Quality Assurance Project Plan

STORMWATER INFILTRATION BMPS

Organization

Villanova University
Department of Civil and Environmental Engineering
800 Lancaster Avenue
Villanova, PA 19085

Principal Investigators

Robert G. Traver, Ph.D., P.E.
VUSP Director
robert.traver@villanova.edu
610.519.7899 Signature ______________________ Date ________

Bridget M. Wadzuk, Ph.D.
Project Manager
bridget.wadzuk@villanova.edu
610.519.5365 Signature ______________________ Date ________

Andrea Welker, Ph.D., PE
Project Manager
andrea.welker@villanova.edu
610.519.4959 Signature ______________________ Date ________

John Komlos, Ph.D.
Quality Assurance Manager
john.komlos@villanova.edu
610-519-7397 Signature ______________________ Date ________

PaDEP Project Manager

Steve Lathrop ____________________ _____
PaDEP Division of Watershed Protection
P.O. Box 8555, Harrisburg, PA 17105-8555
slathrop@state.pa.us
717-772-5618

Table of Contents

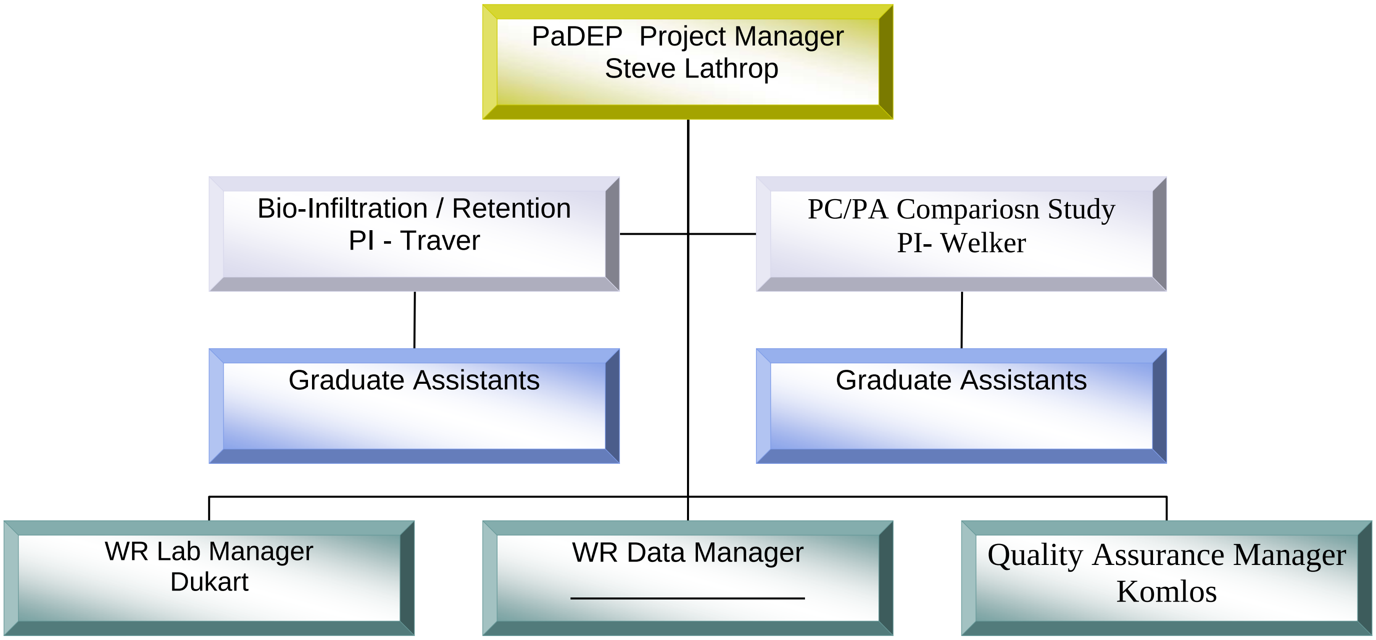
A3. Distribution List

Villanova University (See Title Page)
Project Manager
All Project Investigators
QA Manager/Principal Investigator
Project QA Manager/Laboratory

All VU Graduate Students

PaDEP Project Manager - Steve Lathrop
PaDEP Division of Watershed Protection
P.O. Box 8555, Harrisburg, PA 17105-8555
slathrop@state.pa.us
717-772-5618

A4. Project/Task Organization



Responsibilities for the Quality System Components is as directed in the VUSP QMP. The principal investigators are responsible for reviewing the project and assessment procedures on a semester basis.

