Developed for the

California Environmental Technology Certification Program

STORMWATER PROTOCOL

California Environmental Protection Agency

Stormwater Best Management Practice (BMP) Technology Demonstration and Test QA Plan Development Protocol

I. Purpose:

To establish a protocol for demonstrating stormwater BMP technologies and developing test quality assurance (QA) plans for verifying or certifying the performance of stormwater BMP technologies

II. Introduction:

- 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 Pollution Discharge Elimination System (NPDES) Phase II Stormwater Program, which 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 bring 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. In February 2000, the Los Angeles Regional Water Quality Control Board (RWQCB) passed a rule requiring new commercial construction to capture and treat the "first-flush" or first half-inch storm, thus tightening requirements for controlling stormwater discharges. (ref: http://www.swrcb.ca.gov/~rwqcb4/docs/SUSMP_final_staff_report.pdf

- This Protocol primarily deals with the demonstration of Industrial, Municipal and Construction BMPs which are primarily designed to 1) direct and distribute flows, 2) reduce erosive velocities, and 3) remove contaminants such as suspended or dissolved pollutants from collected stormwater through physical and chemical processes such as settling, media-filtering, ion-exchange, precipitation, etc. Current BMPs used in both Industrial, Municipal and Construction stormwater pollution control include vegetated swales, detention basins, infiltration basins, wet ponds, constructed wetlands, oil/water separators, catch basin/inserts, media filtration, bioretention, dry wells, cisterns and foundation planning

- The focus of environmental technology verification/certification programs are primarily the independent validation of data supporting specific performance claims for a technology. Although the emphasis of this protocol is to provide guidance on the requirements for obtaining performance claim data through use of Test QA Plans, proponents with existing data can check their data to determine if it meets the requirements specified in Test QA Plan development.

III. Protocol Contents

1 Stormwater BMP Evaluation Testing:

- Prior to undertaking a Stormwater BMP Technology evaluation, a proponent should research current developments in the Stormwater BMP area, to assess his technology's capabilities with respect to fielded BMPs or current "state of the art" standards. A large cooperative effort has been undertaken by the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (EPA) to develop a Nationwide Stormwater BMP Database to collect information on the performance of structural and non-structural BMPs. The database includes BMP efficiency data for specific contaminants as well as site specific data, area hydrologic data and BMP specifications for locations throughout the U.S. A web based version of this database can be accessed at the following website: http://www.bmpdatabase.org/.

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

- A technology demonstration 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 is desirable for a technology demonstration. Therefore, field testing in accordance with this protocol is required in addition to existing lab and field studies. Either laboratory or field testing should be conducted in accordance with a test QA plan.

2 Preparing a Stormwater Technology Testing & Evaluation Plan

In order to demonstrate a stormwater BMP technology for regulatory acceptance, technology specifications and performance claim data will need to be reviewed and validated by verification/certification organizations. Technology specifications will be reviewed to ensure that the technology meets program criteria. If the technology meets program criteria, the performance claim data will be reviewed and validated based on elements described by a test QA plan, whose elements include: test objectives, use of standardized test methods and procedures, a data quality assurance and control plan and statistical tests of the data.

A Basic Technology Screening Information

In order to evaluate the validity of a Stormwater Technology, prior to validating a performance claim, the following information and data (if available) should be provided to allow evaluators to objectively determine if a technology meets program criteria, e.g. environmentally beneficial, commercially available, field-tested, product quality control, etc.:

- Physical, Chemical and/or Biological Processes
- Process Flow Diagrams and Algorithms
- Equipment Drawings & Specifications
- Operation & Maintenance (O&M) Manuals
- Existing Test Plans, Performance Data, Certifications
- Description of Process Inputs and Outputs

B Test Objectives for Performance Claims

Test objectives for Performance Claims should be clear, concise, quantitative and unambiguous, such that standardized test methods and procedures can be applied. Stormwater BMP technology's are typically evaluated for contaminant removal efficiency, although pollution prevention claims are also possible. An example of a stormwater treatment BMP performance claim could be:

"The StormCaptor 3 system, can capture and treat the first half-inch, 24-hour storm for a 10-acre run-off area (or 100 gallon per minute (gpm) flow without bypass) with a total suspended solid (TSS) removal rate of 85%± 5% with a 95% confidence, with inflow TSS concentrations greater than 100 mg/l"

