Stormwater Best Management Practice Demonstration
Tier II Protocol for Interstate Reciprocity
Endorsed by California, Massachusetts, New Jersey, Pennsylvania, and Virginia

November 2001

Acknowledgement

For technology evaluations following the elements of this Protocol, the endorsing state partners in California, Massachusetts, New Jersey, Pennsylvania, and Virginia have agreed to:

1. *Address technology review and approval barriers in policy and regulations that do not advance knowledge of a technology's performance or recognize innovative approaches to meet environmental protection goals;*
2. *Accept the performance tests and data, and acknowledge the approval results of a partner's review of a technology demonstration, as appropriate, in order to reduce subsequent review and approval time;*
3. *Increase expertise in the applications and advantages of technologies that may have superior environmental and economic benefits for controlling stormwater pollution;*
4. *Use the Protocol, as appropriate, for state-led initiatives, grants, and verification or certification programs where the objective is to document performance efficiency and cost of best management practices;*
5. *Share technology information with potential users in the public and private sectors using existing state supported programs; and*
6. *Monitor and evaluate the results of using this Protocol, and periodically review and revise the Protocol to maintain its viability.*

This Protocol describes a set of uniform criteria acceptable to the endorsing states. However, specific state requirements must be considered when applying for certification or verification of a stormwater BMP in a particular state. Each partner reserves the right to evaluate any application and request specific information as outlined in Appendix D in order to satisfy an individual state's requirements.

Any state, regional, or private entity interested in using the Protocol should contact the stormwater leads listed in Appendix D. States wishing to join the partnership and endorse this Protocol should contact Calvin Kirby, Pennsylvania Department of Environmental Protection; contact information is provided in Appendix D.

I. Introduction

A. Overview

Stormwater pollution, especially in developed urban areas is a leading cause of water quality degradation in U.S. rivers, lakes, streams, and other surface waters. Water quality problems associated with nonpoint sources of pollution, particularly stormwater, are being addressed by federal mandates that affect all states. Expansion of the National Pollutant Discharge Elimination System (NPDES) Phase II, Storm Water Regulations, requires stormwater plans from thousands of municipalities nationwide, and a renewed focus on the total maximum daily load provisions (TMDL) in the Clean Water Act brings unprecedented attention and increased resources to stormwater control issues. These programs also are predicted to have a significant influence on the rate at which new technologies enter the marketplace.

To support responsible use of stormwater technologies, the Demonstration Protocol is designed to be flexible and inclusive of both structural and nonstructural best management practices (BMPs). The Protocol primarily deals with the demonstration of BMPs that are designed for one or more of the following: 1) directing and distributing flows; 2) reducing erosive velocities; and 3) removing contaminants such as suspended or dissolved pollutants from collected stormwater through physical and chemical processes such as settling, media-filtering, ion-exchange, carbon adsorption, and precipitation. Current BMPs used in industrial, municipal, and construction stormwater pollution control applications, include vegetated swales, detention basins, infiltration basins, wet ponds, constructed wetlands, media filtration, bioretention, and sedimentation units (e.g., hydrodynamic structures, oil/sediment separators, and screen separators).

B. Purpose

The purpose of the Protocol is to provide a uniform method for demonstrating stormwater technologies and developing test quality assurance (QA) plans for certification or verification of performance claims. The advantages of using the Demonstration Protocol are numerous. Technology proponents will reduce duplicative or overlapping demonstration and performance testing of technologies; maximize research and development dollars; certify or verify the technology in accordance with performance claims and state regulatory standards; demonstrate effectiveness, cost, and marketability; and achieve maximum market penetration.

Since current NPDES Phase I and II regulations require industrial and municipal permittees to provide stormwater discharge control through use of BMPs, specific BMP usage is not subject to regulation. Stormwater BMPs with demonstrated capability, i.e., BMPs with reliable removal rates based on field testing, are more likely to be used in NPDES required Stormwater Pollution Prevention Plans (SWPPP) to control stormwater discharges. Obtaining certification or verification of a stormwater BMP technology from participating states can assist the technology in gaining regulatory acceptance in this application.

The requirements for a stormwater BMP demonstration are minimized in the Protocol to a common set of uniform criteria, acceptable to all participating states. However, specific state requirements must be considered when a technology proponent is pursuing certification or verification of a stormwater BMP in that state, specific requirements for the endorsing states are described in, but are not limited by, Appendix D. In addition, the Protocol does not completely eliminate all state review or approval of projects proposing to use the stormwater technology, nor does it require any state to "rubber stamp" the approval or permit of another state or regulator.

II. Preparing a Test QA Plan Scope for Validation Screening

States endorsing this Protocol recognize that new information and approaches to stormwater control may warrant future adjustments to the Protocol. As acknowledged on page 1, states are committed to reviewing and revising the Protocol, as necessary, to maintain its viability.

A. Preparation

Prior to undertaking a Stormwater BMP Technology Demonstration, a proponent should research current developments in stormwater BMPs to compare a technology's capabilities with applicable field-tested BMPs or state-of-the-art standards. A major effort to develop a nationwide stormwater BMP database on the performance capabilities of structural and non-structural BMPs has been undertaken by the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (EPA). The database includes BMP removal efficiency data for specific contaminants, as well as site-specific data, area hydrologic data, and BMP specifications for locations throughout the U.S. This database can be accessed at the following Web site: http:/www.bmpdatabase.org/.

If a proponent requires financial assistance for evaluating a technology, funding may be available through federal, state, or local government agencies. Financial assistance for evaluation testing of innovative environmental technology can be pursued through the EPA Office of Research and Development (ORD) program Web site: http://es.epa.gov/ncerqa/rfa/.

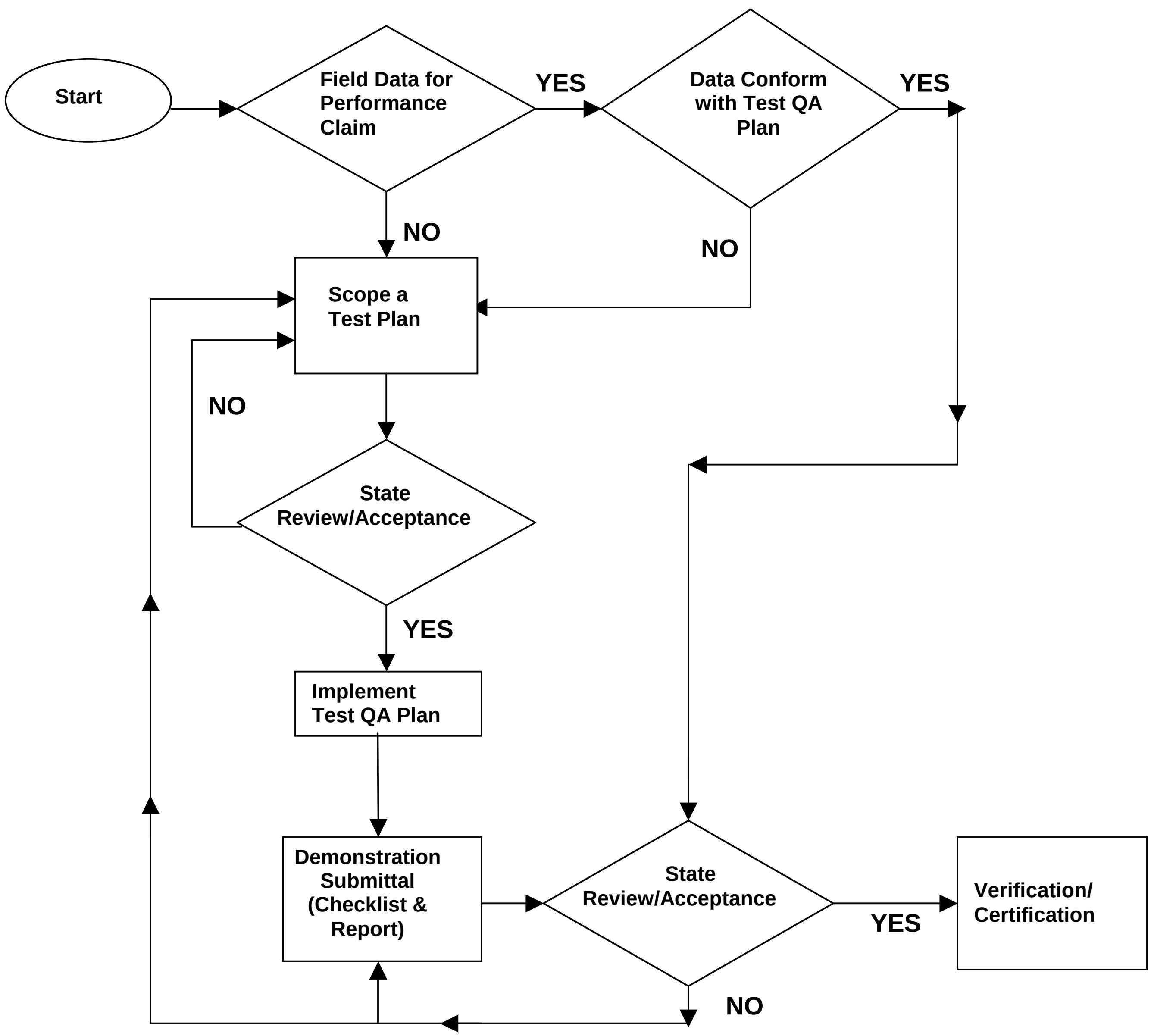
A technology proponent may use existing lab and field studies or other appropriate data to support claims about a technology's performance capabilities. Replication of field-testing under a variety of conditions (i.e., flow rates, contaminant loadings, antecedent moisture conditions, rainfall distribution, maintenance intervals, primary treatment device or treatment train approach, land use, percent imperviousness, and type of drainage system) is desirable for a Stormwater BMP Technology Demonstration. Therefore, field-testing in accordance with the Test QA Plan is required in addition to performance claim data, which may be available in lab and field studies.