The PI's are responsible for;

- organization of the monitoring program
- supervision of the GAs to include
  - conduct and scheduling of sampling
- oversight of WR Lab Manager / Data Manager

The WR Lab Manager

- Lab procedures to include safety (as per the VUSP QMP)
- Supervision of GAs to include
  - lab analysis

The WR Data Manager

- Database structure and reporting
- Supervision of GAs to include
  - Data entry

The QA Manager is responsible for conducting Semester Spot Reviews as discussed in QMP.

A5. Problem Definition/Background

The potential for urban stormwater to deliver pollutants and increased flows to receiving waters over short intervals is well recognized as a problem that must be addressed. Stream bank erosion, nonpoint source pollution, and drought effects are even more critical when dealing with stream headwaters. The advent of NPDES Phase II has brought a new direction to stormwater management design. Volume and quality have joined peak flow as design parameters, radically changing the design approach of the stormwater profession. Design elements used to mitigate these effects are termed Best Management Practices (BMPs). The design, performance, and maintenance of BMPs are still emerging as recognized by the USEPA NPDES Phase II rule (USEPA 2002b). Newer design practices have turned to volume control and infiltration to replace lost recharge, to reduce the increased runoff, and to reduce nonpoint source pollutants caused by changes in land use and increased impervious surfaces. Peak flows and stream bank erosion are evaluated on a watershed scale instead of a site-by-site basis. Studies have shown a direct correlation between impervious surfaces and the resulting health of a stream system (Paul and Meyer, 2001). Best management practices are currently recommended by PaDEP to control stormwater runoff. Infiltration practices are being heavily relied on in most strategies. Detailed information on both stormwater wetlands and infiltration BMP performance is still emerging as recognized by the EPA guidance manual on stormwater monitoring (USEPA, 2002a).

To both demonstrate and to learn about this emerging technology, several BMP demonstration and research facilities have been built as part of the Villanova University Stormwater Research and Demonstration Park (www.villanova.edu/VUSP). This QAPP currently focuses on the infiltration BMPs that have been constructed on the Villanova University campus as described in the VUSP QMP. Specifically, the sites currently under study include:

Pervious Concrete / Porous Asphalt Comparison Site (QMP 1.3.2)
Bioinfiltration Traffic Island (QMP 1.3.3a)
Infiltration Trench (QMP 1.3.3b).

Note that this project is ongoing, and the university has constructed several other infiltration sites that may in the future be included or substituted under this QAPP. As appropriate, all new infiltration sites that are brought under this QAPP will follow the same standards and procedures. Any changes to the sampling scheme or analysis will require a revision to this QAPP / QMP.

The proposed project’s objectives correspond to the EPA Strategic Plan, Goal 2 (http://www.epa.gov/ocfo/plan/06_goal2.pdf), which targets the use of pollution prevention and restoration approaches on a watershed basis to protect the quality of rivers, lakes and streams.

A6. Project/Task Description

The purpose of the Villanova University BMP Research and Demonstration Park is to determine the BMP's effectiveness in reducing stormwater runoff volumes, peak flows, and non-point source pollution to the surface water system, and to determine the volume and quality of the infiltrated runoff.

The project tasks are to determine the effectiveness of multiple BMPs from both a quantity and quality basis, and to provide data for the EPA – ASCE National Stormwater BMP Database. The goals of the infiltration sites at Villanova are to store and infiltrate stormwater and remove nutrients, contaminants and sediment.

The purpose of the study is to determine the effectiveness of this BMP from a quality and quantity basis. The work for this project can be divided into two major tasks: data collection and analysis.

A7. Quality Objectives and Criteria

The collected data will be compared to previous studies recording pollutants from urban stormwater runoff. Blanks, spikes, and duplicates will be used to assure the quality of the data. All objectives and procedures will meet criteria specified in the EPA BMP performance monitoring manual (USEPA 2002a – See QMP)).

As part of data management, checks will be made on all data to ensure the reasonableness of the data (e.g. pH is within the range 0-14).

Data Quality Indicators

Analytical Parameter	**Field – Samples**		
Sampling Procedure	**American Sigma 900 automated sampler**		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Data Completeness	75% of all scheduled events	Monthly calibration/Equipment readiness	S
Representativeness	75% of samples PER event	Monthly calibration/Equipment readiness	S

Analytical Parameter	Field – Samples		
Sampling Procedure	Grab & First Flush		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Data Completeness	75% of all sampling periods	Graduate student work	S

Analytical Parameter	Field – Samples		
Sampling Procedure	Lysimeter		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Data Completeness	75% of all scheduled events	Graduate student work	S
Comparability	>50 ml collected	Adequate Volume	S
Representativeness	>50 ml collected	Adequate Volume	S

