

MONTGOMERY COUNTY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE MONITORING
PROTOCOLS



PREPARED BY:

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**MONTGOMERY COUNTY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE MONITORING
PROTOCOLS
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***MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE (BMP) MONITORING PROTOCOLS***

INTRODUCTION

In October of 1995, the Montgomery County Council enacted the Special Protection Area (SPA) program. Executive Regulation 29-95 was developed to provide procedural, administrative, and technical guidance on the SPA program requirements.

This included guidance on developing SPA performance goals, methods to use for baseline stream monitoring and BMP monitoring, and guidance on other requirements specified in Chapter 19, Article V. Biological stream monitoring, including SPA biological monitoring is conducted by the Department of Environmental Protection on a County-wide basis. BMP monitoring, when part of SPA development projects, is conducted by the developer as required under Executive Regulation 29-95.

In order to promote consistency and comparability among BMP monitoring projects, The Department of Environmental Protection, Special Area Protection Program has developed a BMP sampling protocols document. The document has been written to provide guidance to consultants and others conducting BMP monitoring. It is not the intention of this document to encompass every aspect of BMP monitoring or preclude the use of other protocols or methodologies, rather the intention is to provide a basis on which to develop monitoring plans and to familiarize the development community with the various aspects and requirements of BMP monitoring.

**MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE (BMP) MONITORING PROTOCOLS**

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

PURPOSE:

To define the Quality Assurance/Quality Control (QA/QC) objectives and procedures of the Montgomery County Best Management Practices (BMP) Monitoring Program

OVERVIEW

These QA/QC procedures are based upon the QA/QC guidelines outlined in the Montgomery County Water Quality Monitoring Program; Stream Monitoring Protocols (Van Ness, et al, 1996). These procedures include descriptions of data quality objectives, documentation, training requirements, responsibility and accountability of personnel, equipment maintenance and calibration, information management, and data quality assessment. QA/QC procedures are important parts of data collection, management, and analysis. To achieve the goals and objectives of the County's program it is imperative that all personnel performing BMP monitoring follow the procedures and guidance of this section.

Goals and Objectives

The objective of the County's BMP monitoring program is to collect, analyze and provide information that pass stringent QA/QC requirements in order to document the performance of selected BMP's in meeting performance goals selected for each Special Protection Area (SPA) development site. The goal of BMP monitoring is to provide meaningful information regarding BMP performance and its influence on stream quality. The information collected, when combined with data from the County's biological stream monitoring program, can then be used to assess and refine the County's current BMP designs and promote future BMP development.

Documentation

A completed BMP monitoring information summary sheet must be submitted to the SPA Coordinator prior to the initiation of BMP monitoring.

Information collected as part of a BMP monitoring plan must be documented to insure scientific credibility and repeatability of all BMP monitoring procedures. The location of BMP monitoring stations and a summary of the BMP monitoring plan must be documented on the sediment control/stormwater management plans.

Field sampling, field notes, data management, data analysis, and data interpretation are to be documented by trained personnel meeting the qualifications as specified in Montgomery County Executive Regulation 29-95, Section 10., G.2.. All field data sheets, field notes, laboratory benchsheets, and calibration logs are to be retained by the investigator until completion of the BMP monitoring plan. Data analysis methods shall be fully documented as part of the report process.

Any data submitted to the County on computer disk is to be documented in the form of a log listing the file name and a description of the information in the data file. All data analysis methods should be briefly described, including any special considerations that may affect the data. Any assumptions or problems that may affect data interpretation must also be described in the data transmittal.

Responsibility and Accountability

As part of each BMP monitoring plan, a single individual representing the applicant shall assume responsibility implementing the monitoring plan. This individual will be the contact person for the County and be responsible for all QA/QC measures of the BMP monitoring plan. This individual shall meet the qualifications as specified in Regulation 29-95, Section 10., G.2.

Personnel Training Requirements

All personnel conducting BMP monitoring shall have adequate training and experience to competently perform the required tasks of the BMP monitoring plan. At a minimum the supervisor/project manager of must meet the requirements specified in Regulation 29-95, Section 10.G.

Equipment Maintenance

Maintenance and calibration of all equipment is to be performed according to the manufacturers instructions. Equipment shall be calibrated and inspected daily prior to monitoring. Periodic maintenance should be conducted as per the manufacturers maintenance schedule. A logbook should be used to record the maintenance and calibration of each instrument. Maintenance records should include the date, time, personnel performing the maintenance, and the maintenance performed. Calibration records should include date, personnel, battery life remaining, pre-calibration values, standard values, and the post-calibration values for each instrument.

Data Management

The data management procedures defined in each BMP monitoring protocol are to be followed. All data sheets are to be reviewed by the field crew leader prior to leaving a monitoring location. All information recorded should be consistent with units specified with standard sampling methods and units specified on the data sheets. All information entered into a data management system is to be immediately verified against the original data sheets and a backup copy of the data base is created.

Reports

Monitoring data must be submitted quarterly to the County, unless otherwise specified. Data analysis and format must be in accordance with the BMP Monitoring Plan as specified for each project.

**MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE (BMP) MONITORING PROTOCOLS**

STREAM TEMPERATURE MONITORING

PURPOSE:

To document the existing thermal regime of the stream and determine changes to the streams thermal regime after BMP installation.

PREFERRED MONITORING TOOL:

Continuous recording temperature monitor (recording thermograph).

APPROPRIATE LOCATION (GENERAL):

Locate above and below the selected BMP, within the inlet/outlet channel or stream

OVERVIEW

The collection of stream temperature data has become increasingly easier over the last few years with the invention of small, inexpensive, and accurate recording thermographs. Recording thermographs that once weighed several pounds, now barely weigh a few ounces and are as small as match boxes.

The collection of stream temperature data can be broken down into three phases, selecting the proper thermograph, deploying the thermograph, and recovering the stored thermograph data.

SELECTING THE PROPER THERMOGRAPH UNIT

Selection of the proper thermograph unit involves four main aspects, how long the thermograph will be deployed, at what interval will the thermograph record temperatures, how will the thermograph be downloaded, and what type of channel will the thermograph be deployed in.