C Applicable Standardized Test Methods & 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 organizational standards may also be used, such as American Water Works Association (AWWA), National Sanitation Foundation (NSF) or Standard Methods. The standards typically used for the specific field where a technology is applied should be specified, e.g. AWWA for wastewater treatment technologies. Use of standardized test methods and procedures have the following advantages:

- Standards meet organizational protocol
- Standards are prepared by technology specific, expert subcommittees
- Standards typically incorporate peer-reviewed data QA/QC
- Statistical analysis and sample frequency typically specified

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 & C. Some examples are:

- EPA Test Methods (Appendix C) for contaminant analysis http://www.epa.gov/epahome/index/nameindx.htm
- ASME Standards & 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 (package treatment system testing protocols, water treatment sampling and analysis standards)
- Test QA Plans and Protocols for Package Water Treatment Systems are available on EPA's Environmental Technology Verification (ETV) website: http://www.epa.gov/etv/test_plan.htm#11

D Data Quality Assurance/Quality Control

The 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 EPA QA/G5 Guidance for Quality Assurance Project Plans (QAPP) or ASTM D5612-94 Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program . Both EPA QA/G5 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 guide covers development of a sampling and analysis plan, sampling procedures, analytical requirements, data quality assurance/control requirements, and documentation. For a copy of EPA QA/G5 see the following website: http://www.epa.gov/swerust1/cat/epaqag5.pdf

- Use Standardized Test Methods and Procedures were applicable. (Appendix B)

- Use Qualifed Personnel in testing and data acquisition.

- Prepare and coordinate a Stormwater Sampling and Analysis Plan (see Appendix C for example outline). Ensure Sampling and Analysis Plans include:

  - Establishing 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
  - Sample Equipment Decontamination

- Use Certified/Accredited Laboratories for Sample Analysis
  See Environmental Laboratory Accreditation Program website:
  http://www.dhs.ca.gov/ps/ls/elap/html/lablist.htm
- Use Certified/Accredited Laboratories for Testing (ASTM, ASCE). See following ASTM laboratory listing website: http://www.astm.org/labs/STATES/CA.htm
- Test Equipment and Instrument Calibration/Certification

E Data Quality Assessment (Statistical Testing/Data Reduction)

Statistical Testing should be performed on performance claim data to ensure that data is reliable, significant and confident. Normally distributed data sets should have parametric analysis performed, e.g. mean, standard deviation and confidence interval. Standard Deviations should be no greater than $\pm$10% for efficiency data. Data sets that are not normally distributed, may need to be reviewed by a statistician to determine best statistical tests to apply.

EPA QA G-9 Data Quality Assessment Guidance Manual, provides a “toolbox” of statistical methods, e.g. parametric analysis (mean, standard deviation , confidence intervals, Z-statistic, etc), comparision of populations (analysis of variance, box-whisker plots, Tugey-tests, etc.), that can be used to compare and validate data sets. EPA QA-G9 can be downloaded from the following website:
http://www.epa.gov/r10earth/offices/oea/epaqag9.pdf

F EPA’s NPDES Stormwater Sampling & Analysis Guidance

Although more applicable to field demonstrations than laboratory or bench scale testing, the following section covers criteria for sampling and analysis currently used for compliance of NPDES permits. It should be noted that for stormwater removal rate efficiencies, that sampling locations for stormwater BMPs should be taken in as close proximity to the BMP inlet and outlet to avoid potential contamination sources that would alter the efficiency data for the BMP. EPA’s NPDES Stormwater Sampling & Analysis Guidance (EPA 833-B-92-001) provides specific guidance on procedures for sampling and analyzing stormwater for compliance with Industrial, Municipal and Construction NPDES Permits. A copy of the guidance manual can be downloaded from the following website: http://www.epa.gov/owm/enhance/pd/owm0093.pdf

The following elements provide the highlights of the NPDES Sampling and analysis guidance

1) Storm Event Criteria for Sampling

In order to obtain contaminant loading data (flows and contaminant concentrations) for stormwater to be treated, the following criteria will need to be considered in obtaining representative data:

How to Obtain Rainfall Data

- Obtain National Weather Service (NWS) data from nearest NWS weather station (airport)
- Current weather forcast available on: http://weather.noaa.gov/weather/ccus.html
- Use on-site rain guage if feasible

Determining a Representative Storm to Sample

- More than 0.1 inch of total rainfall
- More than 72 hrs since last event .1 in
- Storm volume is 50% above or below average rainfall
- Collect sample for first 30 minutes of discharge
- Obtain flow-weighted composite sample first 3 hrs

Expected Stormwater Flows: Historical Data

Rainfall data for a site may be obtain from local weather station records and almanacs. The following website can be accessed for rainfall data for any location in the U.S. (U.S. Meterological Service).