Analytical Parameter	Field - Flow		
Sampling Procedure	Depth / Weir (SOP J)		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Precision	Within 10%	Monthly calibration	S
Accuracy/Bias	Within 10%	Monthly calibration	S
Sensitivity	Within 10%	Monthly calibration	S
Data Completeness	75% of all scheduled events/sampling periods	Monthly calibration	S
Representativeness	X minute intervals on a continuous basis	Monthly calibration	S

X – time varies per site – 1 minute IT, 5 minute all other sites

Analytical Parameter	Field – Flow - AV		
Sampling Procedure	American Sigma 950		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Precision	Within 10%	Monthly calibration	S
Accuracy/Bias	Within 10%	Monthly calibration	S
Sensitivity	Within 10%	Monthly calibration	S
Data Completeness	75% of all scheduled events/sampling periods	Monthly calibration	S
Representativeness	X minute intervals on a continuous basis	Monthly calibration	S

Analytical Parameter	Field - Rainfall		
Sampling Procedure	American Sigma Tipping Bucket		
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Precision	Within 10%	Monthly calibration	S
Accuracy/Bias	Within 10%	Monthly calibration	S
Sensitivity	Within 10%	Monthly calibration	S
Data Completeness	75% of all attempted events/sampling periods	Monthly calibration	S
Representativeness	X minute intervals on a continuous basis	Monthly calibration	S

Analytical Parameter SOP-B HACH Nutrients	**Test Method**	**Detection Limit (mg/L)**	**ASCE/EPA Database (mg/L) (QMP App. A)**
Phosphorus - Total	PhosVer3 with Acid Persulfate Digestion Hach # 8190	0.06 mg/L PO_4^{3-}	0.06 mg/L PO_4^{3-}
Nitrogen - Total	Persulfate Digestion Hach # 10071	1.7 mg/L N	2.0 mg/L N
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Precision	Within 20%	Duplicates	A
Accuracy/Bias	Within 20%	Standards/Spikes/Blanks	A
Sensitivity	Within 20%	Detection level	A
Comparability	Within 20%	Duplicate	A

Analytical Parameter HPLC SOP C	**Test Method**	**Detection Limit (mg/L)**	**ASCE/EPA Database (mg/L) (QMP App. A)**
Chloride (Cl^-)	Mod. EPA Method 300.1	0.5	1
Nitrite (NO_{2}^{-} -N	Mod. EPA Method 300.1	0.05	NA
Nitrate (NO_3^--N)	Mod. EPA Method 300.1	0.05	0.1
Phosphate (PO4--P or PO4)	Mod. EPA Method 300.1	0.20	0.05
Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)
Precision	Within 10%	Duplicates	A
Accuracy/Bias	Within 10%	Standards / Blanks	A
Sensitivity	Within 10%	Detection level	A
Comparability	Within 10%	Duplicate	A

NOTE HPLC and HACH DR 4000 are being replaced with the EASY CHEM

Analytical Parameter Solids SOP D&E	**Test Method**	**Detection Limit (mg)**	**ASCE/EPA Database (mg/L) (QMP App. A)**
TDS / TSS	Standard Methods	Scale Accuracy 0.1mg (Note much lower then ASCE EPA)	TSS 4mg/l
Data Quality Indicators	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)**
Precision	Within 20%	Duplicates	A
Accuracy/Bias	Within 20%	Calibration	A

Analytical Parameter GF / AA SOP D-G Metals	**Test Method**	**Detection Limit (mg/L)**	**ASCE/EPA Database (mg/L)**
Cadmium	Modified Method 7010	0.5	1
Copper	Modified Method 7010	2.8	1
Chromium	Modified Method 7010	2.2	NA
Lead	Modified Method 7010	4.8	5
Zinc	Modified Method 7010	TBD	NA
Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)
Precision	Within 10%	Duplicates	A
Accuracy/Bias	Within 10%	Standards/Blanks	A
Sensitivity	Within 10%	Detection level	A
Comparability	Within 10%	Duplicate	A

Analytical Parameter Easy Chem SOP M-T	**EASY CHEM Test Method**	**Detection Limit (mg/L)**	**ASCE/EPA Database (mg/L)**
Nitrates (NO_3^--N) SOP - M	Nitrate USEPA by Discrete Analysis 353.2-01	0.01	0.1
Nitrites (NO_2^- -N) SOP – N	Nitrite USEPA by Discrete Analysis 353.2-01	0.005	NA
Orthophosphate- PO_4 SOP - O	OrthoPhosphate USEPA by Discrete Analysis 365.1-01	0.01	0.05
Choride – CL SOP - P	Chloride USEPA by Discrete Analysis 325.2-01	0.5	1
TKN SOP S	TKN USEPA by Discrete Analysis 351.2-03	0.1	2.0 mg/L N (Total N)
TP SOP T	TP USEPA by Discrete Analysis 365.4-01	0.01	0.06 mg/L PO_4^3
Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample to Assess Error for Sampling (S), Analytical (A) or both (S&A)
Precision	Within 10%	Duplicates	A
Accuracy/Bias	Within 10%	Standards/Blanks/Spike	A
Sensitivity	Within 10%	Detection level	A
Comparability	Within 10%	Duplicate	A

