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
LOCATION	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Inlet	1	7/10/2010 6:39	0.130	0.383		
	2	7/10/2010 6:44	0.139	0.334		
	3	7/10/2010 6:49	0.124	0.293		
	4	7/10/2010 6:54	0.112	0.357		
	5	7/10/2010 6:59	0.148	0.396		
	6	7/10/2010 7:04	0.139	0.387		
	7	7/10/2010 7:09				
	8	7/10/2010 7:14	0.126	0.418		
	9	7/10/2010 7:19				
	10	7/10/2010 7:24	0.128	0.331		
	11	7/10/2010 7:29				
	12	7/10/2010 7:34	0.147	0.365		
	13	7/10/2010 7:39				
	14	7/10/2010 7:44	0.182	0.388		
	15	7/10/2010 7:49				
	16	7/10/2010 7:54	0.164	0.411		Sampler Disabled
Outlet						Sampler Disabled

Event Date: 7/12/2010

Field site:	CHS Biofilter	Date of Analysis:	7/12/2010			
Who performed analysis?		Kate Abshire, Tina Tang, Jeff Park, Ben Popovich, and Michael Downey				
Detection range for NO_3:		0.2 - ?	Detection range for PO_4		0.3 - ?	
NO_3 Blank completed?		Yes	PO_4 Blank completed?		Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?		Yes	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank	Deionized	0.005	0.000		
Inlet	1	7/12/2010 13:46	0.234	0.381	16.98	
	2	7/12/2010 13:51	0.209	0.390	14.19	
	3	7/12/2010 13:56	0.197	0.382	11.00	
	4	7/12/2010 14:01	0.237	0.287	11.38	
	5	7/12/2010 14:06	0.194	0.390		
	6	7/12/2010 14:11	0.167	0.363		
	7	7/12/2010 14:16	0.184	0.269		
	8	7/12/2010 14:21	0.170	0.230	8.54	
	9	7/12/2010 14:26				
	10	7/12/2010 14:31	0.186	0.429		
	11	7/12/2010 14:36				
	12	7/12/2010 14:41	0.167	0.308		P .412
	13	7/12/2010 14:46			6.22	
	14	7/12/2010 14:51	0.210	0.523		
	15	7/12/2010 14:56		0.233		
	16	7/12/2010 15:01	0.143	0.290	4.75	
	17	7/12/2010 15:06				
	18	7/12/2010 15:11	0.152	0.379	6.74	
	19	7/12/2010 15:16	0.167	0.388		
	20	7/12/2010 15:21				minimal Vol collected
	21	7/12/2010 15:26			6.13	
	22	7/12/2010 15:31	0.197	0.368		N 0.195 P 0.351
	23	7/12/2010 15:36			16.01	
	24	7/12/2010 15:41	0.268	0.518		
	25	7/12/2010 15:46				
	26	7/12/2010 15:51				
	27	7/12/2010 15:56				
	28	7/12/2010 16:45	0.193	0.425	6.70	
	29	7/12/2010 16:50				
	30	7/12/2010 16:55	0.187	0.370	6.93	
	31	7/12/2010 17:00				
	32	7/12/2010 17:05	0.261	0.345		
	33	7/12/2010 17:10			2.06	
	34	7/12/2010 17:15	0.251	0.333		
	35	7/12/2010 17:20				
	36	7/12/2010 17:25	0.327	0.331	2.82	
	37	7/12/2010 17:30	0.330			
	38	7/12/2010 17:35	0.311	0.308		
	39	7/12/2010 17:40			4.32	
	40	7/12/2010 17:45	0.329	0.371		Sampler Disabled
Outlet	1					Sampler Disabled

EVENT DATE: 7/14/2010

Field site:	CHS Biofilter	Date of Analysis	7/14/2010			
Who performed analysis?		Kate Abshire, Tina Tang, Jeff Park, and Bobby Arthur				
Detection range for NO_3		0.2 - ?	Detection range for PO_4		0.3 - ?	
NO_3 Blank completed?		No	PO_4 Blank completed?		No	
NO_3 Replicate completed?		No	PO_4 Replicate completed?		No	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank	Deionized				
Inlet	1	7/13/2010 22:17	0.188	0.095	24.485	
	2	7/13/2010 22:22	0.187	0.124		
	3	7/13/2010 22:27	0.167	0.144		
	4	7/13/2010 22:32	0.190	0.112		
	5	7/13/2010 22:37	0.179	0.102	12.429	
	6	7/13/2010 22:42	0.185	0.120		
	7	7/13/2010 22:47		0.128	24.007	
	8	7/13/2010 22:52	0.236	0.141		
	9	7/13/2010 22:57		0.190	33.617	
	10	7/13/2010 23:02	0.310	0.219		
	11	7/13/2010 23:07		0.000	49.777	
	12	7/13/2010 23:12	0.287	0.243		
	13	7/13/2010 23:17		0.218		
	14	7/13/2010 23:22	0.393	0.190		
	15	7/13/2010 23:27		0.173		
	16	7/13/2010 23:32	0.534	0.000	148.000	
	17	7/13/2010 23:37		0.117		
	18	7/13/2010 23:42	0.641	0.156		
	19	7/13/2010 23:47		0.163	39.100	
	20	7/13/2010 23:52		0.161		
	21	7/13/2010 23:57		0.167		Sampler Disabled
Outlet	1	7/14/2010 0:50	0.168	0.073	6.284	
	2	7/14/2010 1:00	0.210	0.088		
	3	7/14/2010 1:10	0.217	0.085	7.317	
	4	7/14/2010 1:20	0.217	0.076		
	5	7/14/2010 1:30	0.210	0.086	2.088	
	6	7/14/2010 1:40	0.222	0.085		
	7	7/14/2010 1:50	0.205	0.061	1.644	
	8	7/14/2010 2:00	0.198	0.060		
	9	7/14/2010 2:10	0.169	0.060	0.000	
	10	7/14/2010 2:20	0.174	0.069		
	11	7/14/2010 2:30	0.167	0.101		
	12	7/14/2010 2:40		0.047	13.263	
	13	7/14/2010 2:50		0.052		Sampler Disabled

EVENT DATE: 7/20/2010

Field site:	CHS Biofilter	Date of Analysis	7/20/2010			
Who performed analysis?		Celine H-J and Michael Boone				
Detection range for NO_3:		0.2 - ?	Detection range for PO_4:		0.3 - ?	
NO_3 Blank completed?		No	PO_4 Blank completed?		No	
NO_3 Replicate completed?		No	PO_4 Replicate completed?		No	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Inlet	1	7/20/2010 17:45			182.837	
	2	7/20/2010 17:50			49.961	
	3	7/20/2010 17:55			149.259	
	4	7/20/2010 18:00			41.683	
	5	7/20/2010 18:05			34.457	Sampler Disabled
Outlet	1					Sampler Disabled

EVENT DATE: 7/31/2010

Field site:	CHS Biofilter	Date of Analysis:	7/31/2010			
Who performed analysis?		Kate Abshire, Tina Tang, Jeff Park, and Bobby Arthur				
Detection range for NO_3:		0.2 - ?	Detection range for PO_4:		0.3 - ?	
NO_3 Blank completed?		No	PO_4 Blank completed?		No	
NO_3 Replicate completed?		No	PO_4 Replicate completed?		No	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Inlet	1	7/31/2010 22:25			14.656	
	2	7/31/2010 22:30				
	3	7/31/2010 22:35			18.980	
	4	7/31/2010 22:40				
	5	7/31/2010 22:45			7.581	
	6	7/31/2010 22:50				
	7	7/31/2010 22:55				
	8	7/31/2010 23:00			8.249	
	9	7/31/2010 23:05				Sampler Disabled
Outlet	1					Sampler Disabled

EVENT DATE: 8/4/2010

Field site:	CHS Biofilter	Date of Analysis	8/4/2010			
Who performed analysis?		Michael Downey, Ben Popovich, Teresa Culver				
Detection range for NO_3		I: 0.10-1.00; O: .2-1.5	Detection range for PO_4		0.3 - ?	
NO_3 Blank completed?		Yes	PO_4 Blank completed?		Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?		Yes	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank	Deionized	0.030	0.088	55.891	
Inlet	1	8/4/2010 20:18	0.137	0.141	57.865	
	2	8/4/2010 20:23	0.114	0.142	15.063	
	3	8/4/2010 20:28	0.170	0.336	8.744	
	4	8/4/2010 20:33	0.143	0.121	6.686	P: 0.132
	5	8/4/2010 20:38	0.221	0.228	4.078	
	6	8/4/2010 20:43	0.183	0.192	5.604	N: 0.185
	7	8/4/2010 20:48	0.183	0.224		Sampler Disabled
Outlet	1	8/4/2010 21:49	0.909	0.124	4.357	
	2	8/4/2010 21:59	0.887	0.184		
	3	8/4/2010 22:09	0.933	0.000		
	4	8/4/2010 22:19	0.942	0.045	6.085	
	5	8/4/2010 22:29	0.640			N: 0.77
	6	8/4/2010 22:39	0.900	0.177		
	7	8/4/2010 22:49	0.674	0.138	5.502	
	8	8/4/2010 22:59	0.848	0.089		
	9	8/4/2010 23:09	0.629			
	10	8/4/2010 23:19	0.721	0.150		
	11	8/4/2010 23:29	0.610			
	12	8/4/2010 23:39	0.674	0.076	5.970	P: 0.073
	13	8/4/2010 23:49	0.640			
	14	8/5/2010 0:09	0.583	0.129	5.371	
	15	8/5/2010 0:19	0.520			Sampler Disabled

EVENT DATE: 8/16/2010

Field site:	CHS Biofilter	Date of Analysis	8/16/2010			
Who performed analysis?		Cannatelli, Culver, Park				
Detection range for NO_3		0.1-1 ppm	Detection range for PO_4			
NO_3 Blank completed?		Yes	PO_4 Blank completed?			
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?			
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank	Deionized	0.030			
Inlet	1	8/16/2010 15:34	0.240			Nitrate: 0.23
	2	8/16/2010 15:39	0.172			
	3	8/16/2010 15:44	0.18			
	4	8/16/2010 15:49	0.2			
	5	8/16/2010 15:54	0.075			
	6	8/16/2010 15:59	0.143			Sampler Disabled
Outlet	1	8/16/2010 16:59	0.221			
	2	8/16/2010 17:09	0.420			
	3	8/16/2010 17:19	0.480			
	4	8/16/2010 17:29	0.330			
	5	8/16/2010 17:39	0.551			Sampler Disabled

EVENT DATE: 8/18/2010

Field site:	CHS Biofilter	Date of Analysis:	8/18/2010		
Who performed analysis?		Kristen Cannatelli, Jeff Park			
Detection range for NO_3:	.1-1 ppm	Detection range for PO_4:	.3-8 ppm		
NO_3 Blank completed?	yes	PO_4 Blank completed?	yes		
NO_3 Replicate completed?	yes	PO_4 Replicate completed?	yes		

LOCATION	**SAMPLE** NUMBER	**DATE/TIME**	**NUTRIENTS (mg/L)** NO_3-N	PO_4	**SEDIMENTS** TSS (mg/L)	**Comments/ Replicates**
Blank	Blank	Deionized	0.073	0.000		
Inlet	1	8/18/2010 15:19	0.182	0.224	58.205163	
	2	8/18/2010 15:24	0.150	0.125		
	3	8/18/2010 15:29	0.141	0.098		
	4	8/18/2010 15:34	0.123	0.230	27.430509	
	5	8/18/2010 15:39	0.110	0.085		
	6	8/18/2010 15:44	0.083	0.120		
	7	8/18/2010 15:49	0.140	0.139		
	8	8/18/2010 15:54	0.124		38.269227	
	9	8/18/2010 15:59	0.124	0.251		
	10	8/18/2010 16:04	0.116			
	11	8/18/2010 16:09	0.078	0.448		
	12	8/18/2010 16:14	0.110		19.760934	
	13	8/18/2010 16:19	0.105	0.211		
	14	8/18/2010 16:24	0.116			Sampler Disabled
Outlet	1	8/18/2010 17:15	0.190	0.091	2.881	
	2	8/18/2010 17:25	0.202	0.083		
	3	8/18/2010 17:35	0.261	0.127	2.115	
	4	8/18/2010 17:45	0.158	0.008		
	5	8/18/2010 17:55	0.204	0.161	7.091	
	6	8/18/2010 18:05	0.136	0.117		
	7	8/18/2010 18:15	0.263	0.094		
	8	8/18/2010 18:25	0.164	0.140		
	9	8/18/2010 18:35	0.179	0.426	3.7759156	P: 0.388
	10	8/18/2010 18:45	0.139			
	11	8/18/2010 18:55	0.176	0.023	0.4725586	
	12	8/18/2010 19:05	0.155	0.096		
	13	8/18/2010 19:15	0.257	0.109	0.8208617	
	14	8/18/2010 19:25	0.149			
	15	8/18/2010 19:35	0.171	0.151	0.7965556	N:0.171
	16	8/18/2010 19:45	0.170	0.007		N: 0.116
	17	8/18/2010 19:55	0.156	0.091		
	18	8/18/2010 20:05	0.110	0.000		
	19	8/18/2010 20:15	0.148	0.135	4.2183277	
	20	8/18/2010 20:25	0.091	0.014		
	21	8/18/2010 20:35	0.136	0.128	1.0345792	
	22	8/18/2010 20:45	0.147			
	23	8/18/2010 20:55	0.143	0.023	4.5285966	
	24	8/18/2010 21:05	0.134	0.035		Sampler Disabled

EVENT DATE: 8/24/2010

Field site:	CHS Biofilter	Date of Analysis:	8/24/2010			
Who performed analysis?		Michael Downey, Ben Popovich, Jeff Park, Tina Tang				
Detection range for NO_3:		I: 0.2-1.5; O: 0.1-1	Detection range for PO_4:		0.30-8.00	
NO_3 Blank completed?		Yes	PO_4 Blank completed?		Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?		Yes	
LOCATION	**SAMPLE** NUMBER	**DATE/TIME**	**NUTRIENTS (mg/L)** NO_3-N	PO_4	**SEDIMENTS** TSS (mg/L)	**Comments/ Replicates**
Blank	Blank	Deionized	0.076	0.000		
Inlet	1	8/24/2010 2:59	0.280	0.074		P: 0.000 ppm
	2	8/24/2010 3:04	0.308	0.047		N: 0.321
	3	8/24/2010 3:09	0.368	0.175		
	4	8/24/2010 3:14	0.312	0.194		
	5	8/24/2010 3:19	0.382	0.188		
	6	8/24/2010 3:24	0.459	0.280		Sampler Disabled
Outlet	1	8/24/2010 4:56	0.565	0.000		
	2	8/24/2010 5:06		0.050		
	3	8/24/2010 5:16	0.510			
	4	8/24/2010 5:26	0.453	0.000		
	5	8/24/2010 5:36		0.084		
	6	8/24/2010 5:46	0.550	0.042		
	7	8/24/2010 5:56				
	8	8/24/2010 6:06	0.407	0.000		
	9	8/24/2010 6:16		0.051		
	10	8/24/2010 6:26	0.385	0.050		
	11	8/24/2010 6:36				
	12	8/24/2010 6:46	0.439	0.051		
	13	8/24/2010 6:56				
	14	8/24/2010 7:06	0.318	0.009		
	15	8/24/2010 7:16	0.438			
	16	8/24/2010 7:26	0.088	0.071		
	17	8/24/2010 7:36	0.408			
	18	8/24/2010 7:46		0.051		Sampler Disabled

EVENT DATE: 9/26/2010

Field site:	CHS Biofilter	Date of Analysis:	9/28/2010			
Who performed analysis?		Fritz Doster, Adam Branham, Kelly Lauston, Lauren Kaufman, Michael Cartoski				
Detection range for NO_3:		0.10 - 1.00 mg/L	Detection range for PO_4:		0.05 mg/L - 1.5 mg/L	
NO_3 Blank completed?		Yes	PO_4 Blank completed?		Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?		Yes	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank		0.059	-0.017		
Inlet	1	9/26/2010 18:46	0.266	0.202		
	2	9/26/2010 18:58	0.132	0.213	30.600	
	3	9/26/2010 19:58	0.263	0.220		
	4	9/26/2010 20:10	0.220	0.207		
	5	9/26/2010 20:22	0.187	0.291		
	6	9/26/2010 20:34	0.220	0.286		
	7	9/26/2010 20:46	0.214	0.311		
	8	9/26/2010 20:58	0.157	1.985		
	9	9/26/2010 21:10	0.200	0.276		
	10	9/26/2010 21:22	0.130	0.200		
	11	9/26/2010 21:34	0.120	0.248		
	12	9/26/2010 21:46	0.119	0.266		
	13	9/26/2010 21:58	0.206	0.291		
	14	9/26/2010 22:10	0.237	0.266		
	15	9/26/2010 22:22	0.21	0.296	4.300	
	16	9/26/2010 22:34	0.220	0.258		
	17	9/26/2010 22:46	0.190	0.268		
	18	9/26/2010 22:58	0.350	0.268		
	19	9/26/2010 23:10	0.340	0.263		
	20	9/27/2010 4:22	0.353	0.213	4.700	
	21	9/27/2010 4:34	0.206	0.142		
	22	9/27/2010 4:46	0.134	0.147	6.300	
	23	9/27/2010 4:58	0.120	0.144		
	24	9/27/2010 5:10	0.110	0.159		P: 0.002
	25	9/27/2010 10:21	0.175	0.261	4.800	
	26	9/27/2010 10:33	0.182	0.281		
	27	9/27/2010 10:45	0.193	0.263		
	28	9/27/2010 10:57	0.173	0.281		
	29	9/27/2010 11:09	0.191	0.271	2.300	
	30	9/27/2010 11:21	0.188	0.263		
	31	9/27/2010 11:33	0.182	0.261		
	32	9/27/2010 11:45	0.226	0.263	4.400	
	33	9/27/2010 11:57	0.168	0.261		
	34	9/27/2010 12:09	0.156	0.152		
	35	9/27/2010 12:21	0.212	0.256	2.6	
	36	9/27/2010 12:33	0.227	0.288		
	37	9/27/2010 12:45	0.256	0.291		
	38	9/27/2010 12:57	0.199	0.271	1.9	
	39	9/27/2010 13:09	0.253	0.283		
	40	9/27/2010 13:21	0.241	0.278		
	41	9/27/2010 13:33	0.176	0.283		

EVENT DATE: 9/26/2010 CONTINUED

LOCATION	SAMPLE	DATE/TIME	NUTRIENTS (mg/L)		SEDIMENTS	Comments/
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	Replicates
	42	9/27/2010 13:45	0.152	0.238	5.6	
	43	9/27/2010 13:57	0.104	0.245		
	44	9/27/2010 14:09	0.099	0.293		
	45	9/27/2010 14:21	0.102	0.288	6.7	
	46	9/27/2010 14:33	0.124	0.309		
	47	9/27/2010 14:45	0.147	0.301	4.5	Sampler Disabled
	48	9/27/2010 14:57	0.161	0.202		
REPLICATE	48	9/27/2010 14:57	0.163	0.045		
Outlet	1	9/26/2010 21:56	0.28	0.175	12.300	
	2	9/26/2010 22:16	0.84	0.139		
	3	9/26/2010 22:36	1.06	0.142		
	4	9/26/2010 22:56	0.9	0.157	8.600	
	5	9/26/2010 23:16	0.85	0.132		
	6	9/26/2010 23:36	0.84	0.147		
	7	9/26/2010 23:56	0.69	0.134		
	8	9/27/2010 0:16	0.63	0.137	9.200	
	9	9/27/2010 5:56	0.28	0.182		
	10	9/27/2010 6:16	0.3	0.172		
	11	9/27/2010 10:51	0.12	0.261	8.800	
	12	9/27/2010 11:11	0.134	0.245		
	13	9/27/2010 11:31	0.13	0.263		N: 0.12
	14	9/27/2010 11:51	0.12	0.061	7.500	
	15	9/27/2010 12:11	0.12	0.253		
	16	9/27/2010 12:31	0.142	0.268	7.000	
	17	9/27/2010 12:51	0.14	0.266		
	18	9/27/2010 13:11	0.1	0.228	10.300	
	19	9/27/2010 13:31	0.12	0.248		
	20	9/27/2010 13:51	0.12	0.220	6.200	
	21	9/27/2010 14:11	0.12	0.205		
	22	9/27/2010 14:31	0.13	0.190		
	23	9/27/2010 14:51	0.135	0.210	8.400	
	24	9/27/2010 15:11	0.116	0.185		
	25	9/27/2010 15:31	0.128	0.185		
	26	9/27/2010 15:51	0.109	0.185	8.100	
	27	9/27/2010 16:11				
	28	9/27/2010 16:31	0.126	0.243	11.300	
	29	9/27/2010 16:51	0.112	0.233		
	30	9/27/2010 17:11	0.115	0.223		
	31	9/27/2010 17:31	0.109	0.200	7.500	
	32	9/27/2010 17:51	0.116	0.240		
	33	9/27/2010 18:11	0.099	0.230	45.900	
	34	9/27/2010 18:31	0.116	0.228		
	35	9/27/2010 19:08	0.04	0.185	6.650	
	36	9/27/2010 19:28	0.07	0.175		
	37	9/27/2010 19:48	0.032	0.185		
	38	9/27/2010 20:08	0.052	0.175		
	39	9/27/2010 20:28	0.062	0.299		
	40	9/27/2010 20:48	0.04	0.162		Sampler Disabled