How long the thermograph will be deployed will dictate how much memory the unit must have. The longer the deployment the greater the memory requirement. The recording interval will also dictate memory requirements, as the shorter the recording interval, the greater the number of temperature measurements collected during a given period of time and thus a greater memory requirement.

Currently, thermographs are available that can be downloaded in the field using laptop computers either by wire or infra-red optics, other units may be downloaded in the field to a device that stores data from several thermographs for later retrieval by a PC. The lack of a laptop computer or other downloading and storage device may require that the thermographs be retrieved and downloaded to a PC in the office.

Whatever unit is chosen must be compatible with the type of study being conducted. For a long term temperature study, choosing an inexpensive low memory thermograph that requires weekly downloading to an office PC may cost considerably more to operate than initially choosing the more expensive high memory thermograph that can be downloaded in the field at much longer intervals.

The location and type of channel the thermograph will be deployed will dictate the specific type of unit required. Some units have an external temperature probe allowing the unit to be buried or located away from the stream channel or structure, while other units have internal probes that require the unit to be submerged at all times. The temperature recording range of the thermograph must also correspond with the highest and lowest temperatures expected to occur in the waters being sampled.

Once these questions are addressed the proper thermograph unit can be selected and deployed.

OFFICE PREPARATION OF THERMOGRAPH:

1. Prior to deploying the units calibrate unit and replace batteries as per manufacturers specifications
2. Follow manufacturers software directions for activating the temperature monitor.
3. Enter, at a minimum, Station Name, Location, and Date of deployment in Header Field.
4. Set the appropriate recording interval (Recording interval to be determined by DEP).
5. If unit is equipped, set to delayed or "triggered" activation to minimize out of stream sample records. If unit is not capable of delayed activation, activate meter.
6. Record station name, station location, date and time of activation, temperature monitor ID number, and approximate date for retrieval on the temperature monitor log sheet (example log sheet attached). Field location is recorded in the log sheet after field deployment.
7. Clean case and inspect for cracks and chips. Only cases free of damage should be used.
8. Insure that sealing flanges are clean and free of any dirt or sealant from previous uses. Clean "O" rings and inspect for damage. Replace damaged "O" rings.
9. Use only cases certified by the manufacturer for underwater use. (e.g. watertight not just waterproof)
10. Before closing case, verify that the external temperature probe (if present) is attached to the case and plugged into temperature monitor.
11. Inspect cases after closing for proper "O" ring seating and seal.

LOCATING THE THERMOGRAPH

There are several points to keep in mind when choosing a location to deploy a thermograph. As with choosing the right thermograph unit, the location of the thermograph must meet the objectives of the study. Of critical importance is whether the channel the unit will be deployed in is wet, dry, or experiences both. If there is a chance that the channel may be dry at times, it is best to treat it as if it were a dry channel.

1. Wet Channel Location:

- a. The temperature monitor should be located so that it will be underwater during all flow stages. The thermograph should be located in a stable pool or run area of the stream. The thermograph should be placed in a protected location (e.g., protected by stout tree roots and/or an overhanging bank). Avoid highly confined stream sections or areas subject to scouring flows.
- b. To monitor variations in temperatures of receiving waters below a BMP, the thermograph unit should be installed in the stream immediately below the mixing zone of the BMP outfall and stream.
- c. To monitor variations in the outfall water temperature of a BMP, the unit should be installed within the outfall structure or as close to the outfall as possible

2. Dry Channel Location:

The temperature monitor must be securely anchored, either buried in the channel bottom or buried away from the channel. A thermograph unit with an external thermistor (temperature probe) would be appropriate in these applications. The external thermistor can then be mounted along the channel bottom.

Dry channel deployments are not common and can be problematic. SPA staff will assist in determining the site specific deployment methods and locations when this type of deployment is required.

RECOMMENDED FIELD DEPLOYMENT METHODS (wet channel):**A. Stowawaytm or similar thermographs**

1. Trigger temperature meter and reseal case (if necessary) .
2. Near the streambank, drive two (2), 2 foot long rebar sections into stream bed or channel bottom, with the distance between them approximating the width of the thermograph case.
3. Secure temperature monitor case to both rebar sections using 8-14 inch cable ties (wire ties),
4. The case should also be attached to a nearby secure tree root either underwater or on the bank with galvanized wire or chain. The wire or chain must be securely attached to the case. The wire or chain is to prevent the loss of the meter in case the rebar is pulled from the substrate.
5. If there are no tree roots available, attach wire or chain to a third section of rebar that is secured in the bank or channel bottom.
6. In areas where rebar cannot be securely driven into the substrate (bedrock substrate), stowaway type units can be secured directly to stout underwater tree roots. The tree must not be in danger of toppling and the tree roots must be underwater at all flow stages.
7. If the unit is equipped with an external temperature probe, the unit can either be buried in

the stream bank or secured to a tree and the temperature probe mounted in the channel on a piece of rebar.

B. Tempmentortm or similar thermographs

Tempmentor type thermographs can be deployed in the same manner as a stowaway type unit, but due to their larger size, longer cable ties will be needed to securely place the units.

Alternative deployment method for deeper waters:

1. Obtain a military surplus .50 cal. ammunition box. These can be purchased at any army/navy surplus store.
2. Using an electric drill, perforate the box on the sides and bottom creating a grid pattern.
3. Using galvanized wire, secure short lengths of rebar to the bottom of the inside of the can to act as ballast.
4. Secure the tempmentor to the inside of the can with wire, cable ties or elastic tie downs and close can. Ensure that the latch is securely closed.
5. Attach metal chain to box. Chain should be long enough to allow ammunition box to rest on the bottom and be secured to a tree or post.
6. Inspect ammunition boxes before each deployment for rust and deterioration. Secure chain to tree or post and drop ammunition box can into pool. Ammunition boxes have a life span of from 2 to 4 years when submerged in water.

Alternative deployment method for ponds:

1. Obtain a float (buoy), a weight (anchor), and nylon rope.
2. Determine the depth of water where the thermograph will be deployed.
3. Attach the float to one end of the rope and attach thermograph to the rope so that it will be suspended at the correct distance below the waters surface. Attach the weight (anchor) so that it will rest on the bottom of the pond with the thermograph suspended at the proper depth.
4. Lower anchor, thermograph, and float into water.