The main focus of the states' technology verification and certification programs is the independent validation of data supporting specific technology performance claims. Although the emphasis of the Protocol is to provide guidance on the requirements for obtaining performance data through use of Test QA Plans, proponents with existing data can check their data to determine if the requirements of a Test QA Plan can be fulfilled. A flowchart of the test QA plan and field demonstration review process is shown in Figure 1.

B. Stormwater BMP Screening for Validation

Before undertaking a Stormwater BMP Demonstration, technology specifications, performance claims, the Test QA Plan scope, and performance claim data (if available) must be submitted for review and validation by verification/certification organizations. Technology specifications and existing data will be reviewed first to ensure that the technology meets program criteria, e.g., environmentally beneficial, commercially available, field-tested, and the product has been quality controlled.

Figure 1. Overview of the Test QA Plan and Field Demonstration Review Processes



The performance claim and Test QA Plan scope will be reviewed and validated based on elements in the Test QA Plan scope, including: test objectives, use of standardized test methods and procedures, a data quality assurance and control plan, data collection, and statistical tests of the data. Each test plan must have a quality assurance project plan (QAPP), meeting the requirements specified in Appendix F.

C. Technology Specifications

The technology, components, and all process units should be described completely. Generally, the technology specifications must include physical, chemical, and biological processes, operation and maintenance (O&M) requirements, process flow diagrams and algorithms, equipment drawings and specifications, existing test plans, performance data, certifications, and a description of process inputs and outputs. More specifically, the following information should be provided in the specifications.

1. A summary of the underlying scientific and engineering principles for the technology.
2. Technology specifications, alternative technology configurations, and any associated disadvantages, such as physical constraints and limitations, weight and buoyancy, transportability, durability, energy requirements, and consumable materials.
3. Minimum siting and design specifications to achieve stated performance, including but not limited to: pollutants that should and could be addressed; minimum and maximum influent concentrations; pollutants that will not be addressed or that may be increased; and siting, location, land use, and land activity limitations or restrictions.
4. A discussion of the advantages of the technology when compared to conventional stormwater systems providing comparable stormwater control.
5. Standard drawings, including a schematic of the technology and a process flow diagram.
6. A discussion of technology hydraulics and system sizing to meet performance standards and goals (e.g., to handle the water quality volume, rate of runoff, type of storm, or recharge requirements).
7. Full range of operating conditions for the technology, including minimal, maximal, and optimal conditions to achieve the performance goals and standards, and for reliability of the technology.
8. Minimum maintenance requirements to sustain performance.
9. Significant modifications and technical advancements in the technology design.
10. Technology limitations, such as performance limits for control of certain water quality parameters, and predicted impacts from construction, operation, and maintenance of the technology.
11. Identified secondary impacts.
12. Discussion of the generation, handling, removal, and disposal of discharges, emissions, and waste byproducts in terms of mass balance, maintenance requirements, and cost.
13. Discussion of pretreatment and preconditioning of stormwater, if appropriate to achieve stated performance of the BMP.
14. Identification of any special licensing or hauling requirements, safety issues, and access requirements associated with operation or maintenance of the technology.

D. Performance Claim

In preparation for a technology demonstration, a proponent must make a performance claim that identifies the technology's intended use and predict the technology's capabilities to remove contaminants and/or control the quantity of stormwater runoff. Performance claims should be objective, quantifiable, replicable, and defensible. Claims that are overstated should be avoided, as they may not be achievable.

Stormwater BMP technologies are typically evaluated for contaminant removal efficiency, although pollution prevention claims also are possible. An example of a stormwater treatment BMP performance claim could be:

> *"The Model X system can capture and treat the first half-inch, 24-hour storm for a 10-acre runoff area. Under these conditions, a total suspended solid (TSS) removal rate of 85%± 5% (at a 95% confidence level) can be achieved with inflow TSS concentrations greater than 100 mg/l."*

E. Test QA Plan Scope

The procedures for a stormwater BMP field test must be described in the Test QA Plan scope, which will be reviewed and validated to ensure that the procedures for collecting, handling, and analyzing samples and data will be accurate, precise, representative, complete, and comparable. Elements in a Test QA Plan include test objectives, use of standardized test methods and procedures, a data quality assurance and control plan, data collection, and statistical tests of the data. Test objectives for performance claims should be clear, concise, quantitative, and unambiguous, such that standardized test methods and procedures can be applied. The entire range of technology performance capabilities should be tested in order to demonstrate the full potential of the technology.

III. Test QA Plan Contents

A. Standardized Test Methods and Procedures

Standardized test methods and procedures should be used to collect stormwater BMP data. For determining stormwater contaminant removal efficiencies or removal rates BMP inlet and outlet flows and contaminant concentrations will need to be measured. Typical standardized test methods may include ASTM flow measurement methods, ASCE hydraulic flow estimation methods, and EPA test methods for water constituent analysis. Other nationally recognized organizations have produced standards, which may be used, such as American Water Works Association (AWWA), NSF International, and American Public Health Association (APHA) Standard Methods. The standards typically used for the specific field where a technology is applied should be specified, e.g., NSF International for water and wastewater treatment technologies. Use of standardized test methods and procedures have the advantages of being prepared by technology specific, expert subcommittees, and these standards typically incorporate peer-reviewed data QA/QC. Where standard methods are not appropriate and alternative methods are proposed, sufficient evidence to assure data quality must be developed and submitted for review. Under most test conditions, a unique sampling plan will be required and a standard operating procedure (SOP) must be developed.