EVENT DATE: 9/28/2010

Field site:	CHS Biofilter	Date of Analysis:	9/28/2010			
Who performed analysis?		Logan Whitehouse, Ethan Heil				
Detection range for NO_3:		0.1 - 1.0 ppm	Detection range for PO_4:		0.05 - 1.5 ppm	
NO_3 Blank completed?		Yes	PO_4 Blank completed?		Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?		Yes	
LOCATION	**SAMPLE**	**DATE/TIME**	**NUTRIENTS (mg/L)**		**SEDIMENTS**	**Comments/**
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
Blank	Blank	Deionized	0.01	-0.019		
Inlet	1	9/28/2010 2:13	0.180	0.660	7.1	
	2	9/28/2010 2:25	0.140	0.559		
	3	9/28/2010 2:37	0.07	0.382		
	4	9/28/2010 2:49	0.05	0.331		
	5	9/28/2010 3:01	0.07	0.382		
	6	9/28/2010 3:13	0.040	0.306	173.5	
	7	9/28/2010 3:25	0.050	0.331	25.1	
	8	9/28/2010 3:37	0.040	0.306		
	9	9/28/2010 3:49	0.084	0.417		
	10	9/28/2010 4:01	0.050	0.331		
	11	9/28/2010 4:13	0.060	0.357	2.2	
	12	9/28/2010 4:25	0.068	0.377		
	13	9/28/2010 4:37	0.114	0.493		
	14	9/28/2010 4:49	0.113	0.491		
	15	9/28/2010 5:01	0.159	0.607		
	16	9/28/2010 5:13	0.131	0.536	2.9	
	17	9/28/2010 5:25	0.119	0.506		
	18	9/28/2010 5:37	0.166	0.625		
	19	9/28/2010 5:49	0.224	0.772		Sampler Disabled
	20					
Outlet	1	9/28/2010 3:48	0.050	0.182	8.200	
	2	9/28/2010 4:08	0.003	0.177		
	3	9/28/2010 4:28	0.051	0.078		
	4	9/28/2010 4:48	0.030	0.089		
	5	9/28/2010 5:08	0.050	0.101		
	6	9/28/2010 5:28	0.014	0.172	3.100	
	7	9/28/2010 5:48	0.046	0.187		
	8	9/28/2010 6:08	0.040	0.149		
	9	9/28/2010 6:28	0.020	0.147		
	10	9/28/2010 6:48	0.038	0.147	4.800	
	11	9/28/2010 7:08	0.023	0.175		
	12	9/28/2010 7:28	0.020	0.167		
	13	9/28/2010 7:48	0.040	0.172		
	14	9/28/2010 8:08	0.032	0.164		
	15	9/28/2010 8:28	0.020	0.134	5.20	
	16	9/28/2010 8:48	0.030	0.195		
	17	9/28/2010 9:08	0.032	0.149		
	18	9/28/2010 9:28	0.017	0.197		
	19	9/28/2010 10:24	0.030	0.172		
	20	9/28/2010 10:44			6.9	
	21	9/28/2010 11:24				
	22	9/28/2010 11:44	0.040	0.083		
	23	9/28/2010 12:24			3.9	
	24	9/28/2010 12:44				
	25	9/28/2010 13:03	0.06	0.0936063		Sampler Disabled

EVENT DATE: 9/29/2010

Field site:	CHS Biofilter	Date of Analysis:	7/14/2010			
Who performed analysis?		Teresa Culver				
Detection range for NO_3:			Detection range for PO_4:			
NO_3 Blank completed?			PO_4 Blank completed?			
NO_3 Replicate completed?			PO_4 Replicate completed?			
LOCATION	**SAMPLE** NUMBER	**DATE/TIME**	**NUTRIENTS (mg/L)** NO_3-N	PO_4	**SEDIMENTS** TSS (mg/L)	**Comments/ Replicates**
Inlet	1	9/29/2010 15:02			3.8	
	2	9/29/2010 15:13			3.8	
	3	9/29/2010 15:25			3.8	
	4	9/29/2010 15:37			19.4	
	5	absent sample				
	6	9/29/2010 16:01				
	7	9/29/2010 16:13				
	8	9/29/2010 16:25			8.9	
	9	9/29/2010 16:37				
	10	9/29/2010 16:49			7.5	
	11	9/29/2010 17:01				
	12	9/29/2010 17:13			4.3	
	13	absent sample				
	14	9/29/2010 17:37				
	15	9/29/2010 17:49				
	16	9/29/2010 18:01			3.1	
	17	9/29/2010 18:13				
	18	9/29/2010 18:25				
	19	absent sample				
	20	9/29/2010 18:49			8.1	
	21	absent sample				
	22	absent sample				
	23	9/29/2010 19:37				
	24	9/29/2010 19:49				
	25	9/29/2010 20:24			2	
	26	9/29/2010 20:54				
	27	9/29/2010 21:24				
	28	9/29/2010 21:54			1.8	
	29	9/29/2010 22:24				
	30	9/29/2010 22:54				
	31	9/29/2010 23:24			1	
	32	9/30/2010 0:24				
	33	9/30/2010 0:54				
	34	9/30/2010 1:24			1	
	35	9/30/2010 1:54				
	36	9/30/2010 2:24				
	37	9/30/2010 3:24			3.2	
	38	9/30/2010 3:54				
	39	9/30/2010 4:24				
	40	9/30/2010 4:54			1.1	
	41	9/30/2010 5:24				
	42	9/30/2010 5:54				

EVENT DATE: 9/29/2010 CONTINUED

LOCATION	SAMPLE	DATE/TIME	NUTRIENTS (mg/L)		SEDIMENTS	Comments/
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	**Replicates**
	43	9/30/2010 6:24			0	
	44	9/30/2010 6:54				
	45	9/30/2010 7:24			19.3	
	46	9/30/2010 7:54				
	47	9/30/2010 9:34			1.6	
	48	9/30/2010 10:04				
	49	9/30/2010 10:34				
	50	9/30/2010 11:04			1.2	
	51	9/30/2010 11:34				
	52	9/30/2010 12:04				
	53	9/30/2010 12:34			3.2	
	54	absent sample				
	55	9/30/2010 13:34				
	56	9/30/2010 14:04				
	57	9/30/2010 14:34				
	58	9/30/2010 15:04			3	
	59	9/30/2010 15:34				
	60	9/30/2010 16:04				
	61	absent sample				
	62	9/30/2010 17:04			5.3	
	63	9/30/2010 17:34				
	64	absent sample				
	65	absent sample				
	66	9/30/2010 19:04				
	67	9/30/2010 19:22			4.9	
	68	9/30/2010 19:52				
	69	9/30/2010 20:22			2.6	
	70	9/30/2010 20:52				
	71	9/30/2010 21:22				
	72	9/30/2010 21:52				
	73	9/30/2010 22:22			2.7	
	74	9/30/2010 22:52				
	75	9/30/2010 23:22			1.9	
	76	9/30/2010 23:52				
	77	10/1/2010 0:22				
	78	10/1/2010 0:52				
	79	10/1/2010 1:22			1	
	80	10/1/2010 1:52				
	81	10/1/2010 2:22				
	82	10/1/2010 2:52				
	83	10/1/2010 3:22				
	84	10/1/2010 3:52				
	85	10/1/2010 4:22				Sampler Disabled

EVENT DATE: 9/29/2010 CONTINUED

LOCATION	SAMPLE	DATE/TIME	NUTRIENTS (mg/L)		SEDIMENTS	Comments/
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	Replicates
Outlet	1	9/30/2010 2:18			2.041	
	2	9/30/2010 2:38				
	3	9/30/2010 2:58				
	4	9/30/2010 3:18				
	5	9/30/2010 3:38			2.462	
	6	9/30/2010 3:58				
	7	9/30/2010 4:18				
	8	9/30/2010 4:38				
	9	9/30/2010 4:58			1.834	
	10	9/30/2010 5:18				
	11	9/30/2010 5:38				
	12	9/30/2010 5:58				
	13	9/30/2010 6:18			1.833	
	14	9/30/2010 6:38				
	15	9/30/2010 6:58				
	16	9/30/2010 7:18				
	17	9/30/2010 7:38			5.501	
	18	9/30/2010 7:58				
	19	9/30/2010 8:18				
	20	9/30/2010 8:38				
	21	9/30/2010 8:58			5.621	
	22	9/30/2010 9:18				
	23	9/30/2010 9:38				
	24	9/30/2010 10:15			268.646	
	25	9/30/2010 10:35				
	26	9/30/2010 10:55				
	27	9/30/2010 11:15				
	28					
	29	9/30/2010 11:55			2.336	
	30	9/30/2010 12:15				
	31	9/30/2010 12:35				
	32	9/30/2010 12:55				
	33	9/30/2010 13:15			3.042	
	34	9/30/2010 13:35				
	35	9/30/2010 13:55				
	36	9/30/2010 14:15				
	37	9/30/2010 14:35			2.463	
	38	9/30/2010 14:55				
	39	9/30/2010 15:15				
	40	9/30/2010 15:35				
	41	9/30/2010 15:55			2.854	
	42	9/30/2010 16:15				
	43	9/30/2010 16:35				
	44	9/30/2010 16:55				
	45	9/30/2010 17:15				
	46	9/30/2010 17:35				
	47	9/30/2010 19:59			2.55	
	48	9/30/2010 20:19				

EVENT DATE: 9/29/2010 CONTINUED

LOCATION	SAMPLE	DATE/TIME	NUTRIENTS (mg/L)		SEDIMENTS	Comments/
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	Replicates
	49	9/30/2010 20:39				
	50	9/30/2010 20:59				
	51	9/30/2010 21:19			1.72	
	52	9/30/2010 21:39				
	53	9/30/2010 21:59				
	54	9/30/2010 22:19				
	55	9/30/2010 22:39			2.11	
	56	9/30/2010 22:59				
	57	9/30/2010 23:19				
	58	9/30/2010 23:39				
	59	9/30/2010 23:59			2.37	
	60	10/1/2010 0:19				
	61	10/1/2010 0:39				
	62	10/1/2010 0:59				
	63	10/1/2010 1:19			2.43	
	64	10/1/2010 1:39				
	65	10/1/2010 1:59				
	66	10/1/2010 2:19				
	67	10/1/2010 2:39			2.69	
	68	10/1/2010 2:59				
	69	10/1/2010 3:19				
	70	10/1/2010 3:39				Sampler Disabled

EVENT DATE: 11/16/2010

Field site:	CHS Biofilter	Date of Analysis:	11/16-19/2010		
Who performed analysis?		Michael Downey, Michael Boone, Tina Tang			
Detection range for NO_3:		0.1 - 1.0 ppm	Detection range for PO_4:	0.05 - 1.5 ppm	
NO_3 Blank completed?		Yes	PO_4 Blank completed?	Yes	
NO_3 Replicate completed?		Yes	PO_4 Replicate completed?	Yes	

LOCATION	**SAMPLE** NUMBER	**DATE/TIME**	**NUTRIENTS (mg/L)** NO_3-N	PO_4	**SEDIMENTS** TSS (mg/L)	**Comments/ Replicates**
Blank	Blank	Deionized	0.032	-0.003		
Inlet	1	11/16/2010 7:05	0.280	0.067	3.79	
	2	11/16/2010 7:48	0.200	0.067	40.51	
	3	11/16/2010 7:58	0.16	0.073	5.88	
	4	11/16/2010 8:23	0.167	0.079	3.23	
	5	11/16/2010 8:37	0.1735	0.070	3.56	
	6	11/16/2010 8:45	0.180	0.061	0.63	
	7	11/16/2010 8:57	0.170	0.059	13.64	
	8	11/16/2010 9:03	0.143	0.057	25.09	
	9	11/16/2010 9:13	0.139	0.063	6.40	
	10	11/16/2010 9:35	0.207	0.068	0.56	
	11	11/16/2010 9:56	0.204	0.073	14.27	
	12	11/16/2010 10:14	0.190	0.078	8.57	
	13	11/16/2010 11:00	0.170	0.073	4.15	
	14	11/16/2010 11:48	0.272	0.069	7.75	
	15	11/16/2010 11:57	0.286	0.067	14.94	
	16	11/16/2010 12:03	0.154	0.064	84.14	
	17	11/16/2010 12:07	0.159	0.070	169.10	
	18	11/16/2010 12:10	0.140	0.076	123.63	
	19	11/16/2010 12:14	0.130		67.16	
	20	11/16/2010 15:08	0.116	0.044	0.88	
	21	11/16/2010 15:27	0.128		5.55	
	22	11/16/2010 15:50	0.14	0.036	4.11	
	23	11/16/2010 16:08	0.170	0.041	2.67	
	24	11/16/2010 18:16	0.2	0.046	2.13	
	25	11/16/2010 18:29	0.241	0.054	1.82	
	26	11/16/2010 18:50	0.281	0.062	5.61	
	27	11/16/2010 19:13	0.266	0.054	4.15	
	28	11/16/2010 19:29	0.251	0.046		
	29	11/16/2010 19:34	0.221	0.046	2.95	
	30	11/16/2010 19:53	0.190	0.046	74.86	
	31	11/16/2010 19:57	0.175	0.042	33.90	
	32	11/16/2010 20:06	0.160	0.038	25.91	
	33	11/16/2010 20:48	0.152	0.040	2.47	
	34	11/16/2010 23:41	0.144	0.043	230.65	
	35	11/16/2010 23:45	0.146	0.047	27.27	
	36	11/16/2010 23:48	0.148	0.051	15.34	P: 0.016 ppm
	37	11/16/2010 23:52	0.164	0.057	3.32	
	38	11/17/2010 0:00	0.180	0.063	4.81	
	39	11/17/2010 0:16	0.145	0.059	4.35	
	40	11/17/2010 0:27	0.110	0.054	2.21	
	41	11/17/2010 0:40	0.061	0.054	1.87	
	42	11/17/2010 0:57	0.011	0.054		

EVENT DATE: 11/16/2010 CONTINUED

LOCATION	SAMPLE	DATE/TIME	NUTRIENTS (mg/L)		SEDIMENTS	Comments/
	NUMBER		NO_3-N	PO_4	TSS (mg/L)	Replicates
Outlet	1	11/16/2010 10:51	0.180	0.002	1.822	
	2	11/16/2010 11:12	0.179	0.002	4.961	
	3	11/16/2010 11:32	0.11	0.004	6.132	
	4	11/16/2010 11:51	0.15	0.081	4.516	
	5	11/16/2010 12:09	0.208	0.085	1.580	
	6	11/16/2010 12:25	0.150	0.083	1.787	
	7	11/16/2010 12:37	0.110	0.084	2.318	
	8	11/16/2010 12:49	0.160	0.080	15.685	
	9	11/16/2010 12:56	0.190	0.074	1.391	
	10	11/16/2010 13:01	0.130	0.073	2.264	N: 0.145 ppm
	11	11/16/2010 13:05	0.165	0.098	5.445	
	12	11/16/2010 13:09	0.162	0.104	1.457	
	13	11/16/2010 13:13	0.166	0.093		
	14	11/16/2010 13:16	0.211	0.068	4.385	
	15	11/16/2010 13:19	0.142	0.051	2.637	
	16	11/16/2010 13:23	0.160	0.062	1.998	
	17	11/16/2010 13:27	0.110	0.061	4.378	
	18	11/16/2010 13:31	0.133	0.078	4.279	
	19	11/16/2010 13:35	0.141	0.081	3.617	
	20	11/16/2010 13:39	0.138	0.082	4.439	
	21	11/16/2010 15:24	0.132	0.054	3.259	
	22	11/16/2010 15:42	0.121	0.023	4.004	
	23	11/16/2010 16:00	0.11	0.048	1.471	
	24	11/16/2010 16:16	0.100	0.000	3.875	
	25	11/16/2010 16:35	0.090	0.000	0.543	
	26	11/16/2010 16:57	0.067	0.000	0.195	N: .064 ppm
	27	11/16/2010 17:21	0.043	0.049	2.029	
	28	11/16/2010 17:46	0.071	0.028	1.115	
	29	11/16/2010 18:13	0.099	0.058	1.796	
	30	11/16/2010 18:40	0.085	0.037	3.242	
	31	11/16/2010 19:06	0.070	0.058	1.963	
	32	11/16/2010 19:31	0.094	0.028	2.617	
	33	11/16/2010 19:53	0.118	0.049	2.734	
	34	11/16/2010 20:10	0.119	0.034	1.118	
	35	11/16/2010 20:25	0.120	0.064	1.843	
	36	11/16/2010 20:42	0.111	0.047	1.291	
	37	11/16/2010 21:01	0.101	0.062	2.525	
	38	11/16/2010 21:22	0.096	0.026	7.985	
	39	11/16/2010 21:45	0.090	0.043	1.546	
	40	11/16/2010 22:08	0.097	0.013	1.711	
	41	11/16/2010 22:34	0.104	0.049	1.299	
	42	11/16/2010 23:01	0.102	0.024	1.090	
	43	11/16/2010 23:28	0.100	0.054	2.648	
	44	11/16/2010 23:56		0.079	1.318	

Appendix C - Load Calculations

For sample measurements occurring in intervals greater than those found in the "Sample Date and Time" column, representative (Rep.) volumes are combined and assigned to either the preceding or proceeding sample, pro-rata, for use in calculating the load.

EVENT DATE: 7/10/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	Mass N (mg)	Mass PO_4 (mg)
7/10/2010 6:39	6,940.172	0.130	0.383	902.222	2,658.086
7/10/2010 6:44	3,643.357	0.139	0.334	506.427	1,216.881
7/10/2010 6:49	5,153.365	0.124	0.293	639.017	1,509.936
7/10/2010 6:54	5,153.365	0.112	0.357	577.177	1,839.751
7/10/2010 6:59	4,393.099	0.148	0.396	650.179	1,739.667
7/10/2010 7:04	2,619.145	0.139	0.387	364.061	1,013.609
7/10/2010 7:09	2,619.145	0.133	0.403	347.037	1,054.206
7/10/2010 7:14	2,507.673	0.126	0.418	315.967	1,048.207
7/10/2010 7:19	2,247.569	0.127	0.375	285.441	841.715
7/10/2010 7:24	2,247.569	0.128	0.331	287.689	743.945
7/10/2010 7:29	1,930.918	0.138	0.348	265.501	671.959
7/10/2010 7:34	1,192.064	0.147	0.365	175.233	435.103
7/10/2010 7:39	1,192.064	0.165	0.377	196.095	448.812
7/10/2010 7:44	927.594	0.182	0.388	168.822	359.907
7/10/2010 7:49	310.498	0.173	0.400	53.716	124.044
7/10/2010 7:54	527.847	0.164	0.411	86.567	216.945
Total:	43,605.448			5,821.151	15,922.776
EMC:				0.133	0.365

EVENT DATE: 7/12/2010

Sample Date and Time	Rep Vol (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	Mass N (mg)	Mass PO_4 (mg)	TSS (mg/L)	Sediment Mass (g)
7/12/2010 13:46	239.87	0.23	0.38	56.13	91.39	16.98	7.16
7/12/2010 13:51	258.27	0.21	0.39	53.98	100.72	14.19	11.15
7/12/2010 13:56	1,193.22	0.20	0.38	235.06	455.81	11.00	84.71
7/12/2010 14:01	1,193.22	0.24	0.29	282.79	342.45	11.38	42.74
7/12/2010 14:06	1,222.73	0.19	0.39	237.21	476.86		
7/12/2010 14:11	1,340.76	0.17	0.36	223.91	486.69		
7/12/2010 14:16	1,340.76	0.18	0.27	246.70	360.66		
7/12/2010 14:21	1,227.75	0.17	0.23	208.72	282.38	8.54	47.29
7/12/2010 14:26	775.73	0.18	0.33	138.08	255.60		
7/12/2010 14:31	775.73	0.19	0.43	144.28	332.79		
7/12/2010 14:36	753.37	0.18	0.39	132.97	297.21		
7/12/2010 14:41	663.96	0.17	0.36	110.88	239.03		
7/12/2010 14:46	663.96	0.19	0.44	125.16	293.14	6.22	10.42
7/12/2010 14:51	611.13	0.21	0.52	128.34	319.62		
7/12/2010 14:56	399.80	0.18	0.23	70.56	93.15		
7/12/2010 15:01	399.80	0.14	0.29	57.17	115.94	4.75	3.73
7/12/2010 15:06	385.41	0.15	0.33	56.85	128.92		
7/12/2010 15:11	327.87	0.15	0.38	49.84	124.26	6.74	5.37
7/12/2010 15:16	327.87	0.17	0.39	54.75	127.21		
7/12/2010 15:21	283.06	0.18	0.38	50.01	107.14		
7/12/2010 15:26	103.80	0.19	0.37	19.34	38.30	6.13	2.14
7/12/2010 15:31	103.80	0.20	0.36	20.34	37.31		
7/12/2010 15:36	119.41	0.23	0.44	27.70	52.39	16.01	4.82
7/12/2010 15:41	181.87	0.27	0.52	48.74	94.21		
7/12/2010 15:46	181.87	0.23	0.38	42.56	69.29		
7/12/2010 15:51	527.46	0.21	0.39	110.24	205.71		
7/12/2010 15:56	6,505.48	0.20	0.38	1,281.58	2,485.09		
7/12/2010 16:45	5,155.53	0.19	0.43	995.02	2,191.10	6.70	39.19
7/12/2010 16:50	692.92	0.19	0.40	131.65	275.44		
7/12/2010 16:55	860.67	0.19	0.37	160.95	318.45	6.93	17.89
7/12/2010 17:00	860.67	0.22	0.36	192.79	307.69		
7/12/2010 17:05	860.67	0.26	0.35	224.63	296.93		
7/12/2010 17:10	514.38	0.26	0.34	131.68	174.38	2.06	3.18
7/12/2010 17:15	514.38	0.25	0.33	129.11	171.29		
7/12/2010 17:20	514.38	0.29	0.33	148.66	170.77		
7/12/2010 17:25	343.22	0.33	0.33	112.23	113.61	2.82	2.90
7/12/2010 17:30	343.22	0.33	0.32	113.26	109.66		
7/12/2010 17:35	343.22	0.31	0.31	106.74	105.71		
7/12/2010 17:40	252.73	0.32	0.34	80.87	85.80	4.32	4.20
7/12/2010 17:45	720.61	0.33	0.37	237.08	267.35		
Total:	34,084.54			6,978.58	12,601.47		286.90
EMC:				0.18	0.33		8.42