FIELD NOTES:

1. Record the temperature monitor location to include:
 - a. Description of pool/channel.
 - b. Description of the tree where the case is attached (if applicable).
 - c. Exact location of temperature monitor on site plan.
 - d. Distance from the temperature meter to the nearest landmark shown on site plan (road crossing, outfall, etc.)

2. Submit notice of deployment to DEP.
3. Submit completed BMP Monitoring Summary Sheet, copies of thermograph log sheet including deployment field notes, and site plan with thermograph location marked to DEP.

DATA MANAGEMENT:

1. Submission of recorded water temperature data will include a data file of temperature data and a copy of the data file formatted for export (generic spreadsheet format), both on 3.5" diskette(s)
2. For each monitoring station, a summary table is to be provided. This table should follow the format shown in Table 1.

Table 1. Stream Temperature Monitoring Summary

STATION ID	MAX. TEMP.	MEDIAN TEMP.	# DAYS STATE USE CRITERIA EXCEEDED	% OF TIME STATE USE CRITERIA EXCEEDED

Maximum Temperature - The maximum temperature recorded during the thermograph deployment.

Median Temperature - The median (50th percentile) temperature recorded during the thermograph deployment.

of days State Use Criteria Exceeded - the number of days during the period June 1st through September 31st that the stream temperature exceeded 75° F. (24° C.) for Use I and IV streams, and 68° F. (20°C.) for Use III streams.

% of time State Use Criteria Exceeded - The percentage of time during the period June 1st through September 31st that the stream temperature exceeded 75° F. (24° C.) for Use I and IV streams, and 68° F. (20°C.) for Use III streams.

GRAPHING:

A minimum of three graphs per thermograph deployment are to be submitted.

1. A graph depicting the stream temperatures during the entire deployment period
2. Graphs depicting stream temperatures on a monthly basis.
3. Graphs depicting any significant storm related temperature fluctuations

Graphs can be either time series or line graphs (XY). Graphs should be formatted with the X axis as time/date and the Y axis as stream temperature. Graphs should be labeled with stream name, deployment location, project name, and time period of deployment.

**MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE MONITORING PROTOCOLS**

GROUNDWATER MONITORING

PURPOSE:

To document existing groundwater elevation and quality and to determine changes to these parameters after BMP installation.

PREFERRED MONITORING TOOL:

Groundwater observation well

APPROPRIATE LOCATION (GENERAL):

Located on the development site where there is an expectation that groundwater elevations may change due to development activities.

OVERVIEW:

Groundwater observation wells are used for determining the elevation of water tables and for sampling groundwater quality. A groundwater observation well is a 2" dia. PVC pipe that extends from the surface down into the groundwater table. The upper portion of this pipe is referred to as the well casing. This upper portion extends down from the surface to within about five feet of the groundwater surface. Below the well casing, a 2" diameter well screen is attached. The well screen consists of a section of 2" dia. PVC pipe with narrow slits cut into it. The well screen extends down into the water table and allows for groundwater movement into and out of the well.

Initially, a borehole is drilled for the well installation. To prevent surface water from running down the borehole and into the well after installation, several steps are taken to seal the well from surface influences. After placing the 2" observation well into the hole, the borehole is backfilled to the top of the well screen with graded and washed sand. The sand keeps soil materials from washing into the well. Above the sand, a layer of Bentonite clay is placed to seal the well screen. This prevents surface water from reaching the well screen. Above the bentonite seal, the borehole is backfilled with spoil from the borehole. At the ground surface a concrete cap is placed over the fill material. A steel casing with a lockable cap is placed over the well casing and into the concrete cap. This steel casing protects the well from being broken off by vehicles or construction equipment and prevents vandals from tampering with the well.

Groundwater wells are located to serve the purposes of a specific study. If the purpose of the study is to document groundwater quality near a stream, then one may suffice. If the purpose of the study is to map the elevations of the groundwater over some area, then an array of wells across the study area will be needed. The number and location of observation wells, as well as the sampling frequency, is decided on a case by case basis during the development of the Water Quality Plan.

Installation of Ground Water Observation Wells:

Installation should follow the standard well detail as shown in Figure 1. The well must be installed by a licensed well driller. Well depth should be approximately ten feet below the existing groundwater elevation, depth of refusal, or 40 feet, whichever is shallower. Generally, in Montgomery County, MD, groundwater is found within thirty feet of the surface.

Once the well has been installed, the well location, the elevation of the top of the well casing, and the elevation of the ground surface at the well must be surveyed and reported.

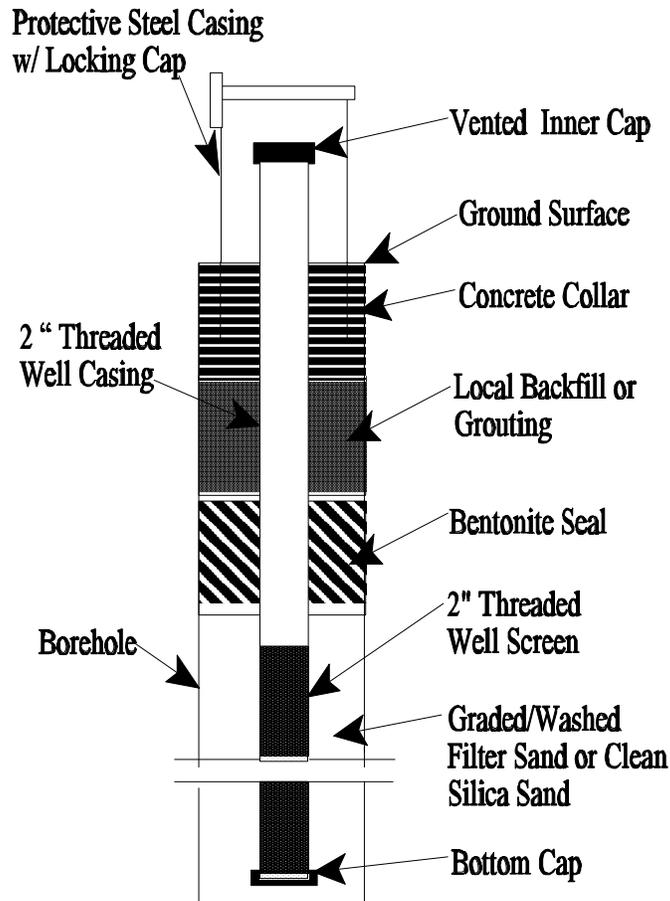


Figure 1 Typical Groundwater Monitoring Well Construction

MONITORING GROUND WATER ELEVATION:

To monitor groundwater elevations, the depth from the ground surface to the groundwater surface must be measured. Until fairly recently, a chalked line with a weight was used to measure the distance to groundwater. The chalked line would be lowered into the well until the groundwater surface was broken, the line would be retrieved, and the distance to the point indicated by the wetted chalk would be recorded.

While this method is satisfactory, water level meters have greatly speeded up the process. A water level meter consists of a cable marked like a tape measure on a reel. This cable has a sensor on the end that when it contacts the groundwater surface, completes a circuit and sounds a buzzer. The line is then raised and lowered till the point where the buzzer just sounds is found. The distance to groundwater is then read off the cable and recorded. The number recorded reflects the distance from the top of the well casing to the groundwater elevation. The distance from the top of the well casing to the ground surface must be subtracted. This final distance represents depth to groundwater. The top of the well casing should be marked in one spot around its diameter. All depth measurements should be made from this mark to ensure consistency. The depth measurements should be made three times and recorded as the mean of the three measurements.

DATA MANAGEMENT:

1. Recorded groundwater observations should be submitted in spreadsheet and graphic format (Table 1. Submission of recorded groundwater elevation data should include a copy of the spreadsheet file on 3.5" diskette and a hard copy of the data.
2. Spreadsheet format for data submission:

Table 1. Data reporting table for groundwater

(Rows 1-3 Header Information)								
Well I.D. (Row 4)	Date	Time	Water depth #1	Water depth #2	Water depth #3	Mean Water Depth	Height of Well Casing	Depth to Ground Water
(Row 5)								

3. Spreadsheet should be saved as ASCII text unless otherwise specified by DPS.

Graphing Ground Water Data:

1. Graphs should be in XY line format.
2. Axis identification:
 - X axis - Date
 - Y axis - Groundwater depth
3. If more then one well is used, results from each of the wells may be depicted together on one graph. Each well plot should be depicted by a unique symbol and identified in the graph legend.

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EMBEDDEDNESS

PURPOSE

To document existing in-stream fine sediment loads in riffle habitats and to record changes in these fine sediment loads before, during and after BMP installation.

Preferred Monitoring Tools:

½ meter² plot frame.

Appropriate Location (General)

Located within the riffle portion of a stream

Monitoring Riffle Embeddedness

At the selected closest upstream and downstream riffle from BMP outfall, determine and record the percent embeddedness using the following guidelines:

Use a ½ meter² plot randomly placed to define and limit a subsample. Location of this sample point should be recorded on the data sheet. One subsample is recorded for each side of the riffle, and one for the thalweg or center. For each riffle subsample, a discrete embeddedness percent (e.g., 15%, 30%, etc) is recorded to the nearest 5%. Determine the mean of the subsample embeddedness readings to calculate the average embeddedness for the entire riffle.

In addition to the above, rocks, randomly selected within each of the half meter plots, are examined to determine the degree to which fines and silt had covered the area under the rocks (fouling). This area is of primary importance for benthic macroinvertebrate habitat. Observations are described in the sample notes. Examples of observations include the amount, type, and the color of any sediment released by lifting up rocks.

Suggested criteria for assigning embeddedness ranges to the subsamples.

0 to 25%: Tops of the majority of rocks > 0.5" are clean of silt, sediment, sand. Sides of the majority of rocks are not surrounded by silt, sediment, or sand. Most rocks look as if they have been set on the stream bed. The degree that the sides are covered will determine the embeddedness value to record.

25 to 50%: Tops of the majority of rocks > 0.5" are clean of silt, sediment, sand. Sides of the majority of rocks are surrounded, or mostly surrounded, by silt, sediment, or sand, giving them a "cemented in" look. The degree that the sides are covered will determine the embeddedness value to record on the data sheet.

50 to 75%: Tops of the majority of rocks > 0.5" are partly covered by silt, sediment, or sand. Sides of the majority of rocks are surrounded by silt, sediment, or sand, giving them a "cemented in" look. The degree that the rock tops are covered will determine the embeddedness value recorded on the data sheet.

>75%: Tops of the majority of rocks > 0.5" are covered by silt, sediment, or sand. Sides of the majority of rocks are surrounded by silt, sediment, or sand, giving them a "cemented in" look. The degree that the rock tops are covered will determine the embeddedness value recorded on the data sheet.

Data Management

Submission of embeddedness data will include a copy of the original spreadsheet data file and a copy of the spreadsheet data file formatted for export (if necessary). Notes that describe the degree of fouling should be submitted as text (*.txt) files.

The spreadsheet data file should follow the format In Table 1.

Table 1. Data submission format for embeddedness recordings

Station ID	Date	Left side of Riffle Embeddedness (%)	Right side of Riffle Embeddedness (%)	Thalweg (center) of Riffle Embeddedness (%)	Mean Riffle Embeddedness (%)

Graphing

1. Graphs should be bar graph option or xy line format.
2. Axis identification:

X axis-Time(date)

Y axis- % embeddedness

One graph is required per monitoring quarter to include results from all embeddedness monitoring stations. One graph is to be provided per monitoring year to record monitoring results during the term of monitoring from all embeddedness monitoring stations.

**MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE MONITORING PROTOCOLS**

PHYSICOCHEMICAL MONITORING

PURPOSE:

To determine the physicochemical water quality of a stream before and after BMP installation

PREFERRED MONITORING TOOL:

Portable or Hand-held electronic meters.