Several sources of test plans, test methods, procedures, and standards are available for testing stormwater technologies. Test methods for measuring flow and water constituent analysis are provided in Appendices B and C. Some examples are:

- EPA Test Methods (Appendix C) for contaminant analysis, http://www.epa.gov/epahome/index/nameindx.htm
- ASME Standards and Practices (pressure flow measurements),
- ASCE Standards (hydraulic flow estimation methodologies),
- ASTM Standards (precision open-channel flow measurements/practices for water constituent analysis),
- American Water Works Association Standards, water treatment sampling and analysis standards), http://www.awwa.org/awwastds.htm.
- Wilde et al, 1998. National Field Manual for Collection of Water Quality Data, Techniques of Water Resources Investigations Book 9, USGS (ISBN:0-607-90623-5),
- Caltrans "Guidance Manual: Stormwater Monitoring Protocols," http://www.dot.ca.gov/hq/env/stormwater/special/guidance_manual.htm, and

- Test QA Plans and Protocols for wet weather flow technologies are available on the Environmental Technology Verification (ETV) Web site sponsored by EPA and National Sanitation Foundation (NSF): http://www.epa.gov/etv.

B. Data Quality Assurance Project Plan

The test QA plan must show that following practices and procedures will be followed in obtaining performance claim data to ensure data quality assurance and control:

- Prepare a Quality Assurance Project Plan (QAPP) and/or a sampling and analysis plan to ensure that performance claim data sets meet data quality objectives (DQOs) and are "defensible." The QAPP and/or SAP should be prepared using either *Guidance for Quality Assurance Project Plans (QAPP), EPA QA/G-5, 1998* or *Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program, ASTM D5612-94.* Both EPA QA/G-5 and ASTM 5612-94 provide directions for developing a sampling and analysis plan, which includes all necessary requirements to obtain valid data for water monitoring. The guides cover development of sampling and analysis plans, sampling procedures, analytical requirements, data quality assurance/control requirements, and documentation. For a copy of EPA QA/G-5, see the EPA Web site: http://www.epa.gov/quality.
- The current national QAPP requirements are available in *Requirements for Quality Assurance Project Plans (EPA QA/R-5, 2001).* The minimum elements of a QAPP in Appendix F are cited from EPA QA/R-5. This document can be downloaded from the EPA Quality System Documents Web page, http://es.epa.gov/ncerqa/qa/qa_docs.html.

    - Use standardized test methods and procedures where applicable (Appendix B).
    - Use qualified personnel in testing and data acquisition.
    - Prepare and coordinate a Stormwater Sampling and Analysis Plan (see Appendix C). Ensure Sampling and Analysis Plans include:
        - Data quality objectives (DQOs);
        - Sampling equipment and procedures (location and frequency) (ASTM D3694-96/D3370-95A);
        - Chain-of-custody procedures (ASTM D4840-99);
        - Sample preservation/holding times (ASTM D4841- 88/D4515-85/D3694-96);
        - QC sample protocol (splits & composites; field, trip, equipment blanks; spikes; duplicates) (ASTM D5612-94/D5810-96/D5788-95); and
        - Sample equipment decontamination.
    - Use certified or accredited laboratories for sample analysis. See the National Environmental Laboratory Accreditation Conference (NELAC) Program Web site: http://www.epa.gov/ttn/nelac/.
    - Use certified or accredited laboratories for testing (ASTM, ASCE). See the following ASTM laboratory listing Web site: http://www.astm.org/labs.
    - Test equipment and instrument calibration/certification.

C. Stormwater Data Collection Guidance

This section guides the selection of criteria for data collection; it is based in part on criteria currently used for NPDES permit compliance. The *NPDES Storm Water Sampling Guidance Document* (EPA 833-B-92-001) provides additional guidance for sampling and analyzing stormwater for compliance with industrial, municipal, and construction NPDES permits. A copy can be downloaded from the EPA Web site: http://www.epa.gov/owm/enhance/pd/owm0093.pdf.

Specific stormwater technologies should tailor data collection and analysis to their specific performance claim Test QA Plan. Although there are different approaches for collecting performance data, the following criteria are considered by the participating states to be necessary for obtaining scientifically valid data, particularly for field demonstrations.

1a. Storm Event Criteria to Sample

The following criteria will need to be considered, in order to obtain representative contaminant loading data (flows and contaminant concentrations).

- Historic data: obtain monthly mean rainfall and snowfall data, for all 12 months over the period of record, from the nearest National Weather Service (NWS) station (airport). Rainfall data for a site may be obtained from local weather station records and almanacs. The National Climatic Data Center Web site can be accessed for rainfall data for locations throughout the U.S.: http://www.ncdc.noaa.gov/ol/climate/climateresources.html.

  Note: Precipitation data from a single, distant station may not accurately estimate local weather patterns. In this situation, use of data from several stations with appropriate averaging methodologies (e.g., isohyetal or Theissen) may be necessary.

- Current weather forecast available on: http://weather.noaa.gov/weather/MAcc_us.html *(Substitute any state's abbreviation for "MA" in the Web site address above.)*

- Use continuous recording rain gauges to measure the intensity of the storm for its duration. Measurements in 15-minute increments are recommended for consistency with NWS reporting of precipitation intensity.

1b. Identifying Storms to Sample

- More than 0.1 inch of total rainfall.

- A minimum inter-event period of 6 hours, where cessation of flow from the system begins the inter-event period.

- Obtain flow-weighted composite samples covering a minimum of 70 % of the total storm flow, including as much of the first 20 % of the storm as possible.

Note: Composite samples are not appropriate for all parameters.

- A minimum of 10 water quality samples (i.e., 10 influent and 10 effluent samples) should be collected per storm event. For composite samples, a minimum of 5 subsamples is acceptable (i.e., 2 composites with 5 subsamples = 10 water quality sample minimum or 1 composite sample with 10 subsamples = water quality sample minimum).

Note: If a storm is too small for 10 samples, an average of 10 samples per storm may be substituted. However, more than 10 samples per storm event should be collected wherever possible.

1c. Determining a Representative Data Set

- Flow measurements should be taken to predict or calculate pollutant loads. The mass of pollutants in the discharge should be based on flow rates and pollutant concentrations or another reasonable approach.
- Data are needed to characterize the flow rate and flow volume for each storm event.
- The number of water quality sampling events should be representative of the storm events in the climatic region. At least 50 % of the total annual rainfall must be sampled, for a minimum of 15 inches of precipitation and at least 15, but preferably 20, storms. (Also see Appendix D for California's requirements.) Storm events should be consecutive, where practicable. One-year of water quality sampling is optimal to observe performance changes as a function of season. Collection of a representative number of water quality samples may take more than a year in some regions.
- Some sampling must be done during adverse weather conditions; for example, during spring snowmelt and heavy rainfall, when runoff and contaminant transport is expected to be greater. Data quantifying process inputs and outputs should be collected for use in mass balances and cost analysis.

2. Selecting Stormwater Sampling Locations

Sampling locations for stormwater BMPs should be taken in as close proximity as possible to the BMP inlet and outlet to avoid potential sources of contamination that would alter the BMP efficiency data. Typically, the inlet and outlet for a BMP should be sampled to obtain performance claim data.

Describe and provide a scaled plan view of the demonstration site, indicating all buildings, land uses, storm drain inlets, and other control devices. Include a description of the site drainage area, percent impervious area, percent area directly connected to the BMP, description of the path of storm water flow to the BMP, type of activities conducted, pollutant sources, soil type, geological and hydrological conditions, existing control structures, and a site drainage plan. Estimate the impervious area within the drainage area and show sample inflow and outflow points.

Specify the location of flow devices and samplers in relationship to the inlets and outlets of the stormwater technology. Demonstrate that flow devices and samplers are installed and positioned properly to ensure that samples are representative of influent runoff and effluent runoff, (i.e., sample the influent as close as possible to the inlet of the system and sample the total treated effluent). For systems that bypass runoff, the influent location will be directly upstream of the system and before the flow is split between the treatment system and the bypass. The second, effluent sampling location will be directly downstream of the treated flow (i.e., the technology or treatment system outlet) and after the effluent joins the bypass. If the treated effluent flow does not join the bypass, the second location will allow sampling of the total flow after the treatment unit outlet.