EVENT DATE: 7/14/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Inlet:							
7/13/2010 22:17	197.496	0.188	0.095	24.485	37.977	18.762	170.555
7/13/2010 22:22	1,139.208	0.187	0.124		213.032	141.262	
7/13/2010 22:27	2,814.548	0.167	0.144		470.030	405.295	
7/13/2010 22:32	2,814.548	0.190	0.112		534.764	315.229	
7/13/2010 22:37	3,760.826	0.179	0.102	12.429	673.188	383.604	107.983
7/13/2010 22:42	5,180.242	0.185	0.120		1,437.517	621.629	
7/13/2010 22:47	5,180.242		0.128	24.007		663.071	208.567
7/13/2010 22:52	3,891.139	0.236	0.141		2,046.711	685.421	
7/13/2010 22:57	4,382.485		0.190	33.617		832.672	292.061
7/13/2010 23:02	4,382.485	0.310	0.219		2,509.499	959.764	
7/13/2010 23:07	3,042.858		0.000	49.777		0.000	273.963
7/13/2010 23:12	1,033.417	0.287	0.243		881.536	251.120	
7/13/2010 23:17	1,033.417		0.218			225.285	
7/13/2010 23:22	788.320	0.393	0.190		595.538	149.781	
7/13/2010 23:27	420.673		0.173			72.776	
7/13/2010 23:32	420.673	0.534	0.000	148.000	438.513	0.000	286.487
7/13/2010 23:37	380.351		0.117			44.501	
7/13/2010 23:42	319.867	0.641	0.156		1,151.772	49.899	
7/13/2010 23:47	319.867		0.163	39.100		52.138	50.313
7/13/2010 23:52	278.947		0.161			44.910	
7/13/2010 23:57	687.980		0.167			114.893	
Outlet:							
7/14/2010 0:50	128.723	0.168	0.073	6.284	21.625	9.397	2.192
7/14/2010 1:00	220.084	0.210	0.088		46.218	19.367	
7/14/2010 1:10	266.673	0.217	0.085	7.317	57.868	22.667	4.045
7/14/2010 1:20	286.139	0.217	0.076		62.092	21.747	
7/14/2010 1:30	297.950	0.210	0.086	2.088	62.569	25.624	1.211
7/14/2010 1:40	281.739	0.222	0.085		62.546	23.948	
7/14/2010 1:50	271.925	0.205	0.061	1.644	55.745	16.587	0.872
7/14/2010 2:00	258.695	0.198	0.060		51.222	15.522	
7/14/2010 2:10	243.052	0.169	0.060	0.000	41.076	14.583	0.000
7/14/2010 2:20	233.541	0.174	0.069		40.636	16.114	
7/14/2010 2:30	220.652	0.167	0.101		148.984	22.286	
7/14/2010 2:40	205.974		0.047	13.263		9.681	11.858
7/14/2010 2:50	895.180		0.052			46.549	
Total Inlet:	Nutrients: 42469.6; TSS: 41,755.9				10,990.077	6,032.014	1,389.929
Total Outlet:	NO_3: 3,380.6; PO_4: 3,810.3; TSS: 3,603.2				650.581	264.072	20.178
EMC Inlet:					0.259	0.139	33.287
EMC Outlet:					0.192	0.069	5.600

EVENT DATE: 7/20/2010

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Sediment mass (g)
1/1/04 17:45	1,199.976	182.837	219.400
1/1/04 17:50	2,399.951	49.961	80.935
1/1/04 17:55	2,399.951	149.259	241.794
1/1/04 18:00	1,349.973	41.683	56.270
1/1/04 18:05	749.985	34.457	25.843
Total:	8,099.835		624.242
EMC:			95.452

EVENT DATE: 7/31/2010

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Sediment mass (g)
7/31/2010 22:25			
7/31/2010 22:30	3,600.000	14.656	39.572
7/31/2010 22:35			
7/31/2010 22:40	2,700.000	18.980	51.246
7/31/2010 22:45			
7/31/2010 22:50			
7/31/2010 22:55	6,000.000	7.581	20.469
7/31/2010 23:00			
7/31/2010 23:05	1,200.000	8.249	9.899
Total:	13,500.000		121.187
EMC:			13.031

EVENT DATE: 8/4/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Sediment mass (g)
Inlet:							
8/4/2010 20:18	3,494.779	0.137	0.141	55.891	478.785	492.764	195.327
8/4/2010 20:23	5,844.767	0.114	0.138	57.865	514.900	623.300	261.355
8/4/2010 20:28	5,841.777	0.170	0.336	15.063	767.833	1,517.600	68.033
8/4/2010 20:33	4,252.131	0.143	0.121	8.744	608.055	514.508	37.181
8/4/2010 20:38	2,019.816	0.221	0.228	6.686	446.379	460.518	13.504
8/4/2010 20:43	746.286	0.184	0.192	4.078	137.317	143.287	3.043
8/4/2010 20:48	383.776	0.183	0.224	5.604	70.231	85.966	2.151
Outlet:							
8/4/2010 21:49	146.654	0.909	0.124	4.357	133.309	18.185	0.200
8/4/2010 21:54	195.683	0.898	0.154		175.723	30.135	
8/4/2010 21:59	239.230	0.887	0.184		212.197	44.018	
8/4/2010 21:04	258.941	0.910	0.092		235.636	23.823	
8/4/2010 22:09	261.122	0.933	0.000		243.626	0.000	
8/4/2010 22:14	257.094	0.938	0.023		241.025	5.785	
8/4/2010 22:19	247.963	0.942	0.045	6.085	233.582	11.158	0.200
8/4/2010 22:24	239.287	0.824	0.078		197.053	18.664	
8/4/2010 22:29	228.378	0.705	0.111		161.006	25.350	
8/4/2010 22:34	216.934	0.803	0.144		174.090	31.239	
8/4/2010 22:39	210.352	0.900	0.177		189.316	37.232	
8/4/2010 22:44	205.173	0.787	0.158		161.471	32.315	
8/4/2010 22:49	197.954	0.674	0.138	5.502	133.421	27.318	0.200
8/4/2010 22:54	183.415	0.761	0.114		139.578	20.818	
8/4/2010 22:59	177.577	0.848	0.089		150.586	15.804	
8/4/2010 22:04	168.390	0.739	0.104		124.356	17.555	
8/4/2010 23:09	156.004	0.629	0.120		98.127	18.643	
8/4/2010 23:14	146.340	0.675	0.135		98.780	19.719	
8/4/2010 23:19	140.643	0.721	0.150		101.404	21.096	
8/4/2010 23:24	132.440	0.666	0.131		88.139	17.383	
8/4/2010 23:29	122.140	0.610	0.113		74.505	13.741	
8/4/2010 23:34	117.957	0.642	0.094		75.729	11.058	
8/4/2010 23:39	106.646	0.674	0.075	5.970	71.880	7.998	0.153
8/4/2010 23:44	99.375	0.657	0.089		65.289	8.795	
8/4/2010 23:49	93.825	0.640	0.089		60.048	8.304	
8/4/2010 23:54	85.880	0.626	0.102		53.739	8.760	
8/4/2010 23:59	77.749	0.612	0.116		47.543	8.980	
8/4/2010 23:04	68.164	0.597	0.116		40.711	7.873	
8/5/2010 0:09	62.717	0.583	0.129	5.371	36.564	8.090	0.054
8/5/2010 0:14	53.208	0.552	0.129		29.344	6.864	
8/5/2010 0:19	158.995	0.520	0.129		82.677	20.510	
Total Inlet:	22,583.333				3,023.500	3,837.943	580.593
Total Outlet:	Nutrients: 5056.2; TSS: 4,080.4				3,930.457	547.213	0.807
EMC Inlet:					0.152	0.193	29.131
EMC Outlet:					0.777	0.108	5.442

EVENT DATE: 8/16/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Mass N (mg)
Inlet:			
8/16/10 15:34	947.140	0.240	227.314
8/16/10 15:39	3,490.271	0.172	600.327
8/16/10 15:44	3,483.129	0.180	626.963
8/16/10 15:49	3,428.478	0.200	685.696
8/16/10 15:54	1,572.767	0.075	117.958
8/16/10 15:59	804.574	0.143	115.054
Outlet:			
8/16/2010 16:59	222.103	0.221	49.085
8/16/2010 17:09	234.877	0.420	98.648
8/16/2010 17:19	198.638	0.480	95.346
8/16/2010 17:29	160.026	0.330	52.809
8/16/2010 17:39	240.202	0.551	132.351
Total Inlet:	13,726.359		2,373.311
Total Outlet:	1,055.846		428.239
EMC Inlet:			0.173
EMC Outlet:			0.406

EVENT DATE: 8/18/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Inlet:							
8/18/2010 15:19	1,872.66	0.18	0.22	58.21	340.82	419.48	395.39
8/18/2010 15:24	5,186.65	0.15	0.13		778.00	648.33	
8/18/2010 15:29	5,898.12	0.14	0.10		831.64	578.02	
8/18/2010 15:34	5,771.21	0.12	0.23	27.43	709.86	1,327.38	186.34
8/18/2010 15:39	4,423.49	0.11	0.09		486.58	376.00	
8/18/2010 15:44	818.90	0.08	0.12		67.97	98.27	
8/18/2010 15:49	815.70	0.14	0.14		114.20	113.38	
8/18/2010 15:54	1,631.71	0.12	0.20	38.27	202.33	318.18	259.97
8/18/2010 15:59	2,838.03	0.12	0.25		351.92	712.34	
8/18/2010 16:04	2,352.81	0.12	0.35		272.93	822.31	
8/18/2010 16:09	1,257.72	0.08	0.45		98.10	563.46	
8/18/2010 16:14	587.00	0.11	0.33	19.76	64.57	193.42	21.71
8/18/2010 16:19	284.86	0.11	0.21		29.91	60.11	
8/18/2010 16:24	226.56	0.12	0.21		26.28	47.80	
Outlet:							
8/18/2010 17:15	46.75	0.19	0.09	2.88	8.88	4.25	1,485.10
8/18/2010 17:20	118.20	0.20	0.09		23.17	10.28	
8/18/2010 17:25	163.19	0.20	0.08		32.96	13.54	
8/18/2010 17:30	187.32	0.23	0.11		43.36	19.67	
8/18/2010 17:35	200.95	0.26	0.13	2.11	52.45	25.52	1,803.79
8/18/2010 17:40	213.52	0.21	0.14		44.73	28.93	
8/18/2010 17:45	219.99	0.16	0.14		34.76	31.68	
8/18/2010 17:50	218.49	0.18	0.15		39.55	33.32	
8/18/2010 17:55	214.50	0.20	0.16	7.09	43.76	34.53	8,796.69
8/18/2010 18:00	210.60	0.17	0.14		35.80	29.27	
8/18/2010 18:05	208.86	0.14	0.12		28.40	24.44	
8/18/2010 18:10	205.49	0.20	0.11		41.00	21.68	
8/18/2010 18:15	199.55	0.26	0.09		52.48	18.76	
8/18/2010 18:20	201.57	0.21	0.12		43.04	23.58	
8/18/2010 18:25	192.32	0.16	0.14		31.54	26.92	
8/18/2010 18:30	191.01	0.17	0.28		32.76	54.06	
8/18/2010 18:35	186.87	0.18	0.43	3.78	33.45	79.61	4,208.26
8/18/2010 18:40	185.01	0.16	0.33		29.42	60.18	
8/18/2010 18:45	179.75	0.14	0.22		24.99	40.35	
8/18/2010 18:50	179.54	0.16	0.12		28.28	22.22	
8/18/2010 18:55	171.35	0.18	0.02	0.47	30.16	3.94	316.54
8/18/2010 19:00	169.78	0.20	0.06		33.28	10.10	
8/18/2010 19:05	165.55	0.16	0.10		25.66	15.89	
8/18/2010 19:10	163.17	0.20	0.10		31.98	16.72	

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
8/18/2010 19:15	157.06	0.26	0.11	0.82	40.36	17.12	506.18
8/18/2010 19:20	155.92	0.20	0.12		31.65	18.63	
8/18/2010 19:25	153.38	0.15	0.13		22.85	19.94	
8/18/2010 19:30	150.28	0.16	0.14		24.04	21.11	
8/18/2010 19:35	146.00	0.17	0.15	0.80	24.97	22.05	669.92
8/18/2010 19:40	146.46	0.20	0.14		28.71	19.92	
8/18/2010 19:45	141.52	0.17	0.12		24.06	17.12	
8/18/2010 19:50	138.05	0.20	0.11		27.06	14.63	
8/18/2010 19:55	134.89	0.16	0.09		21.04	12.28	
8/18/2010 20:00	134.10	0.20	0.10		26.28	13.68	
8/18/2010 20:05	132.39	0.11	0.11		14.56	14.96	
8/18/2010 20:10	131.09	0.20	0.12		25.69	16.26	
8/18/2010 20:15	127.57	0.15	0.14	4.22	18.88	17.22	3,183.24
8/18/2010 20:20	122.25	0.20	0.13		23.96	16.29	
8/18/2010 20:25	122.19	0.09	0.13		11.12	16.07	
8/18/2010 20:30	119.13	0.20	0.13		23.35	15.46	
8/18/2010 20:35	113.28	0.14	0.13	1.03	15.41	14.50	443.54
8/18/2010 20:40	106.46	0.14	0.10		15.06	10.83	
8/18/2010 20:45	104.91	0.15	0.08		15.42	7.92	
8/18/2010 20:50	104.06	0.15	0.05		15.09	5.13	
8/18/2010 20:55	101.66	0.14	0.02	4.53	14.54	2.34	5,720.06
8/18/2010 21:00	98.29	0.20	0.03		19.26	2.85	
8/18/2010 21:05	1,063.15	0.13	0.04		142.46	37.21	
Total Inlet:	Nutrients: 33,965.4; TSS: 21,477.666				276.99	192.34	863.40
Total Outlet:	8,297.43				1,451.69	1,002.97	27,133.33
EMC Inlet:					0.129	0.185	40.20
EMC Outlet:					0.17	0.12	3.27

EVENT DATE: 8/24/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	Mass N (mg)	Mass PO_4 (mg)
Inlet:					
8/24/2010 2:59	2,024.347	0.280	0.074	566.817	149.802
8/24/2010 3:04	4,354.588	0.308	0.047	1,341.213	204.666
8/24/2010 3:09	4,348.126	0.368	0.175	1,600.110	760.922
8/24/2010 3:14	4,347.649	0.312	0.194	1,356.467	843.444
8/24/2010 3:19	2,183.922	0.382	0.188	834.258	410.577
8/24/2010 3:24	1,992.016	0.459	0.280	914.335	557.765
Outlet:					
8/24/2010 4:56	277.974	0.565	0.000	267.496	0.000
8/24/2010 5:06	390.938		0.050		30.271
8/24/2010 5:16	428.955	0.366		228.227	
8/24/2010 5:26	417.207	0.453	0.000	280.656	0.000
8/24/2010 5:36	404.683		0.084		33.993
8/24/2010 5:46	385.024	0.550	0.042	423.576	23.847
8/24/2010 5:56	365.544				
8/24/2010 6:06	348.661	0.407	0.000	284.020	0.000
8/24/2010 6:16	332.808		0.051		16.973
8/24/2010 6:26	319.848	0.385	0.050	244.870	23.481
8/24/2010 6:36	299.545				
8/24/2010 6:46	276.322	0.439	0.051	245.150	28.480
8/24/2010 6:56	264.668				
8/24/2010 7:06	251.348	0.318	0.009	122.011	4.487
8/24/2010 7:16	229.648	0.438		100.586	
8/24/2010 7:26	215.331	0.088	0.071	18.949	30.464
8/24/2010 7:36	197.833	0.408		377.754	
8/24/2010 7:46	728.035		0.051		42.175
Total Inlet:	5,128.365			6,613.201	2,927.175
Total Outlet:	6,134.374			2,593.293	234.171
EMC Inlet:				0.344	0.152
EMC Outlet:				0.423	0.038

EVENT DATE: 9/26/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Inlet:							
9/26/2010 18:46	6,151.571	0.266	0.202		1,636.318	1,245.029	
9/26/2010 18:58	1,328.687	0.132	0.213	30.600	175.387	282.361	1,063.337
9/26/2010 19:58	2,268.552	0.263	0.220		596.629	499.311	
9/26/2010 20:10	7,144.532	0.220	0.207		1,571.797	1,482.146	
9/26/2010 20:22	6,403.255	0.187	0.291		1,197.409	1,862.953	
9/26/2010 20:34	3,495.792	0.220	0.286		769.074	999.372	
9/26/2010 20:46	1,923.101	0.214	0.311		411.544	598.426	
9/26/2010 20:58	1,590.006	0.157	1.985		249.631	3,156.365	
9/26/2010 21:10	1,601.848	0.200	0.276		320.370	441.724	
9/26/2010 21:22	9,495.996	0.130	0.200		1,234.479	1,897.890	
9/26/2010 21:34	7,473.210	0.120	0.248		896.785	1,852.834	
9/26/2010 21:46	2,009.728	0.119	0.266		239.158	533.863	
9/26/2010 21:58	808.148	0.206	0.291		166.478	235.121	
9/26/2010 22:10	489.830	0.237	0.266		116.090	130.118	
9/26/2010 22:22	333.576	0.210	0.296	4.300	70.051	98.738	72.007
9/26/2010 22:34	264.771	0.220	0.258		58.250	68.324	
9/26/2010 22:46	228.298	0.190	0.268		43.377	61.223	
9/26/2010 22:58	197.428	0.350	0.268		69.100	52.944	
9/26/2010 23:10	1,111.236	0.340	0.263		377.820	292.377	
9/27/2010 4:22	953.104	0.353	0.213	4.700	336.446	202.546	33.828
9/27/2010 4:34	6,638.994	0.206	0.142		1,367.633	940.575	
9/27/2010 4:46	9,710.271	0.134	0.147	6.300	1,301.176	1,424.829	222.855
9/27/2010 4:58	10,755.917	0.120	0.144		1,290.710	1,551.049	
9/27/2010 5:10	37,327.697	0.110	0.159		4,106.047	5,949.426	
9/27/2010 10:21	12,067.305	0.175	0.261	4.800	2,111.778	3,144.495	62.433
9/27/2010 10:33	751.461	0.182	0.281		136.766	211.024	
9/27/2010 10:45	616.530	0.193	0.263		118.990	162.215	
9/27/2010 10:57	569.992	0.173	0.281		98.609	160.065	
9/27/2010 11:09	536.838	0.191	0.271	2.300	102.536	145.322	4.155
9/27/2010 11:21	541.039	0.188	0.263		101.715	142.353	
9/27/2010 11:33	542.783	0.182	0.261		98.786	141.438	
9/27/2010 11:45	446.016	0.226	0.263	4.400	100.800	117.351	4.507
9/27/2010 11:57	345.457	0.168	0.261		58.037	90.019	
9/27/2010 12:09	289.014	0.156	0.152		45.086	43.871	
9/27/2010 12:21	260.211	0.212	0.256	2.600	55.165	66.489	1.812
9/27/2010 12:33	249.705	0.227	0.288		56.683	72.017	
9/27/2010 12:45	225.090	0.256	0.291		57.623	65.487	
9/27/2010 12:57	206.941	0.199	0.271	1.900	41.181	56.019	1.834
9/27/2010 13:09	190.185	0.253	0.283		48.117	53.889	
9/27/2010 13:21	182.177	0.241	0.278		43.905	50.698	
9/27/2010 13:33	439.028	0.176	0.283		77.269	124.398	
9/27/2010 13:45	2,252.496	0.152	0.238	5.600	342.379	535.667	111.017
9/27/2010 13:57	10,384.102	0.104	0.245		1,079.947	2,548.262	