APPROPRIATE LOCATION (GENERAL)

In stream channel above and below proposed BMP facilities

OVERVIEW

Physicochemical is a term used to define a group of water quality parameters that are influenced by both physical and chemical processes. Physicochemical water quality parameters include, but are not limited to, dissolved oxygen (DO) and percent saturation, pH, conductivity, and temperature. They are the routine water quality parameters collected during most stream studies. These parameters are usually sampled with individual hand held meters or portable multiple parameter samplers.

Monitoring Methods:

The exact method and location for monitoring physicochemical parameters is dependent upon the goals and objectives of the BMP monitoring plan. The BMP monitoring plan should specify what type of water resource, (e.g., pond, stream, wetland) and what aspect of the aquatic resource (e.g., riffle, run, pool) is to be sampled. If pond monitoring is required it is important to specify at what depth or range of depths the samples are to be collected. In addition, how samples are collected is dependent upon the type of monitoring equipment chosen. It is critical to follow the manufacturers specifications for use of the monitoring equipment.

Aside from the specifics of when and where to sample there are several basic steps that need to be taken whenever sampling equipment is used. These steps include maintenance and calibration, storage and transportation, data recording, and data management.

Maintenance and calibration

Maintenance and calibration of all equipment is to be performed to the manufacturers specifications. Equipment should be calibrated and inspected daily prior to use in the field. A logbook for each piece of equipment should be maintained to record maintenance and calibration. Calibration records should include date, personnel, battery life remaining, pre-calibration values, standard values, and the post-calibration values for each instrument. The logbook should also record the date and personnel performing any periodic maintenance or. Periodic maintenance should be conducted at the frequency stated by the manufacturer.

Data Recording

After deployment of the unit following manufacturers instructions, allow sufficient time for the readings to stabilize before recording data.

Frequency

Physicochemical data should be collected whenever other BMP monitoring activities are performed (other than groundwater monitoring).

Data Management

1. Submission of recorded physicochemical data will include a copy of the original spreadsheet data file and a copy of the spreadsheet data file formatted for export (if necessary).
2. The spreadsheet data file should follow the following the format shown in Table 1.

Table 1. Data file format for physicochemical monitoring

Station ID	Date/Time	pH	Conductivity	Dissolved Oxygen	% Saturation	Water/Air Temperature	

Graphing

1. Graphs can be either bar graph or line format.
2. Axis identification:
 - X axis-Time(date)
 - Y axis- Parameter of interest
3. One graph is required per monitoring quarter for each physicochemical parameter monitored. Multiple sampling stations can be depicted on a single graph if each is uniquely identified in the legend. One graph is to be provided per monitoring year to record cumulative monitoring results during the term of monitoring per monitoring station.

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CREST GAUGE

PURPOSE:

To determine the highest elevation of the water surface of a stream over a given time period

PREFERRED MONITORING TOOL:

Crest Gauge

APPROPRIATE LOCATION (GENERAL)

Located instream along the streambank in a straight run of stream

OVERVIEW:

A crest gauge is used to determine the highest elevation of the water surface of a stream during a storm event. The crest gauge does not determine the volume or velocity of flow, only the maximum elevation. A crest gauge is used when continuous flow volumes or flow depths are not required. The crest gauge can be used to determine the bankfull storm event when correlated to rainfall data.

The crest gauge uses a wooden dowel suspended in a tube that allows stream water to enter at the bottom. Ground cork is placed in a small container at the bottom of the tube. The crest gauge is then placed in the stream. As the water surface rises during a storm event, the cork floats up in the tube. As the water surface drops after the storm event, the cork adheres to the wooden dowel at the highest water surface elevation. Later, the dowel can be removed from the crest gauge and the elevation of the highest water surface during the storm event can be determined from the level of the cork left on the dowel.

CREST GAUGE CONSTRUCTION

A crest gauge can be easily made from materials available at any hardware store and a few simple tools.

Materials List:

- 1- 4' long section of 1½" diameter PVC pipe
(a longer pipe may be needed for use in larger streams)
- 2 - 1½ " PVC end caps
- 1 - 4' long section of ¾" diameter hardwood dowel
(if a longer pipe is used increase dowel length)
- 1 - 35mm film canister
- 2 - 1" long wood screws
- Enough ground cork to fill a film canister

Tool list :

Handsaw
 Drill (manual or electric)
 Screwdriver
 PVC cement

1. Take the four foot (or longer) section of PVC pipe and glue one of the endcaps to the bottom of the pipe.
2. At the very bottom of the PVC pipe drill one hole (3/8") through the side of the endcap and pipe. On the opposite side of the crest gauge drill three holes through the side of the endcap and pipe.
3. Drill a pilot hole for one of the screws through the center of the other endcap and drill another hole (1/4") in the top near the side of the endcap. (The 1/4" hole acts as a vent)
4. Mark the wooden dowel in 1" increments, starting from the top and proceeding down. The 1" mark should include the thickness of the topcap.
5. Drill a pilot hole for the screws in the center of each end of the dowel.
6. Attach the dowel to the endcap with one of the screws so that the dowel will be suspended in the tube when the cap is put in place.
7. Use the other screw to attach the film canister to the other end of the dowel. The canister should form a cup on the end of the dowel to hold the cork.
8. Place dowel with canister into the PVC tube. Press fit the top cap in place. **DO NOT CEMENT THE TOPCAP IN PLACE.**

The crest gauge is now ready for deployment. Do not add cork to crest gauge at this time. Cork should not be placed in film canister until just before placing the gauge in the stream.