Note: Sampling points used for NPDES permit compliance monitoring may not be appropriate for testing BMP technologies, e.g., if there is a contaminant source between the BMP and the outfall of a facility.

3. Stormwater Sampling Methods

Programmable automatic flow samplers with continuous flow measurements should be used unless it is demonstrated that alternate methods are superior or that automatic sampling is infeasible. Grab samples should only be used for certain constituents, in accordance with accepted standard sampling protocols, unless it is demonstrated that alternate methods are superior. Constituents that typically require grab sampling include: pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, total petroleum hydrocarbons (TPH), *Escherichia coli,* total coliform, fecal coliform, fecal streptococci, and enterococci. Collection and flow-weighted composite sampling also should follow the NPDES guidance.

Note: Time-weighted composite samples are not acceptable, unless flow is monitored and the event mean concentration can be calculated from the data.

4. Stormwater Flow Measurement Methods

Primary and secondary flow measurement devices are required.

5. Sample Data Quality Assurance and Control

The following elements should be described in the Test QA Plans and Sampling and Analysis Plan (see III. B. Data QA Project Plan):

- Equipment decontamination,
- Preservation,
- Holding time,
- Volume,
- QC samples (spikes, blanks, splits, and field and lab duplicates),
- QA on sampling equipment (e.g., calibration of automatic samplers and flow measurement devices)
- Packaging and shipping,
- Identification and labeling, and
- Chain-of-custody.

6. Selection of Parameters

Parameter testing applies to stormwater quality control BMPs. Municipal and construction site parameters are generally the contaminants in runoff studies, such as total dissolved solids (TDS), total suspended solids (TSS), suspended sediment concentration (SSC), or total petroleum hydrocarbons (TPH), total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus, chemical oxygen demand (COD), biochemical oxygen demand (BOD), *Escherichia coli*, total coliform, enterococci, pH, conductivity, temperature, and the following metals: lead, copper, zinc, and nickel. Runoff contaminant data from BMP evaluation studies can be found in the ASCE-EPA Nationwide Database. Also, data from parking lots and roadways can be found on the following Web site: http://stormwater.water-programs.com.

In selecting test parameters, include total suspended solids (TSS) and suspended sediment concentration (SSC), at a minimum, and consider other parameters that support performance claims, including those listed in Appendix C. (If a parameter is not listed, obtain approval for testing during validation screening of the Test QA Plan scope (see Section II.B.).

For some technologies, TSS and SSC removal efficiency testing will be adequate. However, confirmation of testing requirements with the state reviewing the technology, or by consulting the BMP database, is recommended, as requirements may change over time. Before selecting parameters, also consider the advantages of a comprehensive demonstration. With comprehensive parameter testing, a technology is likely to gain broader acceptance and some relief from specific technology approval requirements of the individual states. A demonstration of removal effectiveness for bacteria, nutrients, or toxics will be available to all in an Internet database.

The results of parameter testing must be compared with influent concentrations to demonstrate removal efficiencies.

7. Analytical Laboratory Requirements

Laboratories used to perform stormwater sample analysis should be certified by a national or state agency regulating laboratory certification or accreditation programs. The National Environmental Laboratory Analysis Certification (NELAC) program or, the Environmental Laboratory Accreditation Program (ELAP) (in California) should be used to perform standardized test methods and procedures.

8. Calculating BMP Efficiencies (ASCE BMP Efficiencies Task 3.1)

Process efficiencies or removal rates should be determined from influent and effluent contaminant concentration and flow data to quantify the performance of the BMP technology.

ASCE and EPA have published a Technical Memorandum on determining removal efficiencies for stormwater BMPs. This document should be used in determining BMP efficiencies (Development of Performance Measures, Task 3.1 – Technical Memorandum, Determining Urban Stormwater Best Management (BMP) Removal Efficiencies). The paper can be downloaded from the following Web site: http://www.asce.org/waterresources/nsbmpdb.cfm.

In summary,

- Efficiencies can be calculated for four BMP categories: 1) BMPs with well defined inlets and outlets that depend on extended detention storage, 2) BMPs with well-defined inlets and outlets that do not depend on significant storage of water, 3) BMPs that do not have well-defined inlets and outlets, and 4) widely distributed BMPs that use reference watersheds to determine effectiveness.

- Five methods are typically used to evaluate BMP efficiency: 1) Efficiency Ratio, 2) Summation of Loads, 3) Regression of Loads, 4) Mean Concentration, and 5) Efficiency of Individual Storm Loads.

Note: The Efficiency Ratio method is preferred.

- Data used to calculate efficiencies from the ASCE-EPA database are influent/effluent data of two principal types: 1) event mean concentration data (flow-weighted composite, weighted composite, and no flow or time weighting), and 2) discrete water samples (grab samples).

- Process efficiencies or removal rates should be determined from influent and effluent contaminant concentration and flow data to quantify the performance of the technology. Where applicable, the effect of bypass flow on process efficiency and system performance should be quantified.

D. Statistical Testing of Data (and Data Reduction)

Statistical testing should be performed on performance claim data to ensure that data are reliable, significant, and within confidence limits. When testing at specified ranges of flow and contaminant concentrations and when normal parametric statistical analysis is performed, coefficient of variation (CV) should be within ±10% for efficiency data, wherever possible. A larger range of CV may be allowed where justified. The vendor must demonstrate that the data set is normally distributed prior to using normal parametric statistical analysis. Data sets that are not normally distributed will need to be evaluated using nonparametric statistical analysis and may require further analysis and review.

The *Data Quality Assessment Guidance Manual*, EPA QA/G-9 includes an array of statistical methods, e.g., parametric analysis (mean, standard deviation, confidence intervals, and Z-statistic), comparison of populations (analysis of variance, box-whisker plots, and Tukey-tests), which can be used to compare and validate data sets. EPA QA-G9 can be downloaded from the following Web site:http://www.epa.gov/r10earth/offices/oea/epaqag9.pdf.

IV. Health and Safety Plan

A health and safety plan should be developed and included with the Test QA Plan for a Stormwater BMP technology, covering installation, operation, and maintenance of the technology. Specifically, the plan should address hazard identification and mitigation, engineered controls and procedures, personal protective equipment, and training. Also, where related to the stormwater BMP technology, include: collecting stormwater samples in confined spaces (manholes, storm sewer lines, and utility vaults); collecting high flow stormwater samples from culverts, drainage channels, and sedimentation basins during storms; and chemical, biological or physical hazards associated with the technology.

V. Cost Information

Reliable cost information is an essential component of a stormwater technology demonstration. Consider capital expenses; annual operation and maintenance costs; one time and recurring costs of the design, construction, and operation associated with monitoring/measurement; and cost associated with conducting certification or verification tests. Also, include a discussion of the cost effectiveness of the technology, in terms of pollutant removal to achieve goals and applicable stormwater management standards. Although not required to evaluate the technology's performance claim, a vendor may consider performing a cost-benefit analysis for comparison to similar technology categories to determine the economic viability of the technology. Such an analysis may include capital costs, operations and maintenance costs, and aggregate costs (cost per gallon treated or BMP efficiency may be represented as a cost per pound of each pollutant removed).

VI. Report Contents for Verification/Certification

The suggested format for a Stormwater BMP Demonstration Report is:

- Title/Purpose,
- Theory/Technology Description,
- Performance Claim,
- Test Methods and Procedures,
- Data Quality Assurance Project Plan (EPA QA-G5),
- Test Equipment and Apparatus,
- Verification/Certification Data and Analysis,
- Data Quality Assessment (EPA QA-G9),
- Conclusions/Recommendations/Limitations, and
- Cost Information.