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
9/27/2010 14:09	8,275.011	0.099	0.293		819.226	2,428.454	
9/27/2010 14:21	2,486.295	0.102	0.288	6.700	253.602	717.069	21.956
9/27/2010 14:33	970.508	0.124	0.309		120.343	299.545	
9/27/2010 14:45	1,031.890	0.147	0.301	4.500	151.688	310.659	61.155
9/27/2010 14:57	13,303.463	0.161	0.202		2,141.858	2,692.515	
Outlet:							
9/26/2010 21:56	485.157	0.280	0.175	12.300	135.844	84.691	41.342
9/26/2010 22:16	1,463.264	0.840	0.139		1,229.142	203.605	0.000
9/26/2010 22:36	1,454.749	1.060	0.142		1,542.034	206.101	0.000
9/26/2010 22:56	1,213.315	0.900	0.157	8.600	1,091.984	190.313	28.489
9/26/2010 23:16	953.884	0.850	0.132		810.801	125.488	0.000
9/26/2010 23:36	714.913	0.840	0.147		600.527	104.902	0.000
9/26/2010 23:56	472.026	0.690	0.134		325.698	63.291	0.000
9/27/2010 0:16	517.420	0.630	0.137	9.200	325.975	70.687	88.256
9/27/2010 5:56	646.931	0.280	0.182		181.141	117.840	0.000
9/27/2010 6:16	9,718.988	0.300	0.172		2,915.696	1,671.989	0.000
9/27/2010 10:51	7,889.777	0.120	0.261	8.800	946.773	2,055.916	84.419
9/27/2010 11:11	966.669	0.134	0.245		129.534	237.221	0.000
9/27/2010 11:31	918.911	0.130	0.263		119.458	241.774	0.000
9/27/2010 11:51	895.714	0.120	0.061	7.500	107.486	54.386	13.118
9/27/2010 12:11	875.219	0.120	0.253		105.026	221.422	0.000
9/27/2010 12:31	814.980	0.142	0.268	7.000	115.727	218.553	11.053
9/27/2010 12:51	783.703	0.140	0.266		109.718	208.183	0.000
9/27/2010 13:11	724.751	0.100	0.228	10.300	72.475	165.019	14.053
9/27/2010 13:31	656.642	0.120	0.248		78.797	162.801	0.000
9/27/2010 13:51	603.756	0.120	0.220	6.200	72.451	132.888	13.145
9/27/2010 14:11	668.218	0.120	0.205		80.186	136.932	0.000
9/27/2010 14:31	874.629	0.130	0.190		113.702	165.954	0.000
9/27/2010 14:51	945.768	0.135	0.210	8.400	127.679	198.594	23.546
9/27/2010 15:11	962.626	0.116	0.185		111.665	177.780	0.000
9/27/2010 15:31	929.815	0.128	0.185		119.016	171.721	0.000
9/27/2010 15:51	902.917	0.109	0.185	8.100	147.046	249.146	14.361
9/27/2010 16:11	892.263				0.000	0.000	0.000
9/27/2010 16:31	891.116	0.126	0.243	11.300	168.493	324.778	24.521
9/27/2010 16:51	872.975	0.112	0.233		97.773	203.186	0.000
9/27/2010 17:11	866.195	0.115	0.223		99.612	192.842	0.000
9/27/2010 17:31	830.182	0.109	0.200	7.500	90.490	165.922	15.225
9/27/2010 17:51	792.082	0.116	0.240		91.882	190.369	0.000
9/27/2010 18:11	737.794	0.099	0.230	45.900	73.042	169.856	78.093
9/27/2010 18:31	984.870	0.116	0.228		114.245	224.246	0.000
9/27/10 19:08	839.001	0.040	0.185	6.650	33.560	154.949	19.986
9/27/10 19:28	518.338	0.070	0.175		36.284	90.483	

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
9/27/10 19:48	454.802	0.032	0.185		14.554	83.994	
9/27/10 20:08	387.429	0.052	0.175		20.146	67.631	
9/27/10 20:28	312.075	0.062	0.299		19.349	93.163	
9/27/10 20:48	531.322	0.040	0.162		21.253	86.028	
Total Inlet:	Nutrients: 176,869.083; TSS: 148,258.122				26,863.846	40,238.866	1,660.896
Total Outlet:	Nutrients: 47,965.189; TSS: 46,155.210				12,596.263	9,684.644	469.606
EMC Inlet:					0.152	0.228	11.200
EMC Outlet:					0.263	0.202	10.200

EVENT DATE: 9/28/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Inlet:							
9/28/2010 2:13	647.427	0.180	0.154	7.100	116.537	99.913	128.945
9/28/2010 2:25	1,012.976	0.140	0.190		141.817	192.205	
9/28/2010 2:37	5,029.910	0.070	0.030		352.094	152.702	
9/28/2010 2:49	12,664.026	0.050	0.010		633.201	128.155	
9/28/2010 3:01	5,081.238	0.070	0.008		355.687	38.565	
9/28/2010 3:13	9,031.325	0.040	0.152	173.500	361.253	1,370.901	2,448.530
9/28/2010 3:25	12,852.956	0.050	0.000	25.100	642.648	0.000	
9/28/2010 3:37	13,115.024	0.040	0.197		524.601	2,588.016	
9/28/2010 3:49	12,000.566	0.084	0.200		1,008.048	2,398.458	
9/28/2010 4:01	11,293.031	0.050	-0.003		564.652	0.000	
9/28/2010 4:13	3,847.459	0.060	-0.008	2.200	230.848	0.000	38.701
9/28/2010 4:25	1,237.179	0.068	0.197		84.128	244.135	
9/28/2010 4:37	634.049	0.114	0.177		72.282	112.286	
9/28/2010 4:49	418.137	0.113	-0.003		47.249	0.000	
9/28/2010 5:01	323.409	0.159	0.008		51.422	2.455	
9/28/2010 5:13	305.784	0.131	0.025	2.900	40.058	7.736	5.161
9/28/2010 5:25	265.770	0.119	0.015		31.627	4.034	
9/28/2010 5:37	215.138	0.166	0.114		35.713	24.493	
9/28/2010 5:49	831.163	0.224	0.109		186.180	90.419	
Outlet:							
9/28/2010 3:48	2,586.892	0.050	0.182	8.200	129.345	471.210	57.815
9/28/2010 4:08	858.208	0.003	0.177		2.575	151.983	
9/28/2010 4:28	2,442.189	0.051	0.078		124.552	191.533	
9/28/2010 4:48	2,560.227	0.030	0.089		76.807	226.699	
9/28/2010 5:08	1,812.071	0.050	0.101		90.604	183.374	
9/28/2010 5:28	1,626.788	0.014	0.172	3.100	22.775	279.862	17.743
9/28/2010 5:48	1,465.004	0.046	0.187		67.390	274.267	
9/28/2010 6:08	1,345.175	0.040	0.149		53.807	200.786	
9/28/2010 6:28	1,286.559	0.020	0.147		25.731	188.782	
9/28/2010 6:48	1,244.973	0.038	0.147	4.800	47.309	182.680	22.624
9/28/2010 7:08	1,197.297	0.023	0.175		27.538	209.004	
9/28/2010 7:28	1,158.311	0.020	0.167		23.166	193.407	
9/28/2010 7:48	1,112.803	0.040	0.172		44.512	191.439	
9/28/2010 8:08	1,069.619	0.032	0.164		34.228	175.892	
9/28/2010 8:28	1,028.529	0.020	0.134	5.200	20.571	137.910	29.986
9/28/2010 8:48	977.885	0.030	0.195		29.337	190.494	
9/28/2010 9:08	956.214	0.032	0.149		30.599	142.728	
9/28/2010 9:28	1,734.379	0.017	0.197		29.484	342.249	
9/28/2010 10:24	2,769.544	0.030	0.172		83.086	476.453	
9/28/2010 10:44	4,415.823			6.900			30.469

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
9/28/2010 11:24							
9/28/2010 11:44	2,432.752	0.040	0.083		97.310	203.102	
9/28/2010 12:24	2,186.933			3.900			8.529
9/28/2010 12:44							
9/28/2010 13:03	1,400.460	0.060	0.094		84.028	131.092	
Total Inlet:	Nutrients: 90,806.56; TSS: 53,575.872				5,480.042	7,454.473	3,077.186
Total Outlet:	Nutrients: 35,252.81; TSS: 29428.512				1,144.752	4,744.948	167.166
EMC Inlet:					0.060	0.082	44.100
EMC Outlet:					0.032	0.135	5.600

EVENT DATE: 9/29/2010

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Mass Sediment (g)
Inlet:			
9/29/2010 15:02	566.767	3.800	2.154
9/29/2010 15:13	359.137	3.800	1.365
9/29/2010 15:25	291.757	3.800	1.109
9/29/2010 15:37	2,518.544	19.400	48.860
absent sample			
9/29/2010 16:01			
9/29/2010 16:13			
9/29/2010 16:25	1,463.766	8.900	13.028
9/29/2010 16:37			
9/29/2010 16:49	1,854.795	7.500	13.911
9/29/2010 17:01			
9/29/2010 17:13	6,863.020	4.300	29.511
absent sample			
9/29/2010 17:37			
9/29/2010 17:49			
9/29/2010 18:01	1,669.821	3.100	5.176
9/29/2010 18:13			
9/29/2010 18:25			
absent sample			
9/29/2010 18:49	2,147.445	8.100	17.394
absent sample			
absent sample			
9/29/2010 19:37			
9/29/2010 19:49			
9/29/2010 20:24	6,137.588	2.000	12.275
9/29/2010 20:54			
9/29/2010 21:24			
9/29/2010 21:54	8,179.673	1.800	14.723
9/29/2010 22:24			
9/29/2010 22:54			
9/29/2010 23:24	4,832.052	1.000	4.832
9/30/2010 0:24			
9/30/2010 0:54			
9/30/2010 1:24	46,692.012	1.000	46.692
9/30/2010 1:54			
9/30/2010 2:24			
9/30/2010 3:24	72,391.008	3.200	231.651
9/30/2010 3:54			
9/30/2010 4:24			
9/30/2010 4:54	46,582.663	1.100	51.241
9/30/2010 5:24			

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Mass Sediment (g)
9/30/2010 5:54			
9/30/2010 6:24	51,503.627		
9/30/2010 6:54			
9/30/2010 7:24	98,671.359	19.300	1,904.357
9/30/2010 7:54			
9/30/2010 9:34	53,880.593	1.600	86.209
9/30/2010 10:04			
9/30/2010 10:34			
9/30/2010 11:04	6,071.169	1.200	7.285
9/30/2010 11:34			
9/30/2010 12:04			
9/30/2010 12:34	49,809.216	3.200	159.389
absent sample			
9/30/2010 13:34			
9/30/2010 14:04			
9/30/2010 14:34			
9/30/2010 15:04	4,891.063	3.000	14.673
9/30/2010 15:34			
9/30/2010 16:04			
absent sample			
9/30/2010 17:04	10,131.178	5.300	53.695
9/30/2010 17:34			
absent sample			
absent sample			
9/30/2010 19:04			
9/30/2010 19:22	13,478.425	4.900	66.044
9/30/2010 19:52			
9/30/2010 20:22	39,135.024	2.600	101.751
9/30/2010 20:52			
9/30/2010 21:22			
9/30/2010 21:52			
9/30/2010 22:22	33,573.175	2.700	90.648
9/30/2010 22:52			
9/30/2010 23:22	11,554.864	1.900	21.954
9/30/2010 23:52			
10/1/2010 0:22			
10/1/2010 0:52			
10/1/2010 1:22	6,615.988	1.000	6.616
10/1/2010 1:52			
10/1/2010 2:22			
10/1/2010 2:52			
10/1/2010 3:22			
10/1/2010 3:52			
10/1/2010 4:22			

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Mass Sediment (g)
Outlet:			
9/30/2010 2:18	2,517.333	2.041	5.139
9/30/2010 2:38			
9/30/2010 2:58			
9/30/2010 3:18			
9/30/2010 3:38	9,044.697	2.462	22.271
9/30/2010 3:58			
9/30/2010 4:18			
9/30/2010 4:38			
9/30/2010 4:58	14,446.749	1.834	26.501
9/30/2010 5:18			
9/30/2010 5:38			
9/30/2010 5:58			
9/30/2010 6:18	14,399.495	1.833	26.400
9/30/2010 6:38			
9/30/2010 6:58			
9/30/2010 7:18			
9/30/2010 7:38	12,951.814	5.501	71.248
9/30/2010 7:58			
9/30/2010 8:18			
9/30/2010 8:38			
9/30/2010 8:58	8,249.174	5.621	46.370
9/30/2010 9:18			
9/30/2010 9:38			
9/30/10 10:15	14,874.799	268.646	3,996.051
9/30/10 10:35			
9/30/10 10:55			
9/30/10 11:15			
9/30/10 11:55	7,393.459	2.336	17.269
9/30/10 12:15			
9/30/10 12:35			
9/30/10 12:55			
9/30/10 13:15	8,549.750	3.042	26.007
9/30/10 13:35			
9/30/10 13:55			
9/30/10 14:15			
9/30/10 14:35	10,198.146	2.463	25.113
9/30/10 14:55			
9/30/10 15:15			
9/30/10 15:35			
9/30/10 15:55	14,680.271	2.854	41.902
9/30/10 16:15			
9/30/10 16:35			
9/30/10 16:55			

Sample Date and Time	Rep. Volume (L)	TSS (mg/L)	Mass Sediment (g)
9/30/10 17:15			
9/30/10 17:35			
9/30/2010 19:59	8,944.100	2.547	22.783
9/30/2010 20:19			
9/30/2010 20:39			
9/30/2010 20:59			
9/30/2010 21:19	5,715.298	1.716	9.805
9/30/2010 21:39			
9/30/2010 21:59			
9/30/2010 22:19			
9/30/2010 22:39	7,704.320	2.113	16.276
9/30/2010 22:59			
9/30/2010 23:19			
9/30/2010 23:39			
9/30/2010 23:59	7,302.064	2.373	17.331
10/1/2010 0:19			
10/1/2010 0:39			
10/1/2010 0:59			
10/1/2010 1:19	5,997.047	2.429	14.565
10/1/2010 1:39			
10/1/2010 1:59			
10/1/2010 2:19			
10/1/2010 2:39	8,103.927	2.689	21.794
10/1/2010 2:59			
10/1/2010 3:19			
10/1/2010 3:39			
Total Inlet:	581,865.729		3,006.545
Total Outlet:	117,305.686		4,406.824
EMC Inlet:			5.167
EMC Outlet:			27.359

EVENT DATE: 11/16/2010

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Inlet:							
11/16/2010 7:05	2,341.239	0.280	0.067	3.795	655.547	155.975	8.884
11/16/2010 7:48	3,406.871	0.200	0.067	40.511	681.374	226.968	138.016
11/16/2010 7:58	3,406.871	0.160	0.073	5.881	545.099	248.516	20.037
11/16/2010 8:23	3,406.871	0.167	0.079	3.234	568.947	270.063	11.019
11/16/2010 8:37	3,406.871	0.174	0.070	3.560	591.092	238.460	12.129
11/16/2010 8:45	3,406.871	0.180	0.061	0.635	613.237	206.857	2.163
11/16/2010 8:57	3,406.871	0.170	0.059	13.644	579.168	201.111	46.484
11/16/2010 9:03	3,406.871	0.143	0.057	25.088	487.182	195.365	85.471
11/16/2010 9:13	3,406.871	0.139	0.063	6.401	473.555	214.040	21.806
11/16/2010 9:35	3,406.871	0.207	0.068	0.561	705.222	232.714	1.910
11/16/2010 9:56	3,406.871	0.204	0.073	14.275	695.002	248.516	48.631
11/16/2010 10:14	3,406.871	0.190	0.078	8.572	647.305	264.317	29.204
11/16/2010 11:00	3,406.871	0.170	0.073	4.150	579.168	249.952	14.139
11/16/2010 11:48	3,406.871	0.272	0.069	7.751	926.669	235.587	26.406
11/16/2010 11:57	3,406.871	0.286	0.067	14.939	974.365	226.968	50.894
11/16/2010 12:03	3,406.871	0.154	0.064	84.144	524.658	218.349	286.667
11/16/2010 12:07	3,406.871	0.159	0.070	169.105	541.692	238.460	576.118
11/16/2010 12:10	3,406.871	0.140	0.076	123.631	476.962	1,226.866	421.196
11/16/2010 12:14	25,516.028	0.130		67.160	3,317.084		1,713.662
11/16/2010 15:08	25,516.028	0.116	0.044	0.884	2,959.859	1,651.984	22.553
11/16/2010 15:27	3,406.871	0.128		5.548	436.079		18.901
11/16/2010 15:50	3,406.871	0.140	0.036	4.113	476.962	185.309	14.014
11/16/2010 16:08	3,406.871	0.170	0.041	2.671	579.168	139.341	9.101
11/16/2010 18:16	3,406.871	0.200	0.046	2.134	681.374	155.143	7.271
11/16/2010 18:29	3,406.871	0.241	0.054	1.824	819.352	183.873	6.214
11/16/2010 18:50	3,406.871	0.281	0.062	5.607	957.331	212.603	19.101
11/16/2010 19:13	3,406.871	0.266	0.054	4.145	906.228	183.873	21.183
11/16/2010 19:29	3,406.871	0.251	0.046		855.125	155.143	
11/16/2010 19:34	3,406.871	0.221	0.046	2.951	751.215	155.143	15.083
11/16/2010 19:53	3,406.871	0.190	0.046	74.857	647.305	155.143	255.028
11/16/2010 19:57	3,406.871	0.175	0.042	33.900	596.202	142.214	115.493
11/16/2010 20:06	3,406.871	0.160	0.038	25.907	545.099	129.286	88.262
11/16/2010 20:48	3,406.871	0.152	0.040	2.474	517.844	137.905	8.428
11/16/2010 23:41	3,406.871	0.144	0.043	230.650	490.589	146.524	785.795
11/16/2010 23:45	3,406.871	0.146	0.047	27.266	497.403	159.452	92.891
11/16/2010 23:48	3,406.871	0.148	0.051	15.343	504.217	172.381	52.271
11/16/2010 23:52	3,406.871	0.164	0.057	3.319	558.727	193.928	11.307
11/17/2010 0:00	3,406.871	0.180	0.063	4.813	613.237	215.476	16.396
11/17/2010 0:16	3,406.871	0.145	0.059	4.347	493.996	199.674	14.809
11/17/2010 0:27	3,406.871	0.110	0.054	2.213	374.756	183.873	7.538
11/17/2010 0:40	3,406.871	0.061	0.054	1.873	206.797	183.873	16.731
11/17/2010 0:57	5,526.410	0.011	0.054		63.001	298.267	