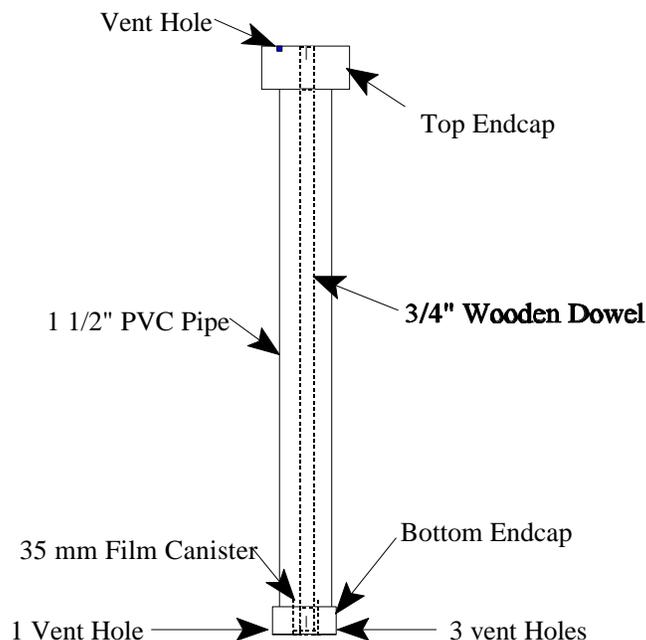


Figure 1 Typical crest gauge construction

CREST GAUGE INSTALLATION

A crest gauge should be installed in a relatively straight run of stream. Examine the downstream area to insure that there are no obstructions or debris jams that may create a backwater situation at the crest gauge. The crest gauge can be mounted to a steel/wooden fence post with cable ties (Figures 1 and 2).

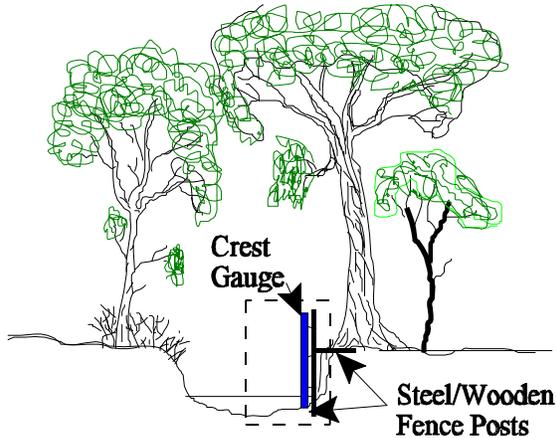


Figure 1.

In situations where a post cannot be driven into the substrate or bank securely, the crest gauge can be secured to a tree or tree roots along the bank. The tree selected must be in good health and not in danger of being undermined or toppling over. The crest gauge should be placed in the stream so that the side of the crest gauge with one vent hole faces upstream.

Once the crest gauge has been secured in the stream, remove the cap and dowel assembly and add the ground cork to the film canister. After replacing the cap and dowel assembly the crest gauge is operational.

The elevation of the top of the crest gauge will need to be tied into a benchmark. The benchmark can be either a three foot, capped iron rebar driven into the ground near the stream bank, a permanent feature (manhole, storm drain outlet, bridge pier, etc...), or an actual surveyed benchmark. A relative datum is acceptable.

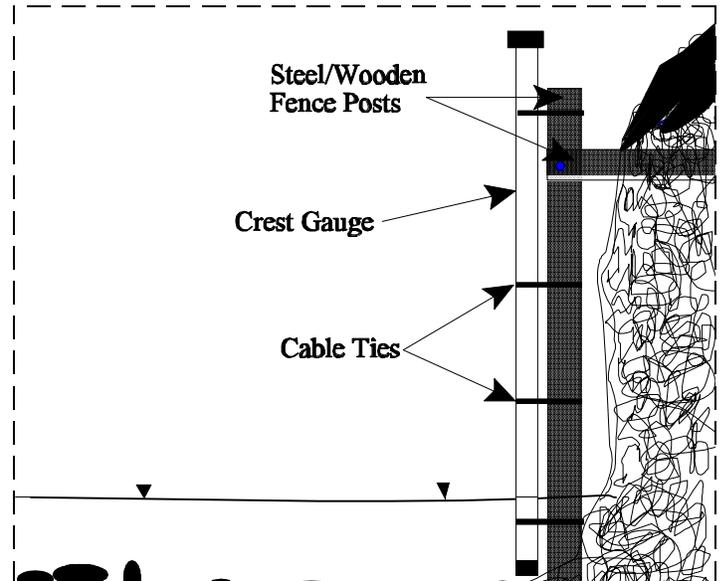


Figure 2.

MONITORING THE CREST GAUGE

There does not need to be a systematic schedule for monitoring the crest gauge. The crest gauge only needs to be checked after a runoff producing rain event. The gauge should be checked as soon as possible after a such a rain event in order to prevent loss of data should another rain event occur soon after. To retrieve data from the crest gauge remove the cap and dowel assembly, being careful not to scrape it against the sides or top of the crest gauge. Examine the dowel to determine the elevation of the cork residue. If the dowel had been previously marked in increments, the elevation can be read off the dowel, otherwise measure the distance from the top of the topcap to the cork and record the distance.

DATA MANAGEMENT:

1. Recorded surface water elevations should be submitted in spreadsheet and graphic format. Submission of recorded surface water elevation data should include a copy of the spreadsheet file on 3.5" floppy disk as well as a hard copy of the data.
2. Spreadsheet format for data submission should follow the example in Table 1.

Table 1. Data submission format for crest gauges

(Rows 1-3 Header Information)					
Gauge I.D. (Row 4)	Date	Time	elevation at top of gauge (A)	elevation of cork on dowel (B)	Elevation of water surface (A-B)
(Row 5)					

3. Spreadsheet should be saved as ASCII text unless otherwise specified by DEP.
4. Data submission should also include documentation of the location of the crest gauge(s), rationale for crest gauge location(s), and any supporting information.

**MONTGOMERY COUNTY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BEST MANAGEMENT PRACTICE MONITORING PROTOCOLS**

STREAM FLOW MONITORING

PURPOSE: To document the existing flow regime of a stream and determine changes to the streams flow regime after BMP installation.

PREFERRED MONITORING TOOL:

Continuous flow logger

APPROPRIATE LOCATION (GENERAL):

In stream channel below BMP structure(s)

OVERVIEW

The collection of accurate stream flow data requires a great deal of time and effort on the part of the investigator. There are numerous methods for monitoring stream flow. Most of these methods involve four aspects: the establishment of a permanent stream cross-section, the installation of flow recording equipment, the measurement of stream flow at various flow stages, and the development of a stage-discharge relationship to create a flow rating curve.