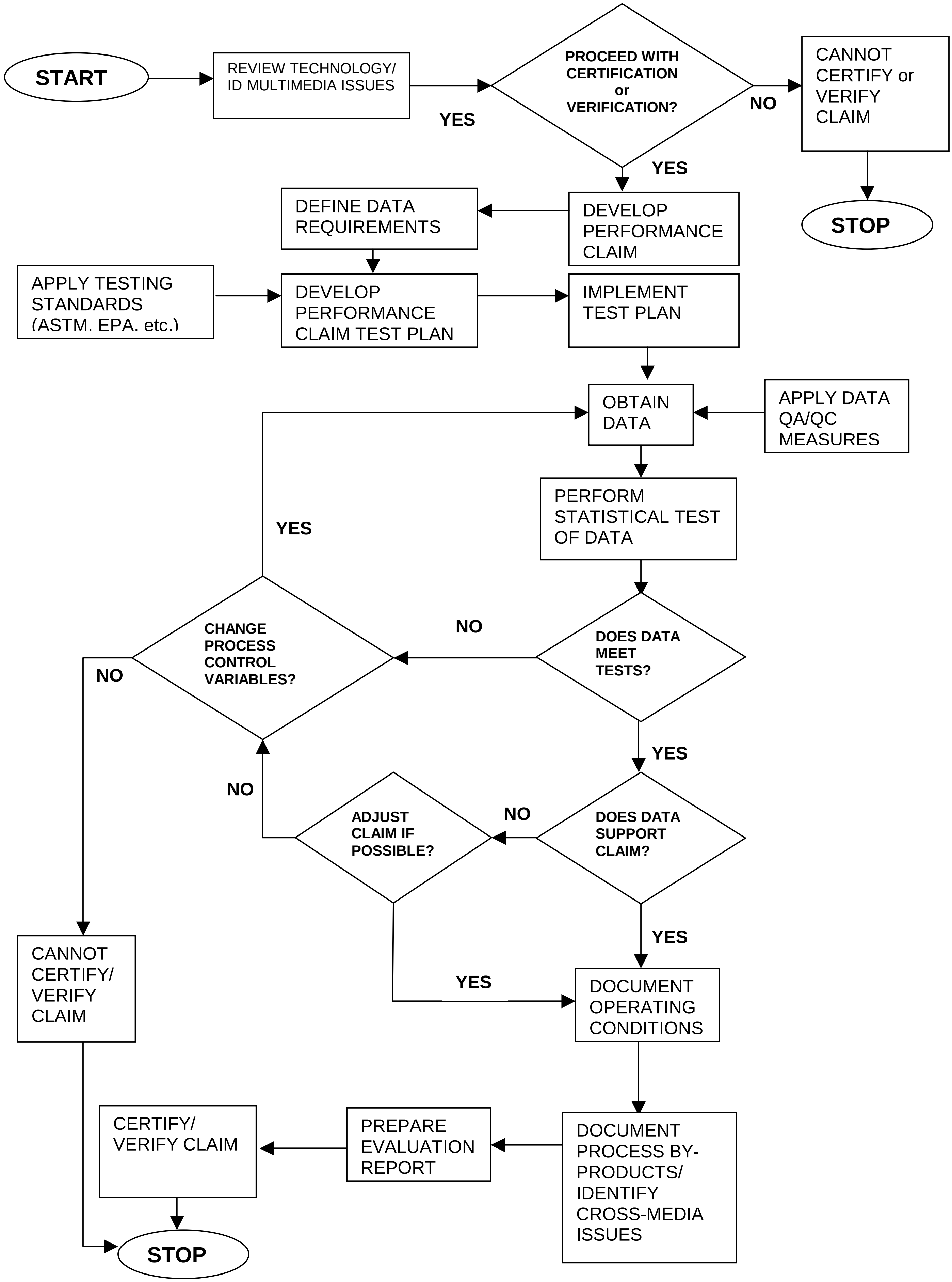
In addition, the report should include a completed Stormwater BMP Demonstration Application Form (Appendix E), an executive summary, and a signed statement on the first page certifying that all information is accurate and true to the best of the proponent's knowledge.

VII. Protocol Limitations, Release of Liability, and Disclosure

This protocol has been published for the purpose of evaluating or generating performance claim data for stormwater BMP technologies for environmental certification and verification programs. The Technology Acceptance and Reciprocity Partnership (TARP) accepts no responsibility or liability for performance of stormwater technologies being evaluated using this protocol.

Appendices

Appendix A: Performance Claim Test Plan Flowchart



Appendix B: List of Applicable Test Methods and Procedures

ASTM Methods

D3370, Practices for Sampling Water.

D4840, Guide for Sampling Chain of Custody Procedures.

D4841, Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents.

D5612-94 (1998), Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program.

D5847-99a , Standard Practice for Writing Quality Control Specifications for Standard Test Methods for Water Analysis.

D5851-95, Standard Guide for Planning and Implementing a Water Monitoring Program.

D6145097, Standard Guide for Monitoring Sediments in Watersheds.

D3977-97, Standard Test Method for Determining Sediment Concentration in Water Samples.

D5907-96a, Standard Test Method for Filterable and Non-filterable Matter in Water.

D4841-88 (1998), Standard Practice for Estimation of Holding Time for Water Samples containing Organic and Inorganic Constituents.

PS74-98, Provisional Standard Test Method for Oil and Grease (Solvent Extractable Substances in Water by Gravimetric Determination.

D5790-95, Standard Test Method for Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectroscopy.

D6362-98, Standard Practice for Certificates of Reference Materials for Water Analysis.

D6104-97, Standard Practice for Determining the Performance of Oil/Water Separators Subjected to Surface Water Run-off.

F625-94, Standard Practice for Classifying Water Bodies for Spill Control Systems.

D5906-96, Standard Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths.

D5073-90 (1996), Standard Practice for Depth Measurement of Surface Water.

D5413-93 (1997), Standard Test Methods for Measurement of Water Levels in Open-Water Bodies.

D5243-92 (1996), Standard Test Method for Open-Channel Flow Measurement of Water Indirectly at Culverts.

D5130-95, Standard Test Method for Open-Channel Flow Measurement of Water Indirectly by Slope-Area Method.

D5129-95, Standard Test Method for Open Channel flow Measurement of Water Indirectly by Using Width Constrictions.

D3858-95, Standard Test Method for Open-Channel flow Measurement of Water by Velocity-Area Method.

D5614-94 (1998), Standard Test Method for Open Channel Flow Measurement of Water with Broad-Crested Weirs.

D5242-92 (1996), Standard Test Method for Open-Channel Flow Measurement of Water with Thin-Plate Weirs.

D5640-955, Standard Guide for Selection of Weirs and Flumes for Open-Channel Flow Measurement of Water.

D5089-95, Standard Test Method for Velocity Measurements of Water in Open Channels with Electromagnetic Current Meters.

D4409-95, Standard Test Method for Velocity Measurements of Water in Open Channels with Rotating Element Current Meters.

D5390-93 (1997), Standard Test Method for Open Channel Flow Measurement of Water with Palmer-Bowlus Flumes.

D1941-91 (1996), Standard Test Method for Open Channel Flow Measurement of Water with the Parshall Flume.

D4375-96, Standard Practice for Basic Statistics in Committee D-19 on Water.

E178, Practice for Dealing with Outlying Observations.

F1779-97, Standard Practice for Reporting Visual Observations of Oil on Water.

F1084-90 (1995), Standard Guide for Sampling Oil/Water Mixtures for Oil Spill Recovery Equipment.