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
Outlet:							
11/16/2010 10:51	706.308	0.180	0.002	1.822	127.136	1.413	1.287
11/16/2010 11:12	757.082	0.179	0.002	4.961	135.518	1.514	3.756
11/16/2010 11:32	757.082	0.110	0.004	6.132	83.279	3.028	4.642
11/16/2010 11:51	757.082	0.150	0.081	4.516	113.562	61.324	3.419
11/16/2010 12:09	757.082	0.208	0.085	1.580	157.473	64.352	1.196
11/16/2010 12:25	757.082	0.150	0.083	1.787	113.562	62.838	1.353
11/16/2010 12:37	757.082	0.110	0.084	2.318	83.279	63.595	1.755
11/16/2010 12:49	757.082	0.160	0.080	15.685	121.133	60.567	11.875
11/16/2010 12:56	757.082	0.190	0.074	1.391	143.846	56.024	1.053
11/16/2010 13:01	757.082	0.130	0.073	2.264	98.421	55.267	1.714
11/16/2010 13:05	757.082	0.165	0.098	5.445	124.919	74.194	4.123
11/16/2010 13:09	757.082	0.162	0.104	1.457	122.647	78.737	1.103
11/16/2010 13:13	757.082	0.166	0.093		125.676	70.409	0.000
11/16/2010 13:16	757.082	0.211	0.068	4.385	159.744	51.482	3.320
11/16/2010 13:19	757.082	0.142	0.051	2.637	107.506	38.611	1.997
11/16/2010 13:23	757.082	0.160	0.062	1.998	121.133	46.939	1.513
11/16/2010 13:27	757.082	0.110	0.061	4.378	83.279	46.182	3.314
11/16/2010 13:31	757.082	0.133	0.078	4.279	100.692	59.052	3.239
11/16/2010 13:35	757.082	0.141	0.081	3.617	106.749	61.324	2.738
11/16/2010 13:39	6,420.538	0.138	0.082	4.439	886.034	526.484	28.503
11/16/2010 15:24	7,366.891	0.132	0.054	3.259	972.430	397.812	24.005
11/16/2010 15:42	1,703.435	0.121	0.023	4.004	206.116	39.179	6.821
11/16/2010 16:00	1,703.435	0.110	0.048	1.471	187.378	81.765	2.505
11/16/2010 16:16	1,703.435	0.100	0.000	3.875	170.344	0.000	6.601
11/16/2010 16:35	1,703.435	0.090	0.000	0.543	153.309	0.000	0.925
11/16/2010 16:57	1,703.435	0.067	0.000	0.195	113.278	0.000	0.333
11/16/2010 17:21	1,703.435	0.043	0.049	2.029	73.248	83.468	3.456
11/16/2010 17:46	1,703.435	0.071	0.028	1.115	120.944	47.696	1.899
11/16/2010 18:13	1,703.435	0.099	0.058	1.796	168.640	98.799	3.059
11/16/2010 18:40	1,703.435	0.085	0.037	3.242	143.940	63.027	5.523
11/16/2010 19:06	1,703.435	0.070	0.058	1.963	119.240	98.799	3.344
11/16/2010 19:31	1,703.435	0.094	0.028	2.617	160.123	47.696	4.458
11/16/2010 19:53	1,703.435	0.118	0.049	2.734	201.005	83.468	4.657
11/16/2010 20:10	1,703.435	0.119	0.034	1.118	202.709	57.917	1.904
11/16/2010 20:25	1,703.435	0.120	0.064	1.843	204.412	109.020	3.140
11/16/2010 20:42	1,703.435	0.111	0.047	1.291	188.230	80.061	2.198
11/16/2010 21:01	1,703.435	0.101	0.062	2.525	172.047	105.613	4.300
11/16/2010 21:22	1,703.435	0.096	0.026	7.985	162.678	44.289	13.602
11/16/2010 21:45	1,703.435	0.090	0.043	1.546	153.309	73.248	2.634
11/16/2010 22:08	1,703.435	0.097	0.013	1.711	165.233	22.145	2.915
11/16/2010 22:34	1,703.435	0.104	0.049	1.299	177.157	83.468	2.213
11/16/2010 23:01	1,703.435	0.102	0.024	1.090	173.750	40.882	1.857

Sample Date and Time	Rep. Volume (L)	Nitrate-N (mg/L)	Phosphate (mg/L)	TSS (mg/L)	Mass N (mg)	Mass PO_4 (mg)	Mass Sediment (g)
11/16/2010 23:28	20,604.170	0.100	0.054	2.648	2,060.417	1,112.625	4.510
11/16/2010 23:56			0.079	1.318			27.147
Total Inlet:	83,791.222				30,115.196	10,439.493	5,113.208
Total Outlet:	Nutrients: 84,497.5; TSS: 86,200.9				9,565.525	4,254.314	215.907
EMC Inlet:					0.160	0.168	27.146
EMC Outlet:					0.110	0.151	2.505

Appendix D – Validation Meeting Notes

CHS Biofilter Monitoring Study
Data Validation/Reconciliation Meeting – conducted via telephone
January 13, 2011

Attendees: Erin Yancey, TJPDC
Dr. Teresa Culver, UVA

1) Item: Event dates 7/10/2010, 7/12/2010, 7/14/2010 occurred after initial equipment calibrations, but before site visit from Ryland Brown, ISCO representative. At this visit, the inlet flow meter was recalibrated, and red caps removed from the desiccant. The caps may have caused less air to enter the compressor, causing potential inaccuracy in level readings. Should these events be used?
Decision: Dr. Culver charted all summer events in an effort to estimate volume intervals for volume passing in the Fall. She did not notice outlier flow data from the first three events in comparison to the other events, concluding that calibration and air flow issues were not a significant problem. The data from these events should be used.

2) Item: The inlet flow of many events maxed out the flume's ability to accurately measure the level. This would lead to underestimation of flow at the inlet end.
Decision: Because this occurred in so many events, data cannot be eliminated because of it, but it should be disclosed in the report. Underestimation of flow was not a major concern, since the flow meter data showed that the flume only maxed out for 5 – 15 minutes during these events, although for shorter rain events, this represents a larger volume not recorded. The report will acknowledge that the flow reduction results are underestimated, which means that the inlet loads are also underestimated, resulting in the underestimation of Summation of Loads (SOLs)

3) Item: For many events, the lab analyses of water samples is approaching or below detection limit of the lab kits.
Decision: Again, because this affected so many events, it is not possible to eliminate data because of it, but it will be disclosed in the final report. The sacrifice in accuracy was not seen as a major problem, in Dr. Culver's opinion, because the lab kit supply companies conservatively estimate the detection limit, and concentrations below the limit don't mean that they are wrong, it only means that there is less assurance that it is correct.

4) Item: There is one sample for TSS on the 9/29 event whose concentration represented a large spike in the concentration over the length of the storm. It was flagged for discussion.
Decision: There were no comments on the lab form, or any other indication that this sample was handled differently. A review of the hydrograph seemed to indicate that the sample was taken during a period of bypass through the riser, which is likely why the concentration is so high. The sample will be used in data analysis.

5) The July 20, 2010 event did not meet the minimum depth or minimum number of samples established as guidelines for "representativeness" in the data quality objectives. Dr. Culver and Ms. Yancey decided however, that there was no reason to exclude the data from this event from analysis for the following reasons: The "representativeness" data quality objective guideline for a

minimum storm depth of 0.1" is was based on an assumption that approximately 0.1" of rain is needed to produce runoff. Since the data at the CHS site indicates that runoff is produced with less than 0.1", it is permissible to deviate from this guideline. Additionally, because of the small size of this event, it was not possible to obtain six water quality samples, which is the guideline for minimum number of samples to be considered "representative." However, 80% of the hydrograph was sampled for this event, which is in line with the sampling density of other rain events, thus Dr. Culver and Ms. Yancey agreed that deviation from the guideline was permissible in this instance.

Appendix E - Biofilter Design Specifications

CHS Biofilter Detention *Rainfall Duration=10 min, Inten=5.37 in/hr*

Prepared by {enter your company name here}

HydroCAD® 8.00 s/n 005075 © 2006 HydroCAD Software Solutions LLC 5/20/2009

Pond 2P: Biofilter

Inflow Area =	3.989 ac,	Inflow Depth = 0.58"		
Inflow =	14.05 cfs @	0.16 hrs, Volume=	0.193 af	
Outflow =	2.44 cfs @	0.30 hrs, Volume=	0.190 af,	Atten= 83%, Lag= 8.1 min
Primary =	2.44 cfs @	0.30 hrs, Volume=	0.190 af	

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 427.04' @ 0.30 hrs Surf.Area= 2,651 sf Storage= 6,791 cf

Plug-Flow detention time= 33.5 min calculated for 0.189 af (98% of inflow)
Center-of-Mass det. time= 33.7 min (43.4 - 9.7)

Volume	Invert	Avail.Storage	Storage Description
#1	424.00'	9,857 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
424.00	1,851	20.0	0	0
427.00	2,600	100.0	6,677	6,677
428.00	3,761	100.0	3,181	9,857

Device	Routing	Invert	Outlet Devices
#1	Primary	424.00'	**8.0" x 105.0' long Culvert** RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 417.50' S= 0.0619 '/' Cc= 0.900 n= 0.010 PVC, smooth interior
#2	Primary	427.50'	**24.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=2.44 cfs @ 0.30 hrs HW=427.04' (Free Discharge)
1=Culvert (Inlet Controls 2.44 cfs @ 6.99 fps)
2=Orifice/Grate (Controls 0.00 cfs)

Appendix F - Monitoring Plan and Quality Assurance Project Plan

Thomas Jefferson Planning District Commission and the University of Virginia, in partnership with the Rivanna River Basin Commission

Charlottesville High School Biofilter Monitoring Plan

Prepared by:
Thomas Jefferson Planning District Commission
401 E. Water St.
Charlottesville, VA 22902

Prepared for:
Rivanna River Basin Commission

Acknowledgments

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REVISION HISTORY

Revision #	Date	Section	Revision
1	10/22/2010	All	Document version control header added.
		3.0	Problem quantification clarification.
		5.0	Lab product corrections. Clarification on lab product method. Addition that “specific qualifying criteria” for sediment samples to be analyzed for P at Occ. Lab will be documented in the project journal for future reference.
		8.0	EPA document numbers added to references.
		8.0; 2	Verbiage added on methods approval, revisions, distribution.
		8.0; 7	Naming of Teresa Culver as lead on oversight of student training on field and lab equipment.
		8.0; 9	Detail added about qualifying event criteria.
		8.0; 10	Clarification on documentation of sample interval changes between monitored events.
		8.0; 13	Establishment of a QAPP Corrective Measures Log. Creation of metadata for electronic data.
		8.0; 19	Addition that data that are found to contain errors or issues that disqualify them from use in the study are maintained in a separate file with documentation on the issue(s) that disqualified them.

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1.0 Introduction

This study of the bioretention filter (biofilter) at Charlottesville High School (CHS) is a collaborative effort between the Thomas Jefferson Planning District Commission (TJPDC), under contract with the Rivanna River Basin Commission (RRBC), and the University of Virginia (UVa). The installation of the biofilter was partially funded by the RRBC through a grant from the National Fish and Wildlife Foundation (NFWF), in partnership with the Environmental Protection Agency. The grant requires that monitoring be undertaken to quantify reductions of nitrogen (N), phosphorous (P), and sediment from the biofilter. In addition, RRBC plans to use documented biofilter efficiency to showcase effectiveness of stormwater best management practices on public lands.

The study team for the biofilter is comprised of Erin Yancey of the TJPDC, and a team of undergraduates and one PhD student from UVa, working under the supervision of professors Dr. Teresa Culver and Dr. Joanna Curran from the Department of Civil and Environmental Engineering, and Dr. Janet Herman from the Department of Environmental Sciences. The lead students involved in the study are Kristen Cannatelli, Ph.D. student in the Dept. of Civil and Environmental Engineering, and Michael Downey, fourth-year double major in Environmental Thought and Practice and Anthropology.

2.0 Objectives

The study will determine the runoff reduction and pollutant removal capabilities of the CHS biofilter. This study will satisfy the monitoring requirement of the grant and contribute to the collective knowledge of stormwater management in the Rivanna River basin. The study will also provide a study site for our UVa partners, while they provide important resources to assist in carrying out this monitoring plan. Ms. Yancey will be responsible for all equipment purchase and installation. She will also be responsible for report preparation to document the results for the RRBC (and NFWF). The UVa team will collect and analyze flow and water quality data. The physical and chemical data and analysis will be promptly provided to Ms. Yancey for use in subsequent reports. The UVa team will retain the right to publish and disseminate the data and their analyses in student theses, conference posters and presentations, and scientific journals. UVa will provide RRBC the option to have publications refer to a generic 'biofilter in central Virginia.' Lab analysis of samples may from time to time be performed by a commercial lab if the UVA team is unable to support the project for portions of the study.

3.0 Monitoring Parameters

As a best management practice (BMP) for stormwater, the purpose of the biofilter is to receive and treat stormwater runoff from urban areas exhibiting altered hydrology. The drainage area is dominated by impervious surface, preventing infiltration of rainwater, resulting in a large increase in surface runoff as compared to its natural hydrological state. The extra volume of runoff also drains at a much faster rate than it would under predevelopment conditions, since the impervious area provides little impedance to slow the runoff down. The biofilter is designed to receive and retain this extra volume of runoff, and release it slowly to mimic a more natural hydrologic response. In addition, the biofilter is designed to improve water quality of stormwater runoff by encouraging gradual infiltration at the site and uptake of stormwater by plants and consumption by soil bacteria.

Flow discharge (volume/time) at the inlet and outlet of the biofilter will be monitored and recorded throughout storm events. The UVa team will download flow data within one week of each monitored event. To analyze the biofilter's ability to return the hydrologic response to one more resembling pre-development conditions, the UVa team will calculate the following criteria for each storm event: runoff volume reduction, reduction in peak flow rate, and reduction in the ratio of rising limb time to falling limb time from the inlet to the outlet.

The main focus of the NFWF grant is to assist with projects that remove nitrogen, phosphorus, and sediment from stormwater, because these are the pollutants that are largely responsible for degradation of water quality in the Chesapeake Bay. Table 1 contains the pollutants and masses estimated during the grant proposal process for removal by the biofilter. The results from this study will be reported in summation of loads (SOL) so they can be compared to these estimations. Water samples will be analyzed for nitrate, orthophosphate (also known as reactive phosphate), and suspended sediment concentration (SSC), which represent nitrogen, phosphorus, and sediment concentrations, respectively. Additionally, total suspended solids concentration (TSS) determined by turbidity measurements will be quantified for use in comparing to a commonly measured constituent in the stormwater literature.

Baseline hydrographical, nutrient and sediment data do not exists for the Charlottesville High School Biofilter site, however, the magnitude of the problems associated with the stormwater runoff will be quantified by measuring these parameters in the runoff entering the biofilter.

Table 1. Anticipated impacts and goals of CHS biofilter.

Activities	Indicators	Baseline	Projected Project Output/Outcome over (2) year grant period	Projected Post Project Output/Outcome (5) years
Charlottesville HS Bioswale to treat parking lot runoff	Flow volume Pounds of N, P, and tons of sediment delivered downstream	Zero acres of parking lot and rooftop treated at site Zero lbs of N, P, and sediment reduced at site	4.5 acres treated Annual pollution reductions: 2 lbs P, 19 lbs N, 0.2 tons sediment	Same Extrapolated for 5 years

Source: RRBC grant proposal to NFWF.

The UVa students will analyze samples for nitrate. Nitrate is the nitrogen species most often present in stormwater since it is the most stable nitrogen compound. Ammonia and nitrite are quickly transformed to nitrate in water, and thus are only present in negligible amounts (Murphy, 2007). Several samples from the first storm will be analyzed for nitrite to confirm that it is only present in negligible amounts, and thereafter nitrate will be the only nitrogen species analyzed. Recent stormwater analyses on the Grounds of UVA have shown nitrite to be present in only trace amounts and ammonia to be completely absent.

The students will also analyze water samples for orthophosphate. Phosphorus is present in natural waters in the form of phosphates. Organic phosphate is bound by plant and animal tissue and is generally not a stormwater constituent of concern. Inorganic phosphate, on the other hand, is present in stormwater, often in excessive amounts and contributes to processes that degrade water quality. Inorganic phosphate is comprised of orthophosphates and polyphosphates. Polyphosphates are transformed to orthophosphates in water, and thus are present in negligible amounts in stormwater (Murphy, 2007). The students will analyze samples for orthophosphates for each sampled event.

If samples with high levels of suspended sediments are obtained, a limited number of samples will be sent to the Occoquan Watershed Monitoring Laboratory in Manassas, Virginia to be analyzed for particulate bound phosphate. This analysis will determine the amount of phosphate that is dissolved versus the amount that is sediment bound in the stormwater samples. Knowing this, the study team can estimate an amount of phosphate being treated in the biofilter based on the amount of sediment removed by the BMP. This analysis will not be undertaken if sediment collection at the site is too low to garner useful information from such analysis.

Students will also analyze samples for SSC. This method of analysis was chosen because it will allow the TJPDC to report the mass loading of sediment removed by the biofilter over the course of the study. SSC is expected to best represent the actual mass of sediment in stormwater samples, as compared with measurements of total suspended solids (TSS), which tends to underestimate the mass to varying degrees, depending on the particle size distribution and sediment concentration (Guo, 2006). On the other hand, because so much of the stormwater literature reports sediment concentrations in TSS and because turbidity measurements are easy to complete, TSS will also be determined

The study team may send biofilter samples from a limited number of rain events to a commercial lab to be analyzed for Total Petroleum Hydrocarbons and heavy metals. However, the NFWF grant does not require monitoring of these constituents.

4.0 CHS Biofilter Plan

See Appendix A for CHS biofilter site plan and monitoring schematic.

4.1 Characterization of Drainage Area.

The biofilter project at Charlottesville High School is designed to treat the stormwater runoff from an approximately four acre drainage area comprised of a portion of the large adjacent parking lot, and several residential parcels off of Grove Road. Before the biofilter, runoff from the lot was conveyed directly to Meadowbrook Creek without any water quantity or quality treatment. With a surface area of 2,600 square feet, the biofilter was designed to provide water quality treatment to the volume of runoff received from the first ½ inch of rain that occurs in a given storm event. Treating this "first flush" is most important, as it is this portion of stormwater runoff that contains the highest concentration of pollutants.

The biofilter was designed for high intensity, low duration storms, specifically a 10 minute (duration), 5.37 inches/hour (intensity) storm event, which is equal to 0.895 total inches of rain. These storms cause high runoff velocities that have the potential to erode receiving stream channels. Rains of 0.5 inch or less (total) account for approximately 70 percent of rain events in the region (Weather Underground, 2010). The typical intensity is equal to or less than 1.5 inches/hour (The Center for Watershed Protection, 2010).

In this drainage area, nitrogen and phosphorus are expected from lawn fertilizer and possibly pet waste. Phosphorus may also result from soap used for car washing on the residential lots and accompany any sediment present in runoff. Sediment is not expected in large amounts, but may result from minor erosion on the school grounds, and any deposits on the asphalt parking lot from on or off site will also wash into the biofilter. Other pollutants that will likely be present in the drainage area include petroleum hydrocarbons and heavy metals. Cars are the source of these pollutants, which is why it is typical to find them in parking lots. Cars leave behind residues of gasoline and other petroleum-based lubricants. Asphalt sealant also leaches polyaromatic hydrocarbons. Additionally, heavy metals such as lead, cadmium, copper and zinc, among others, are typical of parking lots and so may be present in the drainage area. They are deposited by abrading tires, brake linings, engine wear and car exhaust (Sansalone, 2010).

4.2 Rainfall Events to be Sampled.
The sampling team will attempt to capture as many rain events at the biofilter as are practical. Recognizing the steep learning curve to use the equipment, observed level of user error in other studies, as well as the unpredictable nature of stormwater, our partners at UVa recommend one rain event per month as a realistic goal for which to aim. It is desired to obtain as much data as possible to more accurately report "normal behavior" of the biofilter, so it is expected that the sampling team will continue to sample rain events that meet the criteria for sampling until the equipment is needed for sampling at another site or the study concludes. It is hoped that at least 10 rain events can be sampled and analyzed.

If the project budget allows for extra equipment purchases and staff time, monitoring at the biofilter will continue through May 2011, or until the number of events needed to produce statistically relevant results is reached, based on the "difference of means" and coefficient of variance of the biofilter data (Law *et al*., 2008).

4.3 Equipment & Supplies.
- 2 Flow Meters
- 2 Palmer Bowlus flumes
- 2 autosamplers with 24, 1-liter bottles
- Whirl-Pak bags for bottles
- Rain gauge
- Laptop, Flowlink software
- 2 deep cycle marine 12 volt batteries
- 2 30 Watt solar panels
- 2 Storm Boxes
- Manhole puller
- Cooler(s) and ice packs
- Digital camera

Descriptions:

Whirl-Pak bags are disposable plastic bags that are used to line the autosampler bottles so that samples are contained in the plastic *Whirl-Pak* and can be easily removed and transported back to the lab. This precludes the need to transport the bottles to and from the lab between uses, and also precludes the need to acid wash the bottles between uses. In addition, if there is a need to continue sampling during a storm event that exceeds the sampling duration to which the sampler has been set, the study team can remove the first round of samples in the bags and immediately replace with fresh bags so that the sampling can continue during the rain event.

The *Storm Box* (Fig. 1) is a fiberglass clamshell box made to house the sampling equipment. It is manufactured by Precision Systems. It has specific mounting features for the flow meter, autosampler, battery and rain gauge, and provides security for the sampling equipment.

Figure 1. Storm Box
Source: Precision Systems

5.0 Laboratory Analysis of Water Quality

The UVa students will analyze the water samples from each autosampler bottle for each rain event. The samples will be analyzed for nitrate, orthophosphate, SSC and TSS. The concentration of each pollutant will be measured in milligrams/liter (mg/L) and recorded in the Event Report spreadsheet (see Appendix E).

The students will measure a subset of samples collected by the autosamplers based on their best professional judgment (under the oversight of their professors) of which samples best represent changing conditions of the rain event. The students will extract well-mixed aliquots of individual samples for nutrient measurements, and store the remainder of each sample in the refrigerator to await measurement of TSS and SSC.

The students will use CHEMetrics™ and/or HACH™ pre-loaded kits to measure nitrate and orthophosphate concentrations easily and inexpensively using colormetric methods. The kits consist of pre-loaded ampoules that contain an analyte-specific reagent. The reagent mixes with the water sample, turning the solution a distinct shade of color in proportion to the concentration of analyte present in the sample. The students will use a multi-analyte LED photometer to read the exact shade of color development.