The location of the stream cross-section is critical for accurately monitoring stream flow. The most appropriate location is in a straight reach of the stream where the channel substrate and stream banks are uniform and there are no obstructions. Generally, the best location is within a run just above a riffle. The cross-section is the location where flow measurements will be made to establish the stage discharge relationship and create the rating curve for the flow station.

The equipment needed for installation at the flow monitoring station consists of a continuously recording flow monitoring unit (flow logger) and a staff plate. The flow monitoring unit continuously records water depth at or near the cross-section. The flow monitoring unit is installed along the stream near the established cross-section. There are several types of sensors used by flow monitoring units to measure water depth. The most popular type of flow monitoring unit utilizes a pressure transducer mounted in the stream to record changes in water pressure resulting from changes in water depth over the transducer. The unit converts these pressure readings to water depths. Another flow monitoring units utilize a bubbler, which measure the pressure required to force a stream of bubbles out of a tube mounted in the stream. Still other types of units utilize infrared sensors or floats to measure water depth.

A staff plate is a permanently installed graduated rod (scale) that indicates the depth of flow or stage. It is mounted on the stream bank at or near the cross-section so as to be easily read from the streambank. The staff plate is used to quickly determine the depth of flow or stage of the stream.

In order to convert the depth measurements recorded by the flow monitor to discharge, a series of flow measurements must be made at various flow stages to develop a rating curve that correlates stream depths with flow volumes. Generally, a minimum of six flow measurements at various high and low flow stages are necessary to accurately establish a rating curve. Once a rating curve is established, knowing the depth of flow (stage) will allow the investigator to determine the volume of flow.

Establishing a Stream Cross-section

Select a location where the stream is relatively straight with uniform banks and substrate. There should be no obstructions within the channel above or below the water level. Ideally, the cross-section will be located in a straight run above a riffle. It is important that the run area selected have as little water surface slope as possible (flat water), while still maintaining positive downstream flow. In addition, the substrate must be stable. Stream cross-sections with sand or silt substrates may scour away during high flow events and redeposit as the flow returns to normal. In a situation such as this the stream cross section will not be the same during all flow stages. A resistant substrate such as bedrock, cobble, or clay should be selected.

Once a suitable location has been found, use rebar (capped) to permanently mark the endpoints of the cross-section. The endpoints should be far enough away from, and above, the streambank so as not to be inundated during a bankfull flow event. The rebar should be located by recording the distance to at least two points, usually the two closest mature trees, or a combination of trees and other permanent structures (e.g., bridge abutments, manholes).

Once a suitable cross-section location has been found, the initial cross-sectional measurements can be made and the flow monitoring equipment can be installed. The methodology for completing cross-sectional measurements is detailed in the Montgomery County Stream Monitoring Protocols (Van Ness et al., 1997).

Installation of Flow Monitoring Equipment

The flow monitoring equipment consists of a flow logger to record stream flow, a probe (pressure transducer) to measure water depth, and a staff plate (Figure 1). The flow logger can either be mounted on a post in a weatherproof box or installed in a small weather proof housing on the ground (Figures 1-2). The type of installation depends upon the size of the stream and the likelihood of the equipment being inundated in a flood. The staff plate is mounted to a post. The post can be either an iron pipe, heavy gauge metal fence post, or 4x4 treated wooden post. The post should be driven into the substrate and supported by a second post attached to the first and driven horizontally into the streambank. In order to protect the post from being dislodged at high flows it may be necessary to excavate a small cut in the bank to protect the staff plate. The specific location of the flow monitoring station will dictate exactly how the post should be installed.

The pressure transducer should be protected by placing it inside PVC pipe. A length of PVC pipe with a right angle bend at the bottom will not only protect the pressure transducer, but will also protect the wire connecting it to the flow logger (Figure 4). The short length of pipe extending out from the bend into the stream channel can be secured to the stream substrate with rebar for additional protection.

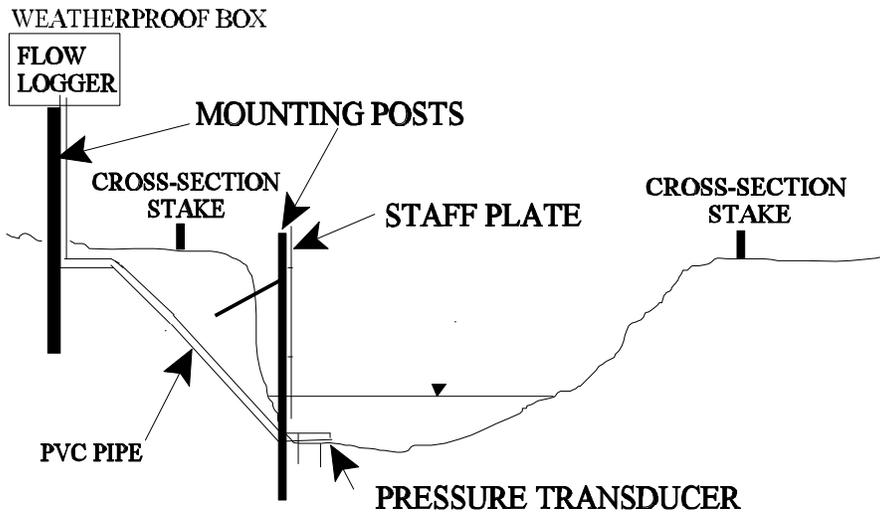


Figure 1. Example flow monitoring station with flow logger mounted on post

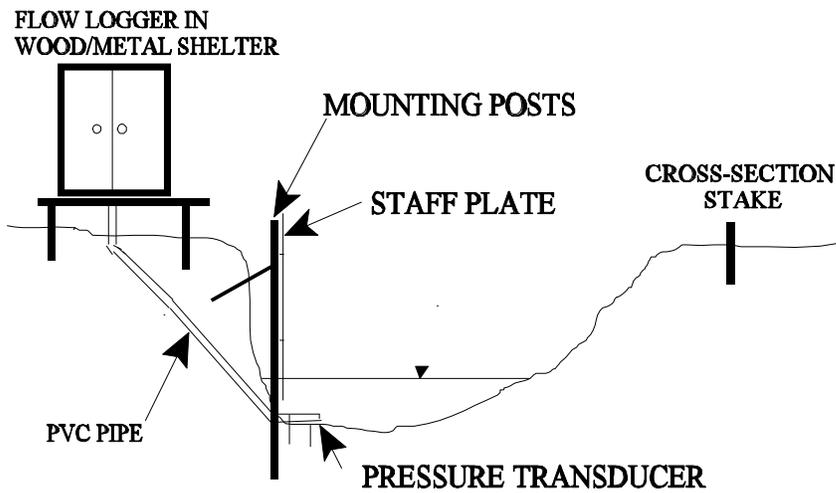


Figure 2. Example flow monitoring station with flow logger mounted on ground

The staff plate must be installed so that it can be easily read from the streambank but will not be dislodged by debris at high flows. The PVC pipe holding the pressure transducer can be secured to the bottom of the post (Figure 4). If a second post is needed, it should be installed in the same manner as the first. The staff plate must be set low enough to register at the lowest expected flows. The staff plate must be permanently fixed and not moved during the period of study or erroneous stage measurements and inaccurate flow readings will result.

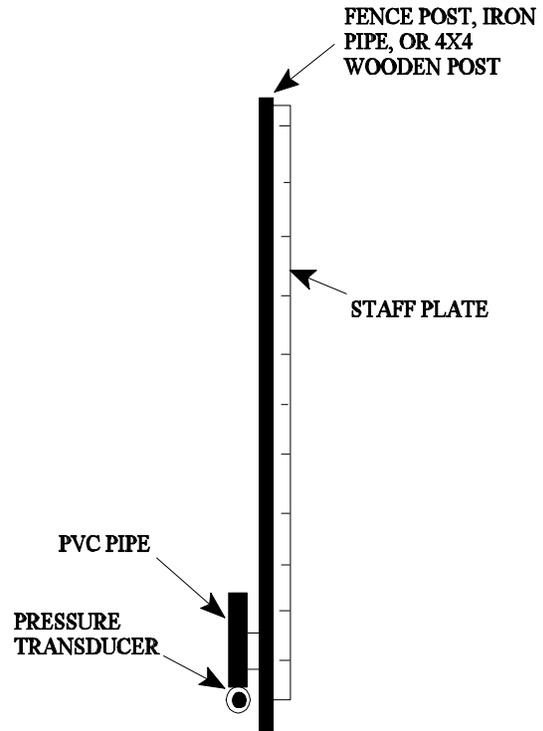


Figure 4. Example staff plate installation

Once the necessary equipment has been installed, the initial discharge measurement can be made. This initial discharge measurement will become the first point on the rating curve. The flow is measured at the cross section as detailed in Montgomery County’s Stream Monitoring Protocol Manual. In order to maximize accuracy, the cross-section must be broken up into enough segments so that no one segment has more than 10% of the flow in it and there must be at least ten segments within the flowing portion of the channel. Once this initial discharge is determined, record the stage or flow level from the staff plate and flow meter along with the discharge.

The stage discharge relationship is expressed as a rating curve (Figure 5). The rating curve correlates the stream discharge recorded at the cross section to flow depths recorded by the flow logger. Once sufficient discharge measurements have been made and the curve developed only the depth of flow (stage) is needed to determine the discharge. These additional discharge measurements must be made at a variety of flow stages. The discharge measurements should be collected on the falling limb of the storm hydrograph.

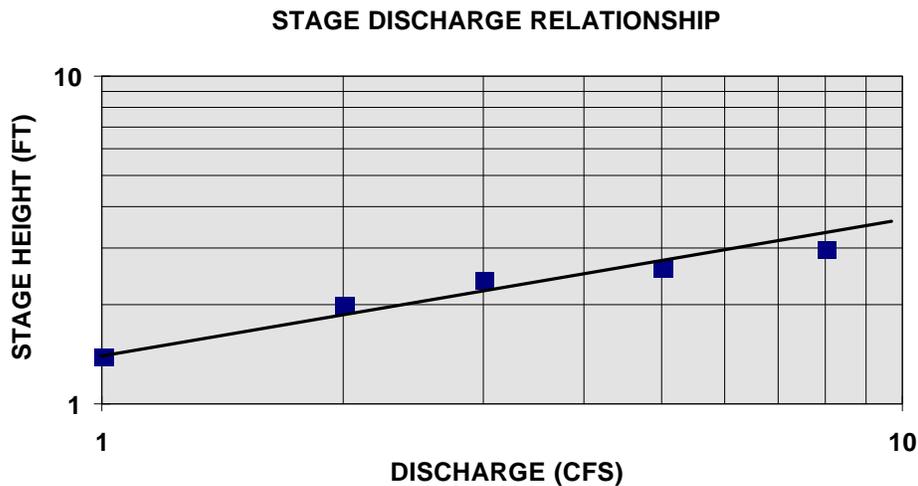


Figure 5 Example stage-discharge relationship

To develop the rating curve, graph the depth of flow (stage) versus discharge for the flow measurements made. The rating curve should be plotted on log-log paper as parabolic curves will plot as straight lines. Plot the discharge on the X-axis and stage on the Y-axis.

DATA MANAGEMENT

Submission of stream flow monitoring data will include documentation of rationale for where and how the flow station was located and installed, a copy of the data files from the flow logger on 3.5" diskette, a copy of the stream discharge rating curve and documentation of how it was developed, and other relevant data used to establish the flow station. All data should be submitted as hard copies and on floppy disk.

QA/QC

The flow monitoring station must be recalibrated periodically to insure accurate data collection. On at least a quarterly basis, the stream cross-section and flow should be remeasured to insure that there has been no change in the cross-sectional area of the channel. Any noticeable change in the cross sectional area of the stream will require modification to the rating curve. At the same time, the actual flow should be compared to the flow indicated on the current rating curve. Any significant difference (>10%) between the actual and predicted flows will also require modification to the rating curve. DEP biological staff should be contacted when it appears a modification to the rating curve is necessary.