A8. Special Training/Certification

The Principal Investigators are degreed civil engineers with experience in environmental engineering laboratories. In addition, a trial period of sampling and testing has been conducted with all project staff to assure knowledge and repeatability of the results. Upon reading and being trained on this QAPP to include field sampling operations, the SOP must be signed and witnessed by the PI. Upon reading and being trained on each Standard Operating Procedure (SOP) the SOP must be signed and witnessed by the WRLM. Safety training is required for all personnel.

A9. Documents and Records

A standard labeling and recording system is in place for sampling, see Fig B.3.1 for an example sample container label. A set of procedures to include calibration is in place for all instruments, according to the instruments operation manual. All field data sheets, laboratory data, and reports written are stored in notebooks in the Villanova University Water Resources Laboratory which is maintained by the Laboratory Manager. Again, all documents and records will meet the criteria specified in the EPA BMP monitoring manual (USEPA 2002a) and according to SOP – VUSP's. All electronic data is maintained on the Villanova University network, which is backed up regularly; each graduate student is responsible for the daily maintenance of data on the network drive. Additionally, all network files are updated on an external hard drive by the VUSP Director on a weekly and monthly basis. Semi-annually the network files are updated on DVDs by the PI's. All collected data and documentation is archived for a minimum of the project life.

CHAPTER 1: Collected Data

Data Generation and Acquisition

The following section addresses both the water quality and quantity aspects of this study.

B1. Sampling Process Design (Experimental Design)

An accurate water quantity mass balance is an integral part of the evaluation of any BMP. Each BMP has a custom designed monitoring system.

Pervious Concrete / Porous Asphalt Comparison Site (PC/PA)

- <u>Stormwater Quantity</u>: The PC/PA has been equipped to observe runoff entering the system through the porous surface. These flows are correlated to the rainfall amounts measured by a raingage located on the premises. The site is further equipped to measure ponded depths and potential overflow. All data is recorded continuously using Canbelkl Scientific Data Logger.
  - Rainfall is measured in 5 minute increments through the use of a tipping bucket raingage.
  - Pressure Transducers that measure the flow in 5 minute increments are used to measure depths in each rock bed. They are also used in conjunction with a V-notch weir to measure any overflow.
- <u>Stormwater Quality</u>: Data is conducted based on precipitation events. The samples are representative of surface runoff and sub-surface soil moisture samples. On average, 12 - 18 storms are sampled yearly.
  - Two first flush samplers catch the first two liters of direct runoff from the impervious surfaces upstream of each pervious surface.
  - Grab samples are taken of runoff stored in the rock bed following the storm
  - Lysimeters are located at depths beneath the surface. They extract a sample from the soil through the use of porous ceramic cups placed under suction during a storm event and pressure after completion using a pressure-vacuum soil water sampler

Bioinfiltration Traffic Island (TI) –

- <u>Stormwater Quantity</u>: The bioinfiltration traffic island has been equipped to observe runoff entering the system via two inlets (north, south). This data is correlated to the rainfall amounts measured by a raingage located on the premises. The site is further equipped to measure ponded depths. All data is recorded continuously and downloaded weekly.
  - Rainfall is measured in 5 minute increments through the use of an American Sigma Tipping Bucket raingage.
  - There are multiple pressure transducers that measure the level in 5 minute increments. One is located in the south inlet box in conjunction with a V-notch weir for overflow measurement. There are several transducers in a series of wells surrounding the BMP.

  - An ultrasonic transducer is located in the basin to measure the depth of ponded water in 5 minute intervals.

- Stormwater Quality: Data is collected based on precipitation events. The samples are representative of surface runoff and sub-surface soil moisture samples. On average, 12-18 storms are sampled yearly.
  - Two first flush samplers each catch the first two liters of direct runoff from the impervious surface and the grass area adjacent to the basin.
  - Two surface water samples are taken as 250 mL grab samples. The first sample is taken during the storm event and a second comes at the conclusion of rainfall, if ponding has occurred.
  - Lysimeters are located at depths of 0, 4 and 8 feet beneath the surface. They extract a sample from the soil through the use of porous ceramic cups placed under suction during a storm event and pressure after completion using a pressure-vacuum soil water sampler.
  - Grab samples are taken of the groundwater.