Reconnaissance sample analysis was done with the UVa lab’s existing CHEMetrics kits to determine the appropriate detection range for nutrient measurement kits to be purchased for the remainder of the project. The products listed in Table 2 will be used to measure nitrate and orthophosphate concentrations in samples for the remainder of the study. The methods employed by these test kits are based on the EPA approved 4500-P method found in the American Public Health Association Standard Methods, 21st edition.

Table 2. Nutrient measurement laboratory materials.

Analyte: PHOSPHATE (reactive, ortho) (as PO_4) Vendor: HACH Product number: TNT843 Method: Phosphomolybdate, Method 10209 Detection Range (mg/L): 0.15 – 4.5 PO_4

OR

Analyte: PHOSPHATE (reactive, ortho) Vendor: Chemetrics Product number: K8513 Method: Molybdenum Blue/Stannous Chloride Method Detection Range (mg/L): 0.3 – 8.0 PO_4

Analyte: NITRATE (as N) Vendor: Chemetrics Product number: K-6913; K-6903 Method: Cadmium Reduction/Azo Dye Formation Method Detection range (mg/L): 0.1 – 1.00 NO_3-N; 0.2 – 1.5 NO_3-N

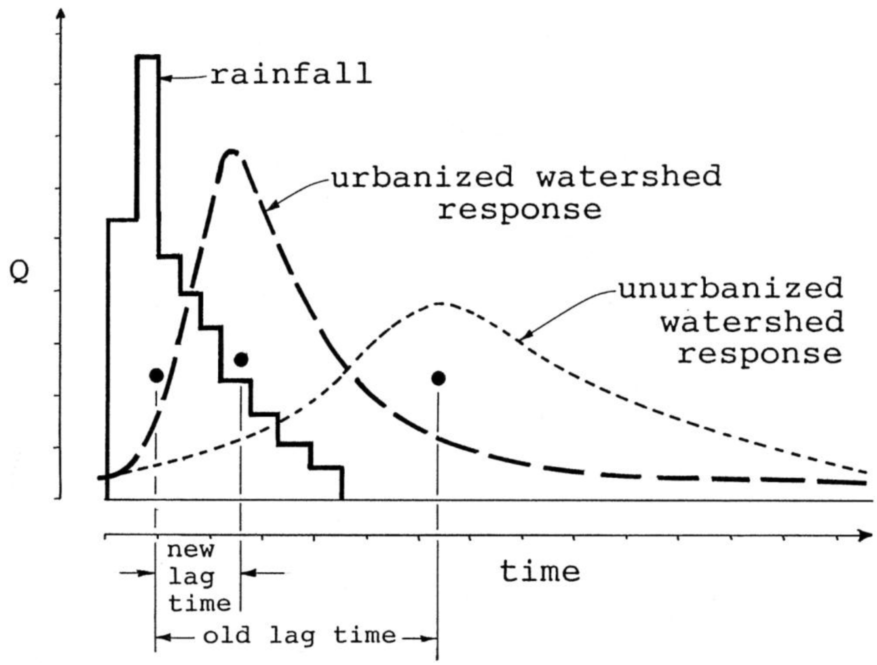
The students will measure both TSS and SSC to determine sediment concentrations. They will directly measure TSS and turbidity in enough samples to develop a calibration curve for conversion of turbidity in NTU to TSS in mg/L for the biofilter site. Subsequent analyses will be for turbidity only so that the calibration curve can be used to derive the TSS concentration. The students will measure SSC using the ASTM D3977-97 (2007) method, which involves filtering the entire sample remaining after nutrient and turbidity aliquots have been removed, to obtain the full mass of sediment present in the sample. For a limited number of events at the biofilter, Dr. Joanna Curran may send the sediment samples to the Occoquan Watershed Monitoring Laboratory in Manassas, Virginia to be analyzed for particulate-bound phosphate if sample analyses indicate that there is enough sediment to warrant further analysis. The UVA professors will use their best professional judgment in determining the appropriate sediment concentration needed to make this measurement worthwhile. This specific qualifying criterion will be documented in the project journal for future reference.

The particulate-bound phosphate measurement would tell us how much phosphate is associated with different sizes of sediment particles. The students would first identify a representative particle size distribution for the influent and effluent sediment samples using a particle size analyzer. They would then determine the mass of each particle size that is removed by the biofilter. With this information, the study team can estimate an additional load of phosphate being treated by the biofilter. Since it is not possible to do this for every event, these data will not be used in data analysis, but its implications will be discussed in the report.
See 8.0 Quality Assurance Project Plan (12.0 Analytical Methods Requirements)
for sample analysis methods.

6.0 Data Analysis and Interpretation

6.1 Discharge Data.

Discharge data from the biofilter will reveal the nature of the hydrologic response to rain events in the biofilter's drainage area. For drainage areas with high percentages of impervious surfaces, such as the one used in this study, the hydrologic response is usually "flashy". A flashy response is one characterized by a high percentage of runoff versus infiltration, high peak flow rates, and short lag time. Flashy responses to rain events threaten the health of receiving streams. Figure 2 depicts hypothetical discharge data for developed and pre-development conditions. The urbanized hydrograph illustrates a flashy response to a rain event, as described above.



Q = Discharge (volume/time)

Figure 2. Hypothetical discharge data.
Source: Missouri University of Science and Technology

6.1.1 Runoff Reduction

Hydrographs recorded by the inlet and outlet flow meters provide discharge datasets from each rain event. Total influent and effluent volumes for each event are obtained by integrating the area under the hydrographs. The difference in the influent and effluent volumes is equal to the volume of stormwater retained within the biofilter after the rain event is over. The percent of runoff reduced for each rain event will be averaged to provide an average runoff reduction for the biofilter.

6.1.2 Peak Flow Reduction

Peak flow reductions will be determined by taking the difference in peak flow rate from the inlet hydrograph and outlet hydrograph for each rain event. The percent reduction in peak flow rate will be calculated for each storm, and will be averaged to obtain the average peak flow reduction provided by the biofilter.

6.1.3 Lag Time

Finally, the ratio of the rising limb time on the hydrograph to the falling limb time will be calculated for the inlet and out ends of each BMP for each storm, and compared to calculate the percent reduction in this ratio provided by retention/detention of runoff in the biofilter. A larger ratio is indicative of a longer lag time, which more closely resembles a natural hydrologic response to a rain event. The percent reduction for individual storms will be averaged to provide an average rising limb to falling limb time ratio percent reduction for the BMP.

6.2 Water Quality Data.

The effectiveness of the BMP to achieve water quality improvements can be determined by calculating the efficiency of the BMP to remove each of the pollutants of interest. The removal efficiency based on sum of loads (SOL%) was chosen for data analysis because it weights concentrations based on the volume of flow represented by each sample and reflects data from all of the sampled rainfall events during the study time period. Using data from all events is important for since treatment efficiency of biofilter will be variable throughout the year as rain event duration, frequency, intensity, and anthropogenic drainage area usage vary. The SOL% is calculated as follows:

$$SOL\% = 1 - \frac{\sum_{i=1}^{m} L_{out,i}}{\sum_{i=1}^{m} L_{in,i}} \qquad (1)$$

where $L_{in,i}$ and $L_{out,i}$ are the mass pollutant loads at the inlet and outlet, respectively, for event i
m is the total number of rainfall events sampled

The loads for each event are calculated as follows:

$$L_{out} = \sum_{j=1}^{n} C_{out,j} V_{out,j} \qquad \text{and} \qquad L_{in} = \sum_{j=1}^{n} C_{in,j} V_{in,j}$$

where, $V_{in,j}$ and $V_{out,j}$ are the inlet and outlet flow volumes, respectively, during period j
$C_{in,j}$ and $C_{out,j}$ are the representative inlet and outlet pollutant concentrations, respectively, during period j (mg/L)
n is the total number of samples taken during the event

There are several advantages of defining efficiency by SOL%. It is important to become familiar with BMPs' efficiency in reducing loads, since the Chesapeake Bay TMDL will require load reductions of N, P, and sediment, and understanding how to measure BMP load reduction is important in developing policy, determining sites for BMPs, and evaluating strategies for reducing loads. Additionally, SOL% summarizes performance over all of the sampled events, giving it more relevance than comparing individual events.

Descriptions of measurements from individual storm events will refer to the Event Mean Concentrations (EMC) which are calculated as follows:

$$EMC_{out} = \frac{\sum_{j=1}^{n} C_{out,j} V_{out,j}}{\sum_{j=1}^{n} V_{out,j}} \quad \text{and} \quad EMC_{in} = \frac{\sum_{j=1}^{n} C_{in,j} V_{in,j}}{\sum_{j=1}^{n} V_{in,j}}$$

7.0 Reporting

Within two weeks of each event, UVa team will provide the data and event performance criteria to the TJPDC. They will also provide a summary report to the TJPDC. This information will be uploaded to the biofilter Collab website as it is completed. The TJPDC will report the final results of the study to the RRBC. The final report will state the loadings of pollutants removed by the biofilter for the events studied and the efficiency of pollutant removal as a percent ratio of inlet loads to outlet loads.

In order to compare the results of the study to the estimated loads to be removed over a two year and five year period from the NFWF grant proposal (Table 1), extrapolation of the results will be necessary. The report will recognize that extrapolation is a necessarily crude estimation of loadings, as stormwater treatment is highly variable and unpredictable over time for a number of reasons. Variability in stormwater treatment is caused by changes in activity occurring in the drainage area, variable antecedent dry days, variable intensity and duration of rain events, maintenance practices, aging of the system, etc.

To estimate the load of each pollutant removed by the biofilter, TJPDC will develop classes of rain events (by depth) for which average treated loads will be determined. TJPDC will examine all precipitation data collected by the rain gauge at the biofilter site to determine the frequency of rain events occurring in each size range. The average treated load for each size range will then be multiplied by the number of times an event in that range occurred in 2010. The sum of these values will result in the estimated load removed per year.

The report will also provide the average runoff reduction, average reduction in peak flow rate, and the average reduction in the ratio of rising limb time to falling limb time from the inlet to the outlet of the filter. These parameters describe the ability of the BMPs to reproduce the pre-development hydrologic condition.

8.0 Quality Assurance Project Plan

Preface

The following elements making up the Quality Assurance Project Plan (QAPP) outline the specific procedures that will be used to collect data to ensure that the data is of sufficient quality to meet project objectives. The QAPP will address project management, data acquisition, assessment and oversight, data validation and usability. The definition and descriptions of the individual elements of the plan and further guidance can be found in the EPA resources *The Volunteer Monitor's Guide to Quality Assurance Project Plans,* EPA document number **EPA 841-B-96-003** (US EPA, 1996) and *EPA Requirements for Quality Assurance Project Plans,* EPA document number **EPA/240/B-01/003** (US EPA, 2001). Using this QAPP as a guide will ensure the data collected in this study can be analyzed to meet project objectives.

1. **Approval**

Signatories to this page confirm that they have read and are in agreement with the content of this document. Each party agrees to the execution of specific tasks assigned herein.

Project Administrator — Leslie Middleton, September 2, 2010
Leslie Middleton
Rivanna River Basin Commission

Project Coordinator — Erin Yancey LAST
Erin Yancey
Thomas Jefferson Planning District Commission

Project Partner — Janet P Herman O
Dr. Janet Herman
University of Virginia

Project Partner — O
Dr. Joanna Curran
University of Virginia

Project Partner — Teresa B. Culver O
Dr. Teresa Culver
University of Virginia

USEPA QA Officer/ NFWF QA

Signature Denise R. Weingart Webb

Name/date DENISE R. WEINGART WEBB
12/24/10

2. Distribution List

The following individuals will receive the QAPP and are responsible for dissemination to project team members under their oversight as appropriate.

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All methods, method deviations (changes), and/or changes to data collection procedures are approved by the project coordinator, and partners, to ensure consistency and and comparability of data sets for inclusion in the project prior to use. Method deviations or changes to data collection procedures, if needed, are noted in the project journal and available for reference. This assures the integrity of the project findings.

The QAPP is revised if a substantive change affecting the scope, implementation, or assessment of he outcome occurs. The plan and QAPP is then revised to keep project information current. The Project Manager, with assistance of associated personnel, determines the impact of any changes on the technical and quality objective of the project.

All project signatories, project personnel, including field staff, are provided a copy of this QAPP and any subsequent revisions.

3. Problem Definition/Background

The study will determine the runoff reduction and pollutant removal capabilities of the CHS biofilter. This study will satisfy the monitoring requirement of the grant and contribute to the collective knowledge of stormwater management in the Rivanna River basin. The study will also provide a study site for our UVa partners, while they provide important resources to assist in carrying out this monitoring plan. Ms. Yancey will be responsible for all equipment purchase and installation. She will also be responsible for report preparation with respect to documenting this study to the RRBC and NFWF. The UVa team will collect and analyze flow and water quality data. The physical and chemical data and analysis will be promptly provided to Ms. Yancey for use in subsequent reports. The UVa team will retain the right to publish and disseminate the data and their analyses in student theses, conference posters and presentations, and scientific journals. UVa will provide RRBC the option to have publications refer to a generic ‘biofilter in central Virginia.’ The study is not bound by any regulatory requirement.

4. Project/Task Description

The performance of the CHS biofilter will be evaluated by collecting water samples using automatic samplers and flow data using flow meters over a number of rain events. Influent and effluent samples will be analyzed for suspended sediment concentration (SSC), total suspended sediments (TSS), nitrates and phosphates.

TJPDC Responsibilities

TJPDC will work in cooperation with City of Charlottesville staff to install monitoring equipment at CHS when it is received, where it will then be calibrated and tested by the TJPDC. Other members of the study team and members of the RRBC TAC monitoring subcommittee are encouraged to be involved if interested.

With respect to responding to the needs of the NFWF grant and the RRBC, TJPDC will be responsible for making any final decisions on modifications to the study design, data collection or analysis, or other conditions affecting the project, based on input from the study team. TJPDC will update and reissue the QAPP if changes to any element are required.

TJPDC will keep a project journal documenting the details of the study. The journal will document changes in study design, equipment programming, and other decisions affecting the project, and document the processes by which the decisions were made. The journal will serve as a “lessons learned” document that can be used by the RRBC in future studies. TJPDC will also provide photo documentation of monitoring activities and keep electronic and hardcopy records of the data from each rain event.

TJPDC will go to the biofilter at least once per week to monitor equipment for vandalism and other disturbance. TJPDC will address any observed problems or damage immediately. TJPDC will also be available to assist the UVa team in dealing with unforeseen obstacles or other logistical matters as the project progresses.

UVa Responsibilities

UVa students and professors will be responsible for deciding the rain events to sample, the samples to analyze, and the data to be used for the overall study, with input from TJPDC and RRBC.

If chance of rain is greater than 50% and the team intends to collect water samples during the anticipated rain event, student(s) will make sure all of the bottles in the autosamplers contain new bags, make sure tubes are free of debris, confirm that all other equipment is present, maintained and ready for sampling, and load the sampler with ice to preserve the samples. They will program the samplers with the appropriate sampling interval based previous experience with the biofilter flows. They will inform the TJPDC that they intend to sample the particular rain event by text messaging Erin Yancey. If an unexpected event occurs, students will go to the biofilter at their earliest convenience to pack the samplers with ice. Students should use the field data sheet (see Appendix E) for each rain event to document that all of these steps were completed.

The students will then return to the biofilter within 24 hours after the rain event began to collect samples and data. The students will remove sample bags from the autosamplers, label them according to protocol outlined in this appendix, and store them in coolers during transport to the lab. They will put new bags in the autosampler bottles and either turn the equipment off (unless we use solar panels), or leave them to continue to collect samples if rainfall or drainage is still occurring.

The students will also download data from the flow meters for each event at the following site visit, and provide it to TJPDC to allow timely, on-going event analysis as the study progresses. Prompt analysis of event data will inform the study team of any data quality issues. The study team may use that information to adapt its sampling routine, as required, for the remainder of the study.

While in the field, students will on occasion take pictures of their monitoring activities to supplement TJPDC's photos, and take notes on anything out of the ordinary activity. This may include weather or precipitation details that affected sample collection, equipment malfunction, vandalism or storm damage, pipe clogging, instrument obstruction, issues involving the biofilter itself, or any other observation of activity involving the BMP. These notes should be documented on the field checklist.

The students will deliver the samples to Dr. Herman's lab or the Civil Engineering Stormwater Lab at UVa directly from the BMP. They will be refrigerated until analyzed. Samples will be analyzed within 48 hours to prevent degradation. Sampling event forms will be updated. The students will record sample analysis results in the Event Report spreadsheet (See Appendix E).

Once the flow data is retrieved, students will use the discharge data to flow weight water quality incorporate the water quality results with discharge data to determine biofilter performance. Students will calculate reductions in total volume of runoff, peak flow reductions, ratios of rising and falling limbs at influent and effluent, EMC's at the influent and the effluent, and the SOL% for that single event (See Appendix F). This information will be available to the TJPDC within 2 weeks of the event.

Dr. Joanna Curran or her designee will be responsible for mailing or delivering sediment samples to the Occoquan Watershed Monitoring Lab for analysis. The results will be provided to the TJPDC as they are received.

Site Access Considerations
Between the hours of 8AM and 4PM, both TJPDC and UVa study team members must check in at the CHS main office upon arrival. Any other time outside of these hours, the students and/or TJPDC will email Larry Clarke (CHS Assistant Principle) at Lawrence.Clarke@ccs.k12.va.us (along with Leslie Middleton and Erin Yancey) as notification that they will be working on-site.

School Property Behavior Expectations
All partners participating in this project will adhere to the following when on school property:

A. Conduct one's self with civility and decorum.

B. Loud or obnoxious behavior will not be tolerated.

C. Radios shall not be played on any school campus while students or staff are present on campus.

D. Consumption of drugs, alcohol, or tobacco on School property will constitute grounds for the immediate removal of the offender from the site for the duration of the project.

E. Loitering outside of established work hours will not be permitted.

5. Project Schedule (estimated)

Week of June 7	Equipment/flumes received
Week of June 14	Bench test equipment
Week of June 28	Equipment installation commences
Week of July 2	Installation complete
Week of July 23	ISCO representative site visit
Week of August 16	Conclude summer season of biofilter monitoring at CHS
As weather dictates	Commence fall season of biofilter monitoring at CHS

6. Data Quality Objectives for Measurement Data

Data quality will be assessed using the indicators of accuracy, precision, and measurement range for laboratory analysis, and representativeness, completeness, and for the data acquisition process. Accuracy and precision of field activities will be addressed using a field checklist to reduce variability in sample and data collection procedures, but cannot be quantitatively assessed.

Representativeness
Representativeness of water quality samples will be assured by flow weighting concentrations and collecting samples throughout an event. This ensures that the volume of runoff a sample represents is considered in analysis. Rain events can be highly variable however, making it difficult to predict the conditions of any one event, thus representativeness of data collected from each rain event will inherently vary. To minimize this variability across rain events, a representative sampling event for this study will be defined as:

Guideline	Standard
Minimum number of samples	6 influent
Minimum storm depth	0.1 inches

These guidelines will not be strictly adhered to in the data reconciliation process, but will serve as a point of reference. Events that are far from meeting these guidelines may be deemed unrepresentative, which could disqualify them in that process.

Completeness
Monitoring will continue until at least five events are sampled. This number may be revisited if weather conditions preclude this from being possible.

Accuracy and Precision
Data quality objectives of lab analysis of water quality samples are as follows: For each event analyzed, one (one from either autosampler, not both) quality control (QC) blank, and one quality control duplicate will be processed for each analyte. The QC blank for each analyte should be below the minimum detection limit (accuracy). The QC duplicate for each analyte should not exceed 20% +/- maximum relative percent difference (precision).

7. Training Requirement/Certification

TJPDC and the UVa team are the individuals that will be involved in data acquisition. Teresa Culver will oversee student field and lab training, ensuring that each of these individuals is competent in the following:

1) Use and function of the autosamplers
2) Use and function of the flow meters
3) Use and function of the rain gauge
4) Collection and handling of water samples
5) Knowledge of BMP function and design
6) Processing samples for analysis
7) Awareness and compliance with confined entry regulations

Additionally, the student team will also possess competency in:

1) Use of CHEMetrics Kits
2) Vacuum filtration assembly, use of vacuum pump and drying oven

8. Documentation and Records

The documentation associated with this QAPP (listed below) will be stored electronically on the UVa Collab website that is backed up hourly, and hard copy in a project binder. Key partners

(TJPDC, RRBC and other interested parties) will be given access to this site. This documentation will be provided to the RRBC following the conclusion of the study, and kept for three years following the conclusion of the grant. The documentation will include:

1) Water quality sample analysis results for analyzed rain events
2) Water quality sample analysis results for quality control
3) Flow rate and precipitation data for analyzed rain events
4) Event reports
5) Field checklists
6) Final Report
7) Project journal
8) Photo documentation

9. Sampling Process Design

Qualifying Event Criteria.
All rain events are considered to qualify for data acquisition for use in this study, provided that they meet the 0.1 inch precipitation depth established in Item 6. The runoff events to be sampled will be chosen by the UVa team, as they will be following the weather forecast, and are familiar with the schedules of the student monitoring team.