2) Stormwater Sampling Locations

Sampling locations for Municipal, Industrial and Construction can be at outfalls, closed culverts, storm drain manholes, drainage outlet channels and conveyances, detention basins, etc. Typically the inlet and outlet for a BMP should be sampled to obtain performance claim data. 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

Where feasible programmable automatic flow samplers should be placed at the inlet and outlet for a stormwater BMP technology. If automatic samplers are not feasible Grab Samples should be collected in accordance with guidance provided in the NPDES sampling and analysis guide. Collection and Flow-Weighted Composite Sampling should also follow the NPDES guidance. The NPDES guidance specifies pros and cons of automatic versus manual sampling, but recommends automatic sampling due to procedures for obtaining flow-weighted composite samples which requires sampling at specified time intervals.

4) Stormwater Flow Measurement Methods

There are several ASTM methods for measuring open channel and pressurized flow (See Appendix E), however precision flow measurements using wiers and flumes are not necessarily required, although acceptable. Typical methods for stormwater flow measurement in drainage channels, sedimentation basin overflow, storm sewer manholes, include use of the Rational Method ($Q = CIA$), Manning's Q or bucket and stopwatch. Automatic sampling devices can provide flow measurement.

5) Sample Data Quality Assurance & Control

The following elements should be described in the Test QA Plans Sampling and Analysis Plan (see previous Data QA/QC Section)

- Equipment Decontamination
- Preservation (see Appendix C)
- Holding Time (see Appendix C)
- Volume (sample aliquot > 1000 ml)
- QC Samples (Spikes, Blanks, Splits)
- Packaging & Shipping
- ID & Labeling
- Chain of Custody

6) Analyte Selection (NPDES Ph I & II)

Industrial Analytes have specific contaminants of concern (COCs) based on the industrial application involved (NPDES guidelines specify these COCs based on Standard Industrial Classification (SIC) codes). Municipal and Construction analytes are typically general contaminants found in run-off studies such as Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Petroleum Hydrocarbons (TPH), Total Keldjahl Nitrogen (TKN), Total Nitrogen, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Fecal Coliform, pH, conductivity, and the following metals: lead, copper, zinc and nickel. Run-off contaminant data from existing BMP evaluation studies can be found in the ASCE-EPA Nationwide Database (website provided section I). Also, data from parking lots, highways, etc. can be found on the following website: http://stormwater.water-programs.com/lassessment.htm

7) Analytical Laboratory Requirements

Laboratories used to perform stormwater sample contaminant 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 in California, the Environmental Laboratory Accreditation Program (ELAP) should be used to perform standardized test methods and procedures, e.g. EPA 8240 or 8260.

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

Process efficiencies or removal rates should be determined from influent and effluent contaminant concentration 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 website: http://www.asce.org/peta/tech/pdf/task3_1.pdf

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
- Data used to calculate efficiencies from the ASCE-EPA database are influent/effluent data that are from two principle types: 1) Event Mean Concentration Data (flow weighted composite, weighted composite and no flow or time weighting) and 2) Discrete Water Samples (grab samples).

3 Health & Safety Plan

A health and safety plan should be developed and included with the Test Plan for a Stormwater BMP technology. The technology should also include a health and safety plan for installation, operation and maintenance of the technology. Specifically, the health and safety plan should address the following areas:

- Hazard Identification
- Hazard Mitigation
- Engineered Controls & Procedures
- Personal Protective Equipment
- Training

As they relate to the following Stormwater BMP Technology issues:

- Collecting stormwater samples in confined spaces (manholes, storm sewer lines, utility vaults, etc.)
- Collecting high flow stormwater samples from culverts, drainage channels, sedimentation basins etc. during storms
- Chemical, biological or physical hazards associated with the BMP

4 Verification/Certification Evaluation Report Contents

The following elements are suggested for the format of a Stormwater BMP technology performance claim certification or verification report:

- Title/Purpose
- Theory
- Performance Claim
- Test Methods & Procedures
- Data Quality Assurance Project Plan (EPA QA-G5)
- Test Equipment & Apparatus
- Verification/Certification Data
- Data Quality Assessment (EPA QA-G9)
- Conclusions/Recommendations/Limitations

5 Cost-Benefit Analysis

Although not required to evaluate the technology's performance claim, a vendor may consider performing a cost-benefit analysis for comparison to similar technology category's to determine the economic viability of the technology. Such an analysis may include

- Capital Costs
- Operations and Maintenance Costs
- Aggregate Costs (Cost per gallon treated)

6 Permit/Verification/Certification Reciprocity Applicability

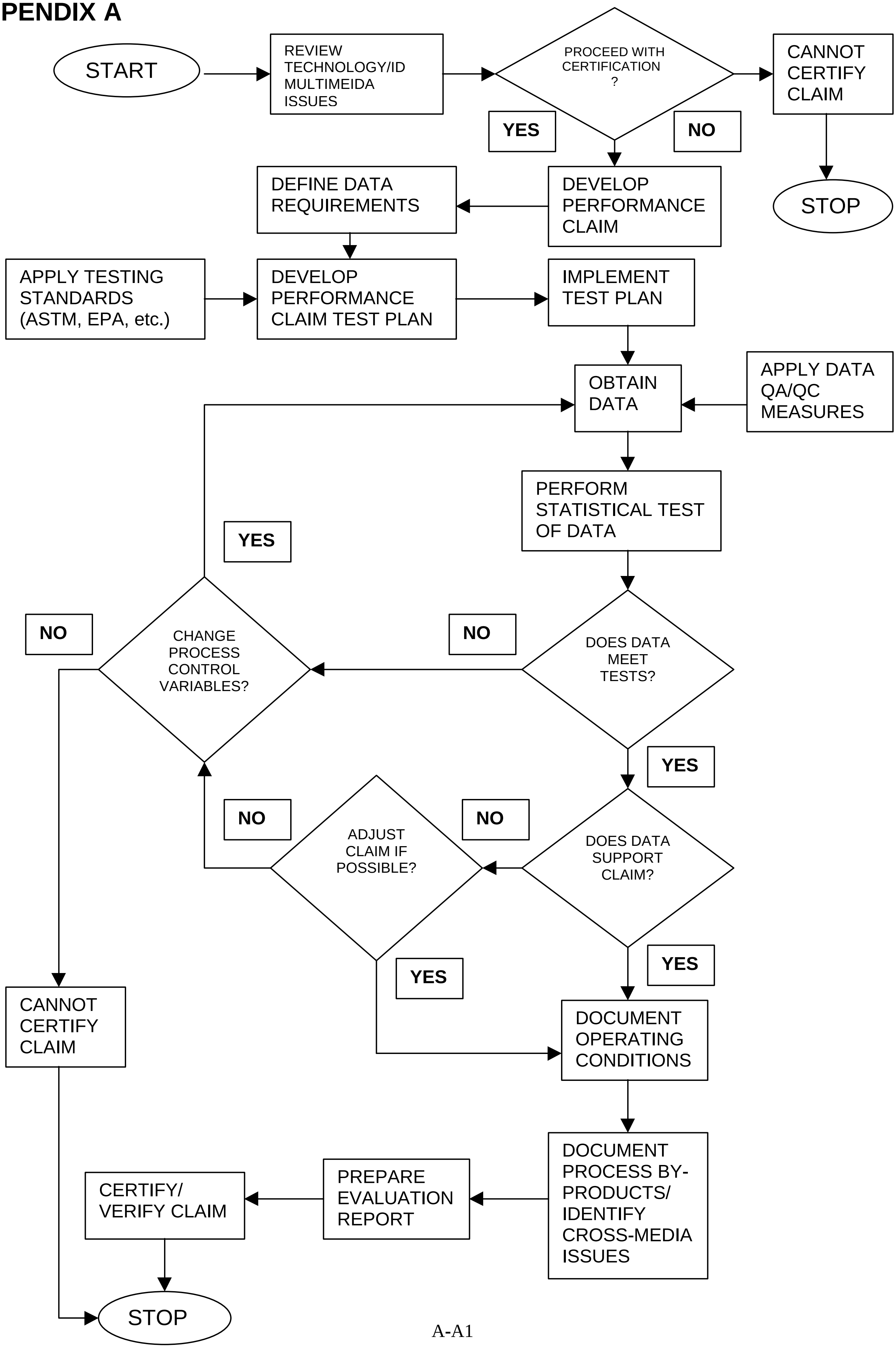
Since current NPDES Phase I and II regulations require industrial, commercial and municipal NPDES permittees to provide stormwater discharge control through use of BMPs, actual use of specific BMPs is not subject to regulation. BMPs with demonstrated capability, e.g. reliable removal rates based on field testing, are more likely to be accepted for use in Stormwater Pollution Prevention Plans (SWPPP) to control stormwater discharge. Obtaining a state's Environmental Certification or Verification of a Stormwater BMP technology can assist the technology in gaining acceptance by regulatory agencies by allowing regulators to observe the performance of fielded BMP units.

7 Protocol Limitations, Release of Liability and Disclosure

This protocol has been published for the sole use of evaluating or generating performance claim data for stormwater BMP technologies for environmental certification and verification programs. ITRC accepts no responsibility or liability for performance of stormwater technologies being evaluated using this protocol.

APPENDICES

APPENDIX A



START
REVIEW TECHNOLOGY/ID MULTIMEIDA ISSUES
PROCEED WITH CERTIFICATION ?
YES
NO
CANNOT CERTIFY CLAIM
STOP
DEVELOP PERFORMANCE CLAIM
DEFINE DATA REQUIREMENTS
APPLY TESTING STANDARDS (ASTM, EPA, etc.)
DEVELOP PERFORMANCE CLAIM TEST PLAN
IMPLEMENT TEST PLAN
OBTAIN DATA
APPLY DATA QA/QC MEASURES
PERFORM STATISTICAL TEST OF DATA
YES
NO
CHANGE PROCESS CONTROL VARIABLES?
NO
DOES DATA MEET TESTS?
YES
NO
ADJUST CLAIM IF POSSIBLE?
NO
DOES DATA SUPPORT CLAIM?
YES
YES
CANNOT CERTIFY CLAIM
DOCUMENT OPERATING CONDITIONS
DOCUMENT PROCESS BY-PRODUCTS/ IDENTIFY CROSS-MEDIA ISSUES
PREPARE EVALUATION REPORT
CERTIFY/ VERIFY CLAIM
STOP

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Appendix B: LIST OF ASTM METHODS RELATED TO TESTING STORMWATER TECHNOLOGIES

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
D6145-97	Standard Guide for Monitoring Sediments in Watersheds
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 WaterIndirectly 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 Wiers
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: BMP TECHNOLOGY EVALUATION

POLLUTANTS TREATED BY DEVICE BASED ON LABORATORY (L) OR FIELD (F) EVALUATION

Test Parameter/Pollutant	EPA Test Method	Standard Method	ASCE Run-off Values (mg/l)
FLOW MEASUREMENT			
• Closed Conduit Flow Measurement	0003.1		
• Flow from Pipe Discharging to Atmospheric	0003.2		
• Open Channel Flow Measurement	0003.3	Appendix E	
GENERAL PARAMETERS			
• pH	150.1/150.2	4500H+	10.3
• Conductivity	120.1	2510B	600
• Biological Oxygen Demand (BOD)	405.1		230
• Chemical Oxygen Demand (COD)	410.4		2030
• Total Dissolved Solids (TDS)		2540C	128.4
• Total Suspended Solids (TSS)		4500-NH3G	84.0
• Total Organic Carbon (TOC)	415.1	5310C	344.71
• Cyanide	335.2/350.1		.014
SOLIDS			
• Floating solids and debris			
• Particles larger than NURP size fractions[a]			
• NURP 10^{th} percentile (20% of TSS)[b]			
• NURP 30^{th} percentile (20% of TSS) [b]			
• NURP 50^{th} percentile (20% of TSS) [b]			
• NURP 80^{th} percentile (40% of TSS) [b]			
• Total Suspended Solids[c]			
HYDROCARBONS			
• Oil & Grease	413.1		66.7
• Total Petroleum Hydrocarbons by IR	418.1		
• Total Polycyclic Aromatic Hydrocarbon	550.1		
• Floating oil			
METALS			
• Aluminum (total/dissolved)	202.2	3500 Al	4918.5
• Arsenic (total/dissolved)	206.2		1.63
• Cadmium (total/dissolved)	213.2	3500 Cd	.008
• Copper (total/dissolved)	220.2		.05
• Chromium (total/dissolved)	218.2	3500 Cr	.012
• Iron (total/dissolved)	236.1	3500 Fe	.518
• Lead (total/dissolved)	239.2		.2905
• Mercury (total/dissolved)	245.1		
• Nickel (total/dissolved)	249.2		3.29
• Selenium (total/dissolved)	270.2		
• Silver (total/dissolved)	272.2		
• Zinc (total/dissolved)	289.2		2.618
NUTRIENTS			
• Total Phosphorus	365.4		80.2
• Total Dissolved Phosphorus	365.4		8.42
• Nitrate	300/353.2	4500 NO3	1.45
• Ammonia	350.1		9
• Total Kjeldahl nitrogen (TKN)	351.3		28
• Total nitrogen	353.1		51.43
BACTERIA (FECAL COLIFORM)		9221/9222/9223	1827000000
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 (if no test result is provided, EVALUATOR will assume the pollutant is not addressed by the device).

a – particles with settling velocities greater than 15 feet per hour

b – refers to particle size fractions measured under the Nationwide Urban Runoff Program (NURP as cited in Driscoll, 1983; USEPA, 1986); particle fractions comprising TSS generally were found to have settling velocities ranging from 0 – 15 feet per hour. Table above expresses the relative percentage of total suspended solids associated with each particle size fraction

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

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:

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 (total area, percent impervious, etc.).

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

Results should be presented for each storm individually, but may be summarized statistically for all storms.

Appendix D: Statistical Analysis (Parametric Analysis for Normally-Distributed Data)

The following equations can be used to calculate the mean, standard deviation and confidence interval for data:

From *Probability and Statistics, Lindgren, McElrath and Berry, 1978*:

a. **Mean:** $\mathbf{X = (\sum X_i) / n}$

where X is mean value,
X_I is value for test data
n is number of test data

b. **Standard Deviation**: $\mathbf{S = \sqrt{(1 / n) * \sum (X_i - X)^2}}$

where S is standard deviation value
n is number of test data
X is mean value,
X_I is value for test data

c. **Confidence Interval:** $\mathbf{C.I. = X \pm t_{.95} * S/ \sqrt{(n -1)}}$

where C.I. is lower & upper value for which there is a 95% probability that data in a specified set (specified by X, S and n) will fall between the upper and lower value.
S is standard deviation value
n is number of test data
X is mean value,
$t_{.95}$ is the t-tail value for a 2-tailed normal distribution (in this case $t_{.95} = 1.96$)

Notes: Depending on the variability and characteristics of the data set, it may be prudent to consult with a statistician to determine the most appropriate statistical test to apply. For most data sets, a normal distribution of the data is assumed. However, in some cases this may be a weak assumption and other methods may be more appropriate (Chi-square distribution, data transformation, etc.)

For guidance on statistical testing of data sets the following EPA publication can be consulted: Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA96 Version, Office of Research and Development, Washington D.C., July 1996. The following is a hyperlink to the publication: http://www.epa.gov/r10earth/offices/oea/epaqag9.pdf

Appendix E: Industrial & Municipal Constituents

For more information about this appendix, please contact the Office of Environmental Technology at (916) 327-5789 or via e-mail at oet@arb.ca.gov.

Appendix F: Example Stormwater Sampling & Analysis Plan

For more information about this appendix, please contact the Office of Environmental Technology at (916) 327-5789 or via e-mail at oet@arb.ca.gov.

Appendix G: Useful Websites for Stormwater BMP Technology Evaluation

1. 40 CFR Part 122: National Pollutant Discharge Elimination System
   http://www.epa.gov/epacfr40/chapt-I.info/subch-D/40P0122.pdf

2. 40 CFR SUBCHAPTER D (1995--1999) - WATER PROGRAMS
   http://www.epa.gov/epacfr40/chapt-I.info/subch-D/

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

4. EPA's Stormwater Program Website (Stormwater Regulations)
   http://www.epa.gov/owm/sw/about/index.htm

5. Caltrans - CSU Sacramento - UC Davis Storm Water Project Website
   http://www.stormwater.water-programs.com/

6. CALTRANS Stormwater Load Assessment for Freeways, Maintenance Yards and Park & Rides http://stormwater.water-programs.com/lassessment.htm

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

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

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

10. ASTM Store, Search for Standards Website (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)

11. American Society of Civil Engineers (ASCE) Website, "ASCE/EPA Stormwater Best Management Practices Nationwide Database", http://www.asce.org/peta/tech/nsbd01.html

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