Infiltration Trench (IT) –

- Stormwater Quantity: The infiltration trench has been equipped to observe runoff entering the system, storage within the system, and overflow. All data is recorded continuously and downloaded weekly.
  - Rainfall is measured in 5 minute increments through the use of an American Sigma Tipping Bucket raingage.
  - Runoff entering the site is measured using two V notch type weirs with corresponding pressure transducers.
  - Depth of runoff stored in the rock bed is measured using a pressure transducers
  - Overflow is measured using a manufactured weir and a pressure transducer.
- Stormwater Quality: Data is collected based on precipitation events. The samples are representative of surface runoff and sub-surface soil moisture samples. On average, 12-18 storms are sampled yearly
  - An automated American Sigma sampler takes rainfall weighted discrete samples.
  - Lysimeters are located at depths beneath the surface. They extract a sample from the soil through the use of porous ceramic cups placed under suction during a storm event and pressure after completion using a pressure-vacuum soil water sampler.
  - A grab sample collector is used to capture overflow quality samples.

B2. Sampling Methods

According to the EPA (2002) manual Urban Stormwater BMP Performance Monitoring "Proper sampling methods are essential in conducting a BMP monitoring program in order to ensure resulting data are meaningful and representative of the water and other media being processed by the BMP." Water quality sampling is conducted using automated samplers, first flush samplers, grab samples and lysimeters.

For example, surface water samples are collected from three locations and include first flush samples at two locations and two time weighted grab samples from the pond surface during and following an event (Fig B.2.1). The pond samples are being replaced with a time weighted composite sample (Nov 2008), and an additional overflow sample will be taken at the V notch weir. The figure below shows a schematic drawing of the sampling locations for surface water samples. First flush samples were collected using the GKY First Flush Sampler. All samples are taken in 1-liter High Density PolyEthylene (HDPE) containers that are washed as stated later in this document. Fig B.2.2 shows the horizontal position of the groundwater lysimeter samples as an example.

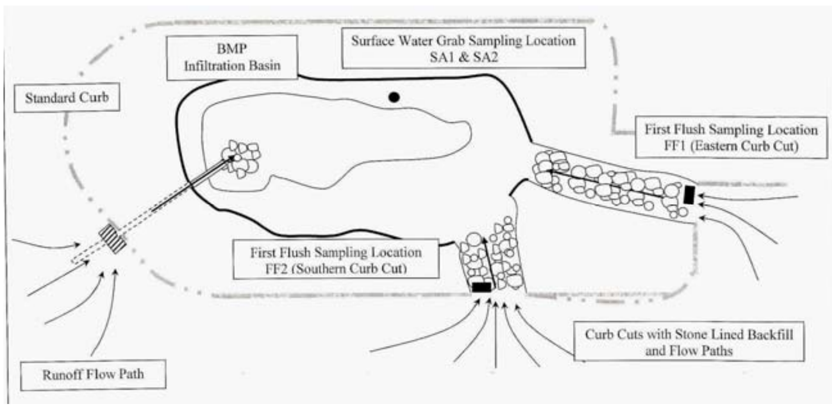


Figure B.2.1 TI Surface Sampling Locations (Ermilio 2005)

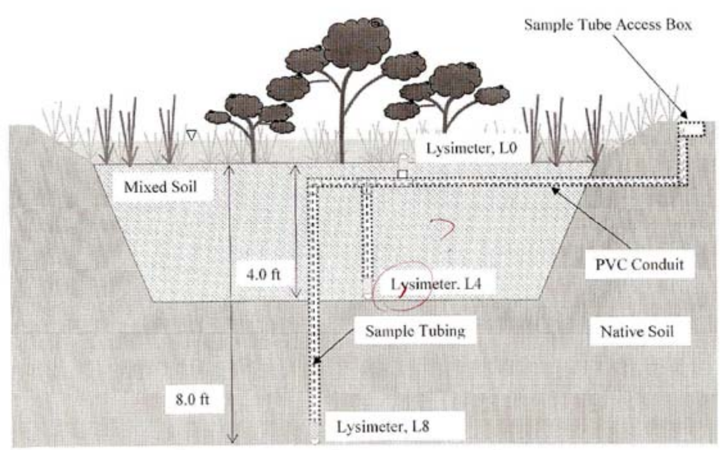


Figure B.2.2. TI Subsurface Sampling Locations (Ermilio 2005)

Lysimeters work by overcoming soil water tension or negative pressure, which is created by capillary forces. These forces are the sum of the adhesive and cohesive forces. By creating a vacuum or negative pressure greater than the soil suction holding the water within the capillary spaces, a hydraulic gradient is established for the water to flow through the porous ceramic cup into the sampler. “The practical limit for water flow in soils is about 65 cb (9.4 psi) (although in some soils, the value can approach 85 cb (12 psi)).” (1920F1 Pressure-Vacuum Soil Water

Samplers Instruction Manual, 1997) A vacuum of 7.3 to 8.0 psi is being used for this project based upon the soil type present.

Automated Samplers –The Sigma 900/950 automated sampler is a stand-alone unit capable of taking up to 24 discrete water samples per storm event. Each sample is collected in a special 350 ml glass bottle made especially to fit in the automated sampler. To get a consistent sampling routine, the automated samplers need to communicate and be able to be triggered through the data logger. Each sampling location is wired to the data logger – and can be triggered through rainfall or depth of water in the BMP. A sampling protocol is set for each site.

All glassware and plastic ware used for collection, transportation, and laboratory analysis of the samples are acid-washed as per EPA recommendations (EPA 2002a). The glassware and plastic ware is first cleaned with a laboratory detergent and rinsed with tap water. Next, the container is rinsed in 1:1 Hydrochloric Acid Solution. Filtering and storage containers for metal samples are washed with diluted Nitric Acid. All glass and plasticware are then rinsed with deionized water three times and allowed to air dry.

The samples are analyzed in Villanova University's Civil and Environmental Engineering Water Resources Laboratory, beginning within 30 minutes of sample collection; completion of all analyses are typically completed within 24 hours of sample collection. Any samples not analyzed within 24 hours are preserved according to appropriate protocols (Table B.2.1).   Each of the tests has a specific method required to properly preserve the sample. Preservation methods include pH control, chemical addition, and refrigeration. Sample preservation is performed according to Standard Methods.

Table B.2.1 Sample preservation summary

Parameter	**Container Type**	**Preservation**	**Holding Time**
pH	NA	NA – Test Immediately	NA
Conductivity	Plastic	store at 4^oC	24 hours
Chloride	Plastic	store at room temp.	28 days
TDS / TSS	Plastic	Filter Immediately Store at at 4^oC	24 hours Preferred (7 Days)
Nutrients			
Total Phosphorus	Plastic	H_2SO_4 to pH <2, store at 4^oC	28 days
Total Nitrogen	No Plastic unless frozen	Freeze at -10 ^oC or add 1 ml HCL/Liter, store at 4^oC	28 days
Orthophosphate	Plastic	store at 4^oC	24 hours
Nitrate	Plastic	store at 4^oC	24 hours
Metals (See SOP D)			
Metals	Plastic	Add 0.4ml of Concentrated HNO_3 (TM Grade) to 20 mL of sample,	6 months

		store at 4^oC	

B3. Sample Handling and Custody

Flow data is recorded and downloaded on a weekly basis. Water quality samples are collected, labeled and transported by hand to the Water Resource Laboratory for immediate analysis or preservation treatment. Tables B3.1 and Figure B.3.1 show the sample labeling notation.

Table B3.1 - Sample Label Notation

PCPA Labeling

Sample	**Description**
Code	PP
1st digit	
A	Asphalt side
C	Concrete side
2nd digit	
GS	Surface Sample
FF	First Flush
06	6 in deep (lysimeter)
12	12 in deep (lysimeter)
18	18 in deep (lysimeter)
3rd digit	
1	Closest to concrete manhole
2	Closest to Asphalt manhole

Trench Sample Labeling

Sample	**Description**
LYS2	Lysimeter at 2’
LYS4	Lysimeter at 4’
AS01	Auto sampler at the Inlet. Sample collected up to 0.25 in of rain
AS02	Auto sampler at the Inlet. Sample collected between 0.25-0.50 in of rain
AS03	Auto sampler at the Inlet. Sample collected between 0.50-1.0 in of rain
AS04	Auto sampler at the Inlet. Sample collected greater than 1.0 in of rain
OVER	Outlet Overflow

BioInfiltration Traffic Island

FF01	First Flush 1 Right
FF02	First Flush 2 Curb
SA01	Surface Area Sample – Beginning of Storm
SA02	Surface Area Sample – 24 hr later
BS01 - 08	Surface Sample (Automated) 01 – 08
MW1a (a-e)	Wells (1-4) Samples a-e

Location: SW
Code – IW4
Preserved - Raw, H2SO4, HNO3
Date/Time: 03/01/03

Figure B3.1 - Sample Label

B4. Analytical Methods

Note that all procedures are as per the appropriate SOP. Each analytic procedures is reviewed here as an overview.

B4.2.1 Hach Company Sension 156 Multiparameter

The Hach Company Sension 156 Multiparameter meter is used to measure pH and conductivity. The Sension156 has a variety of modes to test for different parameters. For this study the pH and conductivity modes are being used. Both the pH and conductivity probes also measure temperature; however temperature is not being recorded for this project.

The Sension Model 51935-00 Gel-filled pH Electrode is a combined pH and temperature probe. It connects to the Multiparameter Meter via a standard 5-pin connection. The pH mode on the Multiprameter Meter must be selected when using the pH electrode. The range of the electrode is 0 to 14 pH units. To prevent contamination of samples and ensure accurate readings the electrode is rinsed with deionized water and blotted dry between sample measurements.

The Hach Conductivity Probe Model 51935-00 is a combined conductivity and temperature probe. It also connects to the Multiparameter Meter via a standard 5-pin connection. The conductivity mode on the Multiprameter Meter must be selected when using the conductivity probe. The range of the conductivity probe is 0.01μS to 200μS. The resolution of the multiparameter meter varies depending on the range of the sample being tested. Between 2.0 and 19.99 μS/cm, the resolution is 0.01 μS/cm. For conductivities between 20.0 and 199.9 μS/cm, the resolution is 0.1 μS/cm and 1 μS/cm between 200 and 1,999 μS/cm. The accuracy while in conductivity mode is +/-0.5% of the range. Typically the samples for this project range from 300 μS/cm to 1,500 μS/cm. Again, between sample testing, the probe is rinsed with deionized water and blotted dry to ensure accurate readings.]

B4.2.2 Hach Company DR 4000 Spectrophotometer (SOP – B)

Total N and Total P can be conducted using the Hach DR/4000 Spectrophotometer. Spectrophotometry is the measurement of the light absorbance of a sample. This absorbance can be related to various chemical parameters through the use of experimental procedures. The spectrophotometer's light source can be set to a wide range of wavelengths from the visible to the ultraviolet scale. The machine is programmed to perform over 120 procedures.

The Total Nitrogen and Total Phosphrous tests require the samples to undergo a digestion period at specific temperatures. The Hach COD Reactor Model 45600 is used to incubate the samples for the required times. The COD Reactor holds up to 25 16x100 mm vials and is capable of sustaining temperatures up to 150 degrees Celsius with an accuracy of ± two degrees Celsius. It also has a space for a thermometer to verify the temperature. The COD Reactor features an adjustable temperature and a timer. The reactor has two modes, 150 degrees Celsius mode and an adjustable temperature mode.

B.4.2.3 Ion Chromatography SOP - C

At the moment this test is retired. The description is retained in case of future need. The modified version of the EPA Method 300.1 includes changes in the calibration and standardization sequences, reagent and standards concentration preparations and in the procedure of the recommended operated condition of the ion chromatography.
The tests are all conducted using the High Pressure Liquid Chromatography (HPLC). The machine is programmed to run a total of 95 samples.

B.4.2.4 Graphite Furnace Atomic Absorption Spectrophotometer (SOP –G)

The Graphite Furnace consist of the following components; a Perkin-Elmer model 4100ZL Zeeman Atomic Absorption Spectrophotometer, a Dell PC, a Perkin-Elmer Furnace Cooling System, a Perkin-Elmer model AS-70 auto sampling system, and printer. After the samples are collected from the desire site and prepared using the Graphite Furnace Atomic Absorption Spectrophotometer SOP, the sample is dispensed into a small graphite tube using an Auto Sampling System. The samples are heated electrically. By increasing the temperature stepwise, the processes of drying, thermal pretreatment of the matrix, and dissociation into free atoms (atomization) can be separated. The techniques of graphite furnace atomic absorption using the Perkin-Elmer HGA (Heated Graphite Atomizer) provide means to determine metals and metalloids in the picogram range. The modified version of the Method 7010 includes changes in the calibration and standardization sequences, reagent and standards concentration preparations, and in the operation conditions of the equipments. Cadmium (Cd), Chromium (Cr), Copper (Cu), and Lead (Pb) in stormwater samples are determined in the parts per billion range.

B.4.2.5 Flame Atomic Absorption Spectrophotometer (SOP –F)

The Perkin-Elmer Model 2380 is an atomic absorption spectrophotometer which measures the concentrations of metals in various matrices. For our purposes, it provides integrated readings in absorbances over a period selected by the user from 0.2 to 60 seconds. A liquid sample is sprayed by a pneumatic nebulizer into a flame. Sample particles vaporize and dissociate into free atoms due to the temperature and reducing power of the flame. The concentration of metal element in the sample is approximated in the parts per million range from the absorbance and standard calibration curve. Trace metals such as Zinc (Zn) in stormwater samples are determined in the parts per million range.

B.4.2.6 EasyChem Discrete Analyzer (SOP's M-T)

An Easy Chem Discrete Analyzer is used to measure nitrate, nitrite, orthophosphate, chloride, Total N Total P. The Hach DR4000 backs up this instrumentation.

B5. Quality Control

See Section D.

B6. Instrument/Equipment Testing, Inspection, and Maintenance

See SOP's –and the instruments operation manual.

B7. Instrument/Equipment Calibration and Frequency

Flow equipment is tested and calibrated as required once a month according to manufactures literature. Analytical equipment is calibrated before each analysis, according to SOP

B8. Inspection/Acceptance of Supplies and Consumables

All supplies are inspected upon arrival to the laboratory to ensure the deliverables are not physically damaged. The expiration dates and standards are checked to ensure the materials are acceptable for use. This check is also performed prior to using any reagents or standards. All samples and standards are certified by the manufacturer.

B9. Data Management

The data management goals for both the water quantity and quality aspect of this project are based on the guidelines set in the EPA manual Urban Stormwater BMP Performance Monitoring. The database should be one that is easy to "…store, retrieve, and transfer…" (EPA, 2002)

Data is downloaded once a week or more often as needed to a computer located in the laboratory. The data is put into a raw data folder identified by year; each month comprises a data file with a name that indicates the site, month and year. The file contains all of the column headings for each of the arrays measured. In each array the following column headings are found: array number and individual columns for year, day, hour, minute, and second that the measurement represents. The data files are opened in Excel and converted into *.xls spreadsheets. Copies of both the original data file and the Excel spreadsheet are kept locally on the laboratory computer and backed-up immediately to the University's network. The University network is backed up by university protocol, as well as to an external hard drive on a weekly and monthly basis.

Water quality data is recorded in a laboratory notebook that is kept in the lab, maintained by the Laboratory Manager, and also entered into an Excel / Access file that is clearly labeled with date and site. This electronic data is managed/backed up similar to the quantity data.

Assessment and Oversight

C1. Assessments and Response Actions

The Principal Investigator will be responsible for reviewing the entire monitoring project three times per year. Reviews will include reviews of sampling, laboratory procedures, and data recording. The Quality Assurance Manager will be the chief inspector, and any identified procedural problems will be corrected. The VUSP Director and PI will overview this process focusing on the data validity as per Section D.

C2. Report to Management

Status of the semester review (including assessment and calibration reports) will be included as a line item in all required reports. A record of each review will be maintained by the WRLM.

Data Validation and Usability

D1. Data Review, Verification and Validation

Data will be reviewed on a semester basis by the Quality Assurance Manager as specified in C1. Data that does not meet the Acceptance Criteria as specified by the SOP will be reviewed. Decisions to accept, qualify, or reject data will be made by the Principal Investigators based upon the Quality Assurance Manager recommendation. All data will be assigned a qualified code as per Appendix A.

D2. Verification and Validation Methods

Validation and verification methods include looking for gaps in the data, reviewing equipment calibrations, checking calculations, and examining raw data for outliers. Data quality problems will be discussed as they occur and in the final report to data users.

D3. Reconciliation with User Requirements

As soon as possible after each sampling event, calculations (view Section D1) and determinations for precision will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in final reports, and other documentation as needed. If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Major revisions will be submitted to appropriate agencies for review and/or approval.

References

EASY CHEM Product Information and SOP's

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Appendix A: Data Qualifier Codes

(Source – EPA) - A data qualifier is a code that is applied to an experimental result to indicate any uncertainties, whether qualitative or quantitative, in the result. After reviewing the results and checking all calculations the appropriate qualifier code will be noted next to the result, if required.

Qualifier Description

B - This flag is used when the analyte is found in the associate blank as well as the sample. It indicates possible blank contamination and warns the user to take appropriate action while assessing the data.

D - This flag is used when the analyte concentration results from a required dilution of the sample.

E - This flag is used to identify analyte concentrations exceeding the upper calibration range of the analytical instrument after dilution of the sample. The reported value is considered to be estimated.

I - Analyte concentration is believed to be influenced by an interference. This flag warns the user to take appropriate action while assessing the data.

N **–** No Test was conducted of this sample. Usually due to volume of collected samples or sampling failure.

Q - This flag applies to analyte data that are severely estimated because of quality control and/or quantitative problems. No value is reported with this flag.

U - This flag is used when the analyte was analyzed, but undetected in the sample. The Detection Limit for the analyte accompanies this flag. As with sample results that are positive, the value is corrected for dry weight, dilution, and/or sample weight or volume.