Special attention should be paid to large storm events at the biofilter. If the biofilter ponds water to the depth of the outlet riser structure, then outflow water will not have received full treatment through the biofilter media. However, bypassing through the riser does not disqualify an event for use in this study.

Flow Rate Monitoring Design.
Flow rate will be measured continuously at the inlet and outlet of the biofilter throughout each rain event using flow meters. A Palmer Bowlus flume will be connected to the inlet and outlet pipes at the point of discharge and a bubble line from the bubbler flow meter will measure the height of water passing through the flume, and convert the height to flow rate. The flow meter will log a continuous record of flow rate throughout the rain events.

The biofilter has been observed to backwater (i.e. flow back up the inlet pipe) during some rain events. To avoid backwater in the flume, an upward bend was added to the influent to the biofilter to raise the flume to an appropriate elevation to prevent inundation of the flume. Attempts will be made to determine the range and type of storm events in which backwatering and overflow through the riser occur.

Water Quality Monitoring Design.
Autosamplers will be installed at the inlet and outlet of the BMP and extract samples from the same location that flow rate is measured. The autosamplers will be programmed to initiate sampling by indication from the flow meter that initial runoff is entering the BMP. The autosampler program will then switch to a time interval for collection of discrete samples. Based on a configuration of 24 1-liter bottles, the autosampler at the inlet end can be programmed to capture the first flush by collecting samples on short time intervals for 30 minutes and then longer intervals can be used. The flow data from earlier events will suggest appropriate time or

volume intervals for the inflow and outflow of the biofilter. This information can help in choosing the intervals for which the autosampler should be programmed. The time or volume interval may change based on the amount of rain forecasted for a given event.

The autosampler on the outlet end will not need to be programmed to capture the first flush. The study team will have the flexibility to change the time interval, or switch to using a volume interval to collect samples as they deem appropriate to achieve the most representative samples.

10. Sampling Methods Requirements

Table 3. Sample Methods Requirements

Matrix	Parameter		Equipment	Sample Holding Container	Preservative	Max. Holding Time
Water	Flow Rate (Q)	Runoff reduction, Increased time to peak, Increased falling limb of hydrograph	Bubbler Flow Meter and mounting rings	n/a	n/a	n/a
			Battery x2			
			Solar Panels			
			Flowlink software			
			Autosampler + 24 bottles, suction line, battery conn. cable, sampler/flow meter conn. cable, USB cable, Whirlpak bags	Plastic Whirlpak bag lined 1-L plastic bottles with caps		
	Nitrogen	Nitrate			refrigeration	48 hours
	Phosphorus	Orthophosphate			refrigeration	48 hours
		Particulate bound orthophosphate				
	Sediment	SSC			refrigeration	7 days
			Equipment housing			
	Precipitation		Rain gauge	n/a	n/a	n/a

Automated Equipment

Influent and effluent samples will be collected using ISCO 6712 Portable Automated Samplers with a 24, 1-liter polypropylene bottle configuration. The autosamplers are equipped with vinyl suction lines that are secured by stainless steel sampling pipes that are mounted to the flumes. Flow rate will be measured using ISCO 4230 Bubbler Flow Meters equipped with a vinyl bubble line. The bubble is secured to the flume in a stainless steel bubbler pipe. An ISCO 674 Tipping Bucket Rain Gauge is connected to the flow meter. The flow meter and autosampler are connected by a cable, and the flow meter is connected to a 12VDC deep cycle marine battery to power the suite of equipment. Specifications of the flow meter, autosampler and rain gauge can be found in Appendix C.

Sample Collection Program

Sampling of influent and effluent stormwater from the biofilter will involve the collection of the first flush and time-paced discrete samples by the automatic samplers over the course of a rain event. A subset of the discrete samples may be analyzed to best represent the event. The record of when each sample was taken in relation to the hydrograph will dictate which samples to analyze to best represent the rain event. Event Mean Concentrations (EMC) will be calculated for influent and effluent for each event using the lab analytical results.

The automatic samplers will be paced on a time or volume interval, and the inlet and outlet intervals do not have to be the same, as discharge rates will be very different from the inlet to the outlet. Due to variability between rain events, sample interval length/volume may change continually throughout the study based on weather forecast and lessons learned from previous rain events on how to capture samples that are the most representative of the rain event. TJPDC will document the reason for changing the interval in the project journal, *only* if there is a reason other than to appropriately accommodate the expected intensity and/or duration of each event. The project journal and raw data (from which the sampling interval for each event will be evident) will reside with the final disposition of the QAPP, allowing readers to review the processes that determined a change to the sample interval was needed. Where no information is found about the change in sampling interval, it should be assumed that the interval was changed to accommodate the expected intensity and/or duration of the event.

Subsample Creation
A splitter will be used to perform a replicate analysis for SSC.

11. Sample Handling

It is important that each sample is handled so that it is not contaminated and is labeled for easy tracking and organization. The students will label each sample with a Sharpie upon removal from the autosampler before placing it in the cooler for transport. Each sample will be labeled according to the following:

Location: CHS
Date of Collection: mm/dd/yy
Sampler orientation: inlet = I; outlet = O
Bottle number: 1 – 24

Example label:
CHS
07/22/10
I
12

Handling
Students will remove the Whirlpak bags that contain the samples from the bottles in the autosamplers and tie down the twist-tie without making contact with the water inside. Each bag will be labeled and placed in a cooler to be transported to the lab. The samples will be taken straight to the lab from the BMP site, and refrigerated until analyzed. All samples will be analyzed within 48 hours to prevent degradation of nutrients. SSC may occur within a week of collection. Samples should not be analyzed if:

- The integrity of the samples is compromised (e.g., leaks, cracks, sample or cooler becomes grossly contaminated, obvious odors, etc.)
- Samples were not refrigerated

With the exception of SSC, these analyses will be performed on an aliquot of sample poured from a well mixed Whirl-Pak bag (turned end-over-end by hand several times immediately prior to pouring aliquot) into a vial provided with the test kit. The remainder of the sample will be left in the bag for subsequent turbidity (TSS) and SSC analyses. All samples will be stored in a refrigerator prior to and following removal of aliquots until final consumption of sample volume for SSC determination.

Custody
Sample custody will be indicated on the field and laboratory sheets.

12. Analytical Methods Requirements

The field equipment stores data with respect to time of sample collection, discharge rates and precipitation. The UVa team will be responsible for downloading the data and providing it to the TJPDC. Bottle number and time of fill is stored in the autosamplers. Discharge data (volume/time) is stored in the flow meter memory. Precipitation data will consist of 0.01-inch resolution measurement of rainfall and will be stored in the memory of the flow meter.

Sample analysis will be handled by the UVa students, under the supervision of Dr. Janet Herman, Dr. Joanna Curran and Dr. Teresa Culver. Analytical methods for sample analysis are shown in Table 2 of this document, and the data quality objectives for sample analysis are described in Item 6 of the QAPP. Specific details on the execution of these analyses are as follows:

Nitrates

CADMIUM REDUCTION/AZO DYE FORMATION METHOD

Nitrate Vacu-vials® Kit

K-6903: 0.20 - 1.50 ppm N
K-6923: 0.40 - 3.00 ppm N
K-6933: 5.0 - 50.0 ppm NO_3

Instrument Set-up
For CHEMetrics photometers, follow the instrument specific **Setup and Measurement Procedures** in the Operator's manual. For spectrophotometers capable of accepting a 13 mm diameter round cell, follow the manufacturer's specifications to set the wavelength to 520 nm and to use the ZERO ampoule supplied with this test kit to zero the instrument.

Safety Information
Read MSDS before performing this test procedure. Wear safety glasses and disposable gloves.

Sample Preparation for K-6933 Only
Using the syringe, measure and dispense 2 mL of the sample to be tested into the reaction tube. Dilute to the 15 mL mark with distilled water. Perform the test procedure below beginning with Step 2.

Test Procedure

1. Fill the **reaction tube** (green screw cap tube) to the 15 mL mark with the sample to be tested.


Figure 1

2. Empty the contents of one Cadmium Foil Pack into the reaction tube (fig 1). Cap the reaction tube and shake it vigorously for exactly **3 minutes.** Allow the sample to sit undisturbed for **2 minutes**.
3. Pour 10 mL of the treated sample into the empty **25 mL sample cup** (fig 2), being careful not to transfer any cadmium particles to the sample cup.

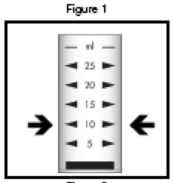
Figure 2

4. Place the Vacu-vial ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. The ampoule will fill leaving a small bubble to facilitate mixing (fig 3).

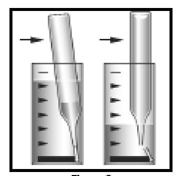
Figure 3

5. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end. Dry the ampoule and wait **10 minutes** for color development.
6. Read the Vacu-vial ampoule in your photometer. If applicable, use the calibration table to obtain test results. Accuracy may be compromised if test results are outside the stated test ranges.

Test Method
The Nitrate Vacu-vials®[1] test kit employs the cadmium reduction method.[2,3,4] Nitrate is reduced to nitrite in the presence of cadmium. In an acidic solution, the nitrite diazotizes with a primary aromatic amine and then couples with another organic molecule to produce a highly colored azo dye. The resulting pink-orange color is proportional to the nitrate concentration. For K-6903 and K-6923, results are expressed in ppm (mg/Liter) nitrate-nitrogen, NO_3-N. For K-6933, results are expressed in ppm (mg/Liter) nitrate, NO_3.

Samples containing nitrite will give erroneous, high test results. Samples containing in excess of 2000 ppm chloride will give low test results. Certain metals, chlorine, oil and grease will also give low test results.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 20th ed., p. 4-117, method 4500-NO_3^- E (1998)
3. ASTM D 3867 - 04, Nitrite-Nitrate in Water, Test Method B
4. EPA Methods for Chemical Analysis of Water and Wastes, method 353.3 (1983)

CHEMetrics, Inc., 4295 Catlett Road, Calverton, VA 20138-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856; E-Mail: orders@chemetrics.com
www.chemetrics.com

Dec. 08, Rev 12

Orthophospates

MOLYBDENUM BLUE/STANNOUS CHLORIDE METHOD

Phosphate Vacu-vials® Kit

K-8513 (V-2000 Photometer): 0.30 - 8.00 ppm PO_4
K-8513 (V-2000 Photometer): 0.10 - 2.64 ppm P
K-8513 (Spectrophotometer): 0.20 - 5.00 ppm PO_4

Instrument Set-up

For CHEMetrics photometers, follow the instrument specific **Setup and Measurement Procedures** in the Operator's manual. For spectrophotometers capable of accepting a 13 mm diameter round cell, follow the manufacturer's specifications to set the wavelength to 690 nm and to use the ZERO ampoule supplied with this test kit to zero the instrument.

Test Procedure

1. Fill the sample cup to the 25 mL mark with the sample to be tested (fig 1).
2. Add 2 drops of A-8500 Activator Solution (fig 2). Cap the sample cup and shake it to mix the contents.
3. Place the Vacu-vial ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. The ampoule will fill leaving a small bubble to facilitate mixing (fig 3).
4. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end. Dry the ampoule and wait **3 minutes** for color development.
5. Read the Vacu-vial ampoule in your photometer. If applicable, use the calibration table to obtain test results in ppm (mg/Liter) phosphate as PO_4. Accuracy may be compromised if test results are outside the stated test range.

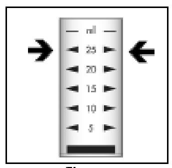

Figure 1

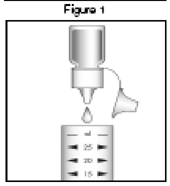
Figure 2

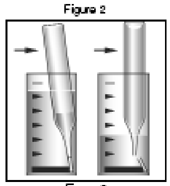
Figure 3

Test Method

The Phosphate Vacu-vials®[1] test kit employs the stannous chloride chemistry.[2] In an acidic solution, ortho-phosphate reacts with ammonium molybdate to form molybdophosphoric acid, which is then reduced by stannous chloride to the intensely colored molybdenum blue. The resulting blue color is directly proportional to the phosphate concentration.

Condensed phosphates (pyro-, meta- and other polyphosphates) and organically bound phosphates do not respond to this test. Sulfide, thiosulfate, and thiocyanate will cause low test results.

1. Vacu-vials is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 21st ed., method 4500-P D (2005)

Safety Information

Read MSDS before performing this test procedure. Wear safety glasses and disposable gloves.

CHEMetrics
Water Analysis Systems

www.chemetrics.com
4295 Catlett Road, Calverton, VA 20138-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856
E-Mail: orders@chemetrics.com

Sept. 09, Rev. 14

Phosphomolybdate, Method 10209 (HACH, 2010):
The UVA lab may switch to HACH brand analysis kits to measure orthophosphate, depending on availability. The HACH kits use the Phosphomolybdate, Method 10209 to determine orthophosphates concentrations in water samples. The reactive or orthophosphate ions react with molybdate and antimony ions in an acidic solution to form an antimonyl phosphomolybdate complex, which is reduced by ascorbic acid to phosphomolybdenum blue. Test results are measured at 890 nm.

An eight page, step-by-step instructions guide on using the HACH kit can be found at the following link: http://www.hach.com/fmmimghach?/CODE%3ADOC316.53.0112415665|1

Sediment

Suspended Sediment Concentration (SSC)
UVA will use the ASTM D3977-97 (2007) standard for measuring SSC. TJPDC and UVA have copies of the ASTM standard methodology on file.

1) Take the sample in the bottle. First process for nutrients.
2) Record the sample volume.
3) Weigh a dry filter and record weight. Mark the sample ID on the edge of the filter.
4) Set up a funnel to a flask with a filter holder and filter in place
5) Pour sample through filter. You will have to do this in steps and you may need to rinse the sample container to get the entire sample out. At this point in the analysis extra water does not matter because you already recorded the sample volume. It matters most that all the sediment sample get to the filter. It is fastest to use a vacuum pump with the filter assembly.
6) Remove filter and place in drying oven.
7) When the filter with sample is dry (overnight usually), remove and re-weigh
8) The difference in the two filter weights is the weight of the suspended sediment.
9) Divide the sediment weight by the sample volume for suspended sediment concentration.

Supplies:
Vacuum filtration assembly, filters, vacuum pump, 47mm diameter, filter paper

Total Suspended Solids
A calibration curve for conversion of turbidity in NTU to TSS in mg/L will be developed from the TSS determinations. Turbidity will be measured using an Oakton T-100 Portable Turbidimeter calibrated to a manufacturer's standard provided in the test kit. This measurement will be performed on an aliquot of sample poured from a well mixed Whirl-Pak bag (turned end-over-end by hand several times immediately prior to pouring aliquot) into the vial provided in the test kit. The remainder of the sample will be left in the bag for subsequent SSC analyses. All samples will be stored in a refrigerator prior to and following removal of aliquots until final consumption of sample volume for SSC determination. Janet Herman may be contacted for details on the conversion from NTU to TSS.

Total Petroleum Hydrocarbons (TPH)

NIOSH 1500 GC/FID
TPH will be analyzed by Analytics lab using the NIOSH 1500 GC/FID method. This method employs gas chromatography to measure several volatile organic compounds. An eight page, step-by-step instructions guide on this method can be found at:
http://www.cdc.gov/niosh/docs/2003-154/pdfs/1500.pdf

13. Quality Control Requirements

Quality control of the field processes will be ensured as best as possible by completion and review of field checklist for each monitored event. The student(s) responsible for each event will complete the checklist. Completeness and consideration of comments will indicate the quality of fieldwork for the event. Problems with field quality discovered through review of field checklists will be brought to the attention of the professor supervisory team, and addressed in the appropriate manner for future sampling events. These corrective measures, as well as any others, involving equipment, or lab activities, for example, will be logged in a "QAPP Corrective Measures Log" that will assist the team in the data verification, validation, and reconciliation process.

Table 4. Quality control process samples.

QC Sample Type	Process	Frequency	Requirement	Follow-up	Responsible Party
Field Blank	Load 800 mL of clean water into a whirlpak bag at the lab. Label "Field Blank". Transport to BMP in cooler. Carefully pour clean water into an unused Whirlpak lined bottle in the autosampler without making contact with water. Process as with the other samples, but make sure to label that bag "Field Blank".	Once during biofilter study	Concentration ≤ a factor of 5 below all sample results	Review/Revise sample handling protocol	Uva
Sample Processing Blank	Load 800 mL of clean water into a Whirlpak bag at the lab. Label "Processing Blank". Process and analyze as with other samples.	Prior to first event analyzed, and one additional time	Concentration < a factor of 5 below all sample results	Review/Revise sample processing protocol	Uva

See "Accuracy and Precision" in Item 6 of the QAPP for sample analysis quality control protocols.

Quality Control of Electronic Data.
Metadata will be completed for electronic data associated with this project. The metadata will include the reasons for data collection, and clearly indicate the intended use of the data.

14. Instrument and Equipment Testing, Inspection and Maintenance Requirements

Extra sets of desiccant and printer paper will be kept on site in the storm boxes.

Table 5. Instrument and Equipment Testing, Inspection and Maintenance Requirements

Instrument	Test	Inspection Item	Maintenance	Frequency	Responsible Party
ISCO 6712 Portable Autosampler	Run diagnostics	desiccant; pump tubing; damage to dispenser arm	Replace	biannually	TJPDC
ISCO 4230 Bubbler Flow Meter	Visual check	Desiccant; tubing condition; printer roll; bubble rate	Dry desiccant; replace or purge tubing and printer paper; Adjust bubble rate to 1/min.	Each time the storm box is opened (visual); bubble rate - biannually, or after any maintenance	UVA and TJPDC

ISCO 674 Rain Gauge	Confirm Output	Mechanical operation; occlusion	Remove funnel, inspect/remove for foreign material	Monthly	TJPDC
12vDC Deep Cycle Marine Battery	Check voltage through autosampler or flow meter	Charge should be 11.5 Volts or higher	Recharge	before sampling an event during times of extended cloud cover	TJPDC

15. Instrument Calibration and Frequency

Calibration of laboratory sample analytical equipment will be performed by the UVa team. Calibration of field equipment will be performed by the TJPDC. Calibration should be performed according the manual instructions.

Table 6. Instrument Calibration and Frequency

Instrument	Calibration Process	Frequency
ISCO 6712 Portable Autosampler	Calibrate pump control software according to manual instructions	Prior to initial event analysis; additionally if improper volume of sample is discovered during sampling
ISCO 4230 Bubbler Flow Meter	Zeroing out of water level; bubble frequency, 1/second	Annually
ISCO 674 Rain Gauge	Factory calibrated; return to factory if recalibration is necessary	Calibrated when purchased; additional if needed
Chemetrics V-2000 Photometer	Calibration per manufacturer's instructions	Prior to initial sample analysis

16. Inspection/Acceptance Requirements for Supplies

The UVa team will supply Whirlpak bags to use in the autosampler bottles to avoid the need to clean the bottles after each rain event. Chemetrics kits (or other appropriate kits) for sample analysis will be purchased by TJPDC or UVa, as necessary. The Whirlpak bags and Chemetrics kits will be stored in Dr. Herman's lab or the Thornton Hall Stormwater Lab to be kept clean and dry prior to use, so as to prevent contamination. Only new supplies will be used in the study. Whirlpak bags are not to be reused in the autosampler bottles.

17. External Data Acquisition Requirements

All data that is collected as part of this project involves direct measurement of site conditions (precipitation, flow rate, water quality). Excluding precipitation, no other data exists that can be substituted in this study. In the event that precipitation data is lost and not recoverable, precipitation data will be obtained from another climatology station near to the site.

Precipitation data may be available from another rain gauge at CHS, to be installed at a future time.

18. Data Management

The following field data will be collected over the course of this project:

- Influent and effluent hydrographs
- Sample collection time stamps for influent and effluent
- Precipitation data

Field data will be collected and stored by the flow meter until downloaded by the UVa student team to the UVA laptop. Data should be downloaded at the next site visit following the end of the rain event to ensure the instruments have time to log all information related to the event, including effluent flow rate, which may continue for several days following the end of the event.

The flow meter is programmed to collect data on five minute intervals and can only store up to 31 days of flow data. Data should be downloaded to the student team laptop at least twice per month to avoid data loss. After 31 days, new data will start overwriting old data.

Sample analysis data will also be generated by the UVa student teams. The students will store the analysis results in the Event Report spreadsheet (see Appendix E).

Field and lab data from each sampled event will be stored on a password protected website internal to UVa. UVa will provide TJPDC with the password to the site. Kristen Cannatelli will inform the TJPDC when all data and event reports from individual sampled events are available on the site. TJPDC will download the electronic data to the TJPDC server where it will be stored in a dedicated file. TJPDC will also keep hard copy records of all data in a project binder. Data on the TJPDC server will be backed up daily.

19. Assessments and Response Actions

For any of the three categories below, assessment findings that require response actions will be reviewed with the UVa professors, who will collaborate with the TJPDC to devise reasonable corrective measures. Corrective measures will be documented in the "QAPP Corrective Measures Log", which will reside with the final disposition of the QAPP. Any action that requires modification to the QAPP will result in a reissuance of the document to signatories.