Appendix C: List of Parameters for Sampling

Pollutant	Target Pollutant	Incidental Pollutant	Not Addressed
SOLIDS			
• Floating solids and debris			
• 0.062 mm – 0.0250 mm			
• 0.250 mm –1.0 mm			
• Larger than 1.0 mm			
• Total Suspended Solids[a]			
• BOD, COD, TOC, TDS			
• Hydrocarbons			
• Oil & Grease			
• TPH by IR			
• Total PAH			
• Floating oil			
METALS			
• Copper (total/dissolved)			
• Lead (total/dissolved)			
• Zinc (total/dissolved)			
• Chromium (total/dissolved)			
• Cadmium (total/dissolved)			
• Other (e.g., cyanide, nickel)_____________			
NUTRIENTS			
• Total Phosphorus			
• Total Dissolved Phosphorus			
• Nitrate/nitrite			
• Ammonium			
• Total Kjeldahl nitrogen			
• Total nitrogen			
BACTERIA (*E. coli*, total coliform), Enterocci			
TEMPERATURE EFFECTS			

NOTES

Target Pollutant -- Pollutant directly addressed by the design of the device; Incidental Pollutant – Pollutant incidentally addressed by device; Not Addressed -- Pollutant not addressed by device

All pollutants with performance claims must be tested. If no test result is provided, EVALUATOR will assume the pollutant is not addressed by the device.

a – assumes that sufficient data has been provided to demonstrate that TSS and SSC of untreated/inflow samples is consistent with the total load and particle size distribution of typical urban runoff (i.e., consistent with the NURP study data distribution.)

Instructions

1. Indicate L if demonstrated in laboratory and F if demonstrated in field evaluation.
2. Provide supporting data for all target and incidental pollutants tested in field or laboratory as outlined below.
3. For metals indicate whether total and/or dissolved forms were evaluated.

DOCUMENTATION OF TESTING RESULTS SHOULD, AT A MINIMUM, INCLUDE:

For laboratory testing:

Testing should demonstrate performance under a range of operating conditions, including high stress conditions. Specify hydraulic loading rates and concentrations of pollutants tested. Also, provide documentation of device performance under flows exceeding design capacity (i.e., we are interested in learning whether captured pollutants are flushed out by extreme events).

For field testing:

Description of site use (e.g., commercial parking lot, roadway, construction site, and pertinent characteristics of area being treated (e.g., total area and percent impervious).

List number storms tested peak rates, and total volumes treated by device; for each storm tested provide information on total storm size, duration, intensity, and antecedent dry period.

Results should be presented for each storm individually and summarized statistically for all storms.

Appendix D: States' Standards and Contacts

Pennsylvania

Pennsylvania's erosion and sediment control requirements stipulate that temporary Best Management (BMPs) should be designed to a 2-year frequency storm; 5-year frequency storm for special protection watersheds; and a 10-year frequency storm for permanent BMPs. These criteria relate to the structural integrity of the BMP rather than the pollutant removal requirements. Pollutant (sediment) removal requires design of erosion and sediment control BMPs according to the established standards in the Pennsylvania Erosion and Sediment Control Program Manual or other criteria equal or greater than these standards.

Stormwater Management requirements: The regulation of stormwater runoff from new development activities and associated groundwater recharge/infiltration and water quality are specified in watershed stormwater plans prepared and adopted by counties in accordance with the PA Stormwater Management Act, Act 167 of 1978. In the absence of such a watershed plan, it is encouraged that: infiltration of one (1) inch of runoff from the contributing impervious drainage area, or infiltrate an equal amount of runoff equal to the average annual infiltration rate from the contributing drainage area, and provide water quality treatment for one (1) inch of runoff from the contributing affected drainage area. Ground water recharge volumes may be part of the water quality volume. For more information on ground water recharge and water quality treatment procedures to be used refer to the Pennsylvania Handbook of Best Management Practices for Developing Areas.

For further information, contact: Kenneth Murin, Bureau of Watershed Management, Rachel Carson State Office Building, P.O. Box 8775, Harrisburg, PA 17105-8775, Phone: 717/772-5975, Fax: 717/772-5986, email: **kmurin@state.pa.us.**

Calvin Kirby, PA DEP, Office of Pollution Prevention and Compliance Assistance, 15th Floor-RCSBO, 400 Market Street, Harrisburg, PA 17105-8772, Phone: 717/772-5834, Fax: 717/783-2703, email: ckirby@state.pa.us.

John Mank, Bureau of Watershed Management, Rachel Carson State Office Building, P.O. Box 8775, Harrisburg, PA 17105-8775, email: jmank@state.pa.us.

Massachusetts

Massachusetts seeks stormwater BMP demonstrations that show effectiveness in terms of the Commonwealth's Stormwater Management Standards in the Stormwater Management Policy. The Stormwater Management Policy and supporting handbooks are available on the Massachusetts Department of Environmental Protection Web site: http://www.state.ma.us/dep. The handbooks can be downloaded from the Wetlands and Waterways Program publication list.

For water quality control: The volume of runoff to be treated for discharges to critical areas is calculated as 1.0 inch of runoff times the total impervious area of the post-development project site. For all other discharges, the volume to be treated is calculated as 0.5 inches of runoff times the total impervious area of the post-development project site.

(Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, cold water fisheries, and recharge areas for public water supplies.)

For stormwater management systems, the Massachusetts Stormwater Management Standard No. 4 is 80 percent removal of the annual load of total suspended solids (TSS). This standard applies to new development and is presumed to met when:

a) Suitable nonstructural practices for source control and pollution prevention are implemented;
b) Stormwater management best management practices (BMPs) are sized to capture the previously prescribed runoff volume; and
c) Stormwater management BMPs are maintained as designed.

For further information, contact: Nancy Baker, Massachusetts Department of Environmental Protection, Bureau of Resource Protection, 5th Floor, One Winter Street, Boston, MA 02108, Phone: 617/556-1143, Fax: 617/292-5850, email: **nancy.baker@state.ma.us**.

Paul Hogan, Massachusetts Department of Environmental Protection Central Region, Division of Watershed Management, 627 Main Street, Worcester, MA 01605, Phone: 508/767-2796, Fax: 508/792-7621, email: paul.hogan@state.ma.us.

New Jersey

Regulation of stormwater runoff by the New Jersey Department of Environmental Protection (NJDEP) presently occurs in a number of different programs: Water Quality Management Planning, Stormwater Management, Stormwater Permitting, and Land Use Regulation. The accepted water quality design storm utilized for evaluation is 1.25 inches of rainfall falling uniformly in two hours. This testing criterion is applicable to all post construction residential and commercial BMP applications. In addition, stormwater management systems are expected to reduce total suspended solids (TSS) from stormwater runoff generated from the water quality design storm.

The Division of Watershed Management's (DWM) Nonpoint Source Program is responsible for the New Jesey Stormwater Management Rules that establish minimum requirements for stormwater discharges from all new development and redevelopment. This program is implemented through the development of municipal and county stormwater management plans, and municipal stormwater ordinances and through cross-reference by other stormwater management programs, including the Department of Community Affairs Residential Site Improvement Standards. Information on BMPs acceptable for use in this program are contained in the New Jersey Stormwater Best Management Practices Manual, available on the NJDEP, DWM Web site (Appendix F).

The NJDEP is presently developing amendments to its Stormwater Management Regulations and NJPDES regulations that will establish a consistent basis for applying stormwater BMPs in all of its regulatory programs. The draft changes to the Stormwater

Management Rules are recommending that all sites remove 80% of TSS and nutrients to the maximum extent practicable. Removal rates for BMPs identified in the New Jersey Stormwater Best Management Practices Manual may be used to satisfy the appropriate regulatory requirement. If a BMP claims to remove 80% of TSS, and those claims are verified under this protocol, then the BMP may be used to satisfy the requirement. Similarly, BMPs with less effectiveness may be combined in a "treatment train" to provide for the total removal of 80% of TSS.

The Bureau of Nonpoint Pollution Control issues permits for discharges of stormwater to surface water from industrial and construction activities under the New Jersey Pollutant Discharge Elimination System (NJPDES). Water quality criteria for industrial applications will vary depending on site activity and adopted federal or state effluent limitation guidelines for targeted pollutants. Generally, the testing criteria established for commercial BMP applications will be sufficient. However, this office should be consulted to determine if specific-testing criteria are applicable to evaluate BMP performance intended for industrial applications. NJPDES permits from the NJDEP for construction activities are coordinated with the local Soil Conservation Districts. Proposed measures for erosion and sediment control associated with construction or agricultural activities are referred to the New Jersey State Soil Conservation Committee for inclusion into the Standards for Soil Erosion and Sediment Control in New Jersey.

The Land Use Regulation Program reviews certain stormwater discharges from new development and generally approves manufactured devices on a case by case basis utilizing the following criteria:

a. 80% TSS removal

b. Removal of oil & grease and floatables

c. Removal of heavy metals

d. Device must operate automatically with no need for someone to activate it during a rain event.

e. Device must have relatively low maintenance with agreements/funding sources for maintain it.

For further information, contact: Manny Patel, New Jersey Department of Environmental Protection, Division of Science, Research & Technology, Office of Innovative Technology & Market Development, P.O. Box 409, Trenton, New Jersey 08625, phone: 609/292-0231, Fax: 609/292-7340, email: **mpatel@dep.state.nj.us**

Brian McLendon, New Jersey Department of Environmental Protection, Division of Water Quality, Bureau of Nonpoint Pollution Control, P.O. Box 029, Trenton, New Jersey 08625-0029, phone: 609/633-7021, Fax: 609/984-2147, email: bmclendo@dep.state.nj.us

Sandy Blick, New Jersey Department of Environmental Protection, Division of Watershed Management, NPS Program, P.O. Box 418, Trenton, New Jersey 08625, phone 609/633-1441, email: sblick@dep.state.nj.us

California

California's Office of Environmental Technology (OET) reserves the right to request additional data from a technology applicant in order to satisfy state requirements and environmental conditions, and to refuse a technology for evaluation based on state needs and available resources.

The OET, State Water Resources Control Board (SWRCB), and Regional Water Quality Control Boards (RWQCBs) are seeking technologies for use in California's Storm Water Pollution Prevention Plans (SWPPPs) and Storm Water Management Plans (SWMPs). Stormwater best management practice (BMP) demonstrations conducted using this protocol, as well as California-specific conditions/regulations, are eligible for California certification considerations. California specific conditions/regulations include, but are not limited to, the following:

1) A minimum inter-event period of 72 hours from the previously measurable storm event should be used. Additional testing/data could be required for technologies that are verified using 6 hours as the minimum inter-event period. This inter-event period is required by Federal Regulation, 40 CFR 122.21 (g)(7), for industrial sites.
2) Water quality samples should be collected from a representative number of storm events to ensure that 80 to 90% of the average yearly rainfall amount, up to a maximum of 15 inches, is captured over a period of one calendar year. A one-year demonstration is optimal to observe performance changes as a function of season. This sampling condition is more reflective of wet weather patterns in California than the conditions specified in section C.1 of this protocol.

The SWRCB has been delegated the NPDES permitting authority in California. The NPDES permitting program is administered by the SWRCB through the nine RWQCBs. For industrial facilities and construction activities, the SWRCB has issued statewide general permits that apply to all stormwater discharges requiring a NPDES permit. In addition to the stormwater general permits, the RWQCBs may, at their discretion, issue industry or regional specific permits, as well as individual permits. Municipal stormwater permits are issued by the individual RWQCBs, with the exception of the municipal permit issued to the State of California's Department of Transportation (Caltrans). Caltrans has been issued a statewide municipal permit by the SWRCB.

The types of permits issued to industrial, construction and municipal operators are different, but the requirements of the permit are similar in that they require the permittees to develop and implement plans to reduce pollutants in stormwater runoff and protect water quality. The plans describe the BMPs that will be implemented to comply with the applicable stormwater permit. Like the permit, the type of plan to be developed also varies by the type of operator.

Construction and industrial operators that are required to obtain an NPDES permit need to file a Notice of Intent (NOI) with SWRCB before commencement of construction or industrial activity. The NOI requirements are intended to establish a mechanism that can be used to clearly identify the responsible parties, locations, scope of discharges, and to document the operator's knowledge of the requirements for SWPPP. The construction and industrial operators that are required to obtain an NPDES permit need to develop and implement the SWPPP that describes the BMPs and other measures to be implemented to reduce pollutants in runoff and protect water quality.

Operators of municipal separate storm sewer systems are required to submit comprehensive SWMPs as part of the permit application. SWMPs describe the BMPs to be implemented throughout the permitted area to reduce pollutants and protect water quality. The federal stormwater regulations require SWMPs, in part, to include BMPs to address industrial, commercial and construction activities, new development and major redevelopment and municipal activities.

For further information on stormwater permits and/or application of a permit, contact: Storm Water Section, State Water Resources Control Board, Division of Water Quality, P.O. Box 100, Sacramento, CA 95812, phone: 916/341-5455, email: **stormwater@dwq.swrcb.ca.gov**.

Questions on the California Certification process for stormwater technologies should be addressed to: Mei Yee, California Environmental Protection Agency, Office of Environmental Technology, 1001 I Street, Sacramento, CA 95812; Phone: 916/322-6948, FAX: 916/445-6011, email: myee@calepa.ca.gov.

Virginia

The Virginia Stormwater Management Regulation Water Quality Criteria (4 VAC 3-20-71) requires compliance by applying *Performance-based* criteria or *Technology-based* criteria. Both criteria require the control or management of the water quality volume (or multiple water quality volumes (WQV), depending on the BMP, i.e., 2 x WQV), defined as the first one-half (½) inch of runoff from impervious surfaces.

Specific test performance claims may be insufficient to support the general acceptance of the technology. Rather, an attempt should be made to transfer the specific test results to an average annual removal efficiency (for phosphorus and/or associated NPS pollutants) based on Virginia's annual rainfall characteristics and typical runoff pollutant concentrations associated with conventional land development practices.

To simplify the calculation procedures for water quality compliance, a "keystone pollutant" is selected. In Virginia, phosphorus has been selected as the keystone pollutant because: 1) Phosphorus has a well defined adverse impact on the Chesapeake Bay and its tributaries; 2) Phosphorus exists in a "composite" form, i.e., roughly an equal split between particulate and soluble phases; and 3) Adequate research exists to provide a reasonable basis for estimating how phosphorus loads change in response to development and to current stormwater control practices. Performance claims should be based on test results for phosphorus, as well as the "overall" performance at removing typical urban pollutants such as: sediment, nitrogen, bacteria, BOD/COD, oil/grease, zinc, lead, and toxics.

Additional information on the Virginia Law and Regulations, Handbooks, etc., can be found at the Department of Conservation and Recreation, Division of Soil and Water Conservation Web site: http://www.dcr.state.va.us/sw.

(PLEASE NOTE: WE ANTICIPATE CHANGES TO THE WEB SITE TO ACCOMMODATE DOWNLOADABLE VERSIONS OF THE STORMWATER LAW, REGUILATIONS, HANDBOOKS, AND OTHER POLICY GUIDANCE.)

For further information contact:

Burt Tuxford, Virginia Department of Environmental Quality, P.O. Box 10009 Richmond, VA 23240-0009, Phone: 804/698-4086, Fax: 804/698-4032, email: **brtuxford@deq.state.va.us**.

Joseph G. Battiata, P.E., Stormwater Program Manager, Virginia Department of Conservation and Recreation, 203 Governor Street, Suite 206, Richmond, Virginia 23219, Phone: (804) 371-7492, Fax: (804) 371-2630, E-mail: jbattiata@dcr.state.va.us

W. Douglas Beisch, Jr., P.E., Senior Environmental Engineer, Chesapeake Bay Local Assistance Department, 101 North 14th Street, 17th Floor, Richmond, VA 23219, Phone: (804) 371-7506, Fax: (804) 225-3447, E-mail: wbeisch@cblad.state.va.us

Stormwater BMP Demonstration Summary

Fill out the following form and submit it in print and electronically with the Stormwater BMP Demonstration Report.
The information in this application will be used in the etarp BMP database.

Technology Name ______________________ Technology Category ______________________ Date ____________
(e.g.,structural, non-structural; detention pond, sand filter)

1. Contact Information

Vendor Name ______________________
Contact Name ______________________
Address (street, city, state, zip) ______________________
Address (street, city, state, zip) ______________________
Phone, Fax, e-mail address ______________________

2. Test Site Information

Site Name ______________________
Address (street, city, state, zip) ______________________
Land Use:

☐ Commercial/Office ☐ Residential ☐ Industrial ☐ Open ☐ Other (specify)

Total Contributing Drainage Area ______________________

3. Watershed Information

Watershed Name ______________________
Total Watershed Area ______________________
Percent of Impervious Area in Watershed ______________________

4. Precipitation Information

Regional Climate Station ______________________
Average Number of Storms Year ______________________
Average Annual Rainfall (cm) ______________________
Monthly Average Rainfall at Test Site (cm) (During Testing) ______________________
Storm Events Start and End Times (During Testing) ______________________
Storm Precipitation (For Each Storm Event During Testing) ______________________

Stormwater BMP Demonstration Summary

Technology Name ____________________	Technology Category ____________________ (e.g.,structural, non-structural; detention pond, sand filter)	Date ____________

5. BMP Information

Date System Installed ____________________
Dates Tested/Sampled ____________________
Test Events Start and End Times (For Each Event) ____________________
Total Storm Flow Volume Into BMP (For Each Event) ____________________
Total Storm Flow Volume Bypassed (For Each Event) ____________________
Type of Samples Collected (e.g., flow-weighted, composite) ____________________
Parameters and Units Measured ____________________
Analysis Method ____________________

6. Report Submittal Checklist (*Use the checklist to affirm that the Stormwater BMP Demonstration Report conforms with the protocol.)*

____________ Executive Summary
____________ Title/Purpose
____________ Theory/Technology Description
____________ Performance Claim
____________ Test Methods and Procedures
____________ Data Quality Assurance Project Plan
____________ Test Equipment and Apparatus
____________ Verification/Certification Data and Analysis
____________ Data Quality Assessment
____________ Conclusions/Recommendations/Limitations
____________ Cost Information

7. Certification

I certify that all information submitted is true and correct and was accumulated using approved methods specified in the Stormwater BMP Demonstration Protocol. I understand that any misrepresentation or misuse of information will result in immediate denial of the technology being demonstrated and may prohibit me or, the company I represent from seeking future approvals.

____

Signature / Date

Appendix F: QAPP Groups and Elements

The elements of a QAPP are categorized into "groups" according to their function. Specifications for each element are found in *EPA Guidance forQuality Assurance Project Plans,* EPA QA/G-5 (EPA/600/R-98/018). Details of each requirement of the elements from that document available at http://www.epa.gov/quality1/qs-docs/g5-final.pdf.
The elements of a QAPP are:

Group A: Project Management
This group of QAPP elements covers the general areas of project management, project history and objectives, and roles and responsibilities of the participants. The following 9 elements ensure that the project's goals are clearly stated, that all participants understand the goals and the approach to be used, and that project planning is documented:

A1 Title and Approval Sheet
A2 Table of Contents and Document Control Format
A3 Distribution List
A4 Project/Task Organization and Schedule
A5 Problem Definition/Background
A6 Project/Task Description
A7 Quality Objectives and Criteria for Measurement Data
A8 Special Training Requirements/Certification
A9 Documentation and Records

- date of event,
- time and duration of the storm event,
- size of the storm event,
- inches of rain and intensity,
- number of days since preceding storm event,
- total volume of runoff treated and volume bypassed,
- time into event and conditions when BMP was bypassed,
- condition of the drainage area prior to and during the event,
- activities being conducted,
- chemicals, materials, equipment, or vehicles stored or handled in drainage area,
- good housekeeping measures implemented prior to event,
- upset, spills, or leaks in drainage area, including the material or chemical,
- construction or maintenance activities in the drainage area, and
- any other information needed to adequately characterize the contributing areas to the BMP.)

Group B: Measurement/Data Acquisition
This group of QAPP elements covers all of the aspects of measurement system design and implementation, ensuring that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented:

B1 Sampling Process Design (Experimental Design)
B2 Sampling Methods Requirements

B3 Sample Handling and Custody Requirements
B4 Analytical Methods Requirements
B5 Quality Control Requirements
B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements
B7 Instrument Calibration and Frequency
B8 Inspection/Acceptance Requirements for Supplies and Consumables
B9 Data Acquisition Requirements (Non-Direct Measurements)
B10 Data Management

Group C: Assessment/Oversight

The purpose of assessment is to ensure that the QAPP is implemented as prescribed. This group of QAPP elements addresses the activities for assessing the effectiveness of the implementation of the project and the associated QA/QC activities:

C1 Assessments and Response Actions
C2 Reports to Management

Group D: Data Validation and Usability

Implementation of Group D elements ensures that the individual data elements conform to the specified criteria, thus enabling reconciliation with the project's objectives. This group of elements covers the QA activities that occur after the data collection phase of the project has been completed:

D1 Data Review, Validation, and Verification Requirements
D2 Validation and Verification Methods
D3 Reconciliation with Data Quality Objectives

Appendix G: Web Sites for Developing Stormwater Test QA Plans

40 CFR SUBCHAPTER D (1995--1999) - WATER PROGRAMS
http://www.epa.gov/epacfr40/chapt-I.info/

40 CFR Part 122: National Pollutant Discharge Elimination System
Select Subchapter D, Part 122 at the referenced Web site.

American Society of Civil Engineers (ASCE) Web site, "ASCE/EPA Stormwater Best Management Practices Nationwide Database," http://bmpdatabase.org
ASTM Store, Search for Standards Web site (List, Title & Description for ASTM Methods)
http://www.astm.org/cgi-bin/SoftCart.exe/STORE/standardsearch.htm?L+mystore+jbqb9438+952582347
(see ASTM appendix for specific methods applicable to Stormwater Technologies)

CALTRANS - CSU Sacramento - UC Davis Storm Water Project Web site
http://www.stormwater.water-programs.com/

CALTRANS Stormwater Management Program
http://www.dot.ca.gov/hq/Environmental/stormwater/index.htm

EPA Web site: Water Quality Standards (Total Maximum Daily Limits)
http://www.epa.gov/OWOW/tmdl/index.html

EPA's Stormwater Program Web site
http://www.epa.gov/owm/sw/about/index.htm

EPA Test Method Index (List of EPA Test Methods)
http://www.epa.gov/epahome/index/nameindx.htm

Los Angeles Regional Water Quality Control Staff Report: Standard Urban Stormwater Mitigation Plans and Numerical Design Standards for Best Management Practices
http://www.swrcb.ca.gov/~rwqcb4/docs/SUSMP_final_staff_report.pdf

NJDEP Bureau of Nonpoint Pollution Control – Industrial Stormwater Permitting Program
http://www.state.nj.us/dep/dwq/stormw.htm

NJDEP Nonpoint Source and Stormwater Management Program – Best Management Practices for Control of Nonpoint Source Pollution from Stormwater
http://www.state.nj.us/dep/watershedmgt/nps_manual_draft.htm

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United States Environmental Protection Agency. 1998b. *Guidance for Quality Assurance Project Plans.* (QA/G-5) EPA/600/R-98/018. Washington, D.C.

United States Environmental Protection Agency. 2001. *EPA Requirements for Quality Assurance Project Plans.* (QA/R-5) EPA/240/B-01/003 Washington, D.C.

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URS Greiner Woodward Clyde, Urban Water Resources Research Council of the American Society of Civil Engineer, Environmental Protection Agency. 1999. *Development of Performance Measures, Task 3.1 – Technical Memorandum, Determining Urban Stormwater Best Management (BMP) Removal Efficiencies.*

Wilde et al, 1998. *National Field Manual for Collection of Water Quality Data, Techniques of Water Resources Investigations Book 9,* USGS (ISBN:0-607-90623-5).