Analytical data

The quality of analytical data will be assessed by comparison of quality control samples to the water quality samples analyzed for the study. Additionally, the undergraduate team should be supervised by Kristen Cannatelli during analysis for at least the first rain event analyzed. Any observed errors should be corrected with reasonable assurance that they will not occur in the future. TJPDC will be responsible for reviewing analysis data provided by the UVa lab and communicating any issues to the professors. If issues are identified, corrective actions may include:

- Retraining of student on lab methods
- Removal of data from the dataset to be used for analysis, interpretation, and reporting. Data suspected to have incurred errors during the collection or analysis processes will be stored separately with sufficient language to accurately describe the reason(s) for the error, if found, but not less than a brief description of the issue(s).
- Modification of analytical method

Field Data

Proper operation of equipment in the field will be the responsibility of the TJPDC and will be ensured through the calibration, inspection and maintenance protocols. In the event any issues are identified, they will be addressed through the processes outlined in Items 15 and 16 of this document. Additionally, TJPDC will accompany the student team on several site visits to ensure data acquisition occurs according to the protocol outlined on the field checklist. If error is observed in the field, it will be corrected by onsite communication with students. Modification will be made to the field checklist, if necessary.

Data Management

TJPDC will be responsible for assessing data management processes. If issues arise where data provided to the TJPDC is incomplete, untimely or otherwise inadequate, corrective action may be necessary.

20. Reports

The TJPDC will make quarterly progress reports to the RRBC. These reports will include work completed, work outstanding, project successes, challenges and lessons-learned. Work completed will include quality assurance activities such as review of completed field checklists, site visits where TJPDC accompanies students, inspection and maintenance of equipment, etc. Project challenges will include any quality assurance issues, and how they were corrected.

Individual rain event data analysis results will be available at the UVA Collab website for the biofilter (https://collab.itc.virginia.edu/portal), and a project journal documents important decisions, pictures, and notes (http://chsbiofilter.wordpress.com/wp-login.php?redirect_to=http%3A%2F%2Fchsbiofilter.wordpress.com%2Fwp-admin%2Findex.php&reauth=1). The username for the journal is chsbiofilter, and the password is 123biofilter.

A final report of the biofilter study will also be submitted to the RRBC. It will include the objectives, methodology, results and discussion of results of the study, and will be accompanied by the field, lab and quality assurance data collected in the study.

21. Data Review, Validation and Verification Requirements

Data collected for the study will be reviewed by the TJPDC on a continual basis. Validation and verification will be conducted by the TJPDC, and Kristen Cannatelli or a participating faculty member. Validation will occur with each event report and verification will occur at the conclusion of the sampling period.

22. Validation and Verification Methods

Any invalidations resulting from the measures below will be documented in the next quarterly report and the project journal. The following process will be used:

- Check for obvious transcription errors. Correct errors immediately.
- Check for errors in EMC calculations. Correct errors immediately.
- Check for nonsensical data and outliers using best professional judgment.
- Check quality assurance documentation for each sampled rain event to include lab quality control results and field checklists. The reviewers will use their best professional

judgment when invalidating data based on inconsistent or incomplete information provided by these documents.

23. Reconciliation with Data Quality Objectives

TJPDC will select the rain events to use in the final report to the RRBC. This will also take place after the sampling period end. Validated and verified events will be assessed using the data quality objectives defined in Section 6 of the QAPP. These include representativeness, completeness, precision and accuracy. Events that meet the data quality objectives as described in Section 6 will be accepted for use in data analysis and interpretation. TJPDC will consider using data from events that do not meet the data quality objectives after discussing the reasons for their disqualification with the study team. The decision to use, or disqualify data that do not meet the data quality objectives will be made on the best professional judgment of the TJPDC. Reasons for disqualification of data will be documented in the project journal.

Reconciliation of the data with the data quality objectives will result in a collection of data that is verified and validated for the use of defining the runoff reduction and pollutant removal capabilities of the biofilter.

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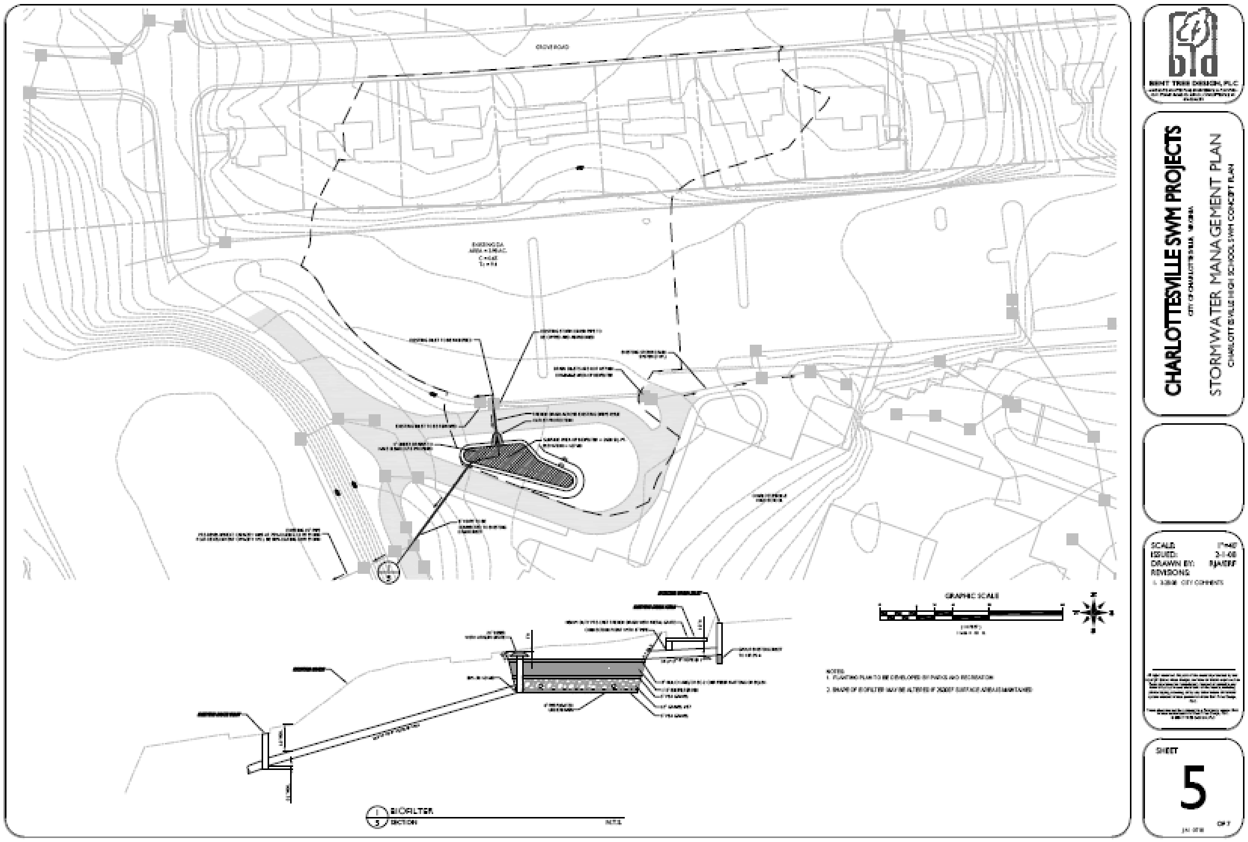
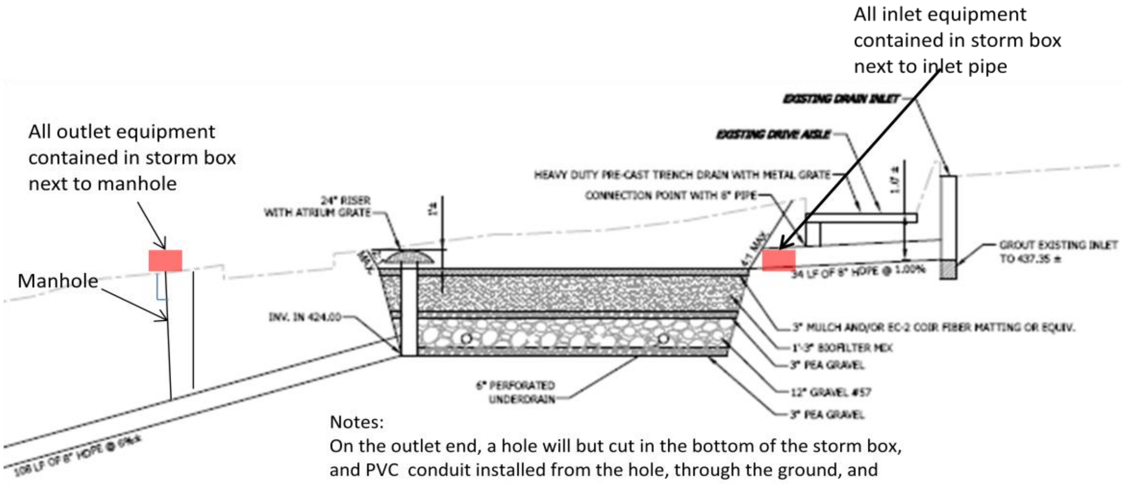
Appendix A
Biofilter Site Plan and Monitoring Schematic



Monitoring Schematic



Notes:

On the outlet end, a hole will but cut in the bottom of the storm box, and PVC conduit installed from the hole, through the ground, and into a hole cut out of the side of the manhole . Hoses and cords will run through this conduit directly, so that they are not exposed to the public.

Pipe entering manhole on outlet end is not as pictured. It was constructed on a 1-2% slope.

Each storm box is to contain a flow meter, auto sampler, and battery. The outlet end box will contain a rain gauge.

Appendix B

Biofilter Design Specifications

CHS Biofilter Detention *Rainfall Duration=10 min, Inten=5.37 in/hr*

Prepared by {enter your company name here}

HydroCAD® 8.00 s/n 005075 © 2006 HydroCAD Software Solutions LLC 5/20/2009

Pond 2P: Biofilter

Inflow Area =	3.989 ac,	Inflow Depth = 0.58"	
Inflow =	14.05 cfs @	0.16 hrs, Volume=	0.193 af
Outflow =	2.44 cfs @	0.30 hrs, Volume=	0.190 af, Atten= 83%, Lag= 8.1 min
Primary =	2.44 cfs @	0.30 hrs, Volume=	0.190 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 427.04' @ 0.30 hrs Surf.Area= 2,651 sf Storage= 6,791 cf

Plug-Flow detention time= 33.5 min calculated for 0.189 af (98% of inflow)
Center-of-Mass det. time= 33.7 min (43.4 - 9.7)

Volume	Invert	Avail.Storage	Storage Description
#1	424.00'	9,857 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
424.00	1,851	20.0	0	0
427.00	2,600	100.0	6,677	6,677
428.00	3,761	100.0	3,181	9,857

Device	Routing	Invert	Outlet Devices
#1	Primary	424.00'	**8.0" x 105.0' long Culvert** RCP, mitered to conform to fill, Ke= 0.700 Outlet Invert= 417.50' S= 0.0619 '/' Cc= 0.900 n= 0.010 PVC, smooth interior
#2	Primary	427.50'	**24.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=2.44 cfs @ 0.30 hrs HW=427.04' (Free Discharge)
1=Culvert (Inlet Controls 2.44 cfs @ 6.99 fps)
2=Orifice/Grate (Controls 0.00 cfs)

Appendix C - Equipment Specifications

Isco 674 Rain Gauge Specifications	
Type:	Tipping bucket
Compatible equipment:	Isco 6700, 6712, and Avalanche Samplers, 4200 Series Flow Meters, 4100 Series Flow Loggers
Connect cable:	50 ft. (15.2 m), 2 conductor with 4-pin plug
Bearings:	Spring-loaded sapphire jewel
Orifice Diameter:	8 in. (20 cm)
Sensitivity:	English - 0.01 inch; Metric 0.1 mm
Accuracy:	English - ±1% at 2 in/hour; +3%/-4% up to 5 in/hour Metric - ±1.5% at 5 cm/hour; +3.5%/-9% up to 13 cm/hour
Capacity:	English – 22 inches/hour Metric – 38 cm/hour
Output Signal:	Contact closure of at least 50 millisecond duration
Switch Type:	Hermetically sealed magnetic proximity switch. Normally open, 200V DC, 0.5 A maximum.
Height:	13 in. (33 cm)
Diameter:	9.5 in. (24 cm) (at mounting base)
Weight:	10 lbs. (4.5 kg)
Operating Temperature:	32° to 140°F (0° to 60°C)
Storage Temperature:	-40° to 140°F (-40° to 60°C)

Specifications

Isco 6712 Full-size Portable Sampler	
Size (Height x Diameter):	27 x 20 inches (50.7 x 68.6 cm)
Weight:	Dry, less battery - 32 lbs (15 kg)
Bottle configurations:	24 - 1 Liter PP or 350 ml Glass 24 - 1 Liter ProPak Disposable Sample Bags 12 - 1 Liter PE or 950 ml Glass 8 - 2 Liter PE or 1.8 Liter Glass 4 - 3,8 Liter PE or Glass 1 - 9,5 Liter PE or Glass 1 - 5.5 gallon (21 Liter)PE or 5 gallon (19 Liter) Glass, (with optional Jumbo Base)
Power Requirements:	12 V DC (Supplied by battery or AC power converter.)
Pump	
Intake suction tubing: Length Material Inside dimension	 3 to 99 feet (1 to 30 m) Vinyl or Teflon 3/8 inch (1 cm)
Pump tubing life:	Typically 1,000,000 pump counts
Maximum lift:	28 feet (8.5 m)
Typical Repeatability	±5 ml or ±5% of the average volume in a set
Typical line velocity at Head height: of 3 ft. (0.9 m) 10 ft. (3.1 m) 15 ft. (4.6 m)	 3.0 ft./s (0.91 m/s) 2.9 ft./s (0.87 m/s) 2.7 ft./s (0.83 m/s)
Liquid presence detector:	Non-wetted, non-conductive sensor detects when liquid sample reaches the pump to automatically compensate for changes in head heights.

Controller	
Weight:	13 lbs. (5.9 kg)
Size (HxWxD)	10.3 x 12.5 x 10 inches (26 x 31.7 x 25.4 cm)
Operational temperature:	32° to 120°F (0° to 49°C)
Enclosure rating:	NEMA 4X, 6 (IP67)
Program memory:	Non-volatile ROM
Flow meter signal input:	5 to 15 volt DC pulse or 25 millisecond isolated contact closure.
Number of composite samples:	Programmable from 1 to 999 samples.
Clock Accuracy:	1 minute per month, typical, for real time clock
Software	
Sample frequency:	1 minute to 99 hours 59 minutes, in 1 minute increments. Non-uniform times in minutes or clock times 1 to 9,999 flow pulses
Sampling modes:	Uniform time, non-uniform time, flow, event. (Flow mode is controlled by external flow meter pulses.)
Programmable sample volumes:	10 to 9,990 ml in 1 ml increments
Sample retries:	If no sample is detected, up to 3 attempts; user selectable
Rinse cycles:	Automatic rinsing of suction line up to 3 rinses for each sample collection
Program storage:	5 sampling programs
Sampling Stop/Resume:	Up to 24 real time/date sample stop/resume commands
Controller diagnostics:	Tests for RAM, ROM, pump, display, and distributor

Isco 4230 Specifications

Flow Meter

Size (H x W x D) (without power source)	15.5 in x 11.5 in x 10.5 in	39.4 cm x 29.2 cm x 26.7 cm
Weight (without power source)	19.1 lbs	8.6 kg
Material	High-impact molded polystyrene structural foam	
Enclosure (self-certified)	NEMA 4X	IP65
Power	12 to 14V DC, 16 mA average at 12.5V DC (printer set at 1 in/hr (2.5 cm/hr), 1 bubble per second, 15 minute purge, and continuous level reading interval)	
Typical Battery Life	(printer set at 1 in/hr (2.5 cm/hr), 1 bubble per second, 15 minute purge, and continuous level reading interval)	
934 Nickel-Cadmium Battery	7 to 10 days	
946 Lead-Acid Battery	10 to 15 days	
948 Lead-Acid Battery	60 to 90 days	
Program Memory	Non-volatile, programmable flash; can be updated via interrogator port without opening the enclosure	
Display	Backlit LCD, 2-line, 80-character	
Level-to-Flow Rate Conversions		
Weirs	V-notch, rectangular with and without end contractions, Cipolletti, Isco Flow Metering Inserts	
Flumes	Parshall, Palmer-Bowlus, Leopold-Lagco, Trapezoidal, H, HS, HL	
Manning formula	Round, U-channel, rectangular, trapezoidal	
Data Points	Four sets of 50 level-flow rate points	
Equation	Two-term polynomial	
Totalizers		
LCD	9-digit, floating decimal point, resettable	
Mechanical	7-digit, non-resettable (optional)	
Rain Gauge Input	Contact closure, normally open	
Resolution	0.01 or 0.004 in	0.25 or 0.1 mm
Parameter Inputs	pH, dissolved oxygen, conductivity, and temperature (with optional YSI 600 Multi-Parameter Water Quality Monitor); pH and temperature (with optional Isco 201 Parameter Module); or dissolved oxygen and temperature (with optional Isco 270 Parameter Module)	
Sampler Activation Conditions	Enabled, disabled, AND and OR combinations of any two of level, flow rate, rainfall, pH, DO, conductivity, and temperature	
Sampler Pacing Output	12V pulse	
Sampler Input	Event mark, bottle number	
Printer		
Recording Modes	Up to 3 graphs of level, flow rate, pH, DO, conductivity, and temperature vs time; includes totalized flow. Rainfall and sampler events (time and bottle number) are also recorded	
Speed	Off, 0.5, 1, 2, 4 in/per hour	Off, 1.25, 2.5, 5, 10 cm/per hour
Recording Span	User selectable with multiple over-ranges	
Resolution	1/240 of recording span	
Reports Printed	Flow meter program, 2 independent time interval reports, flow meter history, sampler history	
Interval Report Contents	Site number; time interval; total flow; minimum, maximum, and average flow rate, level, pH, DO, conductivity, and temperature, and time of occurrence; interval flow; total rainfall; number of samples, flow meter history and sampler history	
Character Size	0.09 in high x 0.07 in wide (2.4 mm x 1.7 mm), 12 pitch	
Paper	4.5 in wide x 58 ft. (11.4 cm x 17.7 m) plain white paper, replaceable roll	
Ribbon	19.7 ft (6.0 m) black nylon, replaceable	
Data Storage Memory Capacity	80,000 bytes (approximately 40,000 readings) divided into a maximum of 12 memory partitions; equal to 100 days of level, rainfall, pH, DO, conductivity, and temperature readings at 15 minute intervals, plus 3,000 sample events.	
Setup and Data Retrieval	Isco Flowlink® software	
Communication	Direct connection, optional internal 2400 bps telephone modem with voice messaging, or optional spread spectrum wireless module	
Data Retrieval (optional)	Isco 581 Rapid Transfer Device (RTD)	
Voice Messaging (with optional internal telephone modem)	Calls up to 5 telephone numbers with programmable delay between calls, activated based on AND and OR combinations of any two of level, flow rate, rainfall, pH, DO, conductivity, and temperature	
Analog Outputs (optional)	Up to 3 isolated internal outputs, 0 to 20 mA or 4 to 20 mA, scaleable based on level, flow rate, pH, DO, conductivity, or temperature, into a maximum of 750 ohms each	
Relay Outputs	2 form C relays with field selectable trip points based on flow rate (with optional High/Low Alarm Relays)	
Serial Output	Current status and readings, in response to command or automatically at selectable time intervals, ASCII comma separated values at 1200, 2400, 4800, or 9600 bps	
Operating Temperature	0° to 140°F	-18° to 60°C
Storage Temperature	-40° to 140°F	-40° to 60°C

Bubbler

Range	0.01 to 10 ft		0.003 to 3.05 m	
Level Measurement Accuracy Linearity, Repeatability, and Hysteresis at 72°F (22°C)	**Level***	**Error**	**Level***	**Error**
	0.01 to 1.0 ft	±0.005 ft	0.003 to 0.31m	±0.002 m
	0.1 to 5.0 ft	±0.010 ft	0.03 to 1.52 m	±0.003 m
	0.1 to 10 ft	±0.035 ft	0.03 to 3.05 m	±0.011 m
Temperature Coefficient Maximum error within compensated temperature range (per degree of temperature change)	±0.0003 x level x temperature change from 72°F where level is measured in feet		±0.0009 x level x temperature change from 22°C where level is measured in meters	
Automatic Drift Correction	After a 5 minute warm-up period, zero level is corrected to ±0.002 ft (±0.0006 m) at intervals between 2 and 15 minutes			
Long-Term Level Calibration Change	Typically 0.5% of reading per year			
Ambient Operating Temperature Range	0° to 140°F		-18° to 60°C	
Compensated Temperature Range	32° to 140°F		0° to 60°C	

Actual vertical distance between the end of the bubble line and the liquid surface

Appendix D
Pictures of Biofilter

Construction Sequence: